Review of particle properties

Particle Data Group

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This review of the properties of leptons, mesons, and baryons is an updating of Review of Particle Properties, Particle Data Group [Phys. Letters **50B**, No.1 (1974), and Supplement, Rev. Mod. Phys. 47 (1975) 535]. Data are evaluated, listed, averaged, and summarized in tables. Numerous tables, figures, and formulae of interest to particle physicists are also included. A data booklet is available.

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I. INTRODUCTION, CREDITS, CONSULTANTS

This review is an updating through December 1975 of our previous review (Particle Data Group, 1974, and Supplement, 1975). In this version, we have attempted to make the text as complete and self-contained as possible.

As usual, the results of our compilation are presented in two sections. The Tables of Particle Properties, usually referred to as simply the Tables, contain a summary of the properties of only those peaks or resonances which in our judgment have a large probability of standing the test of time. This is a conservative judgment, and surely means that some genuine resonances are (temporarily) omitted. See Sec. V below.

The Data Card Listings, on the other hand, are an attempt to give up-to-date information, along with references, on all the reported particles whose existence is either considered confirmed (in which case they are also included in the Tables) or not yet confirmed. The Listings also contain mini-reviews pertaining to questions of interest.

A short survey of the history of some of the constants we compile, as well as some of those compiled by others, has been added to the text as a new feature (Sec. VIII). In general, the reliability of the data has been pretty good; that is, the percentage of the time that our best estimates of various constants have changed by more than one standard deviation over the years is roughly what would be expected from statistical considerations. A history of the Particle Data Group, with a discussion of procedures and problems, has been given by Rosenfeld (1975).

This year we are experimenting with a new statistical procedure in our data averaging. Given in the Tables are our best estimates (and their errors), calculated in the old way. In the Listings, we give simultaneously the old (labeled "AVG") and new (labeled "STUDENT") values. In most cases there is little difference. Details may be found in Sec. VII. User comments are solicited.

A pocket-sized data booklet, containing the Tables and a reprint of the figures and formulae from the first part of the book, is available on request.

For North and South America, Australia, and the Far East, write to Technical Information Division, Lawrence Berkeley Laboratory, Berkeley, California 94720, USA.

For all other areas, write to CERN Scientific Information Service, CH-1211 *Genève 23*, Switzerland.

As usual, we wish to emphasize that we compile the experimental results of others. It is inappropriate to give us the credit for their countless hours of effort. We urge that references be given directly to the original data, and we provide complete references in the Data Card Listings for that purpose.

The responsibilities for the various sections can be broken down as follows:

(1) *Stable particles*: A. Barbaro-Galtieri, N. Barash-Schmidt, and T. G. Trippe.

(2) *Meson resonances*: V. Chaloupka, R. J. Hemingway, M. J. Losty, and M. Roos.

(3) *Baryon resonances*: A. Barbaro-Galtieri, C. Bricman, and R. L. Kelly.

(4) *General, including text*: All authors.

Consultants: To overcome unavoidable gaps in our coverage, both intellectual and geographical, we have solicited the help of consultants:

- Ugo Amaldi (CERN)
- Stanley J. Brodsky (Standford Linear Accelerator Center)
- Denyse M. Chew (Lawrence Berkeley Laboratory)
- Ronald Crawford (University of Glasgow)
- J. Engler (CERN)
- Anatoli Kuznetsov (JINR, Dubna)
- Gerald R. Lynch (Lawrence Berkeley Laboratory)
- F. Mönnig (CERN)
- R. Gordon Moorhouse (University of Glasgow)
- David R. Nygren (Lawrence Berkeley Laboratory)
- Oliver E. Overseth (University of Michigan)
- Sherwood I. Parker (Lawrence Berkeley Laboratory)
- Bernard Sadoulet (Lawrence Berkeley Laboratory)
- Paul Söding (DESY)
- Fumiyo Uchiyama (Lawrence Berkeley Laboratory)

The usefulness of this compilation depends in large part on the interaction between the users and the authors and consultants. We appreciate comments, criticisms, and suggestions for improvements of all stages of data retrieval, processing, and presentation.

II. SELECTION OF DATA

All particles are considered to fall into one of the three groups:

(1) Stable particles, immune to decay via the strong interaction, including the η.

(2) Meson resonances (including all the new high mass particles, whether "stable" or not).

(3) Baryon resonances.

These groups are maintained within the two main parts of the compilation:

(1) Tables of Particle Properties.

(2) Data Card Listings.

The Data Card Listings contain the original information (data, references etc.), weighted averages, comments, and "mini-reviews". Immediately preceding the Data Card Listings is an Illustrative Key thereto. We attempt to give complete Data Card Listings up to our closing date (January 1, 1976) for all journals listed in the Illustrative Key. We also include preprints and unpublished conference reports which have come to our attention, but make no attempt at completeness.

Roughly 40% of our encoded results are not used for averaging. They are set off in parentheses: our reasoning is then often given in a footnote below the data. If the reason is not given, it is one of the following:

- The quantity was presented with no error stated.
- The result comes from a preprint or conference report. It is our experience that such results (and particularly the errors) often change before final publication. Accordingly we keep these new results in parentheses until they are published (or explicitly verified to us by the authors).
- It involves some assumptions that we do not wish to incorporate.

• It is of poor quality, e.g., bad signal-to-noise-ratio.
• The result is inconsistent with others, e.g., because of different methods employed, rendering averaging meaningless.
• It is not independent of other results, e.g., a result from one of several partial-wave analyses all using the same data, again rendering averaging meaningless.

When the data for a particle have received special treatment or when they present special problems, this is noted in a mini-review in the Data Card Listings.

The Tables of Particle Properties represent the output of weighted averages and some critical judgment. The extent to which "blind" averaging has been tempered with judgment is explained in footnotes to the Tables. In general, however, the footnotes are less complete than is the collection of notes and mini-reviews in the Data Card Listings. The reader is therefore encouraged to familiarize himself with the Data Card Listings and, ultimately, with the original experiments.

III. NOMENCLATURE

A. Quantum numbers

The symbols $I^G(J^P)C$ represent:

I = isospin

G = G-parity

J = spin

P = space parity

C = charge conjugation parity .

1. Mesons

The charge conjugation operator C turns particle into antiparticle and has eigenvalues ± 1 only for neutral states; so it is useful to define an extension G which has eigenvalues for charged states too. It is usually[1] defined by

$$G = C \exp(i\pi I_y) \ . \tag{1}$$

A neutral nonstrange state is an eigenstate of $\exp(i\pi I_y)$ with eigenvalue $(-1)^I$. Then we can write the eigenvalue equation for the whole multiplet as

$$G = C_n(-1)^I \ , \tag{2}$$

where C_n (n for neutral) is the eigenvalue C would have if applied to the neutral member of the multiplet. Thus, for a π^0, C has the eigenvalue $+1$, and since $I = 1$, $G = -1$. For the charged pion there are no eigenvalues corresponding to C and to the isospin rotation, but Eqs. (1) and (2) still give $G = -1$.

Consider a meson as a bound state of fermion-antifermion, e.g., $\bar{q}q$, with orbital angular momentum l, and with the two fermion spins coupling to give a spin S. Then one can show that the charge-conjugation eigenvalue [defined in Eq. (2)] is

$$C_n = (-1)^{l+S} \ . \tag{3}$$

Equations (2) and (3) combine to give

$$G = (-1)^{l+S+I} \ . \tag{4}$$

The parity is

$$P = -(-1)^l \ . \tag{5}$$

Equations (3) and (5) combine to give

$$C_n P = -(-1)^S \tag{6}$$

so all singlet ($^1S_0$, $^1P_1$, ...) have $C_nP = -1$, and all triplet ($^3S_1$, ...) have $C_nP = +1$. For proofs of the above, see our 1969 text (Particle Data Group, 1969) and Appendix by C. Zemach.

If, instead of $\bar{q}q$, we consider the meson as a state of *boson-antiboson* (e.g., $A2 \to \bar{K}K$), it turns out that some signs cancel, and Eqs. (3) and (4) [not (5)!] apply *unchanged*. Of course the mesons are often spinless so S is zero, but the equations are more general. Eqs. (3) and (4) can be considered as selection rules forbidding many decays.

We now use Eqs. (3) and (4) to introduce the concept of "Abnormal-C" mesons, i.e., mesons that cannot be composed of $\bar{q}q$.

The unitary triplet of quarks is of course defined to have isospin and hypercharge properties such that $\bar{q}q$ can combine (according to the SU(3) relations $\{3\}\otimes\{3\} = \{8\}\oplus\{1\}$) so as to form only unitary octets and singlets. The non-observation of "exotic" mesons (i.e., mesons in more complicated supermultiplets) is of course one of the bases of the naive quark model. But it is slightly less obvious that even some *octets* are forbidden by the model, namely those with $(J^P)C_n = (0^\pm)-$, $(1^-)+$, $(2^+)-$, ... Such states are also not observed, and this is an additional success of the naive quark model classification scheme.

In what follows, do not confuse "Abnormal-C" with "Normal" or "Abnormal" J^P, both of which are allowed by the quark model. The series $J^P = 0^+, 1^-, 2^+, \ldots$ is called Normal because $P = (-1)^J$ as for normal spherical harmonics, and $J^P = 0^-, 1^+, \ldots$ is called Abnormal.

The top part of Table I shows all the low angular momentum states that can be formed from $\bar{q}q$. Note that half of the J^P states can be formed by both a triplet and a singlet $\bar{q}q$ state, e.g., $^3P_1$, $^1P_1$ or $^3D_2$, $^1D_2$. Eq. (3) shows that $^3P_1$ and $^1P_1$ have opposite C_n, so the $\bar{q}q$ model allows both. But the states $^3P_0$ and $^3P_2$ have no ^1P counterparts. According to Eq. (6) they have $C_nP = +1$, and with the $\bar{q}q$ model there is no way to form a state with a J^P of $^3P_{0,2}$ (i.e., J^P = Normal) and with $C_nP = -1$. As mentioned, such octets have not shown up. With the help of Table I one can also see that the special state $^1S_0$, $C_nP = +1$, cannot be formed, so has Abnormal C.

2. General remarks

Well-established quantum numbers are underlined in the Tables of Particle Properties (except for stable particles, where most of the quantum numbers are established). We have used flimsy evidence to guess many of the remaining ones, and we have indicated with "?" ones (in the baryon table) for which there is almost no evi-

[1] Most texts define it as in Eq. (1); see, e.g., Gasiorowicz (1966); however, sometimes the rotation is taken about I_x. The difference between the two conventions is mentioned in a footnote in Källen (1964).

TABLE I. $I^G(J^P)$ of non-strange mesons from $\bar{q}q$ model. For the distinction between abnormal J^P and abnormal C, see text following Eq. (6). K mesons share the same values of J^P as the $I=0$ and 1 states shown, but are not eigenstates of G. The middle column, which gathers together $(J^P)_{\text{N or A}}\,CP$, is a redundant intermediate step intended to make the table easier to read.

Parity	$\bar{q}q$ State CP −	$\bar{q}q$ State CP +	(J^P) CP, Normal or abnormal	$I^G(J^P)C_n$	Examples and comments
Parity −	$^1S_0$		$(0^-)_A-$	$0^+(0^-)+$ $1^-(0^-)+$	η, η', E ? π
		$^3S_1$	$(1^-)_N+$	$0^-(1^-)-$ $1^+(1^-)-$	ω, ϕ ρ
Parity +	$^1P_1$		$(1^+)_A-$	$0^-(1^+)-$ $1^+(1^+)-$	 B
		$^3P_0$	$(0^+)_N+$	$0^+(0^+)+$ $1^-(0^+)+$	ϵ, S* δ ?
		$^3P_1$	$(1^+)_A+$	$0^+(1^+)+$ $1^-(1^+)+$	D ? A1
		$^3P_2$	$(2^+)_N+$	$0^+(2^+)+$ $1^-(2^+)+$	f, f' A2
Parity −	$^1D_2$		$(2^-)_A-$	$0^+(2^-)+$ $1^-(2^-)+$	 A3
		$^3D_1$	$(1^-)_N+$	same as $^3S_1$	ρ'
		$^3D_2$	$(2^-)_A+$	$0^-(2^-)-$ $1^+(2^-)-$	Regge recurrence of the abnormal-C state $(J^P)C_n = (0^-)-$
		$^3D_3$	$(3^-)_N+$	$0^-(3^-)-$ $1^+(3^-)-$	 g
Parity +	$^1F_3$		$(3^+)_A-$	$J > 2$	
		$^3F_2$	$(2^+)_N+$	same as $^3P_2$	
		$^3F_3$	$(3^+)_A+$	$J > 2$	
		$^3F_4$	$(4^+)_N+$	etc.	

ABNORMAL C STATES THAT CANNOT COME FROM $\bar{q}q$ MODEL

Abnormal C states Have no $\bar{q}q$ model	$(0^-)_A+$	$0^-(0^-)-$ $1^+(0^-)-$	All except $J^P = 0^-$ are J^P = normal, CP = −1
	$(1^-)_N-$	$0^+(1^-)+$ $1^-(1^-)+$	
	$(0^+)_N-$	$0^-(0^+)-$ $1^+(0^+)-$	
	$(2^+)_N-$	$0^-(2^+)-$ $1^+(2^+)-$	
	$(3^-)_N-$	$0^+(3^-)+$ $1^-(3^-)+$	

dence.

As is customary, we define antiparticles as the result of operating with CPT on particles, so both share the same spins, masses, and mean lives. Whenever there is a particularly interesting test of CPT invariance we include it in the Stable Particles Table.

B. Particle names

If a *meson* has a well-accepted colloquial name, we use it. If not, we name it by a single symbol which specifies its baryon number B (=0 for mesons), its isospin I, its hypercharge Y, and, for a nonstrange meson its G parity. For convenience, we also list the strangeness S, which is related to Y and B by

$$S = Y - B \ .$$

The name conventions for mesons are given in the first part of Table II.

To crowd even more information onto the symbol, we sometimes add a subscript giving J^P. If J^P is not known, but must be "Normal" ($0^+, 1^-, 2^+, \ldots$), e.g., because $K\pi$ decays are seen, we use the subscript N. If such modes are *not* seen (and are not otherwise forbidden), we *guess* that it is because J is "Abnormal", and we use the subscript A.

For *some* pairs of *mesons* with supposedly identical quantum numbers, we also use primes; e.g., η, η'; f, f'.

For *baryons* no attempt has been made to attach a subscript about J and P. The name conventions are given in the second part of Table II. For stable baryons of each I and Y we use the symbol standing alone; for resonances, the mass is in parentheses [i.e., $N(1688)$, $\Lambda(1405)$, $\Sigma(1765)$, etc.]. The J^P assignments are reported in the Baryon Table as $\frac{1}{2}^+, \frac{3}{2}^-, \frac{5}{2}^+$, etc., and also by the symbols P_{11}, D_{13}, F_{15}, which refer to the πp or Kp partial-wave amplitude in which the resonant state occurs (the first subscript refers to the isospin state: $2 \times I$ for N and Δ and just I for Z, Λ, and Σ). When two or more baryons have identical quantum numbers we warn the reader by adding primes to the spectroscopic symbol as explained in footnote (a) of the Baryon Table.

TABLE II. Particle name conventions.

Name	I	Y	S	G
		Mesons		
η	0	0	0	+
ω or ϕ [a]	0	0	0	−
ρ	1	0	0	+
π	1	0	0	−
K^+, K^0	$\frac{1}{2}$	+1	+1	
$K^-, \bar{K}^0$	$\frac{1}{2}$	−1	−1	
		Baryons		
N	$\frac{1}{2}$	+1	0	
Δ	$\frac{3}{2}$	+1	0	
Z_0, Z_1	0, 1	+2	+1	
Λ	0	0	−1	
Σ	1	0	−1	
Ξ	$\frac{1}{2}$	−1	−2	
Ω	0	−2	−3	

[a] Since 1973, we have used the symbol ω for those $I^G = 0^-$ mesons that decay mainly into 3π [$\omega(783)$, $\omega(1670)$]; we reserve the symbol ϕ for $\phi(1020)$ and possible future higher-mass $I^G = 0^-$ mesons that decay mainly into $K\bar{K}$.

IV. CONVENTIONS AND PARAMETERS FOR STRONG INTERACTIONS

A. Partial-wave amplitudes and resonance parameters

The vast majority of information concerning baryon resonances comes in the form of partial-wave analyses. In addition data concerning meson resonances ($\pi\pi, K\pi, \pi\pi\pi$) are, with increasing frequency, being subjected to partial-wave analyses. We thus find it natural to introduce the resonance parameters which we compile in terms of a Breit–Wigner approximation for the partial-wave amplitude.

In general the elastic amplitude for a given angular momentum l may be written as

$$T_{11} = \frac{\eta \exp(2i\delta) - 1}{2i} \ , \tag{1}$$

where η is referred to as the absorption parameter ($0 \le \eta \le 1$) and δ, as the phase shift. The subscripts 11 on T denote scattering from channel 1 to channel 1 (i.e., $\pi\pi \to \pi\pi$ or $\bar{K}N \to \bar{K}N$).

In Fig. 1 we show an Argand plot of the elastic partial wave amplitude T_{11}. It illustrates geometrically how the real parameters η and δ are related to the real and imaginary parts of T_{11}. Many examples of such Argand plots may be found in the Baryon Data Card Listings.

Consider the so-called non-relativistic Breit–Wigner approximation for T_{11}:

$$T_{11} = \tfrac{1}{2}\Gamma_1/(M - E - \tfrac{1}{2} i\Gamma) \tag{2}$$

where E is the c.m. energy of invariant mass, Γ_1 and Γ are the *elastic* and *total* widths, and M is called the *resonance mass*. Equation (2) is, of course, not the only possible description of a resonant amplitude; it suffices to illustrate the properties of partial-wave amplitudes which we associate with resonance behavior in the absence of any background in the same partial wave (see, e.g., the πN D_{15} and F_{15} waves in the Baryon Data Card Listings). Usually the widths contain barrier-

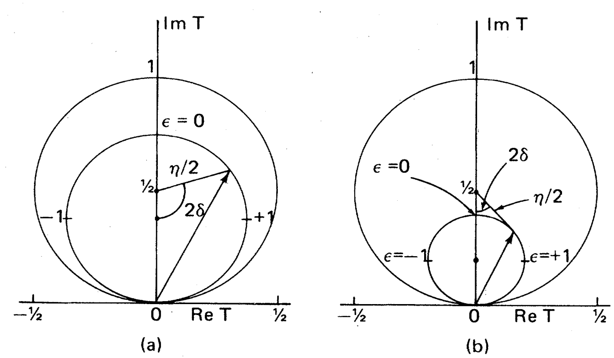

FIG. 1. Argand plots for the partial wave amplitude T_{11}. The outer circles are the unitarity bound (η=1). The inner circles correspond to the Breit-Wigner approximation of Eq. (2) for (a) $x_1 = \Gamma_1/\Gamma = 0.75$ and (b) $x_1 = 0.4$. Note: $\epsilon = 2(M-E)/\Gamma$.

penetration factors which can vary rapidly with energy. Near threshold, $\Gamma_1(E)$ should start up as q^{2l+1} (also true for the inelastic width Γ_β). Various E dependences are then used for Γ_1, mostly of the form

$$\Gamma_1(E) \propto \frac{(qR)^{2l+1}}{\text{const.} + \cdots + (qR)^{2l}}, \tag{3}$$

see Jackson (1964), Pišút and Roos (1968), and Barbaro-Galtieri (1968).

The BW-approximation to the amplitude for an inelastic process leading from channel 1 to channel β ($\pi\pi \to \bar{K}K$ or $KN \to \Sigma\pi$, for example), is

$$T_{1\beta} = \tfrac{1}{2}(\Gamma_1\Gamma_\beta)^{1/2}/(M - E - \tfrac{1}{2}i\Gamma)$$
$$= (x_1 x_\beta)^{1/2}[\tfrac{1}{2}\Gamma/(M - E - \tfrac{1}{2}i\Gamma)], \tag{4}$$

where

$$\Gamma = \sum_1^N \Gamma_\beta, \quad x_\beta = \Gamma_\beta/\Gamma, \tag{5}$$

and x_1 (called the elasticity) is often written x_e. (Note that in the Data Card Listings we use the symbol P_β to denote x_β.) The channel cross-section $\sigma_{1\beta}$ for the reaction $1 \to \beta$, for spin 0-spin $\frac{1}{2}$ scattering, is

$$\sigma_{1\beta} = 4\pi\lambda\!\!\!^{-2}(J + \tfrac{1}{2})\,|T_{1\beta}|^2, \tag{6}$$

where $J = l \pm \frac{1}{2}$.

The important features of Eq. (4) which characterize resonant behavior in the Argand diagram ($\mathrm{Im}\,T_{1\beta}$ versus $\mathrm{Re}\,T_{1\beta}$) are:

(1) Energy variation given by circles with diameter $(x_1x_\beta)^{1/2}$ and maximum amplitude at $E = M$ of

$$T_{1\beta}^{\max} = i(x_1x_\beta)^{1/2}. \tag{7}$$

(2) A maximum in the speed near resonance, given approximately by

$$\text{"Speed"(res)} = |dT_{1\beta}/dE|_{E=M} = \frac{2(x_1x_\beta)^{1/2}}{\Gamma(E)}, \tag{8}$$

for slowly varying $\Gamma(E)$. These features may be related to the η, δ representation of T_{11}. Thus when $E = M$, δ is either $90°(x_1 > \frac{1}{2})$ or $0°(x_1 < \frac{1}{2})$ and η dips to its minimum value.

These simple properties can be used to judge the presence or absence of resonance behavior in an Argand plot. However, it must be kept in mind that Eqs. (2) and (4) are only approximations to the "true" amplitude. The simple picture given above can be distorted by various effects:

- the presence of "background" in the same partial wave as the resonance
- two resonances in the same partial wave overlapping in energy
- the resonant energy M being close to an inelastic channel threshold, in which case a K-matrix-like parametrization is more appropriate.

B. SU(3) sign conventions for Λ and Σ resonances

Consider the partial width Γ_β of a resonance decaying into the channel β. We can always define a coupling constant such that

$$\Gamma_\beta \propto G_\beta^2.$$

In this case the inelastic amplitude in the Breit–Wigner approximation, Eq. (4) will go as

$$T_{1\beta} \propto G_1 G_\beta/(M - E - \tfrac{1}{2}i\Gamma),$$

where G_1 is the coupling constant for the elastic channel. In the context of exact SU(3) symmetry the relative signs of the product G_1G_β for different resonances are often useful as a consistency check on SU(3) assignment of Λ and Σ resonances. See Appendix II for further details.

In the Data Card Listings for Λ and Σ resonances, we tabulate measured values for $(x_1x_\beta)^{1/2} \propto G_1G_\beta$. Whenever there is an explicit sign, it will be according to the convention advocated by Levi-Setti (1969) and used in the table of SU(3) Isoscalar Factors presented in this review. Thus the signs multiplying the Breit–Wigner amplitudes for $\bar{K}N \to \Sigma(1385) \to \Sigma\pi$, $\Lambda\pi$ and $\bar{K}N \to \Lambda(1405) \to \Sigma\pi$ are simply the product of the phases of the appropriate isoscalar factors. This convention is shown in Fig. 2 from Levi-Setti (1969).

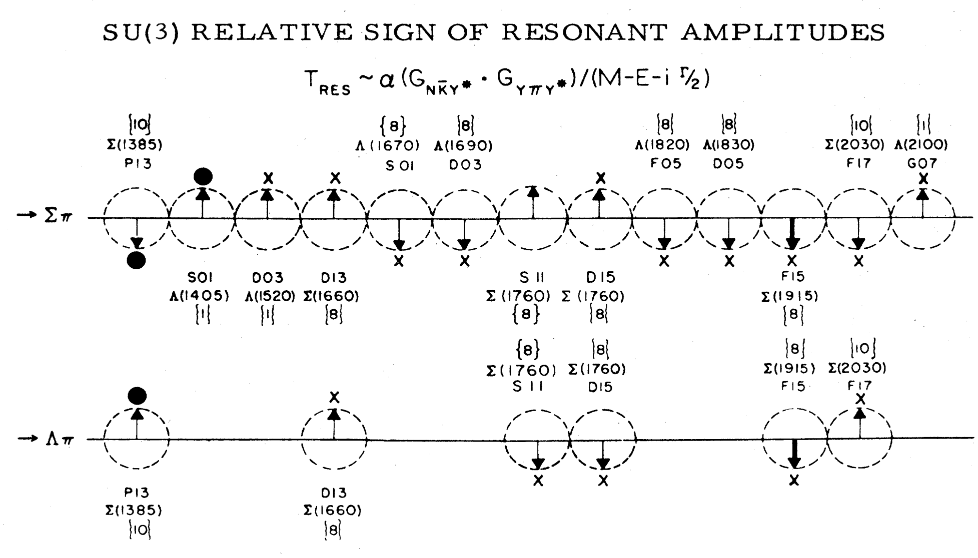

FIG. 2. Plot adapted from Levi-Setti (1969) showing the sign convention adopted here for the $\Sigma\pi$ and $\Lambda\pi$ amplitudes. Once the signs of one $I = 0$ and one $I = 1$ amplitude are fixed, the others can be measured relative to these two. Arrows here indicate signs predicted by SU(3); × marks indicate the observed phases; ● indicates phase chosen according to sign convention described in text. The $\Sigma(1915)$ predictions have been changed from Levi-Setti's original figure.

C. Types of partial-wave analyses

Partial-wave analyses (PWA) are classified into three categories in the Data Card Listings: energy-independent partial-wave analyses (IPWA), energy-dependent partial-wave analyses (DPWA), and model-dependent partial-wave analyses (MPWA), in increasing order of the number of explicit supplementary hypotheses that are used to extract the amplitudes from experimental data.

In an IPWA, data at different energies are analyzed separately. Usually each partial wave included in the fit is allowed to vary freely (subject to unitarity constraints) over some large region, and waves whose angular momenta are above some cutoff value are assumed to be negligible. The sharp cutoff in angular momentum resolves continuum ambiguities in the solution (such as the overall phase ambiguity), but there remains a finite number of indistinguishable "best" solutions (i.e., solutions corresponding to identical physical observables) which have been codified by Barrelet (1972). In addition, there are generally some nearby solutions (and their associated Barrelet ambiguities) which have chi-squared values close to the minimum one.

At the end of the analysis a choice is made among these many solutions, usually on the basis of energy continuity. A popular criterion for making this choice is the shortest path technique in which the total "length" of the preferred solution is chosen to be a minimum. The definition of "length" used here is not universal but is usually closely related to the total geometrical length of the lines representing the various partial-wave amplitudes in Argand plots (see the Baryon section of the Data Card Listings for examples of Argand plots). Various other criteria which are also used in some analyses are, e.g., matching with known solutions at low energies, the presence of known resonances in the final results, and limited inelasticity in high partial waves.

In a DPWA, data at different energies are fit simultaneously by using an energy dependent parametrization of the partial-wave amplitudes. The parametrization is usually chosen to include both resonances and nonresonant background of some sort and an attempt is made to keep it as "model independent" as possible. Often the data are grouped into several energy bins which are fit separately rather than trying to fit the whole energy range under consideration simultaneously. One of the main advantages of DPWA over IPWA is that sparse data spread over many different energies can be analyzed, e.g., nearly all $S=-1$ analyses are DPWA. In addition, the built-in energy continuity helps to resolve the ambiguities that plague IPWA and eases the problems associated with resonance parameter extraction. The price one pays for these advantages lies in the danger of systematic error in the amplitudes and poor fits to the data if the parametrization is poorly chosen or insufficiently flexible.

An MPWA also uses an energy-dependent parametrization, but one based on explicit model-dependent theoretical assumptions such as Regge exchanges. This technique is usually applied to reactions where the data are incomplete. There is, of course, no sharp distinction between DPWA and MPWA, and a well chosen MPWA parametrization may actually be less biased than a model-independent but poorly chosen DPWA parametrization.

D. Production of resonances

Hereby, we mean the observation of statistically significant peaks in invariant mass plots or, loosely, in integrated cross sections. Many meson resonances are of this type. We expect most of these peaks to be associated with Breit–Wigner behavior in appropriate Argand plots; thus the ρ meson peak in $\pi\pi$ mass plots is firmly related to the $I=1$, $l=1$ $\pi\pi$ phase shift passing through 90°.

From mass plots we can determine M, Γ, and the approximate branching ratios

$$x_\alpha / x_\beta = \Gamma_\alpha / \Gamma_\beta \; . \tag{9}$$

In the case of total cross sections, the peak above background gives us, using the optical theorem, the product $(J+\frac{1}{2})x_e$:

$$\sigma^{\text{tot}}(E=M) = 4\pi \lambda\!\!\!^{-2}(J+\tfrac{1}{2})x_e \; . \tag{10}$$

V. CRITERIA FOR RESONANCES

An experimentalist who sees indications of a resonance in some energy (or mass) region will of course want to know what has been seen in that region in the past; hence, we strive to have the Data Card Listings serve as an archive for all substantial claims or evidences for resonances.

For the Tables of Particle Properties, on the other hand, we wish to be more conservative and to include only those peaks or resonances which we feel have a large chance of survival. An arrow (→) at the left of the Tables of Particle Properties indicates that a questionable candidate has been omitted from the Table, but that it can be found in the corresponding part of the Data Card Listings. One's betting odds for survival are of course subjective; therefore no precise criteria can be defined. In what follows we shall attempt to specify some guide lines.

(a) When energy-independent partial-wave analyses are available (mostly for N^*'s), approximate Breit–Wigner behavior of the amplitude appears to us to be the most satisfactory test for a resonance. We can check that the Argand plot follows roughly a left-hand circle, and that the "speed" of the amplitude also shows a maximum near the resonance energy; further, there should be data well above the resonance, showing that the speed again decreases. Indeed proper behavior of the partial-wave amplitude could accredit a resonance even if its elasticity is too small to make a noticeable peak in the cross section.

Of course even if Argand plots are available, it may still be a matter of opinion as to what behavior constitutes a resonance. Such an example is the $Z_0(1780)$ state seen in KN total cross-section experiments and in partial-wave analysis. The recent partial-wave analyses of Giacomelli (1974) and Martin (1975) find preferred solutions which exhibit a resonance-like loop in the P_{01} wave near 1740 MeV (see Fig. 5 of the $S=+1$

mini-review in the Baryon Data Card Listings). However, Giacomelli *et al.* and Martin point out that, despite the resonant-like *appearance* of the loop, the evidence for resonant *energy dependence* is inconclusive. Thus we omit the $Z_0(1780)$ from the Baryon Table. A similar quandary has existed for some time concerning the $Z_1(1900)$, and it too has been omitted from the Tables.

(b) When there are insufficient data to perform energy-independent analyses, one often resorts to energy-dependent partial-wave analyses (mostly for Y^*'s). In this case Breit–Wigner behavior is an input. We therefore require that resonance solutions be found by several different analyses, preferably in different channels ($\bar{K}N \to \bar{K}N$, $\pi\Sigma$, etc.), before putting the claim in the table.

(c) Partial-wave analyses of three-body final states ($\pi N \to \pi\pi N$) are becoming available. While these analyses are based on the isobar model ($\pi N \to \rho N$, $\pi\Delta$, etc.) and are subject to theoretical objections of varying importance, they provide increasingly reliable information on inelastic decay modes of otherwise established resonances.

(d) Most mesons, Ξ^* peaks, and high mass N^* and Y^* peaks fall into a category for which no partial-wave analyses exist. In general we accept such peaks if they are experimentally reliable, of high statistical significance or if they are observed in several different production processes.

(e) A special category of "diffractive mesons" consists of statistically significant peaks like A_1, A_3 or Q, which are not far above the $\rho\pi$, $f\pi$, or $K^*\pi$ thresholds. The question of a resonance interpretation for these states is complicated, because the behavior near threshold in these channels may be described by the Deck effect. Modern partial-wave analyses can shed considerable light on these problems. See the mini-reviews for details.

Thus, we enter into the tables of Particle Properties only states for which there is experimentally convincing evidence, and we expect that most of these will be confirmed as resonances.

VI. CONVENTIONS AND PARAMETERS FOR WEAK AND ELECTROMAGNETIC DECAYS

A. Muon-decay parameters

The μ-decay parameters describe the momentum spectrum (ρ and η), the asymmetry (ξ and δ), and the helicity (h) of the electron in the process $\mu^\pm \to e^\pm + \nu + \bar{\nu}$. Assuming a local and lepton-conserving interaction, the matrix element may be written as

$$\sum_i \langle \bar{e} | \Gamma_i | \mu \rangle \langle \bar{\nu} | \Gamma_i (C_i + C_i' \gamma_5) | \nu \rangle ,$$

where the summation is taken over $i = S, V, T, A, P$. Using the definitions and sign conventions of Kinoshita and Sirlin (1957), we have for the momentum parameters

$$\rho = [3g_A^2 + 3g_V^2 + 6g_T^2]/D ,$$

$$\eta = [g_S^2 - g_P^2 + 2g_A^2 - 2g_V^2]/D ,$$

for the asymmetry parameters:

$$\xi = \frac{6g_S g_P \cos\phi_{SP} - 8g_A g_V \cos\phi_{AV} + 14 g_T^2 \cos\phi_{TT}}{D} ,$$

$$\delta = [-6g_A g_V \cos\phi_{AV} + 6g_T^2 \cos\phi_{TT}]/D\xi ,$$

and for the parameter describing the helicity of the electron:

$$h = \frac{2g_S g_P \cos\phi_{SP} - 8g_A g_V \cos\phi_{AV} - 6g_T^2 \cos\phi_{TT}}{D} .$$

Here

$$D = g_S^2 + g_P^2 + 4g_V^2 = 6g_T^2 + 4g_A^2 ,$$

$$g_i^2 = |C_i|^2 + |C_i'|^2 ,$$

and

$$\cos\phi_{ij} = \mathrm{Re}(C_i^* C_j' + C_i' C_j^*) .$$

The quantities g_i are defined to be real non-negative numbers, and the ϕ_{ij} are phase angles between the i-type and j-type interactions. Under the assumption of two-component neutrinos $C_i' = -C_i$ and $C_j' = -C_j$, the S, P, and T terms vanish, and ϕ_{AV} is the phase angle between C_A and C_V in the complex plane.

By using the above equations and the experimental determinations of ρ, η, ξ, δ, and h, limits can be placed on g_S/g_V, g_A/g_V, g_T/g_V, g_P/g_V, and ϕ_{AV}. The results, given in the Data Card Listings assume neither two-component neutrinos nor time-reversal invariance. If, however, two-component neutrinos are assumed, then $\sin\phi_{AV}$ is the amplitude of time-reversal violation. Note that most experiments study only the upper end of the spectrum where ρ and η are highly correlated, so they can only report ρ for $\eta \equiv 0$ and η for $\rho \equiv \frac{3}{4}$. The values for ρ and η we use here were obtained by combining measurements of both upper and lower ends of the spectrum and turn out to be nearly uncorrelated.

Note also that the radiative corrections are unambiguous only when $g_S = g_T = g_P = 0$. The same limits on g_A/g_V and ϕ_{AV} are obtained, however, as when g_S, g_T, and g_P are left free.

Current values for the asymmetry parameters as well as $|g_A/g_V|$ and ϕ_{AV} are given in the Addendum to the Stable Particle Table. In addition, upper limits on $|g_S/g_V|$, $|g_T/g_V|$ and $|g_P/g_V|$ are given in the μ section of the Stable Particle Data Card Listings.

B. K-decay parameters

1. Dalitz plot for $K \to 3\pi$ decays

The small deviation from uniformity of the Dalitz plot for the 3π decay of the K meson is usually described by a "slope parameter" (Dalitz, 1956). For the τ and τ' decays of the charged K's, and the τ^0 decay mode of the K_L^0, we parametrize the Dalitz plot distribution by the expression

$$|M|^2 \propto 1 + g\frac{s_3 - s_0}{m_{\pi^+}^2} + h\left(\frac{s_3 - s_0}{m_{\pi^+}^2}\right)^2 + j\frac{s_2 - s_1}{m_{\pi^+}^2} + k\left(\frac{s_2 - s_1}{m_{\pi^+}^2}\right)^2 + \cdots , \qquad (1)$$

where $m_{\pi^+}^2$ has been introduced so as to make the coefficients g, h, j, and k dimensionless, and

$$s_i=(P_K-P_i)^2=(m_K-m_i)^2-2m_KT_i\ ,\quad i=1,2,3$$

$$s_0=\frac{1}{3}\sum_i s_i=\tfrac{1}{3}(m_K^2+m_1^2+m_2^2+m_3^2)\ .$$

Here the P_i are 4-vectors, m_i and T_i are the mass and kinetic energy of the ith pion, and the index 3 is used for the odd pion.

The coefficient g is a measure of the slope in the variable s_3 (or T_3) of the Dalitz plot, while h and k measure the quadratic dependence on s_3 and (s_2-s_1), respectively. The coefficient j is related to the asymmetry of the plot and must be zero if CP invariance holds. Note also that if CP is good, g must be the same for τ^+ and τ^-, and similarly for h and k.

At present there is no compelling experimental evidence for the h, k, or j term (for upper limits on the j term, see Sec. B.3(b) below). Thus we stop the above expansion at the first term and list only g. Since different experiments use different forms for $|M|^2$, in order to compare the experiments we have converted to g whatever coefficients have been measured. See the mini-review in the $K^\pm$ section of the Stable Particle Data Card Listings for details on this point. The results are given in the Addendum to the Stable Particle Table and in the $K^\pm$ and K_L^0 sections of the Stable Particle Data Card Listings.

Relations among $\tau^\pm$, $\tau'^\pm$, and τ^0 are predicted by the $\Delta I=\frac{1}{2}$ rule. See Appendix I for these relations and a discussion of this rule.

2. Form factors in K_{l3} leptonic decays

Assuming that only the vector current contributes to these decays, we write the matrix element as

$$M\propto f_+(t)[(P_K+P_\pi)_\mu\bar{u}_l\gamma_\mu(1+\gamma_5)u_\nu]$$
$$+f_-(t)[m_l\bar{u}_l(1+\gamma_5)\mu_\nu]\ ,\qquad (2)$$

where P_K and P_π are the four momenta of K and π mesons; m_l is the lepton mass; f_+ and f_- are dimensionless form factors which can depend only on $t=(P_K-P_\pi)^2$, the square of the four-momentum transfer to the leptons. f_+ and f_- are relatively real if time reversal invariance holds for these decays. $K_{\mu3}$ experiments measure f_+ and f_-, while K_{e3} experiments are sensitive only to f_+ because the presence of the lepton mass makes the f_- term negligible.

(a) $K_{\mu 3}$ experiments

Analyses of $K_{\mu3}$ data frequently assume a linear dependence of f_+ and f_- on t, i.e.

$$f_\pm(t)=f_\pm(0)[1+\lambda_\pm(t/m_\pi{}^2)]\ .\qquad (3)$$

Most $K_{\mu3}$ data are adequately described by Eq. (3) for f_+ and a constant f_- (i.e. $\lambda_-=0$). There are two equivalent parametrizations commonly used in these analyses:

(1) λ_+, $\xi(0)$ *Parametrization.* Analyses of $K_{\mu3}$ data often introduce the ratio of the two form factors

$$\xi(t)=f_-(t)/f_+(t)\ .$$

The $K_{\mu3}$ decay distribution is then described by the two parameters λ_+ and $\xi(0)$ (assuming time reversal invariance and $\lambda_-=0$). These parameters can be determined by three different methods:

Method A: By studying the Dalitz plot or the pion spectrum of $K_{\mu3}$ decay. The Dalitz plot density is (See, e.g. Chounet *et al.*, 1972):

$$\rho(E_\pi,E_\mu)\propto f_+^2(t)[A+B\xi(t)+C\xi(t)^2]\ ,$$

where

$$A=m_K(2E_\mu E_\nu-m_KE_\pi')+m_\mu^2(\tfrac{1}{4}E_\pi'-E_\nu)\ ,$$

$$B=m_\mu^2(E_\nu-\tfrac{1}{2}E_\pi')\ ,$$

$$C=\tfrac{1}{4}m_\mu^2E_\pi'\ ,$$

$$E_\pi'=E_\pi^{\max}-E_\pi=\frac{m_K^2+m_\pi^2-m_\mu^2}{2m_K}-E_\pi\ .$$

Here E_π, E_μ, and E_ν are respectively the pion, muon, and neutrino energies in the kaon center of mass. The density ρ is fit to the data to determine the values of λ_+, $\xi(0)$, and their correlation.

Method B: By measuring the $K_{\mu3}/K_{e3}$ branching ratio and comparing it with the theoretical ratio (See, e.g., Fearing *et al.*, 1970) as given in terms of λ^+ and $\xi(0)$, assuming μ-e universality.

$$\Gamma(K_{\mu3}^\pm)/\Gamma(K_{e3}^\pm)=0.6457+1.4115\lambda_++0.1264\xi(0)$$
$$+0.0192\,\xi(0)^2+0.0080\lambda_+\xi(0)\ ,$$

$$\Gamma(K_{\mu3}^0)/\Gamma(K_{e3}^0)=0.6452+1.3162\lambda_++0.1246\,\xi(0)$$
$$+0.0186\,\xi(0)^2+0.0064\lambda_+\xi(0)\ .$$

This cannot determine λ_+ and $\xi(0)$ simultaneously but simply fixes a relationship between them.

Method C: By measuring the muon polarization in $K_{\mu3}$ decay. In the rest frame of the K, the μ is expected to be polarized in the direction $\vec{A}$ with $\vec{P}=\vec{A}/|\vec{A}|$, where $\vec{A}$ is given (Cabibbo and Maksymowicz, 1964) by

$$\vec{A}=a_1(\xi)\vec{p}_\mu$$
$$-a_2(\xi)\left\{\frac{\vec{p}_\mu}{m_\mu}\left[m_K-E_\pi+\frac{\vec{p}_\pi\cdot\vec{p}_\mu}{|\vec{p}_\mu|^2}(E_\mu-m_\mu)\right]+\vec{p}_\pi\right\}$$
$$+m_K\,\mathrm{Im}\,\xi(t)(\vec{p}_\pi\times\vec{p}_\mu)\ .$$

If time-reversal invariance holds, ξ is real, and thus there is no polarization perpendicular to the K-decay plane. Polarization experiments measure the weighted average of $\xi(t)$ over the t range of the experiment, where the weighting accounts for the variation with t of the sensitivity to $\xi(t)$.

(2) λ_+, λ_0 *Parametrization.* Some of the more recent $K_{\mu3}$ analyses have parametrized in terms of the form factors f_+ and f_0 which are associated with vector and scalar exchange respectively to the lepton pair. f_0 is related to f_+ and f_- by

$$f_0(t)=f_+(t)+[t/(m_K^2-m_\pi^2)]f_-(t)\ .$$

Here $f_0(0)$ must equal $f_+(0)$ unless $f_-(t)$ diverges at $t=0$. The earlier assumption that f_+ is linear in t and f_- is constant leads to f_0 linear in t

$$f_0(t)=f_0(0)[1+\lambda_0(t/m_\pi^2)]\ .$$

With the assumption that $f_0(0)=f_+(0)$, the two parametrizations, $(\lambda_+, \xi(0))$ and (λ_+, λ_0) are equivalent as long as correlation information is retained. (λ_+, λ_0) correlations tend to be less strong than $(\lambda_+, \xi(0))$ correlations.

The experimental results for $\xi(0)$ and its correlation with λ_+ are listed in the $K^\pm$ and K^0_L sections of the Stable Particle Data Card Listings in subsection XIA, XIB, or XIC depending on whether Method A, B or C discussed above was used. The corresponding values of λ^+ are listed in subsection $L+M$.

Because current experiments tend to use the (λ_+, λ_0) parametrization, we have added a subsection $L0$ for λ_0 results. Wherever possible we have converted $\xi(0)$ results into λ_0 results and vice versa.

(b) K_{e3} experiments

Analysis of K_{e3} data is simpler than that of $K_{\mu 3}$ because the second term of the matrix element assuming a pure vector current (Eq. 2 above) can be neglected. Here f_+ is usually assumed to be linear in t, and the linear coefficient λ_+ of Eq. (3) is determined.

If we remove the assumption of a pure vector current, then the matrix element for the decay, in addition to the terms in Eq. (2), would contain

$$+2m_K(f_S\bar{u}_l(1+\gamma_5)u_\nu$$
$$+(2f_T/m_K)(P_K)_\lambda(P_\pi)_\mu\bar{u}_l\sigma_{\lambda\mu}(1+\gamma_5)u_\nu ,$$

where f_S is the scalar form factor, and f_T is the tensor form factor. In the case of the K_{e3} decays where the f_- term can be neglected, experiments have yielded limits on $|f_S/f_+|$ and $|f_T/f_+|$.

The K_{e3} results for λ_+, $|f_S/f_+|$ and $|f_T/f_+|$ are listed in the subsections $L+M$, FS, and FT respectively of the $K^\pm$ and K^0_L sections of the Stable Particle Data Card Listings.

See also the *Note on* $K^\pm_{l3}$ *and* K^0_{l3} *Form Factors* in the $K^\pm$ section of the Stable Particle Data Card Listings for additional discussion of the $K^0_{\mu 3}$ parameters, correlations, and conversion between parametrization and also for a comparison of the experimental results.

3. CP violation in K^0 decays

We list parameters for four different reactions in which CP can be tested [for details, see Okun and Rubbia (1967), Steinberger (1969), and Wolfenstein (1969)].

(a) $K_S\to\pi^+\pi^-\pi^0$. The quantity measured here is the ratio of amplitudes

$$A_S(K_S\to\pi^+\pi^-\pi^0)/A_L(K_L\to\pi^+\pi^-\pi^0)\equiv x+iy \quad . \tag{4}$$

If CPT invariance holds and there is no $I=3$ state present, then x can be neglected and CP violation would be observed as a nonzero y. We give the result for Eq. (4) in the K^0_L section of the Stable Particle Table and under Branching Ratio $R4$ in the K^0_S section of the Stable Particle Data Card Listings. Our procedure is to assume that $x=0$, and to list $(A_S/A_L)^2$ in the form of a branching ratio.

(b) *Charge asymmetry in* $K_L\to 3\pi$ *decays*. As mentioned above, the presence of a term in (s_2-s_1) in expression (1) describing the Dalitz plot distribution for $\tau^\pm$, τ^0 decays of K mesons would be an indication of CP violation. Rather than listing values of the (s_2-s_1) coefficient j in Eq. (1), we choose to list $\sigma_\pm$ from the equivalent expression

$$|M|^2\propto 1+\sigma_\pm(2/\sqrt{3})(T_+-T_-)/T_{\pm\max}$$
$$+(CP \text{ nonviolating terms}) , \tag{5}$$

where $T_\pm$ are the kinetic energies of the charged pions. We have momentarily abandoned the form involving the Mandelstam variables s_i in favor of Eq. (5) because the latter has been consistently used by experimenters searching for CP violation. We list $\sigma_\pm$ among the CP-violating parameters at the back of the K^0_L section of the Stable Particle Data Card Listings. Note that only upper limits have been reported for this quantity.

(c) *Asymmetry in the* $K_L\to\pi^\mp l^\pm\nu$ *decays*. The quantity measured and compiled here is

$$\delta=\frac{\Gamma(K_L\to\pi^-l^+\nu)-\Gamma(K_L\to\pi^+l^-\nu)}{\Gamma(K_L\to\pi^-l^+\nu)+\Gamma(K_L\to\pi^+l^-\nu)} .$$

This asymmetry violates CP invariance. If CPT is good, for a pure K^0_L beam, δ can be written as

$$\delta=2[(1-|x|^2)/(|1-x|^2)]\mathrm{Re}\,\epsilon ,$$

where x is the $\Delta S=\Delta Q$-violating parameters defined in section B4, and ϵ is the parameter of the expansion

$$|K_L\rangle=[(1+\epsilon)|K\rangle-(1-\epsilon)|\bar{K}\rangle]/[2(1+|\epsilon|^2)]^{1/2} , \tag{6a}$$

$$|K_S\rangle=[(1+\epsilon)|K\rangle+(1-\epsilon)|\bar{K}\rangle]/[2(1+|\epsilon|^2)]^{1/2} . \tag{6b}$$

We give δ in the Addendum to the Stable Particle Table. In addition, in the K^0_L CP-violation section of the Stable Particle Data Card Listings, we list δ separately for $K^0_L\to\pi\mu\nu$ and $K^0_L\to\pi e\nu$.

(d) $K_L\to 2\pi$ *decay*. The relevant parameters are

$$\eta_{+-}=A(K_L\to\pi^+\pi^-)/A(K_S\to\pi^+\pi^-)=|\eta_{+-}|\exp(i\phi_{+-}) ,$$
$$\eta_{00}=A(K_L\to\pi^0\pi^0)/A(K_S\to\pi^0\pi^0)=|\eta_{00}|\exp(i\phi_{00}) ,$$

ϵ, defined in Eqs. (6) above, and

$$\epsilon'=\tfrac{1}{2}i\sqrt{2}\,[\exp i(\delta_2-\delta_0)]\,\mathrm{Im}(A_2/A_0) .$$

Here, A_i and δ_i are the amplitude and phase of $\pi\pi$ scattering at the K mass, defined by

$$\langle I=0|T|K\rangle=\exp(i\delta_0)A_0 ,$$
$$\langle I=2|T|K\rangle=\exp(i\delta_2)A_2 .$$

Wu and Yang (1964) have derived the relationships

$$\eta_{+-}=\epsilon+\epsilon' ,$$
$$\eta_{00}=\epsilon-2\epsilon' .$$

We give η_{+-}, η_{00}, ϕ_{+-}, and ϕ_{00} in the Addendum to the Stable Particle Table. The phases are measured directly, whereas the magnitudes η_{+-} and η_{00} are derived parameters. We use, as far as we can, the directly measured quantities as input and calculate η_{+-} and η_{00} from the values given by our constrained fits. Therefore, if one looks at the Data Card Listings, most of the $|\eta|$ measurements appear in the form of branching ratios, with appropriate comments. We then give the values of η_{+-} and $|\eta_{00}|^2$ in a separate list at the end of the CP-violating parameters section of the K^0_L section of the Stable Particle Data Card Listings.

4. $\Delta S = \Delta Q$ rule in K^0 decays

The relative amount of $\Delta S \neq \Delta Q$ component present is measured by the parameter x, defined as

$$x = A(\bar{K}^0 \rightarrow \pi^- l^+ \nu)/A(K^0 \rightarrow \pi^- l^+ \nu) \ .$$

We list Re$\{x\}$ and Im$\{x\}$ for both K_{e3} and $K_{\mu 3}$ at the end of the Stable Particle Data Card Listings and give values in the Addendum to the Stable Particle Table.

C. η-decay parameters

1. C-violation in η-decays

As a test of possible C-violation in electromagnetic interactions, a number of experiments have looked for possible charge asymmetries in the decays $\eta \rightarrow \pi^+\pi^-\pi^0$ and $\eta \rightarrow \pi^+\pi^-\gamma$. We list the following parameters:

(a) The left-right asymmetry

$$A = (N^+ - N^-)/(N^+ + N^-) \ ,$$

where $N^{(\pm)}$ means the number of events with the $\pi^{(\pm)}$ energy greater than the $\pi^{(\mp)}$ energy in the η rest frame.

(b) The sextant asymmetry

$$A_s = \frac{N_1 + N_3 + N_5 - N_2 - N_4 - N_6}{N_1 + N_2 + N_3 + N_4 + N_5 + N_6}$$

for the decay $\eta \rightarrow \pi^+\pi^-\pi^0$. The numbers refer to the sextants of the Dalitz plot [see, for example, Layter (1972)]. A_s is sensitive to an $I=0$ C-violating asymmetry.

(c) The quadrant asymmetry A_q, defined in a similar way as A_s, but with each sector of the Dalitz plot now containing $\pi/2$ rather than $\pi/3$ radians. A_q is sensitive to an $I=2$ C-violating final state.

(d) The d-wave contribution to the C-violating amplitude in the decay $\eta \rightarrow \pi^+\pi^-\gamma$. The upper limit for this contribution is measured by the parameter β, defined by

$$dN/d|\cos\theta| \propto \sin^2\theta(1 + \beta\cos^2\theta) \ ,$$

where θ is the angle between the π^+ and the γ in the dipion center of mass. A term proportional to $\cos^2\theta$ could also be due to p- and f-wave interference.

We list A for the decay modes $\eta \rightarrow \pi^+\pi^-\pi^0$ and $\eta \rightarrow \pi^+\pi^-\gamma$, A_s and A_q for the decay $\eta \rightarrow \pi^+\pi^-\pi^0$, and β for the decay $\eta \rightarrow \pi^+\pi^-\gamma$ in the η section of the Stable Particle Data Card Listings.

2. Dalitz plot for $\eta \rightarrow \pi^+\pi^-\pi^0$

The Dalitz plot for the decay $\eta \rightarrow \pi^+\pi^-\pi^0$ may be fit by the distribution

$$|M(x,y)|^2 \propto 1 + ay + by^2 + cx + dx^2 + exy \ .$$

Here,

$$x = \sqrt{3}\ (T_+ - T_-)/Q \ ,$$

$$y = (3T_0/Q) - 1 \ ,$$

T_+, T_-, T_0 are the kinetic energies of the π^+, π^-, and π^0 in the η rest system, and $Q = m_\eta - m_{\pi^+} - m_{\pi^-} - m_{\pi^0}$. The coefficient of the term linear in x is sensitive to C-violation due to an $I=0$ or $I=2$ final state. We list papers presenting determinations of the parameters a, b, c, and d in the η section of the Stable Particle Data Card Listings. However, we do not tabulate values of these parameters because the assumptions made by different authors are not compatible and do not allow comparison of the numerical values.

3. Dalitz plot for $\eta \rightarrow \pi^+\pi^-\gamma$

The Dalitz plot for the decay $\eta \rightarrow \pi^+\pi^-\gamma$ may be fit to the expression

$$|M|^2 \propto 1 + 2\alpha z \ ,$$

where

$$z = \frac{2}{3}\sum_{i=1}^{3}\left[\frac{3}{m_\eta - 3m_\pi}\left(E_i - \frac{1}{3}m_\eta\right)\right]^2 = \frac{\rho^2}{\rho^2_{\max}} \ .$$

Here E_i is the energy of the ith pion in the η rest frame, and ρ is the distance to the center of the Dalitz plot. We list the parameter α in the η section of the Stable Particle Data Card Listings.

D. Baryon-decay parameters

1. A/V ratio for baryon leptonic decays

Consider the decay

$$B_i \rightarrow B_f + l + \nu \ .$$

Assuming V,A theory, neglecting "induced" scalar, "induced" pseudoscalar, and axial weak-magnetism terms, and neglecting the q^2 dependence of the form factors, the baryon part of the matrix element for these decays may be written (Goldberger and Treiman, 1958) as

$$\langle B_f | \gamma_\lambda(g_V - g_A\gamma_5) + (g_W/m_{B_i})\sigma^{\lambda\nu}q_\nu | B_i\rangle \ ,$$

where B_i and B_f represent initial and final baryons, g_A and g_V the axial and vector coupling constant, g_W the weak magnetism coupling constant, and q_ν the sum of the lepton momenta. Here the Pauli representation is used for the γ matrices. The definition of g_A/g_V is

$$g_A/g_V = |g_A/g_V|\exp(i\delta) \ ,$$

where δ is $0 + n\pi$ if time-reversal invariance holds (see Jackson *et al.*, 1957).

In neutron beta decay the measurements are consistent with time reversal, so g_A/g_V is nearly real and has been considered to be such in all the baryon leptonic decays. Notice that by using the above definition of the matrix element with the Pauli representations, the value of g_A/g_V in neutron beta decay is negative.

Due to statistical limitation the weak magnetism form factor g_W is usually assumed from CVC and SU(3), so only g_A and g_V are determined experimentally. This determination is accomplished in a variety of ways:

(a) The lepton-neutrino angular correlation provides a measure of the absolute value of g_A/g_V (for relevant formulas, see, e.g., Albright, 1959).

(b) The up-down asymmetry of the lepton from polarized baryon decays provides a measure of g_A/g_V with its sign (for relevant formulas, see, e.g. Albright, 1959).

(c) The lepton spectrum, given enough statistics, provides a measure of g_A/g_V with its sign (for relevant formulas, see, e.g., Bender, 1968).

(d) The polarization of the decay baryon, from polarized or unpolarized initial baryon, also provides g_A/g_V with its sign (for formulas, see, e.g., Willis and Thompson, 1968).

We compile the ratio g_A/g_V with its sign, for those decays for which it has been measured. For the neutron beta decay we compile also the phase δ.

All the coupling constants and decay rates for baryon leptonic decays are related by Cabbibo's theory (Cabbibbo, 1964). A recent fit to this theory has been done by Roos (1974).

2. Asymmetry parameters in nonleptonic hyperon decays

The transition matrix for the hyperon decay may be written as

$$M = s + p(\vec{\sigma}\cdot\vec{q}) , \qquad (7)$$

where s and p are the parity-changing and the parity conserving amplitudes, respectively; $\vec{\sigma}$ is the Pauli spin operator, and $\vec{q}$ is a unit vector along the direction of the decay baryon in the hyperon rest frame.

The asymmetry parameters are defined by the relations

$$\alpha = 2\,\mathrm{Re}(s^*p)/(|s|^2 + |p|^2) ,$$

$$\beta = 2\,\mathrm{Im}(s^*p)/(|s|^2 + |p|^2) ,$$

$$\gamma = (|s|^2 - |p|^2)/(|s|^2 + |p|^2) .$$

With the transition matrix (7), the angular distribution of the decay baryon, in the hyperon rest system, is of the form

$$I = 1 + \alpha\vec{P}_Y\cdot\vec{q} ,$$

where $\vec{P}_Y = \langle Y|\sigma|Y\rangle$ is the hyperon polarization.

In the notation of Lee and Yang (1957) the polarization $\vec{P}_B$ of the decay baryon is[2]

$$\vec{P}_B = \frac{(\alpha + \vec{P}_Y\cdot\vec{q})\vec{q} + \beta(\vec{P}_Y\times\vec{q}) + \gamma\vec{q}\times(\vec{P}_Y\times\vec{q})}{1 + \alpha\vec{P}_Y\cdot\vec{q}}$$

where $\vec{P}_B$ is defined in that rest system of the baryon obtained by a Lorentz transformation along $\vec{q}$ from the hyperon rest system in which $\vec{q}$ and $\vec{P}_Y$ are defined. Note that α is the helicity of the decay baryon for unpolarized hyperons.

The three parameters α, β, and γ satisfy the relation

$$\alpha^2 + \beta^2 + \gamma^2 = 1 .$$

It is then convenient to describe hyperon nonleptonic decays in terms of the two independent parameters α and the angle ϕ defined by

$$\beta = (1 - \alpha^2)^{1/2}\sin\phi ,$$

$$\gamma = (1 - \alpha^2)^{1/2}\cos\phi ,$$

which has a more nearly Gaussian distribution than β or γ. Evidently

$$-\tfrac{1}{2}\pi \leq \phi \leq \tfrac{1}{2}\pi \quad \text{for } \gamma > 0 .$$

$$+\tfrac{1}{2}\pi \leq \phi \leq \tfrac{3}{2}\pi \quad \text{for } \gamma < 0 .$$

In discussing time-reversal invariance, the quantity of interest is Δ, defined by

$$\alpha = 2|s||p|\cos\Delta/(|s|^2 + |p|^2) ,$$

$$\beta = -2\,|s||p|\sin\Delta/(|s|^2 + |p|^2) ;$$

that is, Δ is the phase angle of s relative to p. Evidently

$$-\tfrac{1}{2}\pi \leq \Delta \leq \tfrac{1}{2}\pi \quad \text{for } \alpha > 0 ,$$

$$+\tfrac{1}{2}\pi \leq \Delta \leq \tfrac{3}{2}\pi \quad \text{for } \alpha < 0 .$$

Under the assumption of time-reversal invariance, the angle Δ must satisfy the relation

$$\Delta = \delta_s - \delta_p ,$$

modulo π, where δ_s and δ_p are the pion-baryon scattering phase shifts at the appropriate energy and for the appropriate isospin state. For Λ decay, assuming the validity of the $|\Delta I| = \frac{1}{2}$ rule,

$$\Delta = \delta_s - \delta_p = (6.8 \pm 2.0)\ \text{deg.}$$ [3]

In the Stable Particle Data Card Listings we give α and ϕ for each decay since they are the most closely related to the experiments and are essentially uncorrelated. Whenever necessary we have changed the signs of the reported values, so as to agree with our conventions. In the Stable Particle Table we give α, ϕ, and Δ with errors; and for convenience we also give the central value of γ, without an error.

VII. STATISTICAL PROCEDURES

We divide this discussion on obtaining averages and errors into two sections:

A. the unconstrained case, or "simple averaging", and
B. the constrained case.

In what follows, the term "error" means one standard deviation (1σ); that is, for central value $\bar{x}$ and error $\delta\bar{x}$, the range $\bar{x} \pm \delta\bar{x}$ constitutes a 68.3% confidence interval.

A. Unconstrained averaging

We first describe the standard procedure which we have used for several years to determine averages and errors. We will then discuss a second method, newly proposed, which we feel offers a less conservative, and possibly more accurate, estimate of errors.

1. Standard procedure—Gaussian distribution with scale factor

We begin by assuming that measurements of a given quantity obey a Gaussian distribution, and thus we calculate a weighted average and error

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[2]Note that Lee and Yang (1957) contains a misprint. The minus sign in the definition of β should be replaced by a 2. In addition, our unit vector $\vec{q}$ is the direction of the baryon, whereas their unit vector $\vec{p}$ is the direction of the pion.

[3]This value for $\delta_s - \delta_p$ is derived from the phase-shift analyses by Roper *et al.* (1965). The error is our estimation of the uncertainty.

$$\bar{x} \pm \delta\bar{x} = \left(\sum_i w_i x_i \Big/ \sum_i w_i\right) \pm \left[1 \Big/ \left(\sum_i w_i\right)\right]^{-1/2}, \tag{1}$$
$$w_i = [1/(\delta x_i)^2] ,$$

where x_i and δx_i are the value and error, respectively, reported by the ith experiment, and the sums run over N experiments. We also calculate χ^2 and compare it with its expectation value of $N-1$.

If $\chi^2/(N-1)$ is less than or equal to 1, and there are no known problems with the data, we accept the above results.

If $\chi^2/(N-1)$ is ridiculously large, or if there is prior knowledge of extremely large inconsistencies between experiments, we may choose not to average the data at all. Or, in some cases, we may quote the calculated average, but then give an "educated guess" as to the error; such a guess is a generally quite conservative estimate designed to take into account known problems with the data.

Finally, if $\chi^2/(N-1)$ is greater than 1, but not to such a large extent, we still average the data, but then try to make up for this fact in two ways:

(i) We plot an ideogram to guide the reader in deciding which data he might reject before making his own selected average. An example of such an ideogram is given in Fig. 3 below. Each experiment appearing in the plot is represented by a Gaussian with central value x_i, error δx_i, and area proportional to $1/\delta x_i$. The choice of area is a somewhat arbitrary one; it is based on the assumption that an experimenter will work to reduce his systematic errors until they are slightly smaller (but seldom much smaller) than his statistical errors. Thus as a bubble-chamber physicist gets more events, he will use them both to reduce his statistical errors and to study his biases. Our confidence that a significant systematic error has not been made in his experiment, as compared with other contradictory experiments, then tends to go up as $1/\delta x_i$.

But why not assign a weight $1/\delta x_i^2$, as is done when computing a weighted average? We feel that this is equivalent to assuming that large systematic errors are as infrequent as large statistical fluctuations, and that this is unrealistic.

We want to emphasize the difference between least-squares averaging (where the weighting factor is the inverse square of the error) and the ideograms prepared for visual display. The former arithmetic is of course best if one has statistically distributed input, and yields a narrow Gaussian distribution centered at the weighted mean. The ideogram (often multipeaked and certainly not Gaussian) is based on the opposite hypothesis that some of the input is systematically in error. The idea behind least-squares averaging is that experiments 1, 2, 3, etc., are *all* valid (so we should multiply their probabilities); our *ideograms* are based on the assumption that 1 *or* 2 *or* 3, etc., is valid, "hedged" with $1/\delta x_i$ betting odds; we then add their probabilities. Both approaches cannot simultaneously be right; we leave it to the reader to choose. A glance at the ideogram will show, however, that the discrepancy is often not severe for reasonably distributed input.

(ii) The second way in which we try to take account of $\chi^2/(N-1)$ being greater than 1 is to scale up our quoted error $\delta\bar{x}$ in Eq. (1) by a factor

$$\text{SCALE} = [\chi^2/(N-1)]^{1/2} . \tag{2}$$

Our reasoning is as follows. Since we don't know which one or more of the experiments are wrong, we assume that all experimentalists underestimated their errors by the same scale factor (2). If we scale up all input errors by this factor, χ^2 returns to $N-1$, and of course the output error scales up by the same factor.

If all the experiments have errors of about the same size, the above (straightforward) procedure for calculating SCALE is carried out. If, however, we are to combine experiments with widely varying errors, we must modify the procedure slightly. This is because it is the more precise experiments that most influence not only the average value $\bar{x}$, but also the error $\delta\bar{x}$. Now, on the average, the low-precision experiments each contribute about unity to *both* the numerator and the denominator of SCALE, hence the χ^2 contribution of the sensitive experiments is diluted, i.e., reduced. Therefore, we evaluate SCALE by using *only* experiments for which the error are not much greater than those of the more precise experiments. Explicitly, to calculate SCALE we use only the most sensitive experiments, i.e., those with errors less than δ_0, where the ceiling δ_0 is (arbitrarily) chosen to be

$$\delta_0 = 3N^{1/2}\delta\bar{x} .$$

Here $\delta\bar{x}$ is the unscaled error of the mean of all the experiments. Note that if each experiment had the same error δx_i, then $\delta\bar{x}$ would be $\delta x_i/N^{1/2}$, so each individual

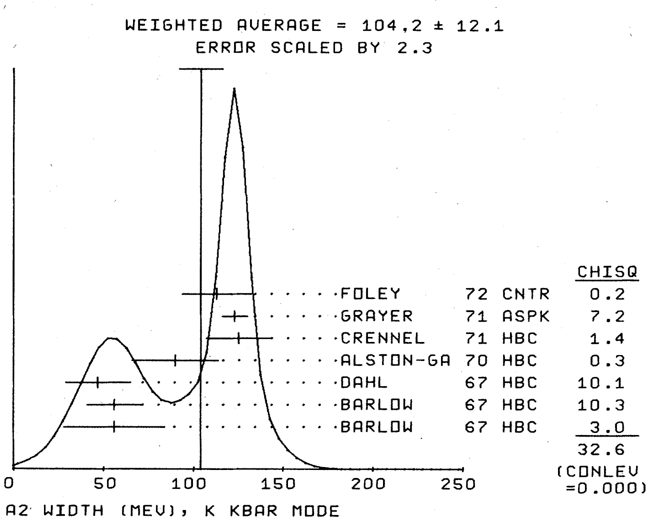

FIG. 3. Ideogram of measurements of the A_2 width, as determined from the $K\bar{K}$ mode. The vertical line indicates the position of the weighted average, while the horizontal bar atop the line gives the error in the average after scaling by the SCALE factor. Only those experiments indicated by + error flags were precise enough to be accepted in the calculation of the SCALE factor; the column on the far right gives the χ^2 contribution of each of these experiments. The less precise experiments were included in the calculation of the weighted average, but not SCALE; they have ⊥ error flags.

experiment would be well under the ceiling on SCALE.

This scaling approach has the property that if there are two values with comparable errors separated by much more than their stated errors (with or without a number of other experiments of lower accuracy), the error on the mean value $\delta\bar{x}$ is increased so that it is approximately half the interval between the two discrepant values.

We wish to emphasize the fact that our scaling procedures for *errors* in no way affect central values. In addition, if one wishes to recover the unscaled error $\delta\bar{x}$, he need only divide the given error by the SCALE factor for that error.

2. A second procedure—Student's distribution

The newly proposed method of averaging data, described in detail in Roos *et al.* (1975), relies upon an empirical determination of the distribution of the residuals for the ensemble of data appearing in the Review. The residual for the ith measurement of a quantity with average value $\bar{x}$ is defined as

$$h_i = (x_i - \bar{x})/\delta x_i .$$

Roos *et al.* select several different subsamples of the data, and show that the residuals for *each* subsample have approximately the same properties; in particular, their first few even moments are similar. Since the distributions have longer tails than a Gaussian, the authors choose to represent them by a distribution function having such a property, namely the Student distribution

$$S_n(h/c) = K\left[1 + \frac{(h/c)^2}{n}\right]^{-(n+1)/2} . \qquad (3)$$

Here K is a normalization constant, and n and c are parameters which the authors then fit to the combined sample of data. The resulting empirical distribution is

$$S_{10}(h/1.11) = 0.351\left[1 + \frac{(h/1.11)^2}{10}\right]^{-11/2} . \qquad (4)$$

Note that the shape of S_{10} is somewhere between that of a Gaussian ($=S_\infty$) and that of a Breit–Wigner ($=S_1$).

The proposed method of averaging the data for a given quantity then consists of finding the value of $\bar{x}$ which maximizes the log-likelihood function

$$\mathrm{Log}\mathcal{L}(\{x_i\}\,|\,\bar{x}) = \sum_i S_{10}\left(\frac{x_i - \bar{x}}{1.11\,\delta x_i}\right); \qquad (5)$$

the sum here is again taken over all N measurements of x. The error $\delta\bar{x}$ is determined by finding the variation in $\bar{x}$ needed to decrease the log-likelihood by 1/2:

$$\log\mathcal{L}(\{x_i\}\,|\,\bar{x}) - \log\mathcal{L}(\{x_i\}\,|\,\bar{x} \pm \delta\bar{x}) = \tfrac{1}{2} . \qquad (6)$$

3. Comparison of procedures

Both of the procedures described above adopt a partially empirical approach to the problem that measured values for the quantities tabulated in this Review do not exhibit the Gaussian behavior naively expected. (This problem, it should be noted, persists even when careful attempts are made to resolve difficulties and inconsistencies in the data prior to averaging.)

The first approach operates on a quantity-by-quantity basis and adjusts the error in each case so that no scaled $\chi^2/(N-1)$ is greater than 1. This is obviously rather conservative, since even if the data obeyed a Gaussian distribution, about half of the quantities would be expected to have $\chi^2/(N-1) > 1$.

The second approach, on the other hand, assumes that (provided we first eliminate quantities with obvious, known problems) all quantities have the same theoretical distribution function, namely the fairly long-tailed $S_{10}(h/1.11)$. With this supposition, if a *particular* quantity has a large χ^2, it is assumed to be just a happenstance, occasioned by a random fluctuation into the long tails, and no special scaling for this quantity is done. This procedure thus results in generally smaller, or less conservative, error estimates for quantities having $\chi^2/(N-1) > 1$. (However, it should be noted that, because of the overall scale of 1.11 appearing in the empirical Student's distribution, the errors for quantities with $\chi^2/(N-1) \leq 1$ are actually increased by about 10%.) Table III shows some comparisons of sample results from the two procedures, using data from the 1974 edition of the Review. Shifts in both $\bar{x}$ and $\delta\bar{x}$ can be observed, especially where SCALE > 1.

Since the new procedure is a significant departure from the past, we have adopted the following approach for this year: in the Data Card Listings we give the average-and-error for each quantity calculated both ways; the standard way is labeled at the left with the code "AVG," while the proposed newer way is labeled

TABLE III. Comparison of procedures.

Particle property	Pure Gaussian $\bar{x} \pm \delta\bar{x}$	Standard method: Gaussian + scale factor $\bar{x} \pm \delta\bar{x}$	SCALE	Proposed method: Student's distribution $\bar{x} \pm \delta\bar{x}$
ρ^0 mass (MeV)	770.32 ± 0.65	770.32 ± 0.91	1.4	770.37 ± 0.82
η' mass (MeV)	957.59 ± 0.24	957.59 ± 0.24	1.0	957.58 ± 0.28
ϕ mass (MeV)	1019.69 ± 0.15	1019.69 ± 0.28	1.9	1019.83 ± 0.20
$K^*(1420)$ mass (MeV)	1421.3 ± 2.3	1421.3 ± 2.3	1.0	1421.3 ± 2.6
K_L^0 mean life (10^{-8} sec)	5.158 ± 0.042	5.158 ± 0.042	1.0	5.158 ± 0.046
Σ^+ mean life (10^{-10} sec)	0.8004 ± 0.0058	0.8004 ± 0.0058	1.0	0.8004 ± 0.0064
Σ^- mean life (10^{-10} sec)	1.482 ± 0.011	1.482 ± 0.017	1.5	1.479 ± 0.013
$K^\pm \to \pi^\pm\pi^+\pi^-$ (%)	5.521 ± 0.075	5.521 ± 0.098	1.3	5.533 ± 0.089
$\Lambda \to p\pi^-$ (%)	63.99 ± 0.49	63.99 ± 0.49	1.0	63.98 ± 0.55

"STUDENT." In the Tables of Particle Properties, we continue to use the standard procedure—Gaussian with SCALE factor. As in the past, a SCALE factor greater than 1 is indicated by the appearance of "$S = \ldots$" next to the value and error.

We heartily invite your comments on the proposed Student's distribution method. They will assist us in deciding on procedures for future editions.

B. Constrained fits

Except for trivial cases, all branching ratios and rate measurements are analyzed by computer program AHR. This program makes a simultaneous least-squares fit to all the data, and outputs the partial-decay fractions $\overline{P}_i$, width Γ, partial widths Γ_i, and their error matrix.

The original version of AHR was written by J. Peter Berge. It is documented separately, and we wish here only to give the simplest nontrivial example that permits us to comment on the error matrix and the scale factor.

Assume that a state has only three partial-decay fractions, P_1, P_2, and P_3 ($\sum P_i = 1$), which have been measured in four different ratios, $R_1, \ldots, R_4$, where, e.g., $R_1 = P_1/P_2, R_2 = P_1/P_3$, etc.[4] Further assume that *each* ratio has been measured by N experiments (we designate each experiment with a subscript x, e.g., R_{1x}). Then AHR finds the best values of P_1, P_2, and P_3 by minimizing χ^2, namely

$$\chi^2 = \sum_{r=1}^{4} \left[\sum_{x=1}^{N} \left(\frac{R_{rx} - R_r(P_1, P_2, P_3)}{\delta R_{rx}} \right)^2 \right]. \qquad (7)$$

In addition to the fitted values $\overline{P}_i$, the program calculates an error matrix $\langle \delta\overline{P}_i \delta\overline{P}_j \rangle$. We tabulate the diagonal elements $\delta\overline{P}_i = \langle \delta\overline{P}_i \delta\overline{P}_i \rangle^{1/2}$ [except that some errors are scaled according to Eq. (2) as discussed below]. In the listings we give the complete error matrix; we also calculate the fitted value of each ratio, for comparison with the input data, and list it below the relevant input, along with a simple unconstrained average of the same input.

Two further comments on the example above:

(1) There was no connection between measurements of the width and the branching ratios. But often we also have information on partial widths Γ_i as well as total width Γ. In this case AHR must introduce Γ as a parameter into the fit, along with the relations $\Gamma_i = \Gamma P_i$, $\sum \Gamma_i = \Gamma$. When appropriate, we tabulate the Γ_i along with the P_i, and give error matrices in the listings.

(2) Note that we do *not* allow for correlations between input data. We *do* try to pick those ratios and widths which are as independent and as close to the original data as possible.

In *asymmetric* errors, we use a continuous function of $\delta(P)^+$ and $\delta(P)^-$ in the fitting. When no errors are reported, we merely list the data for inspection.

Hyperon-decay parameters

The program AHR handles any type of input, α, Φ, Δ, β, or γ, according to the definitions of Sec. VI. If for a particular hyperon decay there are data for more than two of the decay parameters, they are analyzed by using the constraint

$$\alpha^2 + \beta^2 + \gamma^2 = 1 .$$

Inconsistent constrained data

According to our simple example, which led to Eq. (7), the double sum for χ^2 is summed over experiments $x = 1$ to N, leaving a single sum over ratios

$$\chi^2 = \sum_r \chi_r^2 .$$

Even before fitting, some of the χ_r^2 may be too large. But if we scaled them before fitting, then the scaling would move the central value, contrary to our policy. So we do not scale until after the first fit; then, knowing the fitted χ_r^2 and its expectation value $\langle \chi_r^2 \rangle$ we form SCALE factors (just as before), i.e.,

$$(\mathrm{SCALE})_r^2 = \chi_r^2 / \langle \chi_r^2 \rangle ,$$

and if any $(\mathrm{SCALE})_r$ is greater than 1, all N of the measurements of that particular ratio are equally penalized by having their errors increased by SCALE. Program AHR then recycles on all the data, those with errors unchanged as well as those with errors increased. We then get new values, $\delta\overline{P}_i'$ for the errors in the partial decay modes.

Because of the constraint ($\sum P_i = 1$) some SCALE factors may still be greater than 1 even after this second pass. If this is so, the whole procedure (i.e., increasing errors by the new SCALE factors and recycling through AHR) is repeated.

At the end of AHR's final pass we have *two* measures of the errors for the $\overline{P}_i$. One is, of course, the $\delta\overline{P}_i'$, i.e., the errors in the final fitted values $\overline{P}_i'$ which include the effects of scaling the input errors. The other measure of the errors is $(\overline{P}_i - \overline{P}_i')$, i.e., the *shift* in the central values of the ith mode between the first (unscaled) fit and the final (scaled) fit. In practice we find that on the average these two measures of the uncertainty are about equal. Rather than selecting just one or the other, our tabulated errors are given by the combination

$$(\delta\overline{P}_i)_{\mathrm{tab}} = [\delta\overline{P}_i'^2 + (\overline{P}_i - \overline{P}_i')^2]^{1/2} ,$$

where $\overline{P}_i$ is the fitted value of the ith partial-decay mode before scaling, $\overline{P}_i'$ is its value after scaling, and $\delta\overline{P}_i'$ is the error in $\overline{P}_i'$. The SCALE factors we finally list in such cases are defined by

$$(\mathrm{SCALE})_i = (\delta\overline{P}_i)_{\mathrm{tab}} / \delta\overline{P}_i .$$

However, in line with our policy of not letting SCALE affect the central values, we give the values of $\overline{P}_i$ obtained from the original (unscaled) fits. [The differences between the $\overline{P}_i$ calculated with either the scaled or the unscaled errors are, of course, always within the tabulated errors, $(\delta\overline{P}_i)_{\mathrm{tab}}$.]

VIII. A LOOK AT HISTORY

It may be said that one can estimate the age of a high energy physicist by asking him or her the mass of the

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[4] We can handle any R of the form $R = \sum \alpha_i P_i / \sum \beta_i P_i'$, where α_i and β_i are constants, usually 1 or 0.

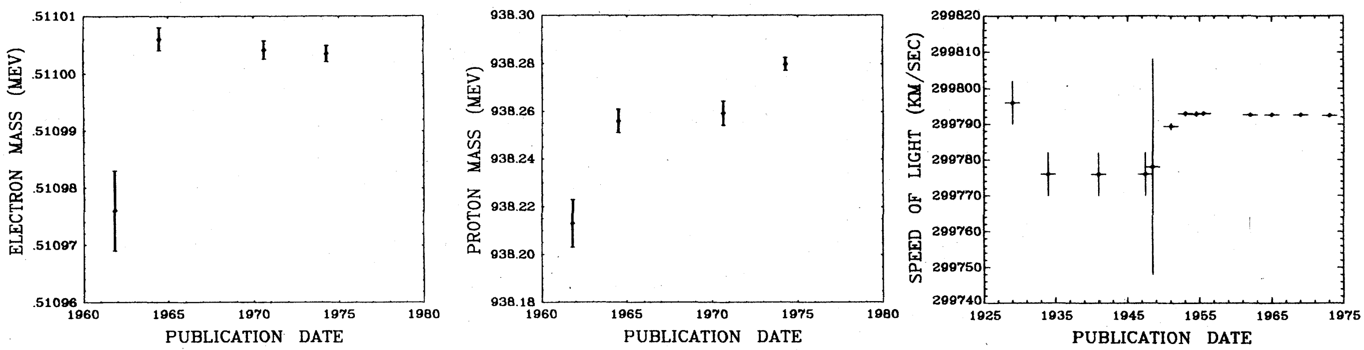

FIG. 4. The "generally accepted values" of the proton mass, the electron mass, and the speed of light, as a function of the publication data of the compilation used (not done by Particle Data Group). Data for the speed of light plot courtesy of E. R. Cohen, Rockwell International Science Center. See the Stable Particle Data Card Listings for references on proton and electron masses.

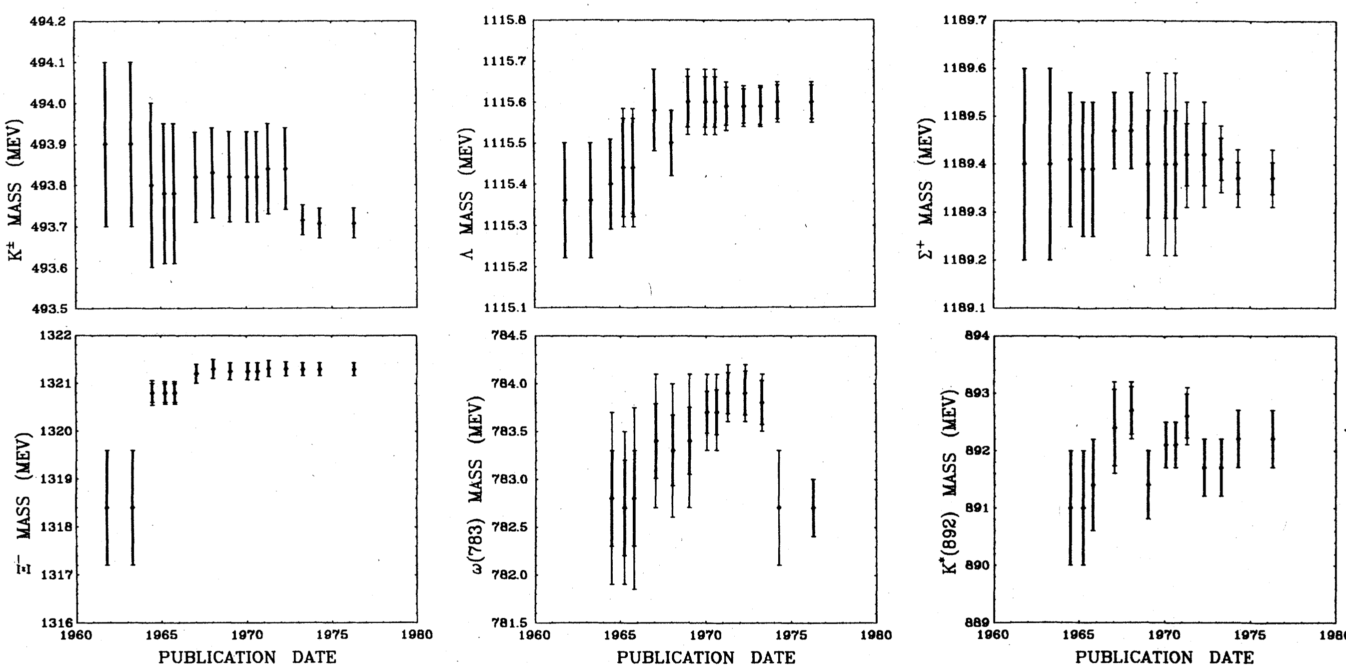

FIG. 5. Particle Data Group averages of the masses of various particles, as a function of date of publication of Review of Particle Properties (Adapted, with permission, from *Annual Review of Nuclear Science,* Volume 25.

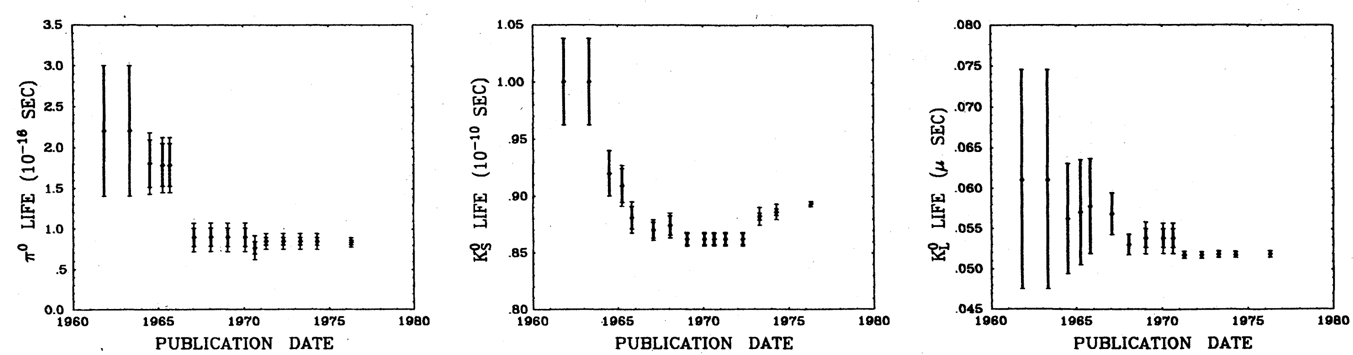

FIG. 6. Particle Data Group averages of the lifetimes of various particles, as a function of publication date of RPP.

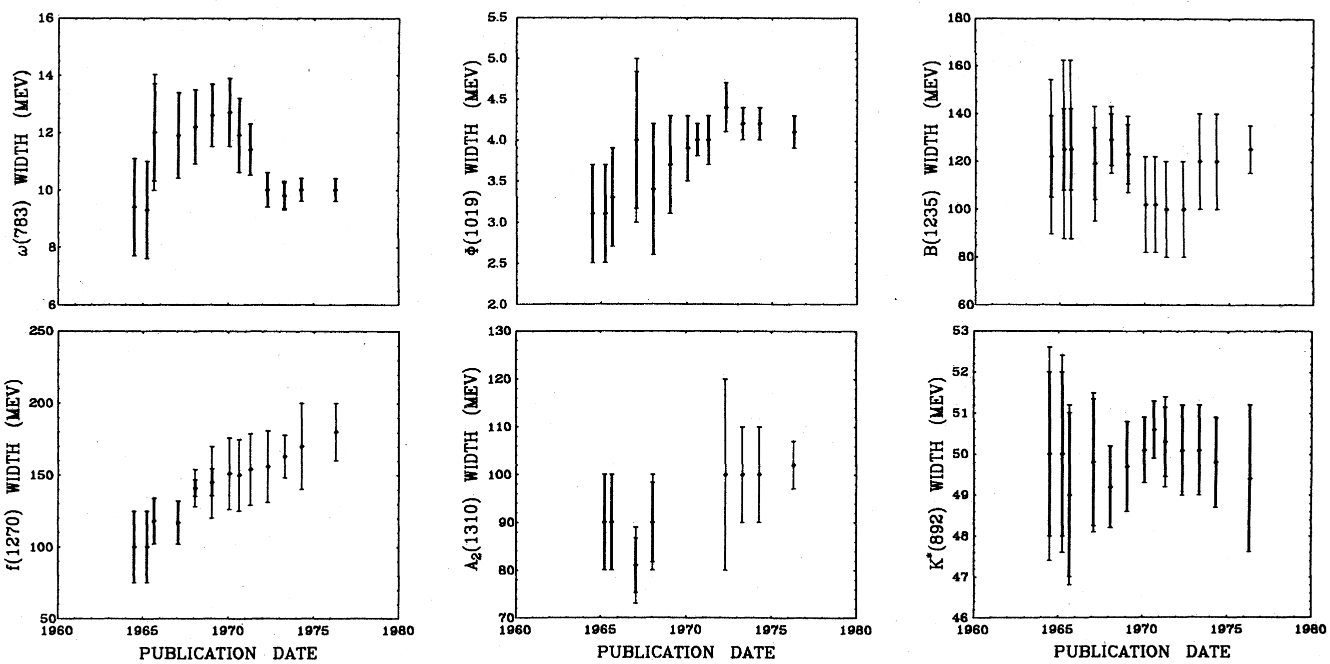

FIG. 7. Particle Data Group averages of the widths of various resonances, as a function of date of publication of RPP. The gap in the A_2 data indicates the years when the A_2 was thought to be split.

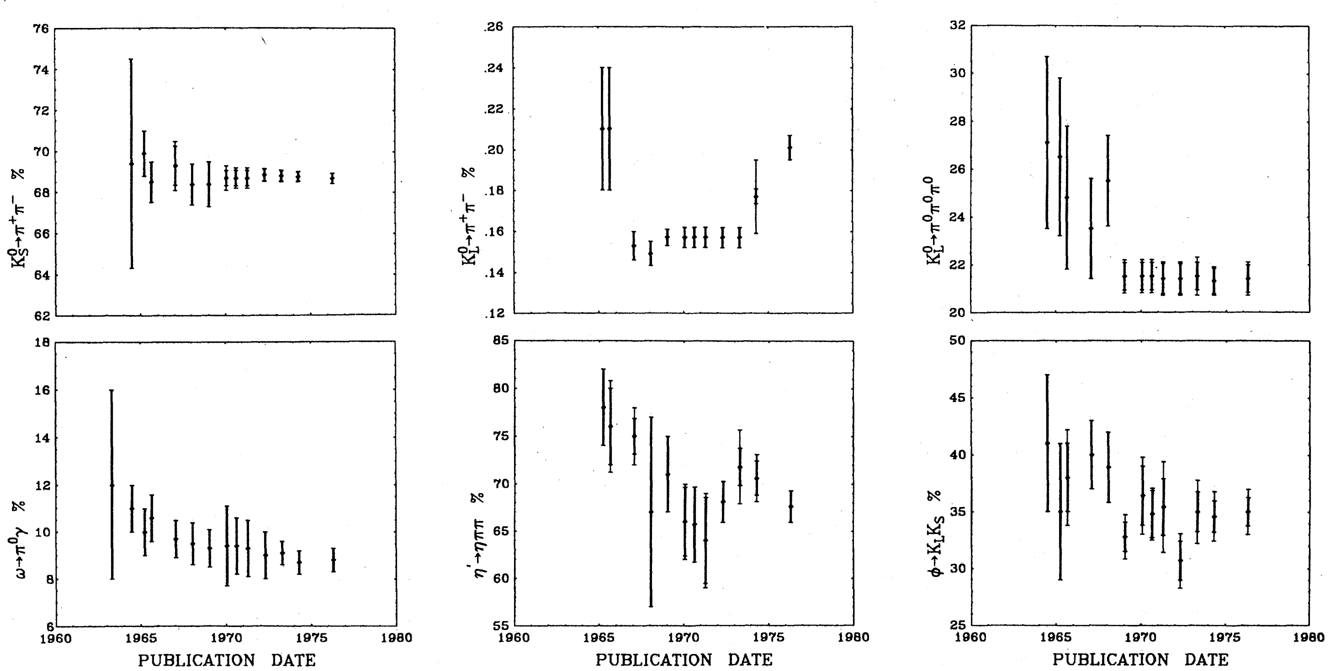

FIG. 8. Particle Data Group averages of various branching fractions, as a function of date of publication of RPP.

Λ^0. If the answer is 1115.44 MeV, he probably was deep into his graduate training in 1965.

A history of the values of physical constants has more than whimsical value. In Fig. 4 we show how the generally accepted values for the speed of light and a couple of other constants have changed with time. The "generally accepted value" is usually an average over several experiments, performed by a compiler (in Fig. 4, the compiler is other than the Particle Data Group in all cases, although we do of course quote the complied results). The x axis on all these figures is the date of publication of the value shown. Clearly there is a general progression toward better understanding—at least as measured by the size of the error bars. However, the size of the error bars do not tell the full story, as we can see by the frequency with which the "best" value has changed by more than one standard deviation. Changes in these values can come from several sources—a new experimental measurement, re-evaluation of an old measurement (which can come about if a previously unrecognized source of bias is discovered and corrected, or if a new value for one of the input constants, e.g. the electric change, is available), or a change in the averaging procedure.

In Fig. 5 we show the history of some masses (including the Λ^0, for radioactive Λ^0 dating of your colleagues), based on averages which we ourselves have performed. All of these were originally presented in Rosenfeld (1975). The publication date refers to the publication of the Review of Particle Properties.

In Fig. 6 we show the best estimates for the lifetimes of some of the particles stable against strong decay. These and subsequent figures have been compiled since publication of Rosenfeld (1975). In Fig. 7 we show the widths of some of the resonances, and in Fig. 8, the values of some of the branching fractions. All values are taken from the Tables. Before 1964, very few branching fractions were listed in the Tables. In all cases, a representative sample is chosen. In each figure, the heavy inner error bar represents the statistical error computed in the averaging procedure, and the thin outer error bars, when present, indicate the increase in the error due to the scale factor. The scale factor is described in the preceding section. It represents an attempt to quantify the increase in the uncertainty which is present in the case of experiments which disagree by more than a certain amount. In the case where the error represents an "educated guess," rather than a calculation, the inner error bar is absent.

On the whole, the number of times the values have changed by more than one standard deviation over the years is remarkably few. Even those branching fractions which involve rare decays and which are therefore presumably difficult to measure (Fig. 8) are, for the most part, within one or two standard deviations in 1974 of their value in any year since 1960. This is in spite of the vast amount of new experimental input, and indicates the general reliability of the results.

Of course, the data points for the different years are hardly independent of each other, but those differing by several years frequently have quite different experimental input. The relative lack of change is a comment both on the experiments and on the averaging procedures. We, of course, are responsible only for the averages (but not on Fig. 4). These averages entail considerable exercise of judgment: there are conflicting experiments, experiments with impossibly small errors, "preliminary" results, and so forth. Statistical procedures will tell us that two experiments do not agree; they do not give a clue as to which (if either) is a good representation of the truth. Major decisions, and their motivations, are usually discussed on a case-by-case basis in the Data Card Listings; general comments may be found in Sec. II and in Rosenfeld (1975). Note that, occasionally, the error bars increase from one publication to the next, in these figures. This is usually the result of decision making by the compiler, e.g., to cease using a particular result.

We show these figures not only to demonstrate that there is not much change in these averages in the usual case, but also to show that there exist cases with relatively large changes. There is a psychological danger in preparing tables of "right" answers. The old joke about the experimenter who fights the systematics until he or she get the "right" answer (read "agrees with previous experiments"), and then publishes, contains a germ of truth (presumably, those who compile and average experimental results are also not immune to this disease). A result can disagree with the average of all previous experiments by five standard deviations, and still be right! Hence, perhaps it is of value to show that large changes can (and do) sometimes occur.

In summary, with the addition of Figs. 7–8, not available at the time of publication of Rosenfeld (1975), we find we can reiterate his conclusions. Namely, that the combination of careful work by experimenters and by compilers (which involved excluding around 40% of the data from the averages, adjusting impossibly small errors, etc.), and the frequent use of the conservative scale factor, has produced averages whose reliability is remarkably good.

ACKNOWLEDGMENTS

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TABLES OF PARTICLE PROPERTIES

April 1976

N. Barash-Schmidt, A. Barbaro-Galtieri, C. Bricman, V. Chaloupka,
R. J. Hemingway, R. L. Kelly, M. J. Losty, A. Rittenberg,
M. Roos, A. H. Rosenfeld, T. G. Trippe, G. P. Yost

(Closing date for data: Jan. 1, 1976)

Stable Particle Table

For additional parameters, see Addendum to this table.

Quantities in italics have changed by more than one (old) standard deviation since April 1974.

Particle	$I^G(J^P)C_n$	Mass (MeV) Mass^2 (GeV)^2	Mean Life (sec) $c\tau$ (cm)	Partial decay mode: Mode	Fraction[a]	p or p_{max}[b] (MeV/c)
γ	0,1(1$^-$)−	0($<7\times10^{-22}$)	stable	stable		
ν	J=$\frac{1}{2}$	ν_e: 0(<0.00006)	stable	stable		
		ν_μ: 0(<0.65)				
e	J=$\frac{1}{2}$	0.5110034	stable ($>5\times10^{21}$y)	stable		
		±.0000014				
μ	J=$\frac{1}{2}$	105.65948	*2.197134×10^{-6}*	$e\nu\bar{\nu}$	100 %	53
		±.00035	*±.000077*	$e\gamma\gamma$	(<4)$\times10^{-6}$	53
		m^2=0.01116	$c\tau=6.5868\times10^4$	3e	(<6)$\times10^{-9}$	53
		$m_\mu-m_{\pi^\pm}$=−33.909		$e\gamma$	(<2.2)$\times10^{-8}$	53
		±.006		$e^+\bar{\nu}_e\nu_\mu$	(<25)%	53
$\pi^\pm$	1$^-$(0$^-$)	139.5688	2.6030×10^{-8}	$\mu\nu$	100 %	30
		±.0064	±.0023	$e\nu$	(1.267±0.023)$\times10^{-4}$	70
		m^2=0.0195	$c\tau$=780.4	$\mu\nu\gamma$	[c](1.24±0.25)$\times10^{-4}$	30
			$(\tau^+-\tau^-)/\bar{\tau}$=	$\pi^0 e\nu$	(1.02±0.07)$\times10^{-8}$	5
			(0.05±0.07)%	$e\nu\gamma$	[c](3.0 ±0.5)$\times10^{-8}$	70
			(test of CPT)	$e\nu e^+e^-$	(<3.4)$\times10^{-8}$	70
π^0	1$^-$(0$^-$)+	134.9645	0.828×10^{-16}	$\gamma\gamma$	(98.85±0.05)%	67
		±.0074	±.057 S=1.8*	γe^+e^-	(1.15±0.05)%	67
		m^2=0.182	$c\tau=2.5\times10^{-6}$	$\gamma\gamma\gamma$	(<5)$\times10^{-6}$	67
		$m_{\pi^\pm}-m_{\pi^0}$=4.6043		$e^+e^-e^+e^-$	[d](3.32)$\times10^{-5}$	67
		±.0037		$\gamma\gamma\gamma\gamma$	(<6)$\times10^{-5}$	67
				e^+e^-	(<2)$\times10^{-6}$	67

Stable Particle Table *(cont'd)*

Particle	$I^G(J^P)C_n$	Mass (MeV) Mass^2 (GeV)^2	Mean life (sec) $c\tau$ (cm)	Partial decay mode: Mode	Fraction[a]	p or p_{max}[b] (MeV/c)
$K^{\pm}$	$\frac{1}{2}(0^-)$	493.707	1.2371×10^{-8}	$\mu\nu$	(63.61±0.16)%	236
		±0.037	±.0026 S=1.9*	$\pi\pi^0$	(21.05±0.14)%	205
		m^2=0.244	$c\tau$=370.9	$\pi\pi^-\pi^+$	(5.59±0.03)% S=1.1*	125
			$(\tau^+-\tau^-)/\bar{\tau}$=	$\pi\pi^0\pi^0$	(1.73±0.05)% S=1.4*	133
			(.11±.09)%	$\mu\pi^0\nu$	(3.20±0.09)% S=1.7*	215
			(test of CPT)	$e\pi^0\nu$	(4.82±0.05)% S=1.1*	228
			S=1.2*	$\mu\nu\gamma$	[c](5.8 ±3.5)$\times10^{-3}$	236
				$e\pi^0\pi^0\nu$	(1.8 $^{+2.4}_{-0.6}$)$\times10^{-5}$	207
		$m_{K^\pm}-m_{K^0}$=−3.99		$\pi\pi^\mp e^\pm\nu$	(3.7 ±0.2)$\times10^{-5}$	203
		±0.13		$\pi\pi^\pm e^\mp\nu$	(<5)$\times10^{-7}$	203
		S=1.1*		$\pi\pi^\mp\mu^\pm\nu$	(0.9 ±0.4)$\times10^{-5}$	151
				$\pi\pi^\pm\mu^\mp\nu$	(<3.0)$\times10^{-6}$	151
				$e\nu$	(1.54±0.09)$\times10^{-5}$	247
				$e\nu\gamma$	[c](1.62±0.47)$\times10^{-5}$	247
				$\pi\pi^0\gamma$	[e,c](2.71±0.19)$\times10^{-4}$	205
				$\pi\pi^+\pi^-\gamma$	[c](1.0 ±0.4)$\times10^{-4}$	125
				$\mu\pi^0\nu\gamma$	[c](<6)$\times10^{-5}$	215
				$e\pi^0\nu\gamma$	[c](3.7 ±1.4)$\times10^{-4}$	228
				πe^+e^-	(2.6 ±0.5)$\times10^{-7}$	227
				$\pi^\mp e^\pm e^\pm$	(<1.5)$\times10^{-5}$	227
				$\pi\mu^+\mu^-$	(<2.4)$\times10^{-6}$	172
				$\pi\gamma\gamma$	[c](<3.5)$\times10^{-5}$	227
				$\pi\gamma\gamma\gamma$	[c](<3.0)$\times10^{-4}$	227
				$\pi\nu\bar{\nu}$	(<0.6)$\times10^{-6}$	227
				$\pi\gamma$	(<4)$\times10^{-6}$	227
				$e\pi^\mp\mu^\pm$	(<2.8)$\times10^{-8}$	214
				$e\pi^\pm\mu^\mp$	(<1.4)$\times10^{-8}$	214
				$\mu\nu\nu\bar{\nu}$	(<6)$\times10^{-6}$	236
K^0	$\frac{1}{2}(0^-)$	497.70	50% K_{Short}, 50% K_{Long}			
		±0.13				
		S=1.1*				
		m^2=0.248				
K^0_S	$\frac{1}{2}(0^-)$		0.8930×10^{-10} (f)	$\pi^+\pi^-$	(68.67)% ±0.25 S=1.1*	206
			±.0023	$\pi^0\pi^0$	(31.33)%	209
			$c\tau$=2.68	$\mu^+\mu^-$	(<3.2)$\times10^{-7}$	225
				e^+e^-	(<3.4)$\times10^{-4}$	249
				$\pi^+\pi^-\gamma$	[c](2.0 ±0.4)$\times10^{-3}$	206
				$\gamma\gamma$	(<0.4)$\times10^{-3}$	249
K^0_L	$\frac{1}{2}(0^-)$		5.181×10^{-8}	$\pi^0\pi^0\pi^0$	(21.4 ±0.7)% S=1.2*	139
			±.040	$\pi^+\pi^-\pi^0$	(12.25±0.18)% S=1.1*	133
			$c\tau$=1553	$\pi\mu\nu$	(27.1 ±0.5)%	216
				$\pi e\nu$	[g](39.0 ±0.5)% S=1.1*	229
				$\pi e\nu\gamma$	[g,c](1.3 ±0.8)%	229
		$m_{K_L}-m_{K_S}$= *0.5349×10^{10}* $\hbar$ sec^{-1}		$\pi^+\pi^-$	[f](*0.201±0.006*)%	206
		±0.0022		$\pi^0\pi^0$	(0.094±0.019)% S=1.5*	209
				$\pi^+\pi^-\gamma$	[c](6.0 ±2.0)$\times10^{-5}$	206
				$\pi^0\gamma\gamma$	(<2.4)$\times10^{-4}$	231
				$\gamma\gamma$	(4.9 ±0.5)$\times10^{-4}$	249
				$e\mu$	(<2.0)$\times10^{-9}$	238
				$\mu^+\mu^-$	[h](1.0 ±0.3)$\times10^{-8}$	225
				$\mu^+\mu^-\gamma$	(<7.8)$\times10^{-6}$	225
				$\mu^+\mu^-\pi^0$	(<5.7)$\times10^{-5}$	177
				e^+e^-	(<2.0)$\times10^{-9}$	249
				$e^+e^-\gamma$	(<2.8)$\times10^{-5}$	249
				$\pi^+\pi^-e^+e^-$	(<7.2)$\times10^{-6}$	206
				$\pi^0\pi^\pm e^\mp\nu$	(<2.2)$\times10^{-3}$	207
η	$0^+(0^-)+$	548.8	[e]Γ=(*0.85±0.12*)keV[i]	$\gamma\gamma$	(38.0 ±1.0)% S=1.2*	274
		±0.6	Neutral decays	$\pi^0\gamma\gamma$	[i](3.1 ±1.1)% S=1.2*	258
		S=1.4*	(71.0±0.7)%	$3\pi^0$	(29.9 ±1.1)% S=1.1*	180
		m^2=0.301	S=1.1*	$\pi^+\pi^-\pi^0$	(23.6 ±0.6)% S=1.1*	175
				$\pi^+\pi^-\gamma$	(*4.89±0.13*)% S=1.1*	236
				$e^+e^-\gamma$	(*0.50±0.12*)%	274
				$\pi^0e^+e^-$	(<0.04)%	258
				$\pi^+\pi^-$	(<0.15)%	236
			Charged decays	$\pi^+\pi^-e^+e^-$	(0.1 ±0.1)%	236
			(29.0±0.7)%	$\pi^+\pi^-\pi^0\gamma$	(<6)$\times10^{-4}$	175
			S=1.1*	$\pi^+\pi^-\gamma\gamma$	(<0.2)%	236
				$\mu^+\mu^-$	(2.2 ±0.8)$\times10^{-5}$	253
				$\mu^+\mu^-\pi^0$	(<5)$\times10^{-4}$	211

Stable Particle Table *(cont'd)*

Particle	$I^G(J^P)C_n$	Mass (MeV) Mass^2 (GeV)^2	Mean Life (sec) $c\tau$ (cm)	Partial decay mode: Mode	Fraction[a]	p or p_{max}[b] (MeV/c)
p	$\frac{1}{2}(\frac{1}{2}^+)$	938.2796 ±0.0027 m^2= 0.8804	stable (>2×10^{30}y)			
n	$\frac{1}{2}(\frac{1}{2}^+)$	939.5731 ±0.0027 m^2= 0.8828 m_p-m_n=−1.29343 ±0.00004	918±14 $c\tau$=2.75×10^{13}	$pe^-\nu$	100 %	1
Λ	$0(\frac{1}{2}^+)$	1115.60 ±0.05 S=1.2* m^2= 1.245	2.578×10^{-10} ±.021 S=1.6* $c\tau$=7.73	$p\pi^-$	(64.2 ± 0.5)%	100
				$n\pi^0$	(35.8 ± 0.5)%	104
				$pe^-\nu$	(8.13±0.29)$\times10^{-4}$	163
				$p\mu^-\nu$	(1.57±0.35)$\times10^{-4}$	131
				$p\pi^-\gamma$	c(0.85±0.14)$\times10^{-3}$	100
Σ^+	$1(\frac{1}{2}^+)$	1189.37 ±0.06 S=1.8* m^2= 1.415	0.800×10^{-10} ±.006 $c\tau$=2.40	$p\pi^0$	(51.6 ±0.7)%	189
				$n\pi^+$	(48.4 ±0.7)%	185
				$p\gamma$	(1.24±0.18)$\times10^{-3}$ S=1.4*	225
				$n\pi^+\gamma$	c(0.93±0.10)$\times10^{-3}$	185
				$\Lambda e^+\nu$	(2.02±0.47)$\times10^{-5}$	71
		$m_{\Sigma^+}-m_{\Sigma^-}$= −7.98 ±.08 S=1.2*	$\frac{\Gamma(\Sigma^+\to\ell^+n\nu)}{\Gamma(\Sigma^-\to\ell^-n\nu)}$<.043 ←	$n\mu^+\nu$	(<3.0)$\times10^{-5}$	202
				$ne^+\nu$	(<0.5)$\times10^{-5}$	224
				pe^+e^-	(<7)$\times10^{-6}$	225
Σ^0	$1(\frac{1}{2}^+)$	1192.47 ±0.08 m^2= 1.422	<1.0×10^{-14} $c\tau$<3×10^{-4}	$\Lambda\gamma$	100 %	74
				Λe^+e^-	d(5.45)$\times10^{-3}$	74
				$\Lambda\gamma\gamma$	(<3)%	74
Σ^-	$1(\frac{1}{2}^+)$	1197.35 ±0.06 m^2= 1.434	1.482×10^{-10} ±.017 S=1.5* $c\tau$=4.44	$n\pi^-$	100 %	193
				$ne^-\nu$	(1.08±0.04)$\times10^{-3}$	230
				$n\mu^-\nu$	(0.45±0.04)$\times10^{-3}$	210
				$\Lambda e^-\nu$	(0.60±0.06)$\times10^{-4}$	79
		$m_{\Sigma^0}-m_{\Sigma^-}$= −4.88 ±.06		$n\pi^-\gamma$	c(4.6 ±0.6)$\times10^{-4}$	193
Ξ^0	$\frac{1}{2}(\frac{1}{2}^+)$(j)	1314.9 ±0.6 m^2= 1.729	2.96×10^{-10} ±.12 $c\tau$=8.87	$\Lambda\pi^0$	100 %	135
				$\Lambda\gamma$	(0.5 ±0.5)%	184
				$\Sigma^0\gamma$	(<7)%	117
				$p\pi^-$	(<3.6)$\times10^{-5}$	299
				$pe^-\nu$	(<1.3)$\times10^{-3}$	323
				$\Sigma^+e^-\nu$	(<1.1)$\times10^{-3}$	120
				$\Sigma^-e^+\nu$	(<0.9)$\times10^{-3}$	112
		$m_{\Xi^0}-m_{\Xi^-}$=−6.4 ±.6		$\Sigma^+\mu^-\nu$	(<1.1)$\times10^{-3}$	64
				$\Sigma^-\mu^+\nu$	(<0.9)$\times10^{-3}$	49
				$p\mu^-\nu$	(<1.3)$\times10^{-3}$	309
Ξ^-	$\frac{1}{2}(\frac{1}{2}^+)$(j)	1321.29 ±0.14 m^2= 1.746	1.652×10^{-10} ±.023 S=1.1* $c\tau$=4.95	$\Lambda\pi^-$	100 %	139
				$\Lambda e^-\nu$	k(0.69±0.18)$\times10^{-3}$	190
				$\Sigma^0e^-\nu$	(<0.5)$\times10^{-3}$	123
				$\Lambda\mu^-\nu$	(3.5 ±3.5)$\times10^{-4}$	163
				$\Sigma^0\mu^-\nu$	(<0.8)$\times10^{-3}$	70
				$n\pi^-$	(<1.1)$\times10^{-3}$	303
				$ne^-\nu$	(<3.2)$\times10^{-3}$	327
				$n\mu^-\nu$	(<1.5)%	313
				$\Sigma^-\gamma$	(<1.2)$\times10^{-3}$	118
				$p\pi^-\pi^-$	(<4)$\times10^{-4}$	223
				$p\pi^-e^-\nu$	(<4)$\times10^{-4}$	304
				$p\pi^-\mu^-\nu$	(<4)$\times10^{-4}$	250
				$\Xi^0e^-\nu$	(<2.3)$\times10^{-4}$	6
Ω^-	$0(\frac{3}{2}^+)$(j)	1672.2 ±.4 m^2= 2.796	$1.3^{+0.3}_{-0.2}\times10^{-10}$ $c\tau$=4.0	$\Xi^0\pi^-$	Total of 43 events seen	293
				$\Xi^-\pi^0$		290
				ΛK^-		211

ADDENDUM TO

Stable Particle Table

e	$1.001\,159\,6567 \frac{e\hbar}{2m_ec}$ $\pm.000\,000\,0035$	
μ	*1.001 166 897* $\frac{e\hbar}{2m_\mu c}$ *±.000 000 027*	

μ Decay parameters (ℓ)

$\rho = 0.752\pm0.003$ $\eta = -0.12 \pm0.21$
$\xi = 0.972\pm0.013$ $\delta = 0.755\pm0.009$ $h = 1.00\pm0.13$
$|g_A/g_V| = 0.86^{+0.33}_{-0.11}$ $\phi = 180°\pm15°$

$K^\pm$

Mode	Partial rate (sec^{-1})	
$\mu\nu$	$(51.42\pm0.17)\times10^6$	S=1.2*
$\pi\pi^0$	$(17.02\pm0.12)\times10^6$	S=1.1*
$\pi\pi^+\pi^-$	$(4.52\pm0.02)\times10^6$	S=1.1*
$\pi\pi^0\pi^0$	$(1.40\pm0.04)\times10^6$	S=1.4*
$\mu\pi^0\nu$	$(2.58\pm0.07)\times10^6$	S=1.7*
$e\pi^0\nu$	$(3.90\pm0.04)\times10^6$	S=1.1*

K^0_S

$\pi^+\pi^-$	n(*0.7689±.0035*)$\times10^{10}$	
$\pi^0\pi^0$	n(0.3509±.0030)$\times10^{10}$	S=1.1*

K^0_L

$\pi^0\pi^0\pi^0$	$(4.13\pm0.14)\times10^6$	S=1.2*
$\pi^+\pi^-\pi^0$	$(2.36\pm0.04)\times10^6$	S=1.1*
$\pi\mu\nu$	$(5.23\pm0.10)\times10^6$	
$\pi e\nu$	$(7.52\pm0.11)\times10^6$	
$\pi^+\pi^-$	f,n(*3.88 ±0.11*)$\times10^4$	
$\pi^0\pi^0$	n(1.81 ±0.37)$\times10^4$	S=1.5*

$\Delta I = \frac{1}{2}$ rule for $K \to 3\pi$ (m)

$K^+\to\pi^+\pi^+\pi^-$	g=−0.214±.005	S=1.7*
$K^-\to\pi^-\pi^-\pi^+$	g=−0.214±.007	S=2.7*
$K^\pm\to\pi^0\pi^0\pi^\pm$	g= *0.550±.020*	S=1.6*
$K^0_L\to\pi^+\pi^-\pi^0$	g= *0.646±.014*	S=2.5*

Form factors for $K_{\ell3}$ decays (For ξ, λ^μ_+, and λ^μ_0 see Data Card Listings, especially note in $K^\pm$ section.)

K^+_{e3} $\lambda^e_+=0.029\pm.004$ K^0_{e3} $\lambda^e_+=0.0288\pm.0028$ S=1.4*

CP violation parameters (o,n,f)

$|\eta_{+-}|=(2.272\pm.023)\times10^{-3}$ $|\eta_{00}|=(2.32\pm.09)\times10^{-3}$ S=1.1*
$\phi_{+-}=(45.0\pm1.2)°$ $\phi_{00}=(48\pm13)°$
$|\eta_{+-0}|^2<0.12$ $|\eta_{000}|^2<0.28$ $\delta=(0.330\pm.012)\times10^{-2}$

$\Delta S = -\Delta Q$

Re x=0.008±.020 S=1.4* Im x = −0.003±.027 S=1.2*

η

Mode	Left−right asymmetry	Sextant asymmetry	Quadrant asymmetry
$\pi^+\pi^-\pi^0$	(0.12±.17)%	(0.19±0.16)%	(−0.17±0.17)%
$\pi^+\pi^-\gamma$	(0.88±.40)%		β=0.047±0.062

	Magnetic moment ($e\hbar/2m_pc$)		Decay parameters (p)					
			Measured		Derived			
			α	φ(degree)	γ	Δ(degree)	g_A/g_V	g_V/g_A
p	2.7928456 ±.0000011							
n	−1.913148 ±.000066	$pe^-\nu$					−1.250±.009 δ=(181.1±1.3)°	
Λ	−0.67 ±.06	$p\pi^-$	0.647±0.013	(−6.5±3.5)°	0.76	$(7.6^{+4.0}_{-4.1})°$		
		$n\pi^0$	0.651±0.045					
		$pe\nu$					−0.66±0.05 S=1.2*	
Σ^+		$p\pi^0$	−0.979±0.016	(36±34)°	0.17	(187±6)°		
	2.62 ±.41	$n\pi^+$	+0.066±0.016	(167±20)°	−0.97	$(-73^{+136}_{-10})°$		
		$p\gamma$	$-1.03^{+.52}_{-.42}$	S=1.1*				
Σ^-	−1.48 ±.37	$n\pi^-$	−0.069±0.008	(10±15)°	0.98	$(249^{+12}_{-115})°$		
		$ne^-\nu$					±(0.435±0.035)	
		$\Lambda e^-\nu$						0.24±0.23 S=1.3*
Ξ^0		$\Lambda\pi^0$	−0.44±0.08 S=1.3*	(21±12)°	0.84	$(216^{+13}_{-19})°$		
Ξ^-	−1.85 ±.75	$\Lambda\pi^-$	−0.392±0.021	(2±6)° S=1.1*	0.92	(185±13)°		
Ω^-		ΛK^-	$-0.66^{+0.36}_{-0.30}$					

Stable Particle Table *(cont'd)*

*S = Scale factor = $\sqrt{\chi^2/(N-1)}$, where N ≈ number of experiments. S should be ≈ 1. If S > 1, we have enlarged the error of the mean, $\delta\bar{x}$; i.e., $\delta\bar{x} \to S\delta\bar{x}$. This convention is still inadequate, since if S >> 1 the experiments are probably inconsistent, and therefore the real uncertainty is probably even greater than $S\delta x$. See text, and ideograms in Stable Particle Data Card Listings.

a. Quoted upper limits correspond to a 90% confidence level.
b. In decays with more than two bodies, p_{max} is the maximum momentum that any particle can have.
c. See Stable Particle Data Card Listings for energy limits used in this measurement.
d. Theoretical value; see also Stable Particle Data Card Listings.
e. The direct emission branching fraction is $(1.56\pm.35)\times10^{-5}$.
f. The $\tau(K_S^0)$ and $|\eta_{+-}|$ averages (and the related $K_L^0 \to \pi^+\pi^-$ branching fraction and rate averages) contain only post-1971 results. The pre-1971 averages were $|\eta_{+-}| = (1.95\pm0.03)\times10^{-3}$ and $\tau(K_S^0) = (0.862\pm0.006)\times10^{-10}$ sec. See notes on $|\eta_{+-}|$ and $\tau(K_S^0)$ discrepancies in Stable Particle Data Card Listings.
g. The branching fraction for $K_L^0 \to \pi e\nu$ includes the radiative events $K_L^0 \to \pi e\nu\gamma$.
h. This is above the contradictory result of Clark et al. ($<0.3\times10^{-8}$). See note in Stable Particle Data Card Listings.
i. See note in Stable Particle Data Card Listings.
j. P for Ξ and J^P for Ω^- not yet measured. Values reported are SU(3) predictions.
k. Assumes rate for $\Xi^- \to \Sigma^0 e^-\nu$ small compared with $\Xi^- \to \Lambda e^-\nu$.
ℓ. $|g_A/g_V|$ defined by $g_A^2 = |C_A|^2+|C'_A|^2$, $g_V^2 = |C_V|^2+|C'_V|^2$, and $\Sigma\langle\bar{e}|\Gamma_i|\mu\rangle\langle\bar{\nu}|\Gamma_i(C_i+C'_i\gamma_5)|\nu\rangle$;
ϕ defined by $\cos\phi = -\mathrm{Re}(C_A^*C'_V+C'_AC_V^*)/g_Ag_V$ [for more details, see text Section VI A].
m. The definition of the slope parameter of the Dalitz plot is as follows [see also text Section VI B.1]:
$$|M|^2 = 1 + g\left(\frac{s_3-s_0}{m_{\pi^+}^2}\right).$$
n. The $K_S^0 \to \pi\pi$ and $K_L^0 \to \pi\pi$ rates (and branching fractions) are from independent fits and do not include results of K_L^0–K_S^0 interference experiments. The $|\eta_{+-}|$ and $|\eta_{00}|$ values given in the addendum are these rates combined with the $|\eta_{+-}|$ and $|\eta_{00}|$ results from interference experiments.
o. The definition for the CP violation parameters is as follows [see also text Section VI B.3]:
$$\eta_{+-} = |\eta_{+-}|e^{i\phi_{+-}} = \frac{A(K_L^0 \to \pi^+\pi^-)}{A(K_S^0 \to \pi^+\pi^-)} \qquad \eta_{00} = |\eta_{00}|e^{i\phi_{00}} = \frac{A(K_L^0 \to \pi^0\pi^0)}{A(K_S^0 \to \pi^0\pi^0)}$$
$$\delta = \frac{\Gamma(K_L^0\to\ell^+)-\Gamma(K_L^0\to\ell^-)}{\Gamma(K_L^0\to\ell^+)+\Gamma(K_L^0\to\ell^-)}, \quad |\eta_{+-0}|^2 = \frac{\Gamma(K_S^0\to\pi^+\pi^-\pi^0)}{\Gamma(K_L^0\to\pi^+\pi^-\pi^0)}, \quad |\eta_{000}|^2 = \frac{\Gamma(K_S^0\to\pi^0\pi^0\pi^0)}{\Gamma(K_L^0\to\pi^0\pi^0\pi^0)}.$$
p. The definition of these quantites is as follows [for more details on sign convention, see text Section VI B]:

$\alpha = \frac{2\lvert s\rvert\lvert p\rvert\cos\Delta}{\lvert s\rvert^2+\lvert p\rvert^2}$	$\beta = \sqrt{1-\alpha^2}\sin\phi$	g_A/g_V defined by $\langle B_f\lvert\gamma_\lambda(g_V-g_A\gamma_5)\rvert B_i\rangle$
$\beta = \frac{-2\lvert s\rvert\lvert p\rvert\sin\Delta}{\lvert s\rvert^2+\lvert p\rvert^2}$	$\gamma = \sqrt{1-\alpha^2}\cos\phi$	δ defined by $g_A/g_V = \lvert g_A/g_V\rvert e^{i\delta}$

Meson Table

April 1976

In addition to the entries in the Meson Table, the Meson Data Card Listings contain all substantial claims for meson resonances. See Contents of Meson Data Card Listings[i].

Quantities in italics have changed by more than one (old) standard deviation since April 1974.

Name (G \ I: − 0 ω/ϕ, 1 π; + 0 η, 1 ρ)	$I^G(J^P)C_n$ (underline = estab.)	Mass M (MeV)	Full Width Γ (MeV)	M^2 $\pm\Gamma M$[a] $(\mathrm{GeV})^2$	Partial decay mode: Mode	Fraction (%) [Upper limits are 1σ (%)]	p or p_{max}[b] (MeV/c)
$\pi^\pm$ π^0	$1^-(0^-)+$	139.57 134.96	0.0 7.8 eV ±.9 eV	0.019479 0.018215	See Stable Particle Table		
η	$0^+(0^-)+$	548.8 ±0.6	2.63 keV ±.58 keV	0.301 ±.000	Neutral Charged	71.1 See Stable 28.9 Particle Table	
$\rho(770)$	$1^+(1^-)-$	773§ ±3§	152§ ±3§	0.598 ±.117	$\pi\pi$ $\pi\gamma$ e^+e^- $\mu^+\mu^-$	≈100 0.024 ±.007 0.0043±.0005 (d) 0.0067±.0012 (d)	360 374 386 372
M and Γ from neutral mode.					For upper limits, see footnote (e)		
$\omega(783)$	$0^-(1^-)-$	782.7 ±0.3	10.0 ±.4	0.613 ±.008	$\pi^+\pi^-\pi^0$ $\pi^+\pi^-$ $\pi^0\gamma$ e^+e^-	89.9±0.6 S=1.2* 1.3±0.3 S=1.5* 8.8±0.5 0.0076±.0017 S=1.9*	327 366 380 391
					For upper limits, see footnote (f)		
$\eta'(958)$	$0^+(0^-)+$	957.6 ±0.3	< 1	0.917 <.001	$\eta\pi\pi$ $\rho^0\gamma$ $\gamma\gamma$	*67.6±1.7* *30.4±1.7* S=1.1* 2.0±0.3	231 167 479
					For upper limits, see footnote (g)		
$\delta(970)$	$1^-(0^+)+$	976(h)§ ±10§	50(h)§ ±20§	0.953 ±.049	$\eta\pi$	seen	315
Possibly coupled to the I = 1 $K\bar{K}$ system¶.							
$S^*(993)$	$0^+(0^+)+$	∿ 993(c) ±5	40(c) ±8	0.986 ±.040	$K\bar{K}$ $\pi\pi$	near threshold	53 476
See note on ππ S wave¶.							
$\Phi(1020)$	$0^-(1^-)-$	1019.7 ±0.3 S=1.6*	4.1 ±.2	1.040 ±.004	K^+K^- K_LK_S $\pi^+\pi^-\pi^0$ (incl. $\rho\pi$) $\eta\gamma$ $\pi^0\gamma$ e^+e^- $\mu^+\mu^-$	46.6±2.3 S=1.6* 35.0±2.0 S=1.6* 16.4±1.5 S=1.1* 2.0±0.4 0.14±0.05 .032±.002 S=1.4* .025±.003	128 111 462 362 501 510 499
					For upper limits, see footnote (i)		
$A_1(1100)$	$1^-(1^+)+$	∿ 1100	∿ 300	1.21 ±.33	$\rho\pi$	∿ 100	251
Broad enhancement in the $J^P=1^+$ ρπ partial wave; not an established resonance¶.							
$\varepsilon(1200)$	$0^+(0^+)+$	1100 to 1300	∿ 600		$\pi\pi$		
Existence of pole not established. See note on ππ S wave¶.							
$B(1235)$	$1^+(1^+)-$	1228§ ±10§	125§ ±10§	1.51 ±.15	$\omega\pi$ [D/S amplitude ratio = .25±.06] For upper limits, see footnote (j)	only mode seen	345
$f(1270)$	$0^+(2^+)+$	1271§ ±5§	180§ ±20§	1.62 ±.23	$\pi\pi$ $2\pi^+2\pi^-$ $K\bar{K}$ $\pi^+\pi^-2\pi^0$	81±1§ *2.8±0.3* 2.7±0.6 S=1.1* seen	620 557 395 560
					For upper limits, see footnote (ℓ)		
$D(1285)$	$0^+(A\ )+$	1286§ ±10§	30§ ±20§	1.65 ±.04	$K\bar{K}\pi$ $\eta\pi\pi$ †[$\delta\pi$ $2\pi^+2\pi^-$ (prob. $\rho^0\pi^+\pi^-$)	seen seen seen] seen	305 484 245 565
	$J^P = 0^-, 1^+, 2^-$, with 1^+ favoured						

Meson Table *(cont'd)*

Name	$I^G(J^P)C_n$ (underline: estab.)	Mass M (MeV)	Full Width Γ (MeV)	M^2 $\pm\Gamma M$[a] $(GeV)^2$	Partial decay mode: Mode	Fraction (%) [Upper limits are 1σ (%)]		p or p_{max}[b] (MeV/c)
$A_2(1310)$	$1^-(2^+)+$	1310 ±5§	102 ±5§	1.72 ±.13	$\rho\pi$	70.9±1.8	S=1.1*	411
					$\eta\pi$	15.0±1.2		529
					$\omega\pi\pi$	9.3±1.9	S=1.2*	354
					$\bar{K}K$	4.7±0.5		428
					$\eta'\pi$	<1		279
E(1420)	$0^+(A\ )+$	1416 ±10§	60 ±20§	2.01 ±.08	$K\bar{K}\pi$	∿ 40		421
					†[$K^*\bar{K} + \bar{K}^*K$	∿ 20]		130
					$\eta\pi\pi$	∿ 60		564
					†[$\delta\pi$	possibly seen]		352
Not a well established resonance.								
f'(1514)	$0^+(2^+)+$	1516 ±3	40 ±10	2.30 ±.06	$K\bar{K}$	only mode seen		572
					For upper limits, see footnote (k)			
$F_1(1540)$	$1\ (A\ )$	1540 ±5	40 ±15	2.37 ±.06	$K^*\bar{K} + \bar{K}^*K$	seen		321
					3π	possibly seen		737
Not a well established resonance.								
ρ'(1600)	$1^+(1^-)-$	∿ 1600	200-800	2.56	4π	dominant		738
					†[$\rho\pi^+\pi^-$	seen with $\pi^+\pi^-$ in S-wave]		573
					$\pi\pi$	possibly seen		788
					$K\bar{K}$	< 8		629
Not a well established resonance.¶								
$A_3(1640)$	$1^-(2^-)+$	∿ 1640	∿ 300	2.69 ±.49	$f\pi$			304
Broad enhancement in the $J^P = 2^-$ $f\pi$ partial wave; not a well established resonance.¶								
ω(1675)	$0^-(3^-)-$	1667 ±10§	150 ±20§	2.78 ±.25	$\rho\pi$	seen		646
					3π	possibly seen		806
					5π	possibly seen		778
					†[$\omega\pi\pi$	possibly seen]		615
g(1680)¶	$1^+(3^-)-$	1690 ±20§	180 ±30§	2.86 ±.30	2π	24±1		833
					4π (incl. $\pi\pi\rho,\rho\rho,A_2\pi,\omega\pi$)	large		787
					$K\bar{K}$	small		683
J^P, M and Γ from the 2π mode.					$K\bar{K}\pi$ (incl. $K^*\bar{K}$)	small		624
h(2040)	$0^+(4^+)+$	2040 ±20	193 ±50	4.16 ±.39	$\pi\pi$	seen		1010
					$K\bar{K}$	seen		890
See note (l) for possible heavier states.								
K^+	$1/2(0^-)$	493.71		0.244	See Stable Particle Table			
K^0		497.70		0.248				
$K^*(892)$	$1/2(1^-)$	892.2 ±0.5	49.4 ±1.8	0.796 ±.044	$K\pi$	≈ 100		288
					$K\pi\pi$	< 0.2		216
M and Γ from charged mode; $m^0 - m^\pm = 4.1\pm0.6$ MeV.					$K\gamma$	0.15±0.07		309
κ(1250)	$1/2(0^+)$	1250 ±100§	∿ 450	1.56 ±.56	$K\pi$			
See note on $K\pi$ S wave¶.								
Q region	$1/2(A\ )$	1200 to 1400			$K\pi\pi$	only mode seen		
					†[$K^*\pi$	large]		
$J^P = 1^+$ is dominant contribution;					†[$K\rho$	seen]		
not a well established resonance¶.					†[$K(\pi\pi)_{\ell=0}$	possibly seen]		
$K^*(1420)$	$1/2(2^+)$	1421 ±3§	108 ±10§	2.02 ±.15	$K\pi$	56.1±2.6		616
					$K^*\pi$	30.9±2.1		415
					$K\rho$	*6.6±1.7*		316
		See note (m).			$K\omega$	4.5±1.7		305
					$K\eta$	2.0±2.0		482

Meson Table *(cont'd)*

Name (G∖I: 0, 1; −: ω/φ, π; +: η, ρ)	$I^G(J^P)C_n$ ⊢ estab.	Mass M (MeV)	Full Width Γ (MeV)	M^2 $\pm\Gamma M$[a] $(GeV)^2$	Partial decay mode: Mode	Fraction (%) [Upper limits are 1σ (%)]	p or p_{max}[b] (MeV/c)
L(1770)	1/2(A)	1765 ±10§	140 ±50§	3.11 ±.25	$K\pi\pi$	dominant	788
					$K\pi\pi\pi$	seen	757
					†[$K^*(1420)\pi$ and other subreactions¶]		
Not a well established resonance¶.							
See note (1) for possible heavier states.							
J/ψ(3100)	$0^-(1^-)-$	3098 ± 3	0.067 ±.012	9.6 ±.0	e^+e^-	7 ± 1	1549
					$\mu^+\mu^-$	7 ± 1	1545
					hadrons	86 ± 2	
					†[identified hadron modes	~ 12]¶	
					†[γ X(2750)	possibly seen]¶	328
ψ(3700)	$0^-(1^-)-$	3684 ± 4	0.228 ±.056	13.6 ± .0	e^+e^-	0.9 ± .2	1842
					$\mu^+\mu^-$	0.9 ± .2	1839
					hadrons	98.1 ± .3	
					†[J/ψ $\pi^+\pi^-$	33 ± 3]	474
					†[J/ψ $\pi^0\pi^0$	17 ± 2]	478
					†[J/ψ η	4.2 ± .7]	189
					†[γP_c, $P_c \to$ J/ψ γ	3.6 ± .7]¶	
					†[γχ(3410)	seen]¶	264
					†[γχ(3530)	seen]¶	151
					†[other identified hadron modes	~ 0.5]¶	
ψ(4100)	$(1^-)-$	~ 4100	~ 200	16.8 ± .8			
Broad enhancement in the e^+e^- total cross section; probably not a single resonance.¶							
ψ(4400)	$(1^-)-$	4414 ± 7	33 ±10	19.5 ± .1	e^+e^-	.0013 ± .0003	2207

→X(2750)
→P_c(3300 or 3500)
→χ(3410)
→χ(3530)

States observed in radiative decays of J/ψ(3100) and ψ(3700). See Meson Data Card Listings for a compilation and discussion of the experimental data.

(1) Contents of Meson Data Card Listings

Non-strange (Y = 0)						Strange (|Y| = 1)	
entry	$I^G(J^P)C_n$	entry	$I^G(J^P)C_n$	entry	$I^G(J^P)C_n$	entry	$I(J^P)$
π	$1^-(0^-)+$	A_1 (1100)	$1^-(1^+)+$	ρ′ (1600)	$1^+(1^-)-$	K	$1/2(0^-)$
η	$0^+(0^-)+$	→ M (1150)		A_3 (1640)	$1^-(2^-)+$	K^*(892)	$1/2(1^-)$
ρ (770)	$1^+(1^-)-$	→ $A_{1.5}$(1170)		ω (1675)	$0^-(3^-)-$	κ (1250)	$1/2(0^+)$
ω (783)	$0^-(1^-)-$	ε (1200)	$0^+(0^+)+$	g (1680)	$1^+(3^-)-$	Q	1/2(A)
→ M (940)		B (1235)	$1^+(1^+)-$	→ X (1690)	−	K^*(1420)	$1/2(2^+)$
→ M (953)		→ ρ′ (1250)	$1^+(1^-)-$	→ X (1795)	1	→ K_N(1700)	1/2
η′ (958)	$0^+(0^-)+$	f (1270)	$0^+(2^+)+$	→ A_4 (1900)	1^-	L (1770)	1/2(A)
δ (970)	$1^-(0^+)+$	D (1285)	$0^+(A\ )+$	→ S (1930)	1	→ K_N(1800)	$1/2(3^-)$
→ H (990)		A_2 (1310)	$1^-(2^+)+$	h (2040)	$0^+(4^+)+$	→ K^*(2200)	
S^* (993)	$0^+(0^+)+$	E (1420)	$0^+(A\ )+$	→ ρ (2100)			
φ (1020)	$0^-(1^-)-$	→ X (1430)	0	→ T (2200)	1		
→ M (1033)		→ X (1440)	1	→ U (2360)	1		
→ B_1(1040)		f′ (1514)	$0^+(2^+)+$	→ $N\bar{N}$(2375)	0	→ Exotics	
→ η_N(1080)	$0^+(N\ )+$	F_1 (1540)	1 (A)	→ X(2500-3600)			

New heavy mesons

J/ψ(3100) ψ(3700) ψ(4100) ψ(4400) →X(2750) →P_c(3300 or 3500) →χ(3410) →χ(3530)

Meson Table *(cont'd)*

→ Indicates an entry in Meson Data Card Listings not entered in the Meson Table. We do not regard these as established resonances.

¶ See Meson Data Card Listings.

* Quoted error includes scale factor $S = \sqrt{\chi^2/(N-1)}$. See footnote to Stable Particle Table.

† Square brackets indicate a subreaction of the previous (unbracketed) decay mode(s).

§ This is only an educated guess; the error given is larger than the error of the average of the published values. (See Meson Data Card Listings for the latter.)

(a) ΓM is approximately the half-width of the resonance when plotted against M^2.

(b) For decay modes into ≥ 3 particles, p_{max} is the maximum momentum that any of the particles in the final state can have. The momenta have been calculated by using the averaged central mass values, without taking into account the widths of the resonances.

(c) From pole position $(M - i\Gamma/2)$.

(d) The e^+e^- branching ratio is from $e^+e^- \to \pi^+\pi^-$ experiments only. The $\omega\rho$ interference is then due to $\omega\rho$ mixing only, and is expected to be small. See note in Meson Data Card Listings. The $\mu^+\mu^-$ branching ratio is compiled from 3 experiments; each possibly with substantial $\omega\rho$ interference. The error reflects this uncertainty; see notes in Meson Data Card Listings. If $e\mu$ universality holds, $\Gamma(\rho^0 \to \mu^+\mu^-) = \Gamma(\rho^0 \to e^+e^-) \times 0.99785$.

(e) Empirical limits on fractions for other decay modes of $\rho(770)$ are $\pi^\pm\eta < 0.8\%$, $\pi^+\pi^+\pi^-\pi^- < 0.15\%$, $\pi^\pm\pi^+\pi^-\pi^0 < 0.2\%$.

(f) Empirical limits on fractions for other decay modes of $\omega(783)$ are $\pi^+\pi^-\gamma < 5\%$, $\pi^0\pi^0\gamma < 1\%$, η + neutral(s) < 1.5%, $\mu^+\mu^- < 0.02\%$, $\pi^0\mu^+\mu^- < 0.2\%$, $\eta\gamma < 0.5\%$.

(g) Empirical limits on fractions for other decay modes of $\eta'(958)$: $\pi^+\pi^- < 2\%$, $\pi^+\pi^-\pi^0 < 5\%$, $\pi^+\pi^+\pi^-\pi^- < 1\%$, $\pi^+\pi^+\pi^-\pi^-\pi^0 < 1\%$, $6\pi < 1\%$, $\pi^+\pi^-e^+e^- < 0.6\%$, $\pi^0e^+e^- < 1.3\%$, $\eta e^+e^- < 1.1\%$, $\pi^0\rho^0 < 4\%$, $\gamma\omega < 5\%$.

(h) The mass and width are from the $\eta\pi$ mode only. If the $K\bar{K}$ channel is strongly coupled, the width may be 120 MeV or more.

(i) Empirical limits on fractions for other decay modes of $\phi(1020)$ are $\pi^+\pi^- < 0.03\%$, $\pi^+\pi^-\gamma < 0.7\%$, $\omega\gamma < 5\%$, $\rho\gamma < 2\%$, $2\pi^+2\pi^-\pi^0 < 1\%$.

(j) Empirical limits on fractions for other decay modes of B(1235): $\pi\pi < 15\%$, $K\bar{K} < 2\%$, $4\pi < 50\%$, $\phi\pi < 1.5\%$, $\eta\pi < 25\%$, $(\bar{K}K)^\pm\pi^0 < 8\%$, $K_SK_S\,\pi^\pm < 2\%$, $K_SK_L\,\pi^\pm < 6\%$.

(k) Empirical limits on fractions for other decay modes of f'(1514) are $\pi^+\pi^- < 20\%$, $\eta\eta < 50\%$, $\eta\pi\pi < 30\%$, $K\bar{K}\pi + K^*\bar{K} < 35\%$, $2\pi^+2\pi^- < 32\%$.

(ℓ) Empirical limits on fractions for other decay modes of f(1270) are $\eta\pi\pi < 1\%$, $K^0K^-\pi^+$ + c.c. < 1% $\eta\eta < 2\%$.

(m) The tabulated mass of 1421 MeV comes from the $K\pi$ mode; the $K\pi\pi$ mode can be contaminated with diffractively produced $Q^\pm$.

Established Nonets, and octet-singlet mixing angles from Appendix IIB, Eq. (2'). Of the two isosinglets, the "mainly octet" one is written first, followed by a semicolon.

$(J^P)C_n$	Nonet members	$\theta_{lin.}$	$\theta_{quadr.}$
$(0^-)+$	π, K, η; η'	-24 ± 1°	-11 ± 1°
$(1^-)-$	ρ, K^*, ϕ; ω	37 ± 1°	40 ± 1°
$(2^+)+$	A_2, $K^*(1420)$, f'; f	29 ± 2°	31 ± 2°

Baryon Table

April 1976

The following short list gives the status of all the Baryon States in the Data Card Listings. In addition to the status, the name, the nominal mass, and the quantum numbers (where known) are shown. States with three- or four-star status are included in the main Baryon Table; the others have been omitted because the evidence for the existence of the effect and/or for its interpretation as a resonance is open to considerable question.

N(939)	P11	****	Δ(1232)	P33	****	Λ(1116)	P01	****	Σ(1193)	P11	****	Ξ(1317)	P11	****
N(1470)	P11	****	Δ(1650)	S31	****	Λ(1330)		Dead	Σ(1385)	P13	****	Ξ(1530)	P13	****
N(1520)	D13	****	Δ(1670)	D33	***	Λ(1405)	S01	****	Σ(1440)		Dead	Ξ(1630)		**
N(1535)	S11	****	Δ(1690)	P33	*	Λ(1520)	D03	****	Σ(1480)		*	Ξ(1820)		***
N(1670)	D15	****	Δ(1890)	F35	***	Λ(1600)	P01	*	Σ(1580)	D13	**	Ξ(1940)		***
N(1688)	F15	****	Δ(1900)	S31	*	Λ(1670)	S01	****	Σ(1620)	S11	**	Ξ(2030)		**
N(1700)	S11	****	Δ(1910)	P31	***	Λ(1690)	D03	****	Σ(1660)	P11	**	Ξ(2250)		*
N(1700)	D13	**	Δ(1950)	F37	****	Λ(1800)	P01	**	Σ(1670)	D13	****	Ξ(2500)		**
N(1780)	P11	***	Δ(1960)	D35	**	Λ(1800)	G09	*	Σ(1670)		**			
N(1810)	P13	***	Δ(2160)		**	Λ(1815)	F05	****	Σ(1690)		**	Ω(1672)	P03	****
N(1990)	F17	**	Δ(2420)	H311	***	Λ(1830)	D05	****	Σ(1750)	S11	***			
N(2000)	F15	*	Δ(2850)		***	Λ(1860)	P03	***	Σ(1765)	D15	****			
N(2040)	D13	**	Δ(3230)		***	Λ(1870)	S01	**	Σ(1770)	P11	*			
N(2100)	S11	*				Λ(2010)		**	Σ(1840)	P13	*			
N(2100)	D15	*	Z0(1780)	P01	*	Λ(2020)	F07	*	Σ(1880)	P11	**			
N(2190)	G17	***	Z0(1865)	D03	*	Λ(2100)	G07	****	Σ(1915)	F15	****			
N(2220)	H19	***	Z1(1900)	P13	*	Λ(2110)	F05	**	Σ(1940)	D13	***			
N(2650)		***	Z1(2150)		*	Λ(2350)		****	Σ(2000)	S11	*			
N(3030)		***	Z1(2500)		*	Λ(2585)		***	Σ(2030)	F17	****			
N(3245)		*							Σ(2070)	F15	*			
N(3690)		*							Σ(2080)	P13	**			
N(3755)		*							Σ(2100)	G17	*			
									Σ(2250)		****			
									Σ(2455)		***			
									Σ(2620)		***			
									Σ(3000)		**			

**** Good, clear, and unmistakable. *** Good, but in need of clarification or not absolutely certain.
** Needs confirmation. * Weak.

[See notes on N's and Δ's, on possible Z^*'s, and on Y^*'s and Ξ^*'s at the beginning of those sections in the Baryon Data Card Listings; also see notes on individual resonances in the Baryon Data Card Listings.]

Particle[a]	I (J^P)[a] estab.	π or K Beam[b] p_{beam} (GeV/c) $\sigma = 4\pi\lambdabar^2$ (mb)	Mass M^c (MeV)	Full Width Γ^c (MeV)	M^2 $\pm\Gamma M^b$ (GeV^2)	Partial decay mode: Mode	Fraction %	p or p_{max}[d] (MeV/c)
p	1/2(1/2$^+$)		938.3		0.880	See Stable Particle Table		
n			939.6		0.883			
N(1470)[g]	1/2(1/2$^+$) P'_{11}	p = 0.66	1390 to	180 to	2.16	Nπ	~60	420
		σ = 27.8	1470	220	±0.29	Nη	~18	d
				(200)		Nππ	~25	368
						[Nε	~ 7][e]	d
						[Δπ	~19][e]	177
						[Nρ	< 9][e]	d
						pγ[f]	0.07-0.14	435
						nγ[f]	< 0.05	435
N(1520)[g]	1/2(3/2$^-$) D'_{13}	p = 0.74	1510 to	110 to	2.31	Nπ	~55	456
		σ = 23.5	1530	150	±0.19	Nππ	~45	410
				(125)		[Nε	< 5][e]	d
						[Nρ	~15][e]	d
						[Δπ	~25][e]	228
						Nη	< 1	d
						pγ[f]	0.4-0.7	471
						nγ[f]	0.3-0.6	471
N(1535)[g]	1/2(1/2$^-$) S'_{11}	p = 0.76	1500 to	50 to	2.36	Nπ	~30	467
		σ = 22.5	1530	120	±0.15	Nη	~65	182
				(100)		Nππ	~ 5	422
						[Nρ	~ 3][e]	d
						[Nε	~ 2][e]	d
						[Δπ	~ 1][e]	243
						pγ[f]	< 0.4	481
						nγ[f]	< 0.4	481

Baryon Table *(cont'd)*

Particle[a]	I (J^P)[a] — estab.	π or K Beam[b] p_{beam} (GeV/c) $\sigma = 4\pi\lambda\!\!\!^{-2}$ (mb)	Mass M^c (MeV)	Full Width Γ^c (MeV)	M^2 $\pm\Gamma M^b$ (GeV^2)	Partial decay mode: Mode	Fraction %	p or p_{max}[d] (MeV/c)
N(1670)[g]	$1/2(5/2^-)D'_{15}$	p = 1.00	1660 to	145 to	2.79	Nπ	~45	560
		σ = 15.6	1685	165	±0.26	Nππ	~55	525
				(155)		[Δπ	~50][e]	360
						ΛK	<0.3	200
						Nη	<0.5	368
						pγ[f]	<0.03	572
						nγ[f]	<0.14	572
N(1688)[g]	$1/2(5/2^+)F'_{15}$	p = 1.03	1670 to	120 to	2.85	Nπ	~60	572
		σ = 14.9	1690	145	±0.24	Nππ	~40	538
				(140)		[Nε	~14][e]	340
						[Nρ	~14][e]	d
						[Δπ	~11][e]	375
						Nη	<0.3	388
						pγ[f]	0.1-0.4	583
						nγ[f]	<0.03	583
N(1700)[g]	$1/2(1/2^-)S''_{11}$	p = 1.05	1660 to	100 to	2.89	Nπ	~55	580
		σ = 14.3	1690	200	±0.26	Nππ	~30	547
				(150)		[Nε	~10][e]	355
						[Nρ	~7][e]	d
						[Δπ	~4][e]	385
						ΛK	~4	250
						ΣK	~2	109
						pγ[f]	<0.1	591
						nγ[f]	<0.15	591
N(1780)	$1/2(1/2^+)P''_{11}$	p = 1.20	1700 to	100 to	3.17	Nπ	~20	633
		σ = 12.2	1800	250	±0.36	Nππ	>40	603
				(200)		[Nε	15-40][e]	440
						[Nρ	20-50][e]	249
						[Δπ	10-20][e]	448
						ΛK	~7	353
						ΣK	~10	267
						Nη	2-20[h]	476
						pγ[f]	<0.15	643
						nγ[f]	<0.13	643
N(1810)	$1/2(3/2^+)P_{13}$	p = 1.26	1700 to	100 to	3.28	Nπ	~20	652
		σ = 11.5	1850	300	±0.36	Nππ	~70	624
				(200)		[Nρ	~70][e]	297
						ΛK	~5	386
						ΣK	~2	307
						Nη	<5	503
						pγ[f]	<0.2	661
						nγ[f]	<0.2	661
N(2190)	$1/2(7/2^-)G_{17}$	p = 2.07	2100 to	150 to	4.80	Nπ	15-35	888
		σ = 6.21	2250	300	±0.55	ΛK	<0.2	710
				(250)		ΣK	<0.2	664
N(2220)	$1/2(9/2^+)H_{19}$	p = 2.14	2200 to	250 to	4.93	Nπ	~20	905
		σ = 5.97	2250	350	±0.67			
				(300)				
N(2650)	$1/2(\ ?^-)$	p = 3.26	~2650	~350	7.02	Nπ	(J+1/2)x	1154
		σ = 3.67		(350)	±0.93		<0.4[j]	
N(3030)	$1/2(\ ?\ )$	p = 4.41	~3030	~400	9.18	Nπ	(J+1/2)x	1366
		σ = 2.62		(400)	±1.21		<0.1[j]	
Δ(1232)[g]	$3/2(3/2^+)P'_{33}$	p = 0.30	1230 to	110 to	1.52	Nπ	~99.4	227
		σ = 94.3	1234	120	±0.14	$N\pi^+\pi^-$	~0	80
				(115)		pγ[f]	0.58-0.66	259
	Δ(++) Pole position:[k]	$M-i\Gamma/2 = (1211.0\pm0.8) - i(49.9\pm0.6)$						
	Δ(0) Pole position:[k]	$M-i\Gamma/2 = (1210.9\pm1.0) - i(53.1\pm1.0)$						
Δ(1650)[g]	$3/2(1/2^-)S'_{31}$	p=0.96	1615 to	140 to	2.72	Nπ	~35	547
		σ =16.4	1695	200	±0.23	Nππ	~65	511
				(140)		[Nρ	10-25][e]	d
						[Δπ	~50][e]	344
						pγ[f]	<0.25	558

Baryon Table *(cont'd)*

Particle[a]	I (J^P)[a] estab.	π or K Beam[b] p_{beam} (GeV/c) $\sigma = 4\pi \lambda\!\!\!^{-2}$ (mb)	Mass M^c (MeV)	Full Width Γ^c (MeV)	M^2 $\pm\Gamma M^b$ (GeV^2)	Partial decay mode: Mode	Fraction %	p or p_{max}[d] (MeV/c)
Δ(1670)[g]	$3/2(3/2^-)D_{33}$	p = 1.00 σ = 15.6	1650 to 1720	190 to 260 (200)	2.79 ±0.33	Nπ Nππ [Nρ [Δπ pγ[f]	~15 ~85 30-60][e] ~45][e] 0.05-0.3	560 525 d 361 572
Δ(1890)[g]	$3/2(5/2^+)F_{35}$	p = 1.42 σ = 9.88	1860 to 1900	150 to 300 (250)	3.57 ±0.47	Nπ Nππ [Nρ [Δπ ΣK pγ[f]	~15 ~80 ~60][e] 10-30][e] <3 <0.1	704 677 403 531 400 712
Δ(1910)[g]	$3/2(1/2^+)P_{31}$	p = 1.46 σ = 9.54	1780 to 1950	160 to 230 (200)	3.65 ±0.38	Nπ Nππ [Nρ [Δπ ΣK pγ[f]	15-35 ? small][e] small][e] 2-20 <0.1	716 691 429 545 420 725
Δ(1950)[g]	$3/2(7/2^+)F_{37}$	p = 1.54 σ = 8.90	1910 to 1940	200 to 240 (220)	3.80 ±0.43	Nπ Nππ [Nρ [Δπ ΣK pγ[f]	~40 >25 ~10][e] ~20][e] <1 0.09-0.15	741 716 471 574 460 749
Δ(2420)[g]	$3/2(11/2^+)H_{3\,11}$	p = 2.64 σ = 4.68	2380 to 2450	300 to 500 (300)	5.86 ±0.73	Nπ	10-15	1023
Δ(2850)	$3/2(\ ?^+\ )$	p = 3.85 σ = 3.05	2800 to 2900	~400 (400)	8.12 ±1.14	Nπ	(J+1/2)x ~0.25[j]	1266
Δ(3230)	3/2(?)	p = 5.08 σ = 2.25	3200 to 3350	~440 (440)	10.43 ±1.42	Nπ	(J+1/2)x ~0.05[j]	1475
Z^*	Evidence for states with strangeness +1 is controversial. See the Baryon Data Card listings for discussion and display of data.							
Λ	$0(1/2^+)$		1115.6		1.245	See Stable Particle Table		
Λ(1405)	$0(1/2^-)S'_{01}$	below K^-p threshold	1405 ±5[ℓ]	40±10[ℓ] (40)	1.97 ±0.06	Σπ	100	142
Λ(1520)	$0(3/2^-)D'_{03}$	p = 0.389 σ = 84.5	1519 ±2[ℓ]	15 ±2[ℓ] (15)	2.31 ±0.02	$N\bar{K}$ Σπ Λππ Σππ	46±1 42±1 10± 1 0.9±0.1	234 258 250 140
Λ(1670)	$0(1/2^-)S''_{01}$	p = 0.74 σ = 28.5	1660 to 1680	20 to 60 (40)	2.79 ±0.07	$N\bar{K}$ Λη Σπ	15-35 15-35 20-60	410 64 393
Λ(1690)	$0(3/2^-)D''_{03}$	p = 0.78 σ = 26.1	1690 ±10[ℓ]	30 to 80 (60)	2.86 ±0.10	$N\bar{K}$ Σπ Λππ Σππ	20-30 15-40 ~25 ~20	429 409 415 352
Λ(1815)	$0(5/2^+)F'_{05}$	p = 1.05 σ = 16.7	1820 ±5[ℓ]	70 to 100 (85)	3.29 ±0.15	$N\bar{K}$ Σπ Σ(1385)π	~60 ~12 15-20	542 508 362
Λ(1830)	$0(5/2^-)D_{05}$	p = 1.09 σ = 15.8	1810 to 1840	60 to 110 (95)	3.35 ±0.17	$N\bar{K}$ Σπ Λη	<10 35-75 <4	554 519 367
Λ(1860)	$0(1/2^+)P_{03}$	p = 1.14 σ = 14.7	1860 to 1910	40 to 110 (80)	3.46 ±0.15	$N\bar{K}$ Σπ	15-35 5-10	576 534
Λ(2100)	$0(7/2^-)G_{07}$	p = 1.68 σ = 8.68	2100 to 2120	150 to 300 (250)	4.41 ±0.53	$N\bar{K}$ Σπ Λη ΞK Λω	~30 ~5 <3 <3 <8	748 699 617 483 443

Baryon Table *(cont'd)*

	Particle[a]	I (J^P)[a] estab.	π or K Beam[b] p_{beam} (GeV/c) $\sigma = 4\pi\lambda^2$ (mb)	Mass M^c (MeV)	Full Width Γ^c (MeV)	M^2 $\pm\Gamma M^b$ (GeV^2)	Partial decay mode: Mode	Fraction %	p or p_{max}[d] (MeV/c)
	Λ(2350)	0(?)	p = 2.29 σ = 5.85	2340 to 2360	100 to 200 (120)	5.52 ±0.28	$N\bar{K}$ Σπ	(J+1/2)x ~0.9[j] seen	913 865
	Λ(2585)	0(?)	p = 2.91 σ = 4.37	~2585	~300 (300)	6.68 ±0.78	$N\bar{K}$	(J+1/2)x ~1.0[j]	1058
	Σ	1(1/2⁺)		(+)1189.4 (0)1192.5 (−)1197.4		1.415 1.422 1.434	See Stable Particle Table		
→→→→	Σ(1385)	1(3/2⁺)P'₁₃	below K⁻p threshold	(+)1382.5±0.5 S=1.2[m] (−)1386.6±1.2 S=2.3[m]	(+)35±2 S=1.9[m] (−)42±4 S=3.2[m] (35)	1.92 ±0.05	Λπ Σπ	88±2 12±2	208 117
→→	Σ(1670)[n]	1(3/2⁻)D''₁₃	p = 0.74 σ = 28.5	1670 ±10[ℓ]	35 to 70 (50)	2.79 ±0.08	$N\bar{K}$ Σπ Λπ	10-25 20-60 < 20	410 387 447
	Σ(1750)	1(1/2⁻)S''₁₁	p = 0.91 σ = 20.7	1700 to 1790	50 to 120 (75)	3.06 ±0.13	$N\bar{K}$ Λπ Σπ Ση	10-40 5-20 <8 15-55	483 507 450 54
→→	Σ(1765)	1(5/2⁻)D₁₅	p = 0.94 σ = 19.6	1723 ±7[ℓ]	110 to 150 (130)	3.12 ±0.23	$N\bar{K}$ Λπ Λ(1520)π Σ(1385)π Σπ	~41 ~14 ~16 ~10 ~1	496 518 187 315 461
	Σ(1915)[g]	1(5/2⁺)F'₁₅	p = 1.25 σ = 13.0	1905 to 1930	70 to 140 (100)	3.67 ±0.19	$N\bar{K}$ Λπ Σπ	5-15 20 ?	612 619 568
→	Σ(1940)[i]	1(3/2⁻)D'''₁₃	p = 1.32 σ = 12.0	1900 to 1960	110 to 280 (220)	3.76 ±0.43	$N\bar{K}$ Λπ Σπ	<20 ~4 ~7	678 680 589
→→→	Σ(2030)[g]	1(7/2⁺)F₁₇	p = 1.52 σ = 9.93	2020 to 2040	120 to 200 (180)	4.12 ±0.37	$N\bar{K}$ Λπ Σπ ΞK	~20 ~20 5-10 < 2	700 700 652 412
	Σ(2250)	1(?)	p = 2.04 σ = 6.76	2200 to 2300	50 to 200 (150)	5.06 ±0.34	$N\bar{K}$ Λπ Σπ	(J+1/2)x ~0.3[j] seen seen	849 841 801
	Σ(2455)	1(?)	p = 2.57 σ = 5.09	~2455	~120 (120)	6.03 ±0.29	$N\bar{K}$	(J+1/2)x ~0.2[j]	979
→	Σ(2620)	1(?)	p = 2.95 σ = 4.30	~2600	~200 (200)	6.86 ±0.52	$N\bar{K}$	(J+1/2)x ~0.3[j]	1064
	Ξ	1/2(1/2⁺)		(0)1314.9 (−)1321.3		1.729 1.746	See Stable Particle Table		
→	Ξ(1530)°	1/2(3/2⁺)P₁₃		(0)1531.8±0.3 S=1.3[m] (−)1535.1±0.6	(0) 9.1±0.5 (−) 10.1±1.9 (10)	2.34 ±0.02	Ξπ	100	144
	Ξ(1820)°,[p]	1/2(?)		1800 to 1850	12 to 100 (60)	3.31 ±0.11	$\Lambda\bar{K}$ $\Sigma\bar{K}$ Ξπ Ξ(1530)π	seen seen seen seen	396 306 413 234
→→→	Ξ(1940)°,[q]	1/2(?)		1900 to 1970	30 to 140 (90)	3.76 ±0.17	Ξπ Ξ(1530)π	seen seen	499 336
	Ω⁻	0(3/2⁺)		1672.2		2.796	See Stable Particle Table		

Baryon Table *(cont'd)*

→ For convenience all Baryon States for which information exists in the Baryon Data Card Listings are listed at the beginning of the Baryon Table. States with only a one or two star (*) rating in that list have been omitted from the main Baryon Table; each omitted state is indicated by an arrow in the left-hand margin of the Table. In the Listings there is an arrow under the name of each state omitted from the Table.

a. The names of the Baryon States in Col. 1 [such as N(1470)] contain a nominal mass which is a rounded average of the reported values in the Data Card Listings. The convention for using primes in the spectroscopic notation for the quantum numbers in Col. 2 [such as P'_{11}] is as follows: no prime is attached when the Data Card Listings include only one resonance in the given partial wave; when there is more than one resonance the first has been designated with a prime, the second with a double prime, etc. The name and the quantum numbers for each state are also given in large print at the beginning of the Data Card Listings for that state.

b. The numbers in Col. 3 and Col. 6 are calculated using the nominal mass (see a. above) for M and the nominal width (see c. below) for Γ.

c. For M and Γ of most baryons we report here an interval instead of an average. Averages are appropriate if each result is based on independent measurements, but inappropriate where the spread in parameters arises because different models or procedures have been applied to a common set of data. A single value with an approximation sign (~) indicates that there is not enough data to give a meaningful interval. A nominal width is included in parentheses in Col. 5; this nominal width is used to calculate the value of ΓM given in Col. 6.

d. For two body decay modes we give the momentum, p, of the decay products in the decaying baryon rest frame. For decay modes into ≥ 3 particles we give the maximum momentum, p_{max}, that any of the particles in the final state can have in this frame. The momenta are calculated using the nominal mass (see a. above) of the decaying baryon, and of any isobars in the final state. Some decays which would be energetically forbidden for the nominal masses actually occur because of the finite widths of the decaying Baryon and/or isobars in the final state. In these cases, the decay momentum is omitted from Col. 9 and replaced with a reference to this footnote.

e. Square brackets around an isobar decay mode indicate that it is a sub-reaction of the previous unbracketed decay mode. In the case of N^* and Δ decays into isobar modes we have used the isobar model results of LONGACRE 75 in addition to other data from the listings (where available) to estimate the branching fractions.

f. The tabulated radiative fractions involve a sum over two helicities (1/2, 3/2). In the case of I = 1/2 resonances, there are two distinct isospin couplings, whence γp and γn. For conventions and further details, see the Mini-Review preceding the Baryon Data Card Listings.

g. Only information coming from partial-wave analyses has been used here. For the production experiments results see the Baryon Data Card Listings.

h. The range given here does not include the branching ratio of approximately 80% reported by FELTESSE 75.

i. There may be more than one state in this region. The only analysis which reports an elastic coupling (LEA 73) also finds unusually low mass and width values. The inelastic branching fractions quoted here are based on an elasticity of 10%, which is a compromise between LEA 73 and RLIC 76.

j. This state has been seen only in an energy-dependent fit to total, channel, or fixed angle cross-section data. J is not known; x is Γ_{el}/Γ.

k. See note on determination of resonance parameters in the Baryon Data Card Listings. Values of mass and width are dependent upon resonance shape used to fit the data. The pole position is much less dependent upon the parametrization used. The pole positions given here are taken from results (in the Data Card Listings) of fits to the phase shifts of CARTER 73 without Coulomb corrections.

ℓ. The error given here is only an educated guess; it is larger than the error of the average of the published values (see the Baryon Data Card Listings for the latter).

m. Quoted error includes an S (scale) factor. See first footnote to Stable Particle Table.

n. In this energy region the situation is still confused. In addition to the effect at ~ 1670 MeV seen in both production and formation experiments, recent formation experiments have found evidence for fairly narrow S_{11} and/or P_{11} states at 1620-1660 MeV. A narrow bump in the I = 1 $\bar{K}N$ total cross section has also been seen recently at ~ 1590 MeV. It is not clear how many states really exist here. No one has reported a strong coupling of any of these states to $\bar{K}N$ but there is much disagreement about branching ratios into $\pi\Lambda$ and $\pi\Sigma$. See the mini-reviews preceding the $\Sigma(1620)$ and $\Sigma(1670)$ Data Card Listings for more information.

o. Only $\Xi(1530)$ is firmly established; information on the other states comes from experiments that have poor statistics due to the fact that the cross sections for S = - 2 states are very low. For Ξ states, because of the meager statistics, we lower our standards and tabulate resonant effects if they have at least a four-standard-deviation statistical significance and if they are seen by more than one group. See the Baryon Data Card Listings for the other states.

p. All four decay modes shown have been seen. Branching ratios are not quoted because there may be more than one state here.

q. This bump has been seen in both final states shown; it is not clear if one, or more, states are present.

PHYSICAL AND NUMERICAL CONSTANTS*

PHYSICAL CONSTANTS

		Uncert. (ppm)
N	$= 6.0220943(63)\times10^{23}$ mole^{-1}	1.05
V_m	$= 22413.83(70)$ cm^3 mole^{-1} = molar volume of ideal gas at STP	31
c	$= 2.99792458(1.2)\times10^{10}$ cm sec^{-1}	0.004
e	$= 4.803242(14)\times10^{-10}$ esu $= 1.6021892(46)\times10^{-19}$ coulomb	2.9; 2.9
1 MeV	$= 1.6021892(46)\times10^{-6}$ erg	2.9
$\hbar=h/2\pi$	$= 6.582173(17)\times10^{-22}$ MeV sec $= 1.0545887(57)\times10^{-27}$ erg sec	2.6; 5.4
$\hbar c$	$= 1.9732858(51)\times10^{-11}$ MeV cm $= 197.32858(51)$ MeV Fermi	2.6; 2.6
	$= 0.6240078(16)$ GeV mb$^{1/2}$	2.6
α	$= e^2/\hbar c = 1/137.035982(30)$	0.22
$k_{Boltzmann}$	$= 1.380662(44)\times10^{-16}$ erg °K^{-1}	32
	$= 8.61735(28)\times10^{-11}$ MeV °K^{-1} = 1 eV/11604.50(36) °K	32; 32
m_e	$= 0.5110034(14)$ MeV $= 9.109534(47)\times10^{-31}$ kg	2.8; 5.1
m_p	$= 938.2796(27)$ MeV $= 1836.15152(70)\ m_e = 6.72270(31)\ m_{\pi^\pm}$	2.8; 0.38; 46
	$= 1.007276470(11)$ amu	0.011
1 amu	$= 1/12\ m_{C^{12}} = 931.5016(26)$ MeV	2.8
m_d	$= 1875.628(5)$ MeV	3
r_e	$= e^2/m_ec^2 = 2.8179380(70)$ fermi (1 fermi $= 10^{-13}$ cm)	2.5
$\lambda\!\!\!^{-}_e$	$= \hbar/m_ec = r_e\alpha^{-1} = 3.8615905(64)\times10^{-11}$ cm	1.6
$a_{\infty Bohr}$	$= \hbar^2/m_ee^2 = r_e\alpha^{-2} = 0.52917706(44)$Å (1Å $= 10^{-8}$ cm)	0.82
$\sigma_{Thomson}$	$= (8/3)\pi r_e^2 = 0.6652448(33)\times10^{-24}$ cm.^{2} (10^{-24} cm^2 = 1 barn)	4.9
μ_{Bohr}	$= e\hbar/2m_ec = 0.57883785(95)\times10^{-14}$ MeV gauss^{-1}	1.6
μ_p	$= e\hbar/2m_pc = 3.1524515(53)\times10^{-18}$ MeV gauss^{-1}	1.7
μ_p/μ_{Bohr}	$= 1.520993136(21)$	0.014
$1/2\omega^e_{cyclotron}$	$= e/2m_ec = 8.794023(25)\times10^6$ rad sec^{-1} gauss^{-1}	2.8
$1/2\omega^p_{cyclotron}$	$= e/2m_pc = 4.789378(13)\times10^3$ rad sec^{-1} gauss^{-1}	2.8

Hydrogen-like atom (nonrelativistic, μ = reduced mass):

$$\frac{v}{c})_{rms} = \frac{ze^2}{n\hbar c};\quad E_n = \frac{\mu}{2}v^2 = \frac{\mu z^2 e^4}{2(n\hbar)^2};\quad a_n = \frac{n^2\hbar^2}{\mu z e^2}$$

$R_\infty = m_ee^4/2\hbar^2 = m_ec^2\alpha^2/2 = 13.605804(36)$ eV (Rydberg)		2.6
$= m_ec\alpha^2/2\hbar = 109737.3143(10)$ cm^{-1}		0.009

pc = 0.3 Hρ (MeV, kilogauss, cm)

1 year (sidereal)	$= 365.256$ days $= 3.1558\times10^7$ sec($\approx\pi\times10^7$ sec)
density of dry air	$= 1.205$ mg cm^{-3} (at 20°C, 760 mm)
acceleration by gravity	$= 980.62$ cm sec^{-2} (sea level, 45°)
gravitational constant	$= 6.6732(31)\times10^{-8}$ cm^{3}g^{-1} sec^{-2}
1 calorie (thermochemical)	= 4.184 joules
1 atmosphere	$= 1033.2275$ dynes cm^{-2} = 1.01325 bar
1 eV per particle	= 11604.50(36) °K (from E = kT)

NUMERICAL CONSTANTS

π	= 3.1415927	1 rad	= 57.2957795 deg	$\sqrt{\pi}$	= 1.7724539
e	= 2.7182818	$1/e$	= 0.3678794	$\sqrt{2}$	= 1.4142136
ln2	= 0.6931472	ln10	= 2.3025851	$\sqrt{3}$	= 1.7320508
$\log_{10}2$	= 0.3010300	$\log_{10}e$	= 0.4342945	$\sqrt{10}$	= 3.1622777

*Prepared by Stanley J. Brodsky, based mainly on the adjustment of the fundamental physical constants by E. R. Cohen and B. N. Taylor, J. Phys. Chem. Ref. Data 2, 663 (1973), plus current values for N, α, μ_p/μ_{Bohr}, R_∞ [see B. N. Taylor and E. R. Cohen, Proceedings of the Fifth International Conference on Atom Masses and Fundamental Constants (AMCO-5), Paris, 1975]. The figures in parentheses correspond to the one-standard-deviation uncertainty in the last digits of the main number. (Updated April 1976.)

CLEBSCH-GORDAN COEFFICIENTS, SPHERICAL HARMONICS, AND d FUNCTIONS

Note: A $\sqrt{\ }$ is to be understood over every coefficient; e.g., for -8/15 read $-\sqrt{8/15}$.

Notation:

		J, M	J, M	...
m_1	m_2			
m_1	m_2	Coefficients		
.	.			
.	.			

1/2 × 1/2

m_1	m_2	J=1, M=+1
+1/2	+1/2	1

m_1	m_2	1, 0	0, 0
+1/2	-1/2	1/2	1/2
-1/2	+1/2	1/2	-1/2

m_1	m_2	1, -1
-1/2	-1/2	1

1 × 1/2

m_1	m_2	3/2, +3/2
+1	+1/2	1

m_1	m_2	3/2, +1/2	1/2, +1/2
+1	-1/2	1/3	2/3
0	+1/2	2/3	-1/3

m_1	m_2	3/2, -1/2	1/2, -1/2
0	-1/2	2/3	1/3
-1	+1/2	1/3	-2/3

m_1	m_2	3/2, -3/2
-1	-1/2	1

2 × 1

m_1	m_2	3, +3
+2	+1	1

m_1	m_2	3, +2	2, +2
+2	0	1/3	2/3
+1	+1	2/3	-1/3

m_1	m_2	3, +1	2, +1	1, +1
+2	-1	1/15	1/3	3/5
+1	0	8/15	1/6	-3/10
0	+1	6/15	-1/2	1/10

m_1	m_2	3, 0	2, 0	1, 0
+1	-1	1/5	1/2	3/10
0	0	3/5	0	-2/5
-1	+1	1/5	-1/2	3/10

m_1	m_2	3, -1	2, -1	1, -1
0	-1	6/15	1/2	1/10
-1	0	8/15	-1/6	-3/10
-2	+1	1/15	-1/3	3/5

m_1	m_2	3, -2	2, -2
-1	-1	2/3	1/3
-2	0	1/3	-2/3

m_1	m_2	3, -3
-2	-1	1

1 × 1

m_1	m_2	2, +2
+1	+1	1

m_1	m_2	2, +1	1, +1
+1	0	1/2	1/2
0	+1	1/2	-1/2

m_1	m_2	2, 0	1, 0	0, 0
+1	-1	1/6	1/2	1/3
0	0	2/3	0	-1/3
-1	+1	1/6	-1/2	1/3

m_1	m_2	2, -1	1, -1
0	-1	1/2	1/2
-1	0	1/2	-1/2

m_1	m_2	2, -2
-1	-1	1

Spherical harmonics

$$Y_1^0 = \sqrt{\frac{3}{4\pi}} \cos\theta$$

$$Y_1^1 = -\sqrt{\frac{3}{8\pi}} \sin\theta\, e^{i\phi}$$

$$Y_2^0 = \sqrt{\frac{5}{4\pi}}\left(\frac{3}{2}\cos^2\theta - \frac{1}{2}\right)$$

$$Y_2^1 = -\sqrt{\frac{15}{8\pi}} \sin\theta\cos\theta\, e^{i\phi}$$

$$Y_2^2 = \frac{1}{4}\sqrt{\frac{15}{2\pi}} \sin^2\theta\, e^{2i\phi}$$

$$Y_\ell^{-m} = (-1)^m Y_\ell^{m*}$$

$$d^\ell_{m,0} = \sqrt{\frac{4\pi}{2\ell+1}}\, Y_\ell^m e^{-im\phi}$$

2 × 1/2

m_1	m_2	5/2, +5/2
+2	1/2	1

m_1	m_2	5/2, +3/2	3/2, +3/2
+2	-1/2	1/5	4/5
+1	+1/2	4/5	-1/5

m_1	m_2	5/2, +1/2	3/2, +1/2
+1	-1/2	2/5	3/5
0	+1/2	3/5	-2/5

m_1	m_2	5/2, -1/2	3/2, -1/2
0	-1/2	3/5	2/5
-1	+1/2	2/5	-3/5

m_1	m_2	5/2, -3/2	3/2, -3/2
-1	-1/2	4/5	1/5
-2	+1/2	1/5	-4/5

m_1	m_2	5/2, -5/2
-2	-1/2	1

3/2 × 1/2

m_1	m_2	2, +2
+3/2	+1/2	1

m_1	m_2	2, +1	1, +1
+3/2	-1/2	1/4	3/4
+1/2	+1/2	3/4	-1/4

m_1	m_2	2, 0	1, 0
+1/2	-1/2	1/2	1/2
-1/2	+1/2	1/2	-1/2

m_1	m_2	2, -1	1, -1
-1/2	-1/2	3/4	1/4
-3/2	+1/2	1/4	-3/4

m_1	m_2	2, -2
-3/2	-1/2	1

3/2 × 1

m_1	m_2	5/2, +5/2
+3/2	+1	1

m_1	m_2	5/2, +3/2	3/2, +3/2
+3/2	0	2/5	3/5
+1/2	+1	3/5	-2/5

m_1	m_2	5/2, +1/2	3/2, +1/2	1/2, +1/2
+3/2	-1	1/10	2/5	1/2
+1/2	0	3/5	1/15	-1/3
-1/2	+1	3/10	-8/15	1/6

m_1	m_2	5/2, -1/2	3/2, -1/2	1/2, -1/2
+1/2	-1	3/10	8/15	1/6
-1/2	0	3/5	-1/15	-1/3
-3/2	+1	1/10	-2/5	1/2

m_1	m_2	5/2, -3/2	3/2, -3/2
-1/2	-1	3/5	2/5
-3/2	0	2/5	-3/5

m_1	m_2	5/2, -5/2
-3/2	-1	1

$$\langle j_1 j_2 m_1 m_2 | j_1 j_2 J M\rangle = (-1)^{J - j_1 - j_2} \langle j_2 j_1 m_2 m_1 | j_2 j_1 J M\rangle$$

$$d^j_{m',m} = (-1)^{m-m'} d^j_{m,m'} = d^j_{-m,-m'}$$

3/2 × 3/2

m_1	m_2	3, +3
+3/2	+3/2	1

m_1	m_2	3, +2	2, +2
+3/2	+1/2	1/2	1/2
+1/2	+3/2	1/2	-1/2

m_1	m_2	3, +1	2, +1	1, +1
+3/2	-1/2	1/5	1/2	3/10
+1/2	+1/2	3/5	0	-2/5
-1/2	+3/2	1/5	-1/2	3/10

m_1	m_2	3, 0	2, 0	1, 0	0, 0
+3/2	-3/2	1/20	1/4	9/20	1/4
+1/2	-1/2	9/20	1/4	-1/20	-1/4
-1/2	+1/2	9/20	-1/4	-1/20	1/4
-3/2	+3/2	1/20	-1/4	9/20	-1/4

m_1	m_2	3, -1	2, -1	1, -1
+1/2	-3/2	1/5	1/2	3/10
-1/2	-1/2	3/5	0	-2/5
-3/2	+1/2	1/5	-1/2	3/10

m_1	m_2	3, -2	2, -2
-1/2	-3/2	1/2	1/2
-3/2	-1/2	1/2	-1/2

m_1	m_2	3, -3
-3/2	-3/2	1

2 × 3/2

m_1	m_2	7/2, +7/2
+2	+3/2	1

m_1	m_2	7/2, +5/2	5/2, +5/2
+2	+1/2	3/7	4/7
+1	+3/2	4/7	-3/7

m_1	m_2	7/2, +3/2	5/2, +3/2	3/2, +3/2
+2	-1/2	1/7	16/35	2/5
+1	1/2	4/7	1/35	-2/5
0	3/2	2/7	-18/35	1/5

m_1	m_2	7/2, +1/2	5/2, +1/2	3/2, +1/2	1/2, +1/2
+2	-3/2	1/35	6/35	2/5	2/5
+1	-1/2	12/35	5/14	0	-3/10
0	1/2	18/35	-3/35	-1/5	1/5
-1	3/2	4/35	-27/70	2/5	-1/10

m_1	m_2	7/2, -1/2	5/2, -1/2	3/2, -1/2	1/2, -1/2
+1	-3/2	4/35	27/70	2/5	1/10
0	-1/2	18/35	3/35	-1/5	-1/5
-1	1/2	12/35	-5/14	0	3/10
-2	3/2	1/35	-6/35	2/5	-2/5

m_1	m_2	7/2, -3/2	5/2, -3/2	3/2, -3/2
0	-3/2	2/7	18/35	1/5
-1	-1/2	4/7	-1/35	-2/5
-2	1/2	1/7	-16/35	2/5

m_1	m_2	7/2, -5/2	5/2, -5/2
-1	-3/2	4/7	3/7
-2	-1/2	3/7	-4/7

m_1	m_2	7/2, -7/2
-2	-3/2	1

2 × 2

m_1	m_2	4, +4
+2	+2	1

m_1	m_2	4, +3	3, +3
+2	+1	1/2	1/2
+1	+2	1/2	-1/2

m_1	m_2	4, +2	3, +2	2, +2
+2	0	3/14	1/2	2/7
+1	1	4/7	0	-3/7
0	2	3/14	-1/2	2/7

m_1	m_2	4, +1	3, +1	2, +1	1, +1
+2	-1	1/14	3/10	3/7	1/5
+1	0	3/7	1/5	-1/14	-3/10
0	1	3/7	-1/5	-1/14	3/10
-1	2	1/14	-3/10	3/7	-1/5

m_1	m_2	4, 0	3, 0	2, 0	1, 0	0, 0
+2	-2	1/70	1/10	2/7	2/5	1/5
+1	-1	8/35	2/5	1/14	-1/10	-1/5
0	0	18/35	0	-2/7	0	1/5
-1	1	8/35	-2/5	1/14	1/10	-1/5
-2	2	1/70	-1/10	2/7	-2/5	1/5

m_1	m_2	4, -1	3, -1	2, -1	1, -1
+1	-2	1/14	3/10	3/7	1/5
0	-1	3/7	1/5	-1/14	-3/10
-1	0	3/7	-1/5	-1/14	3/10
-2	1	1/14	-3/10	3/7	-1/5

m_1	m_2	4, -2	3, -2	2, -2
0	-2	3/14	1/2	2/7
-1	-1	4/7	0	-3/7
-2	0	3/14	-1/2	2/7

m_1	m_2	4, -3	3, -3
-1	-2	1/2	1/2
-2	-1	1/2	-1/2

m_1	m_2	4, -4
-2	-2	1

d functions

$$d^{1/2}_{1/2,1/2} = \cos\frac{\theta}{2} \qquad d^{1/2}_{1/2,-1/2} = -\sin\frac{\theta}{2}$$

$$d^1_{1,1} = \frac{1+\cos\theta}{2} \qquad d^1_{1,0} = -\frac{\sin\theta}{\sqrt{2}}$$

$$d^1_{1,-1} = \frac{1-\cos\theta}{2} \qquad d^1_{0,0} = \cos\theta$$

$$d^{3/2}_{3/2,3/2} = \frac{1+\cos\theta}{2}\cos\frac{\theta}{2}$$

$$d^{3/2}_{3/2,1/2} = -\sqrt{3}\,\frac{1+\cos\theta}{2}\sin\frac{\theta}{2}$$

$$d^{3/2}_{3/2,-1/2} = \sqrt{3}\,\frac{1-\cos\theta}{2}\cos\frac{\theta}{2}$$

$$d^{3/2}_{3/2,-3/2} = -\frac{1-\cos\theta}{2}\sin\frac{\theta}{2}$$

$$d^{3/2}_{1/2,1/2} = \frac{3\cos\theta-1}{2}\cos\frac{\theta}{2}$$

$$d^{3/2}_{1/2,-1/2} = -\frac{3\cos\theta+1}{2}\sin\frac{\theta}{2}$$

$$d^2_{2,2} = \left(\frac{1+\cos\theta}{2}\right)^2$$

$$d^2_{2,1} = -\frac{1+\cos\theta}{2}\sin\theta$$

$$d^2_{2,0} = \frac{\sqrt{6}}{4}\sin^2\theta$$

$$d^2_{2,-1} = -\frac{1-\cos\theta}{2}\sin\theta$$

$$d^2_{2,-2} = \left(\frac{1-\cos\theta}{2}\right)^2$$

$$d^2_{1,1} = \frac{1+\cos\theta}{2}(2\cos\theta-1)$$

$$d^2_{1,0} = -\sqrt{\frac{3}{2}}\sin\theta\cos\theta$$

$$d^2_{1,-1} = \frac{1-\cos\theta}{2}(2\cos\theta+1)$$

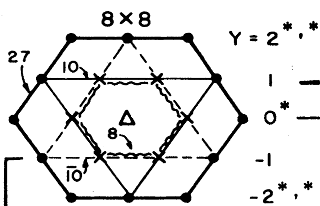
$$d^2_{0,0} = \left(\frac{3}{2}\cos^2\theta - \frac{1}{2}\right)$$

Sign convention is that of Wigner (Group Theory, Academic Press, New York, 1959), also used by Condon and Shortley (The Theory of Atomic Spectra, Cambridge Univ. Press, New York, 1953), Rose (Elementary Theory of Angular Momentum, Wiley, New York, 1957), and Cohen (Tables of the Clebsch-Gordan Coefficients, North American Rockwell Science Center, Thousand Oaks, Calif., 1974). The signs and numbers in the current tables have been calculated by computer programs written independently by Cohen and at LBL. (Table extended April 1974.)

SU(3) ISOSCALAR FACTORS

Adapted from J. J. de Swart, Rev. Mod. Phys. 35, 916 (1963)
The convention used here is: baryon first, meson second.

{8} ⊗ {8} = {27} ⊕ {10} ⊕ {10*} ⊕ {8}₁ ⊕ {8}₂ ⊕ {1}.



Multiplicity of 27;
• = 1, × = 2, Δ = 3

* Five single-coefficient tables are omitted. The one involving a {10*} has a negative coefficient, i.e. (NK|10*) = -1. The others, involving {27} and {10}, are all +1.

$Y = 1 \quad I = 1/2$ N

ξ_1	$\underset{+}{27}$	$\underset{+}{8_D}$	$\underset{-}{8_F}$	$\underset{-}{10^*}$
Nπ	$\sqrt{5}/10$	$3\sqrt{5}/10$	1/2	−1/2
ΣK	$-\sqrt{5}/10$	$-3\sqrt{5}/10$	1/2	−1/2
Nη	$3\sqrt{5}/10$	$-\sqrt{5}/10$	1/2	1/2
ΛK	$3\sqrt{5}/10$	$-\sqrt{5}/10$	−1/2	−1/2

$Y = 1 \quad I = 3/2$ Δ

ξ_1	$\underset{+}{27}$	$\underset{-}{10}$
Nπ	$\sqrt{2}/2$	$-\sqrt{2}/2$
ΣK	$\sqrt{2}/2$	$\sqrt{2}/2$

$Y = 0 \quad I = 0$ Λ

ξ_1	$\underset{+}{27}$	$\underset{+}{8_D}$	$\underset{+}{1}$	$\underset{-}{8_F}$
N$\bar{K}$	$\sqrt{15}/10$	$\sqrt{10}/10$	1/2	$\sqrt{2}/2$
ΞK	$-\sqrt{15}/10$	$-\sqrt{10}/10$	−1/2	$\sqrt{2}/2$
Σπ	$-\sqrt{10}/20$	$-\sqrt{15}/5$	$\sqrt{6}/4$	0
Λη	$3\sqrt{30}/20$	$-\sqrt{5}/5$	$-\sqrt{2}/4$	0

$Y = 0 \quad I = 1$ Σ

ξ_1	$\underset{+}{27}$	$\underset{+}{8_D}$	$\underset{-}{8_F}$	$\underset{-}{10}$	$\underset{-}{10^*}$
N$\bar{K}$	$\sqrt{5}/5$	$-\sqrt{30}/10$	$\sqrt{6}/6$	$-\sqrt{6}/6$	$\sqrt{6}/6$
ΞK	$\sqrt{5}/5$	$-\sqrt{30}/10$	$-\sqrt{6}/6$	$\sqrt{6}/6$	$-\sqrt{6}/6$
Σπ	0	0	$\sqrt{6}/3$	$\sqrt{6}/6$	$-\sqrt{6}/6$
Ση	$\sqrt{30}/10$	$\sqrt{5}/5$	0	1/2	1/2
Λπ	$\sqrt{30}/10$	$\sqrt{5}/5$	0	−1/2	−1/2

$Y = -1 \quad I = 1/2$ Ξ

ξ_1	$\underset{+}{27}$	$\underset{+}{8_D}$	$\underset{-}{8_F}$	$\underset{-}{10}$
Ξπ	$-\sqrt{5}/10$	$-3\sqrt{5}/10$	1/2	1/2
Σ$\bar{K}$	$\sqrt{5}/10$	$3\sqrt{5}/10$	1/2	1/2
Ξη	$3\sqrt{5}/10$	$-\sqrt{5}/10$	−1/2	1/2
Λ$\bar{K}$	$3\sqrt{5}/10$	$-\sqrt{5}/10$	1/2	−1/2

$Y = -1 \quad I = 3/2$

ξ_1	$\underset{+}{27}$	$\underset{-}{10^*}$
Ξπ	$\sqrt{2}/2$	$-\sqrt{2}/2$
Σ$\bar{K}$	$\sqrt{2}/2$	$\sqrt{2}/2$

The phase factor $\xi_1 = \pm 1$, from de Swart's Table I, enters in his symmetry formula (14.3):

$$\langle \mu_1 \mu_2 | \mu \rangle = \xi_1 (-1)^{I_1 + I_2 - I} \langle \mu_2 \mu_1 | \mu \rangle .$$

This factor is irrelevant if you are doing your own self-consistent calculations; it enters when you try to check someone else who chose $\mu_2 \otimes \mu_1$ instead of $\mu_1 \otimes \mu_2$.

{10} ⊗ {8} = {35} ⊕ {27} ⊕ {10} ⊕ {8}.

* Four single coefficient tables are omitted; only the {27} is -1; the three with {35} are +1.

$Y = 1 \quad I = 1/2$ N.

ξ_1	$\underset{-}{27}$	$\underset{+}{8}$
Δπ	$-\sqrt{5}/5$	$-2\sqrt{5}/5$
ΣK	$-2\sqrt{5}/5$	$\sqrt{5}/5$

$Y = 1 \quad I = 3/2$ Δ

ξ_1	$\underset{+}{35}$	$\underset{-}{27}$	$\underset{-}{10}$
Δπ	1/4	$-\sqrt{5}/4$	$\sqrt{10}/4$
Δη	$\sqrt{5}/4$	3/4	$\sqrt{2}/4$
ΣK	$\sqrt{10}/4$	$-\sqrt{2}/4$	− 1/2

$Y = 0 \quad I = 0$ Λ

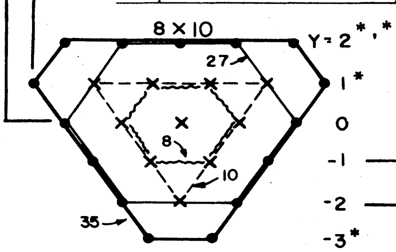
ξ_1	$\underset{-}{27}$	$\underset{+}{8}$
Σπ	$-\sqrt{10}/5$	$-\sqrt{15}/5$
ΞK	$-\sqrt{15}/5$	$\sqrt{10}/5$

$Y = 0 \quad I = 1$ Σ

ξ_1	$\underset{+}{35}$	$\underset{-}{27}$	$\underset{-}{10}$	$\underset{+}{8}$
Σπ	$\sqrt{3}/6$	$-3\sqrt{5}/10$	$\sqrt{3}/3$	$-\sqrt{30}/15$
Ση	$\sqrt{2}/2$	$\sqrt{30}/10$	0	$-\sqrt{5}/5$
ΞK	$\sqrt{3}/3$	$-\sqrt{5}/5$	$-\sqrt{3}/3$	$\sqrt{30}/15$
Δ$\bar{K}$	$\sqrt{3}/6$	$\sqrt{5}/10$	$\sqrt{3}/3$	$2\sqrt{30}/15$

$Y = 0 \quad I = 2$

ξ_1	$\underset{+}{35}$	$\underset{-}{27}$
Σπ	$\sqrt{3}/2$	−1/2
Δ$\bar{K}$	1/2	$\sqrt{3}/2$



Multiplicity of 35;
• = 1, × = 2

$Y = -1 \quad I = 1/2$ Ξ

ξ_1	$\underset{+}{35}$	$\underset{-}{27}$	$\underset{-}{10}$	$\underset{+}{8}$
Ξπ	1/4	$-7\sqrt{5}/20$	$\sqrt{2}/4$	$-\sqrt{5}/5$
Ξη	3/4	$3\sqrt{5}/20$	$-\sqrt{2}/4$	$-\sqrt{5}/5$
ΩK	$\sqrt{2}/4$	$-3\sqrt{10}/20$	− 1/2	$\sqrt{10}/5$
Σ$\bar{K}$	1/2	$\sqrt{5}/10$	$\sqrt{2}/2$	$\sqrt{5}/5$

$Y = -1 \quad I = 3/2$

ξ_1	$\underset{+}{35}$	$\underset{-}{27}$
Ξπ	$\sqrt{2}/2$	$-\sqrt{2}/2$
Σ$\bar{K}$	$\sqrt{2}/2$	$\sqrt{2}/2$

$Y = -2 \quad I = 0$ Ω^-

ξ_1	$\underset{+}{35}$	$\underset{-}{10}$
Ωη	$\sqrt{2}/2$	$-\sqrt{2}/2$
Ξ$\bar{K}$	$\sqrt{2}/2$	$\sqrt{2}/2$

$Y = -2 \quad I = 1$

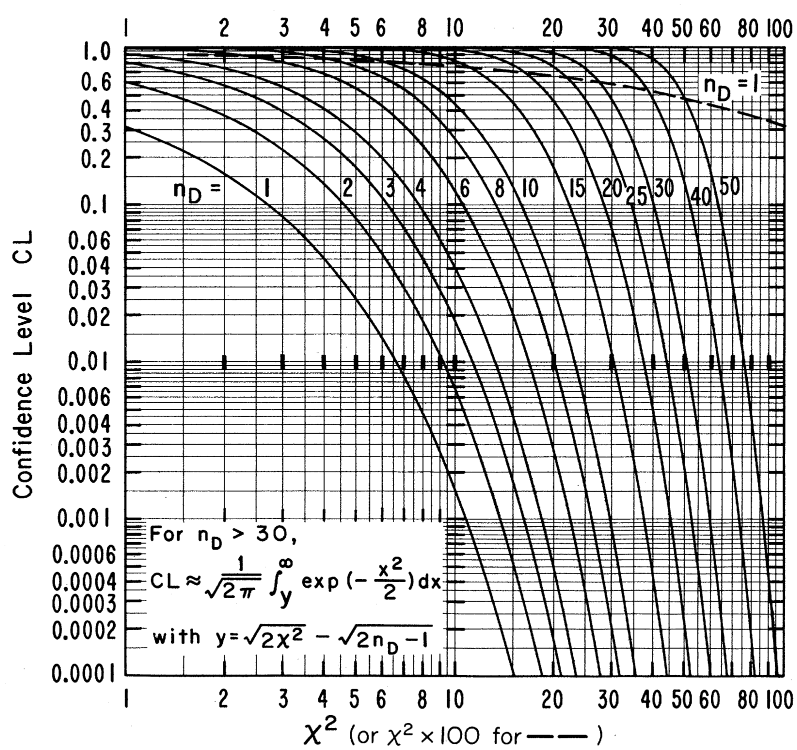
ξ_1	$\underset{+}{35}$	$\underset{-}{27}$
Ωπ	1/2	$-\sqrt{3}/2$
Ξ$\bar{K}$	$\sqrt{3}/2$	1/2

PROBABILITY AND STATISTICS

A. PROBABILITY DISTRIBUTIONS AND CONFIDENCE LEVELS

We give here properties of the three probability distributions most commonly used in high energy physics: Normal (or Gaussian), Chi-squared, and Poisson. We warn the reader that there is no universal convention for the term "confidence level" as used by physicists; thus, explicit definitions are given for each distribution, and we have attempted to choose definitions that correspond to common usage. It is explained below how confidence levels for all three distributions can be extracted from the following figure.

χ^2 Confidence Level vs. χ^2 for n_D Degrees of Freedom



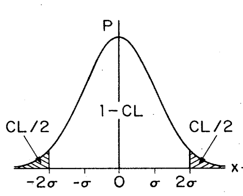
A.1. Normal Distribution

The normal distribution with mean $\bar{x}$ and standard deviation σ (variance σ^2) is:

$$P(x)dx = \frac{1}{\sqrt{2\pi}\sigma} e^{-(x-\bar{x})^2/2\sigma^2} dx. \qquad (1)$$

The confidence level associated with an observed deviation from the mean, δ, is the probability that $|x-\bar{x}| > \delta$, i.e.,

$$CL = 2\int_{\bar{x}+\delta}^{\infty} dx\, P(x) \qquad (2)$$



[The small figure in Eq. (2) is drawn with $\delta = 2\sigma$.] CL is given by the ordinate of the $n_D = 1$ curve in the figure at $\chi^2 = (\delta/\sigma)^2$. The confidence level for $\delta = 1\sigma$ is 31.7%; 2σ, 4.6%; 3σ, 0.3%. The central confidence interval, 1-CL, (which is also sometimes called confidence level) for $\delta = 1\sigma$ is 68.3%; 2σ, 95.4%; 3σ, 99.7%. The odds against exceeding δ, (1-CL)/CL, for $\delta = 1\sigma$ are 2.15:1; 2σ, 21:1; 3σ, 370:1; 4σ, 16,000:1; 5σ, 1,700,000:1. Relations between σ and other measures of the width: probable error (CL = 0.5 deviation) = 0.67σ; mean absolute deviation = 0.80σ; RMS deviation = σ; half width at half maximum = 1.18σ.

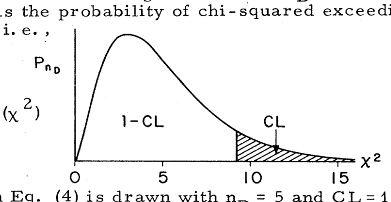
A.2. Chi-squared Distribution

The chi-squared distribution for n_D degrees of freedom is:

$$P_{n_D}(\chi^2)d\chi^2 = \frac{1}{2^h\Gamma(h)} (\chi^2)^{h-1} e^{-\chi^2/2} d\chi^2 \quad (\chi^2 \geq 0), \qquad (3)$$

where h (for "half") = $n_D/2$. The mean and variance are n_D and $2n_D$, respectively. In evaluating Eq. (3) one may use Stirling's approximation: $\Gamma(h) = (h-1)! \approx 2.507\, e^{-h} h^{(h-1/2)} \times (1 + 0.0833/h)$ which is accurate to ± 0.1% for all $h \geq 1/2$. The confidence level associated with a given value of n_D and an observed value of χ^2 is the probability of chi-squared exceeding the observed value, i.e.,

$$CL = \int_{\chi^2}^{\infty} d\chi^2\, P_{n_D}(\chi^2) \qquad (4)$$



[The small figure in Eq. (4) is drawn with $n_D = 5$ and CL = 10%.] CL is plotted as a function of χ^2 for several values of n_D in the above figure. For large n_D, χ^2 becomes normally distributed about n_D. Thus,

$$y_1 = (\chi^2 - n_D)/\sqrt{2n_D} \qquad (5)$$

becomes normally distributed with unit standard deviation. A better approximation, due to Fisher,[1] is that χ, not χ^2, becomes normally distributed, specifically

$$y_2 = \sqrt{2\chi^2} - \sqrt{2n_D - 1} \qquad (6)$$

approaches normality with unit standard deviation. For small CL's in particular, y_2 is much more accurate than y_1. Thus, for $n_D = 50$ and $\chi^2 = 80$, the true CL = 0.45%, but y_1 is 3.0 corresponding to a CL of 0.13%, while y_2 is 2.7 corresponding to a CL of 0.35%.

PROBABILITY AND STATISTICS (Cont'd)

A.3. Poisson Distribution

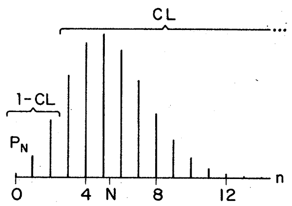
The Poisson distribution with mean $\bar{n}$ is:

$$P_{\bar{n}}(n) = \frac{e^{-(\bar{n})}(\bar{n})^n}{n!} \quad (n = 0, 1, 2, \cdots) . \qquad (7)$$

The variance is equal to the mean. Confidence levels for Poisson distributions are usually defined in terms of quantities called "upper limits" as follows: The confidence level associated with a given upper limit N and an observed value n_0 of n is the probability that $n > n_0$ if $\bar{n} = N$, i. e.,

$$CL = \sum_{n=n_0+1}^{\infty} P_N(n)$$

$$= 1 - \sum_{n=0}^{n_0} P_N(n) \qquad (8)$$



[The small figure in Eq. (8) is drawn with $n_0 = 2$ and CL = 90%.] A useful relation between Poisson and chi-squared confidence levels allows one to look up this quantity on the above figure. Specifically, the quantity 1-CL is given by the ordinate of the $n_D = 2(n_0+1)$ curve at $\chi^2 = 2N$. Thus, 90% confidence level upper limits for $n_0 = 0$, 1, and 2 are given by half the χ^2 value corresponding to an ordinate of 0.1 on the $n_D = 2,4$, and 6 curves, respectively; the values are N = 2.3, 3.9, and 5.3.

- -

Tables of confidence levels for all three of these distributions, the relation between Poisson and chi-squared confidence levels, and numerous other useful tables and relations may be found in Ref. 2.

B. STATISTICS

We consider here the situation in which one is presented with N independent data, $y_n \pm \sigma_n$, and it is desired to make some inference about the "true" value of the quantity represented by these data. For this purpose we interpret each datum y_n as a single sample point drawn randomly (and independently of the other data) from a distribution having mean $\bar{y}_n$ (which we wish to estimate) and variance σ_n^2. (Identification of the true σ_n with the σ_n datum is an approximation which may become seriously inaccurate when σ_n is an appreciable fraction of y_n.) Some methods of estimation commonly used in high energy physics are given below; see Ref. 3 for numerous applications. Section B.1. deals with the case in which all $\bar{y}_n$ are the same, e. g., several different measurements of the same quantity; Sec. B.2. deals with the case in which $\bar{y}_n = \bar{y}(x_n)$, where x_n represents some set of independent variables, e. g., cross-section measurements at various values of energy and angle, $x_n = \{E_n, \theta_n\}$.

B.1. Single Mean and Variance Estimates

(1) If the y_n represent a set of values all supposedly drawn from a single distribution with mean $\bar{y}$ and variance σ^2 (i. e., the σ_n are all the same, but their common value is unknown) then

$$\bar{y}_e = \frac{1}{N} \sum_n y_n \quad \text{and} \qquad (9)$$

$$\sigma_e^2 = \frac{1}{N-1} \sum_n (y_n - \bar{y}_e)^2 \qquad (10)$$

are unbiased estimates of $\bar{y}$ and σ^2. The variance of $\bar{y}_e$ is σ^2/N. If the parent distribution is normal and N is large, the variance of σ_e^2 is $2\sigma^4/N$.

(2) If the $\bar{y}_n$ all have the common value $\bar{y}$ and the σ_n are known, then the weighted average

$$\bar{y}_e = \frac{1}{w} \sum_n w_n y_n, \qquad (11)$$

where $w_n = 1/\sigma_n^2$ and $w = \Sigma w_n$, is an appropriate unbiased estimate of $\bar{y}$. This choice of weighting factors in Eq. (11) minimizes the variance of the estimate; the variance is $1/w$.

B.2. Linear Least Squares Fit

A least squares fit of the function $y(x) = \Sigma_i a_i f_i(x)$ to independent data $y_n \pm \sigma_n$ at points x_n (e. g., a Legendre fit in which the f_i are Legendre polynomials and the a_i are Legendre coefficients) gives the following estimates of the parameters a_i:

$$a_{e,i} = \sum_{j,n} V_{ij} f_j(x_n) y_n/\sigma_n^2 . \qquad (12)$$

Here V is the covariance matrix of the fitted parameters

$$V_{ij} = \overline{(a_{e,i} - \bar{a}_{e,i})(a_{e,j} - \bar{a}_{e,j})} , \qquad (13)$$

which is given by

$$(V^{-1})_{ij} = \sum_n f_i(x_n) f_j(x_n)/\sigma_n^2 . \qquad (14)$$

The variance of an interpolated or extrapolated value of y at point x, $y_e = \Sigma a_{e,i} f_i(x)$, is:

$$\overline{(y_e - \bar{y}_e)^2} = \sum_{ij} V_{ij} f_i(x) f_j(x) . \qquad (15)$$

For the case of a straight line fit, $y(x) = a + bx$, one obtains the following estimates of a and b,

$$a_e = (S_y S_{xx} - S_x S_{xy})/D,$$
$$b_e = (S_1 S_{xy} - S_x S_y)/D, \qquad (16)$$

where

$$S_1, S_x, S_y, S_{xx}, S_{xy} = \Sigma(1, x_n, y_n, x_n^2, x_n y_n)/\sigma_n^2, \qquad (17)$$
$$D = S_1 S_{xx} - S_x^2 .$$

The covariance matrix of the fitted parameters is:

$$\begin{pmatrix} V_{aa} & V_{ab} \\ V_{ab} & V_{bb} \end{pmatrix} = \frac{1}{D} \begin{pmatrix} S_{xx} & -S_x \\ -S_x & S_1 \end{pmatrix} \qquad (18)$$

The variance of an interpolated or extrapolated value of y at point x is:

$$\overline{(y_e - \bar{y}_e)^2} = \frac{1}{S_1} + \frac{S_1}{D}\left(x - \frac{S_x}{S_1}\right)^2 \qquad (19)$$

C. ERROR PROPAGATION

We consider here the situation in which one wishes to calculate the value and error of a function of some other quantities with errors, e. g., in a Monte Carlo program. Let $\{y\}$ be a set of random variables with means $\{\bar{y}\}$ and covariance matrix V. Then the mean and variance of a function of these variables are approximately (to second order in $\{y - \bar{y}\}$):

$$\bar{f} \approx f(\{y\}) + \frac{1}{2} \sum_{mn} V_{mn} \left(\frac{\partial^2 f}{\partial y_m \partial y_n}\right)_{\{y\} = \{\bar{y}\}} , \qquad (20)$$

$$\overline{(f - \bar{f})^2} = \sum_{mn} V_{mn} \left(\frac{\partial f}{\partial y_m}\right)_{\{y\} = \{\bar{y}\}} \left(\frac{\partial f}{\partial y_n}\right)_{\{y\} = \{\bar{y}\}} . \qquad (21)$$

E. g., the mean and variance of a function of a single variable with mean $\bar{y}$ and variance σ^2 are:

$$\bar{f} \approx f(\bar{y}) + \frac{1}{2} \sigma^2 f''(\bar{y}), \qquad (22)$$

$$\overline{(f - \bar{f})^2} = \sigma^2 f'(\bar{y})^2 . \qquad (23)$$

Note that these equations will usually be applied by substituting some measured quantities, $\{\tilde{y}\}$ say, for the true means, $\{\bar{y}\}$. If, as is often the case, $\tilde{y}_n - \bar{y}_n$ is of order $\sqrt{V_{nn}}$, then there is no point in keeping the second order terms in Eq. (20) or (22) since the substitution itself introduces first order errors.

1. R. A. Fisher, Statistical Methods for Research Workers (Oliver and Boyd, Edinburgh and London, 1958).
2. M. Abramovitz and I. Stegun, eds., Handbook of Mathematical Functions (National Bureau of Standards, Applied Mathematics Series, Vol. 55, Washington, 1964).
3. W. T. Eadie, D. Drijard, F. E. James, M. Roos, and B. Sadoulet, Statistical Methods in Experimental Physics (North-Holland, Amsterdam and London, 1971).

Revised and expanded April 1974.

RELATIVISTIC KINEMATICS*

DEFINITIONS AND GENERAL FORMULAE

I. NOTATION

We define any 4-vector p by its components:

$$p \equiv (p_0, \vec{P}) \quad \text{with} \quad \begin{cases} p_0 \equiv E \equiv \text{the energy} \\ \vec{P} \equiv (P_\parallel, \vec{P}_\perp) = \text{3-vector of magnitude } P, \end{cases} \qquad \text{(I-1)}$$

where $\begin{cases} P_\parallel \equiv \text{the longitudinal momentum along a beam direction} \\ \vec{P}_\perp \equiv \text{the transverse momentum (2 components, along 2 axes perpendicular to the beam);} \end{cases}$

then
$$p^{lab} = (E^{lab}, P_\parallel^{lab}, \vec{P}_\perp^{lab}) , \qquad \text{(I-2)}$$
$$p^{cm} = (E^{cm}, P_\parallel^{cm}, \vec{P}_\perp^{cm}) . \qquad \text{(I-3)}$$

The 4-vector scalar products are defined by
$$A \cdot B = A_0 B_0 - \vec{A} \cdot \vec{B} , \qquad \text{(I-4)}$$

so that
$$p^{lab} \cdot p^{lab} = p^{cm} \cdot p^{cm} = m^2 . \qquad \text{(I-5)}$$

II. GENERAL INVARIANT DEFINITIONS AND RELATED FORMULAE

For any 2 particles i and j, the most commonly used invariants are defined as follows:

A. *The invariant mass squared of the combination of particles i and j is*

$$s_{ij} \equiv m_{ij}^2 \equiv (p_i + p_j)^2 = m_i^2 + m_j^2 + 2(E_i E_j - \vec{P}_i \cdot \vec{P}_j) . \qquad \text{(II-1)}$$

Using the function $\Delta(x,y,z)$ [also called $\lambda(x,y,z)$], defined by

$$\Delta(x,y,z) \equiv x^2 + y^2 + z^2 - 2xy - 2yz - 2zx$$
$$= [x - (\sqrt{y} + \sqrt{z})^2][x - (\sqrt{y} - \sqrt{z})^2] , \qquad \text{(II-2)}$$

we have the relations:

A.1. *In the particle j rest frame* ($\vec{P}_j = 0$), the longitudinal axis being along $\vec{P}_i$,

$$p_i^{(j)} = \left(\frac{s_{ij} - m_i^2 - m_j^2}{2m_j} , \frac{\sqrt{\Delta(s_{ij}, m_i^2, m_j^2)}}{2m_j} , 0 \right) ; \qquad \text{(II-6)}$$

A.2. *In the c.m. frame for particles (i and j)* ($\vec{P}_j = -\vec{P}_i$), the longitudinal axis being along $\vec{P}_i$,

$$p_i^{(ij)} = \left(\frac{s_{ij} + m_i^2 - m_j^2}{2\sqrt{s_{ij}}} , \frac{\sqrt{\Delta(s_{ij}, m_i^2, m_j^2)}}{2\sqrt{s_{ij}}} , 0 \right) ; \qquad \text{(II-11)}$$

thus,
$$p_i^{(ij)} = \frac{m_j}{\sqrt{s_{ij}}} p_i^{(j)} . \qquad \text{(II-13)}$$

A.3. *Applications: Useful relations involving* s_{ij}:

i) *In a Dalitz plot for the 3-body decay,* $X \to 1 + 2 + 3$,

$$\sum_{i<j} s_{ij} = \sum_i m_i^2 + m_{123}^2 = \text{const.} \quad (i,j = 1,2,3) \qquad \text{(II-14)}$$

with $m_{123}^2 = (p_1 + p_2 + p_3)^2 = m_X^2$.

ii) *In a triangle plot for the 4-body decay,* $X \to 1 + 2 + 3 + 4$,

$$\sum_{i<j} s_{ij} = 2\sum_i m_i^2 + m_{1234}^2 = \text{const.} \quad (i,j = 1,2,3,4) \qquad \text{(II-15)}$$

with $m_{1234}^2 = (p_1 + p_2 + p_3 + p_4)^2 = m_X^2$.

B. *The invariant momentum transfer squared* between particles i and k is

$$t_{ik} \equiv (p_i - p_k)^2 = m_i^2 + m_k^2 - 2(E_i E_k - \vec{P}_i \cdot \vec{P}_k) . \qquad \text{(II-16)}$$

$$t_{ik} = t_{ik}^{min} + 2(\vec{P}_i \cdot \vec{P}_k - P_i P_k) = t_{ik}^{min} - 4P_i P_k \sin^2 \frac{\theta_{ik}}{2} \qquad \text{(II-19)}$$

(θ_{ik} being the angle between $\vec{P}_i$ and $\vec{P}_k$).

PARTICULAR CASES AND ASYMPTOTIC VALUES ($\simeq$)

III. VERY HIGH ENERGY PHYSICS: ASYMPTOTIC FORMULAE

A. *Colliding beams*

$$s \simeq 2(E_a E_b - \vec{P}_a \cdot \vec{P}_b) \qquad \text{(III-1)}$$

If θ is the *supplement* of the angle between the two beams, (and if we assume $E_i \simeq P_i$), then:

$$s \simeq 4P_a P_b \cos^2 \frac{\theta}{2} \simeq 4P_a P_b \left(1 - \frac{\theta^2}{8} + \ldots\right) \qquad \text{(III-2)}$$

B. *Interaction of particle a with target b at rest*

B.1. *In the lab frame*

$$s = s_{ab} = m_a^2 + m_b^2 + 2m_b E_a^{lab} \simeq 2m_b E_a^{lab} \qquad \text{(III-3)}$$

and
$$P_{inc} \simeq \frac{s}{2m_b} . \qquad \text{(III-4)}$$

B.2. *In the center-of-mass frame*

$$s = s_{ab} = (E_a^{cm} + E_b^{cm})^2 \simeq 4(P_a^{cm})^2 \qquad \text{(III-5)}$$

and
$$P_a^{cm} = P_b^{cm} \simeq \frac{\sqrt{s}}{2} \qquad \text{(III-6)}$$

and
$$\begin{cases} p_a = \left(\dfrac{s + m_a^2 - m_b^2}{2\sqrt{s}} , \dfrac{m_b}{\sqrt{s}} P_{inc}, 0 \right) \\ p_b = \left(\dfrac{s + m_b^2 - m_a^2}{2\sqrt{s}} , \dfrac{-m_b}{\sqrt{s}} P_{inc}, 0 \right) . \end{cases}$$

RELATIVISTIC KINEMATICS (Cont'd)

Application to the reaction a + b → c + d:

1. *General formulae*

$$t \equiv t_{ac} = t_{bd} = t_{ac}^{min} - 4p_a p_c \sin^2\left(\frac{\theta_{ac}}{2}\right) ,$$

with $$t_{ac}^{\substack{min \\ max}} = (E_a - E_c)^2 - (p_a \mp p_c)^2 \quad \text{(II-20)}$$

which, after expansion in powers of (1/s), gives

$$t_{ac}^{min} = -\frac{(m_a^2 - m_c^2)(m_b^2 - m_d^2)}{s} - \frac{(m_a^2 + m_b^2 - m_c^2 - m_d^2)(m_a^2 m_b^2 - m_c^2 m_d^2)}{s^2} + O\left(\frac{1}{s^3}\right) \quad \text{(II-22)}$$

In a similar way, defining $u_{ad} = (p_a - p_d)^2$, one finds

$$u \equiv t_{ad} = t_{bc} = u_{ad}^{min} - 4p_a p_d \sin^2\left(\frac{\theta_{ad}}{2}\right) .$$

$$u_{ad}^{min} = -\frac{(m_a^2 - m_d^2)(m_b^2 - m_c^2)}{s} - \frac{(m_a^2 + m_b^2 - m_c^2 - m_d^2)(m_a^2 m_b^2 - m_c^2 m_d^2)}{s^2} + O\left(\frac{1}{s^3}\right) \quad \text{(II-23)}$$

A general relation between the invariants is

$$s + t + u = m_a^2 + m_b^2 + m_c^2 + m_d^2 .$$

2. *Particular case*

In the c.m.: $dt = 2p_a p_c \, d(\cos\theta_{ac})$.

i) $m_a = m_c$, $m_b \neq m_d$:

$$t_{ac}^{min} \simeq -\frac{m_a^2 (m_b^2 - m_d^2)^2}{s^2} \quad \text{(II-24)}$$

$$u_{ad}^{min} \simeq -\frac{(m_a^2 - m_d^2)(m_b^2 - m_c^2)}{s} \quad \text{(II-25)}$$

ii) For elastic scattering (a + b → a' + b'),

$$t_{aa'}^{min} = 0,$$

and $$t_{aa'} = -4p_a^2 \sin^2\left(\frac{\theta_{aa'}}{2}\right) ,$$

$$dt_{aa'} = 2p_a^2 \, d(\cos\theta_{aa'}); \quad \text{(II-26)}$$

also $$u_{ab'}^{min} = \frac{(m_a^2 - m_b^2)^2}{s} \quad \text{(II-27)}$$

IV. <u>RELATIONS BETWEEN THE (j) PARTICLE AND (ij) PARTICLE REST FRAMES: LORENTZ TRANSFORMATION</u>

The general Lorentz transformation has the matrix form

$$\begin{pmatrix} E \\ p_\parallel \\ \vec{p}_\perp \end{pmatrix}^{(ij)} = \begin{pmatrix} \gamma & -\eta & 0 \\ -\eta & \gamma & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} E \\ p_\parallel \\ \vec{p}_\perp \end{pmatrix}^{(j)} \quad \text{(IV-1)}$$

If we define, in any frame, the quantity: $p_\pm = E \pm p_\parallel$,

$$\begin{pmatrix} p_+ \\ p_- \\ \vec{p}_\perp \end{pmatrix}^{(ij)} = \begin{pmatrix} (\gamma-\eta) & 0 & 0 \\ 0 & (\gamma+\eta) & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} p_+ \\ p_- \\ \vec{p}_\perp \end{pmatrix}^{(j)} , \quad \text{(IV-3)}$$

$$\gamma \mp \eta = \frac{s_{ij} + m_j^2 - m_i^2 \mp \sqrt{\Delta(s_{ij}, m_i^2, m_j^2)}}{2m_j \sqrt{s_{ij}}} = e^{\mp \xi_{ij}} . \quad \text{(IV-4)}$$

$$|\vec{\beta}| = \frac{|\vec{\eta}|}{\gamma} = \tanh \xi_{ij} = \frac{\sqrt{\Delta(s_{ij}, m_i^2, m_j^2)}}{s_{ij} + m_j^2 - m_i^2} = \frac{p_i^{(j)}}{E_i^{(j)} + m_j} \quad \text{(IV-5)}$$

$$\gamma = \frac{1}{\sqrt{1-\beta^2}} = \cosh \xi_{ij} = \frac{s_{ij} + m_j^2 - m_i^2}{2m_j \sqrt{s_{ij}}} = \frac{E_i^{(j)} + m_j}{\sqrt{s_{ij}}} \quad \text{(IV-6)}$$

$$|\vec{\eta}| = |\vec{\beta}|\gamma = \sinh \xi_{ij} = \frac{\sqrt{\Delta(s_{ij}, m_i^2, m_j^2)}}{2m_j \sqrt{s_{ij}}} = \frac{p_i^{(j)}}{\sqrt{s_{ij}}} \quad \text{(IV-7)}$$

The spatial part of the matrix in Eq. (IV-1) above can be written with the classical vector form

$$\vec{p}^{(ij)} = \vec{p}^{(j)} + \vec{\eta}\left(\frac{\vec{\eta} \cdot \vec{p}}{\gamma + 1} - E^{(j)}\right) \quad \text{(IV-9)}$$

A convenient way to write the latter expression is

$$\vec{p}^{(ij)} = \vec{p}^{(j)} - \vec{\eta}\left[\frac{E^{(ij)} + E^{(j)}}{\gamma + 1}\right] \quad \text{(IV-10)}$$

At high energy:

$$e^{\xi_{ij}} \simeq \frac{\sqrt{s_{ij}}}{m_j} \quad \text{and} \quad \xi_{ij} \simeq \ln \frac{\sqrt{s_{ij}}}{m_j} .$$

ξ_{ij} is called the *boost parameter* of the Lorentz transformation that connects the particle ij rest frame to the particle j rest frame.

Application

1. *To reaction* a(beam) + b(target)

The transformation from the lab frame into the c.m. frame is given by:

$$\gamma = \frac{E_a^{lab} + m_b}{\sqrt{s}} \quad \text{and} \quad \eta = \frac{p_{inc}}{\sqrt{s}} ;$$

$$p_\pm^{cm} = e^{\mp\xi} p_\pm^{lab}$$

with

$$e^{\pm\xi} = \frac{s + m_b^2 - m_a^2 \mp \sqrt{\Delta(s, m_a^2, m_b^2)}}{2m_b \sqrt{s}} \quad \text{(IV-11)}$$

2. *The Lorentz transform of any vector* $p_1 = (E_1, \vec{p}_1)$*, given in a frame containing another vector* $p_2 = (E_2, \vec{p}_2)$*, into the* p_2 *rest frame* — where $p_2 = (m_2, 0)$, and $p_1 = (E_1', \vec{p}_1')$ — may be calculated using:

$$\gamma = \frac{E_2}{m_2} \quad \text{and} \quad \vec{\eta} = \frac{\vec{p}_2}{m_2} :$$

$$\left.\begin{aligned} E_1' &= \gamma E_1 - \vec{\eta} \cdot \vec{p}_1 = \frac{E_1 E_2 - \vec{p}_1 \cdot \vec{p}_2}{m_2} , \\ \vec{p}_1' &= \vec{p}_1 - \frac{\vec{p}_2}{m_2}\left(\frac{E_1 + E_1'}{\gamma + 1}\right) = \vec{p}_1 - \vec{p}_2\left(\frac{E_1 + E_1'}{E_2 + m_2}\right) \end{aligned}\right\} \quad \text{(IV-12)}$$

RELATIVISTIC KINEMATICS (Cont'd)

V. RAPIDITY VARIABLE: DEFINITION AND KINEMATIC RELATIONS

Definition: in any system, for a particle of energy E and longitudinal momentum $P_{\parallel}$, the rapidity is defined by

$$y \equiv \tfrac{1}{2}\ln\left(\frac{E+P_{\parallel}}{E-P_{\parallel}}\right) = \tanh^{-1}\left(\frac{P_{\parallel}}{E}\right)$$

$$= \tfrac{1}{2}\ln\left(\frac{P_+}{P_-}\right) = \ln\left(\frac{P_+}{m_\perp}\right) = -\ln\left(\frac{P_-}{m_\perp}\right) , \qquad \text{(V-1)}$$

with the transverse mass $m_\perp \equiv (m^2 + P_\perp^2)^{\frac{1}{2}}$.

From the last of the two equations above, one gets

$$P_+ = m_\perp e^y , \qquad \text{(V-2)}$$

$$P_- = m_\perp e^{-y} , \qquad \text{(V-3)}$$

so that

$$E = m_\perp \cosh y , \qquad \text{(V-4)}$$

$$P_{\parallel} = m_\perp \sinh y . \qquad \text{(V-5)}$$

A. *Relations between the rapidities of different frames:*

$$y^{(ij)} = y^{(j)} - \xi_{ij} \qquad \text{(V-7)}$$

B. *Application to a reaction* $a+b \to c+d$ (or $a+b \to c+X$):

In the lab frame,

$$\left.\begin{aligned} p_a^{lab} &= (m_a \cosh y_a^{lab},\ m_a \sinh y_a^{lab},\ 0) \\ p_b^{lab} &= (m_b,\ 0,\ 0) \\ p_c^{lab} &= (m_{\perp c} \cosh y_c^{lab},\ m_{\perp c} \sinh y_c^{lab},\ \vec{P}_{\perp c}) \end{aligned}\right\} \qquad \text{(V-8)}$$

(and a similar formula for particle d or X).

In the c.m. frame,

$$\left.\begin{aligned} p_a^{cm} &= (m_a \cosh y_a^{cm},\ m_a \sinh y_a^{cm},\ 0) \\ p_b^{cm} &= (m_b \cosh y_b^{cm},\ m_b \sinh y_b^{cm},\ 0) \\ p_c^{cm} &= (m_{\perp c} \cosh y_c^{cm},\ m_{\perp c} \sinh y_c^{cm},\ \vec{P}_{\perp c}) \end{aligned}\right\} \qquad \text{(V-9)}$$

(and a similar formula for particle d or X).

$$y_a^{lab} = \cosh^{-1}\left(\frac{s - m_a^2 - m_b^2}{2m_a m_b}\right) \xrightarrow[\text{at large } s]{} y_a^{lab} \simeq \ln\frac{s}{m_a m_b} \qquad \text{(V-10)}$$

$$y_a^{cm} = \cosh^{-1}\left(\frac{s + m_a^2 - m_b^2}{2m_a\sqrt{s}}\right) \xrightarrow[\text{at large } s]{} y_a^{cm} \simeq \ln\frac{\sqrt{s}}{m_a} \qquad \text{(V-11)}$$

$$y_b^{cm} = \cosh^{-1}\left(\frac{s + m_b^2 - m_a^2}{2m_b\sqrt{s}}\right) \xrightarrow[\text{at large } s]{} y_b^{cm} \simeq -\ln\frac{\sqrt{s}}{m_b} \qquad \text{(V-12)}$$

$$y_c^{cm} = \cosh^{-1}\left(\frac{s + m_c^2 - m_d^2}{2m_{\perp c}\sqrt{s}}\right) \xrightarrow[\text{at large } s]{} y_c^{cm} \simeq \ln\frac{\sqrt{s}}{m_{\perp c}} \qquad \text{(V-13)}$$

and m_d^2 (or m_X^2) $<<s$

With $\xi \simeq \ln\frac{\sqrt{s}}{m_b}$, one gets, at large s:

$$y_c^{lab} \simeq \ln\frac{s}{m_b m_{\perp c}} \qquad \text{(V-14)}$$

$$y^{lab} \simeq \tfrac{1}{2}\ln\left(\frac{p^{lab} + p_{\parallel}^{lab}}{p^{lab} - p_{\parallel}^{lab}}\right) \simeq -\ln(\tan\frac{\theta}{2}) .$$

The *maximum rapidity gap* for the reaction $a+b \to c+d$ at large s is:

i) for the incoming particles (a,b):

$$y_{ab} = y_a^{lab} = y_a^{cm} - y_b^{cm} \simeq \ln\frac{s}{m_a m_b} \qquad \text{(V-15)}$$

ii) for the outgoing particles (c,d):

$$y_{cd} = y_c^{lab} - y_d^{lab} = y_c^{cm} - y_d^{cm} \simeq \ln\frac{s}{m_{\perp c} m_{\perp d}} \qquad \text{(V-16)}$$

Application to reaction $a+b \to 1+2\ldots+N$, with the N outgoing particles being ordered by increasing rapidity.

1. *The maximum rapidity gap* between the outgoing particles has an approximate value

$$y_{1N} \simeq \ln\frac{s}{m_{\perp 1}\, m_{\perp N}} \qquad \text{(V-17)}$$

2. *The rapidity gap* $(y_i - y_j)$ between the rapidities y_i and y_j of particles i and j, respectively, is related to the invariant mass squared of particles i and j

$$s_{ij} = m_i^2 + m_j^2 + 2m_{\perp i} \cdot m_{\perp j} \cosh(y_i - y_j) - 2\vec{P}_{\perp i} \cdot \vec{P}_{\perp j} , \qquad \text{(V-18)}$$

$$y_i - y_j = \cosh^{-1} \frac{s_{ij} - m_i^2 - m_j^2 + 2\vec{P}_{\perp i} \cdot \vec{P}_{\perp j}}{2m_{\perp i} m_{\perp j}} \qquad \text{(V-19)}$$

3. *The rapidity gap between either of the extreme particles (1 or N) and its adjacent neighbor* [2 or (N - 1) respectively] is, on a statistical basis, and in first approximation

$$|y_1 - y_2| \simeq \ln\frac{s}{M_1^2} , \qquad \text{(V-20)}$$

and

$$|y_{N-1} - y_N| \simeq \ln\frac{s}{M_N^2} , \qquad \text{(V-21)}$$

M_1 (M_N) being the missing mass with respect to particle 1 (N) in the reaction $a + b \to 1 + M_1$ ($a + b \to N + M_N$).

4. The rapidity gap y_{a1} between the incoming particle a and the outgoing particle closest to a, 1, is related to the transverse momentum $t_{a1} = (p_a - p_1)^2$:

$$y_a - y_1 = \cosh^{-1}\left(\frac{t_{a1} - m_a^2 - m_1^2}{2m_a m_{\perp 1}}\right) \qquad \text{(V-23)}$$

RELATIVISTIC KINEMATICS (Cont'd)

VI. INCLUSIVE REACTIONS AND SCALING VARIABLES: DEFINITIONS AND KINEMATIC RELATIONS

A. Scaling Variable: Definitions

• For the *inclusive reaction* $a + b \to c + X$

1) Feynman's definition:

$$x = P_{\parallel}^{cm}/P_{max}^{cm} \quad \text{(VI-3)}$$

where

$$P_{max}^{cm} = \frac{\sqrt{\Delta(s, m_c^2, m_{X,min}^2)}}{2\sqrt{s}} \quad \text{(VI-4)}$$

is the center-of-mass momentum of particle c and the lightest possible particle(s) $m_{X,min}$ which, consistent with conservation laws, could recoil against particle c.

A *relationship between* x *and* m_X^2 which becomes useful at high energy [see (VI-6)] derives from

$$m_X^2 = (p_a + p_b - p_c)^2 = s + m_c^2 - 2p_c \cdot (p_a + p_b)$$

2) An alternative definition:

$$x' = P_{\parallel}^{cm}/P_{\parallel max}^{cm} \quad \text{(VI-7)}$$

with

$$P_{\parallel max}^{cm} = \sqrt{\left(P_{max}^{cm}\right)^2 - P_{\perp}^2} \ .$$

• For *electro- and photoproduction*:

1) Bjorken's definition:

$$\omega = \frac{2m_p\nu}{q^2} \ ,$$

where

$\nu = e - e'$ = the difference between the incident and the outgoing energies

m_p = proton mass

q^2 = momentum transfer squared .

(NOTE: ω^{-1} is sometimes also called x.)

2) Bloom-Gilman's definition:

$$\omega' = \omega + \frac{m_p^2 - q^2}{q^2}$$

• *At high energy*,

$$P_{max}^{cm} \simeq \frac{\sqrt{s}}{2} \quad \text{and} \quad x \simeq \frac{2P_{\parallel}^{cm}}{\sqrt{s}} \ . \quad \text{(VI-5)}$$

The relation between x *and* y is trivial:

$$x \simeq 2\frac{P_{\parallel}^{cm}}{\sqrt{s}} \simeq \frac{2m_{\perp}}{\sqrt{s}} \sinh y^{cm} \quad \text{(VI-8)}$$

and, for y also large:

$$y^{cm} \simeq \ln \frac{x\sqrt{s}}{m_{\perp}} \quad \text{(VI-9)}$$

$$x = 1 - \frac{m_X^2 - m_c^2}{s} \simeq 1 - \frac{m_X^2}{s} \quad \text{(VI-6)}$$

$$(\text{for } m_X^2 >> m_c^2) \ .$$

For $P_{\perp}$ fixed as $s \to \infty$,

$$x' \simeq \frac{2P_{\parallel}^{cm}}{\sqrt{s}} \simeq x \ .$$

For q^2 and ν large (Bjorken limit),

$$\omega' \simeq \omega - 1 \ .$$

B. For the inclusive reaction $a + b \to c + X$, *the invariant differential cross section* $E(d^3\sigma/dp_c^3)$ may be written in the following forms using various expressions of the phase space volume d^3p_c/E_c (and omitting the subscript c):

Longitudinal variable of particle c	Transverse variable of particle c	Corresponding invariant (differential) cross section $E(d^3\sigma/dp^3)$
P^{lab}	θ^{lab}	$\frac{E^{lab}}{(P^{lab})^2}\frac{d^3\sigma}{dP^{lab}d\Omega^{lab}}$ (VI-10)
$P_{\parallel}$	$P_{\perp}$	$\frac{E}{\pi}\frac{d^2\sigma}{dP_{\parallel}\, dP_{\perp}^2}$ (averaged over azimuth) (VI-11)
x	$P_{\perp}$	$\frac{E^{cm}}{P_{max}^{cm}} \cdot \frac{1}{\pi}\frac{d^2\sigma}{dxdP_{\perp}^2} \simeq \frac{2E^{cm}}{\pi\sqrt{s}}\frac{d^2\sigma}{dxdP_{\perp}^2}$ (averaged over azimuth) (VI-12)
y	$P_{\perp}$ (or $m_{\perp}$)	$\frac{1}{\pi}\frac{d^2\sigma}{dydP_{\perp}^2} = \frac{1}{\pi}\frac{d^2\sigma}{dydm_{\perp}^2}$ (averaged over azimuth) (VI-13)
$m_X^2 = (p_a + p_b - p_c)^2$	$t = (p_a - p_c)^2$	$\frac{\sqrt{\Delta(s,m_a^2,m_b^2)}}{\pi}\frac{d^2\sigma}{dm_X^2dt}$ (averaged over azimuth) (VI-14)

*See Denyse M. Chew, "Relativistic Kinematics", Particle Data Group Memo PDG-101, for details and references.

Revised and expanded April 1976.

PARTICLE DETECTORS, ABSORBERS, AND RANGES*

A. DETECTOR PARAMETERS

In this section we give various parameters for common detectors. The quoted numbers represent at best an order of magnitude useful only for preliminary design.

A.1 Scintillators: Photon yield $\approx 1\gamma/100$ eV in plastic scintillator[1] and $\approx 1\gamma/25$ eV in Na I.[1,2]

A.2 Čerenkov[3]: Half angle θ_c of cone aperture in terms of velocity β and index of refraction n:

$$\theta_c = \arc\cos\left(\frac{1}{\beta n}\right) \sim \sqrt{2\left(1 - \frac{1}{\beta n}\right)} .$$

Threshold velocity: $\beta_t = 1/n$; $\gamma_t = 1/\sqrt{1-\beta_t^2}$.

Therefore, $\beta_t\gamma_t = 1/\sqrt{2\delta + \delta^2}$, where $\delta = n-1$. Values of δ for various commonly used gases are given as a function of pressure and wavelength in Ref. 4; for values at atmospheric pressure, see the Table of Atomic and Nuclear Properties following.

Number of photons N per cm:

$$N = \frac{\alpha}{c}\int\left(1 - \frac{1}{\beta^2 n^2}\right) 2\pi\, d\nu = \frac{\alpha}{c}\beta_t^2\int\left(\frac{1}{\beta_t^2\gamma_t^2} - \frac{1}{\beta^2\gamma^2}\right) 2\pi d\nu$$

$$\approx 500 \sin^2\theta_c/\text{cm (visible spectrum)}$$

A.3 Photon Collection: In addition to the photon yield, one should take into account the light collection efficiency ($\lesssim$ 10% for typical 1 cm thick scintillator), attenuation length ($\approx$ 1 to 4 m for typical scintillators[5]), and quantum efficiency of the photomultiplier cathode ($\lesssim$ 25%).

A.4 Bubble, Streamer, Wire Chambers:

Chamber Type	Accuracy(rms)	Resolution Time	Dead Time
Bubble	$\pm$ 75μ	$\approx$ 1 ms	$\approx$ 1/20 s[a)]
Streamer	$\pm$ 300μ	$\approx$ 2 μs	$\approx$ 100 ms
Optical Spark	$\pm$ 200μ[b)]	$\approx$ 2 μs	$\approx$ 10 ms
Magnetostrictive Spark	$\pm$ 500μ	$\approx$ 2 μs	$\approx$ 10 ms
Proportional	$\geq \pm$ 300μ[c, d)]	$\approx$ 50 ns	$\approx$ 200 ns
Drift	$\pm$ 50 to 300μ	$\approx$ 2 ns[e)]	$\approx$ 100 ns

a) Multiple pulsing time.
b) 60μ for high pressure.
c) 300μ is for 1 mm pitch.
d) Delay line cathode readout can give $\pm$ 150μ parallel to anode wire.
e) For two chambers.

A.5 Shower Detectors: Typical energy resolution for incident electron in the 1 GeV range, E in GeV.

Na I (20 rad. lengths)[6]: $\frac{2\%}{E^{1/4}}$ (FWHM)

Lead Glass (14 rad. lengths)[7]: $\frac{8\text{-}12\%}{\sqrt{E}}$ (FWHM)

Lead Scintillator Sandwich (10 rad. lengths)[8]: $\frac{22\%}{\sqrt{E}}$ (FWHM)

(10 lead plates, each 1 radiation length, and scintillators, each 1 cm in thickness).

A.6 Proportional Chamber Wire Instability: The limit on the voltage V for a wire tension T is given by[9]

$$V \leq \frac{sT^{\frac{1}{2}}}{\ell C}$$

where s, ℓ, and C are the wire spacing, length, and capacitance per unit length. An approximation to C for chamber half gap t and wire diameter d (good for s $\leq$ t) gives[10]

$$V \lesssim 59T^{\frac{1}{2}}\left[\frac{t}{\ell} + \frac{s}{\pi\ell}\ln\left(\frac{s}{\pi d}\right)\right] ,$$

where V is in kV, and T is in grams.

B. COSMIC RAY FLUXES

The fluxes of particles of different types depend on the latitude, their energy, and on the conditions of measurement. Some typical sea-level values[11] are given below:

I_V vertical flux
J_1 total flux crossing a unit horizontal area
J_2 total flux crossing a sphere of unit radius

	Total Intensity	Hard component	Soft component
I_V	1.14×10^{-2}	0.83×10^{-2}	0.31×10^{-2} cm^{-2}sec^{-1}sterad^{-1}
J_1	1.79×10^{-2}	1.27×10^{-2}	0.52×10^{-2} cm^{-2}sec^{-1}
J_2	2.41×10^{-2}	1.68×10^{-2}	0.73×10^{-2} cm^{-2}sec^{-1}

Very approximately, about 75% of all particles at sea-level are penetrating, and are μ mesons. The absolute flux of protons at sea-level, in a momentum range 700-1100 MeV/c, is 1.5×10^{-5} cm^{-2}sec^{-1}sterad^{-1}, or ~0.1% of all particles.

C. PASSAGE OF PARTICLES THROUGH MATTER

C.1 dE/dx[12]: Ionization energy loss for particles heavier than an electron and having charge z|e| (Bethe-Bloch equation):

$$-\frac{1}{\rho}\frac{dE}{dx} = z^2 D\frac{Z}{A}\frac{1}{\beta^2}\left[\ln\left(\frac{2m_ec^2\beta^2\, T'_{max}}{(1-\beta^2)\, I^2}\right) - 2\beta^2 - K\right],$$

where $D = 2\pi N r_e^2 m_e c^2 = 0.1535$ MeV cm^2/g (see Physical and Numerical Constants Table), Z and A are charge and mass number of the material, $\beta = v/c$ for the incident particle, T'_{max} is the maximum-energy δ ray considered to be ionization loss, I is the mean ionization potential ($I \approx 20Z$ eV for Z = 1, tending toward $I \approx 10Z$ for $Z \gtrsim 20$), and K includes the shell correction (maximum $\approx$ 10% around β = 0.1 in the heaviest elements), density effect (important at high velocities and high densities), and the z^3 correction[13] (important at low velocity, a few percent at $\beta \approx 0.1$).

A point of minimum ionization occurs in the range $\beta \approx 0.95$ to 0.97, with the dependence on absorber confined to that range. Energy loss increases approximately as $\ln\gamma$ thereafter (relativistic rise), until modified by the density effect (which reduces the rate of increase). Values of dE/dx at minimum are listed in the Table of Atomic and Nuclear Properties of Materials (following).

Figures are given below for ionization energy loss and range in lead (with scaling indicated for copper, aluminum, and carbon), and in liquid hydrogen, with T'_{max} taken to be T_{max} as defined in Sec. C.2 below. Energy losses due to bremsstrahlung, nuclear collisions, etc., are not included. For thin samples of absorber, fluctuations are very important.[14] A review of the problem of the penetration of charged particles into matter may be found in Fano[15].

PARTICLE DETECTORS, ABSORBERS, AND RANGES (Cont'd)

Mixtures or compounds may be treated in first (but fairly accurate) approximation using Bragg's additivity rule:

$$\left(\frac{1}{\rho}\frac{dE}{dx}\right)_{mix} = \sum_i \left(\frac{1}{\rho}\frac{dE}{dx}\right)_i f_i ,$$

where f_i is the fractional weight ($= \rho_i/\rho_{mix}$) of element i.

C.2 δ rays[16]: Number N per g/cm^2 per MeV of δ rays of kinetic energy T produced by an incident particle of momentum p and velocity β (Rutherford formula):

$$\frac{dN}{dTdx} = D\frac{Z}{A}\frac{1}{\beta^2 T^2} ,$$

where D is defined in the dE/dx section. This expression is valid for any unit charge incident particle if $T \ll T_{max}$. T_{max} is the maximum δ-ray energy, given by

$$T_{max} = \frac{2\,m_e c^2 (pc)^2}{s} = \frac{2\beta^2\gamma^2\, m_e c^2}{1+2\gamma\frac{m_e}{M}+\frac{m_e^2}{M^2}}$$

where m_e and M are the electron and incident particle masses and s is their center-of-mass energy squared.

C.3 Multiple Coulomb Scattering[17, 18, 19]: Sketched below are the multiple scattering angle θ, displacement y, and sagitta s, of a particle passing through a scatterer of thickness L. If the incident particle has mass M, charge z|e| , velocity β, and energy E, and the scatterer has atomic mass m_s and radiation length L_R, the projection of the 1/e multiple scattering angle (i.e., the value of the scattering angle at which the distribution falls to 1/e of its peak value) is given by

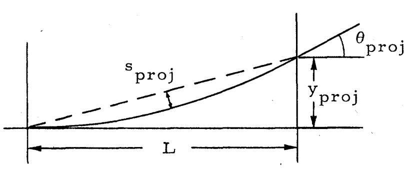
$$\theta_{proj}^{1/e} = z\,\frac{14\,\mathrm{MeV}/c}{p\beta}\sqrt{\frac{L}{L_R}}\left[1+\frac{1}{9}\log_{10}\left(\frac{L}{L_R}\right)\right]\left[1+\frac{M^2}{Em_s}\right],$$

in the small angle approximation. The distribution is approximately Gaussian for $\theta < \theta^{1/e}$, but has long tails.[20] The accuracy of this expression is ≈ 5% except for low z or β, where it is ≈ 10-20%.

For a given θ_{proj},

$$y_{proj} = \frac{L\theta_{proj}}{\sqrt{3}} ,$$

$$s_{proj} = \frac{L\theta_{proj}}{4\sqrt{3}} .$$



C.4 Electron Range in Lead, Copper, Carbon and Hydrogen: See figure following.

C.5 Fractional Energy Loss for Electrons and Positrons in Lead: See figure following.

C.6 Contributions to Photon Cross Section in Lead: See figure following.

C.7 Photon Cross Section: See figure following.

D. ATOMIC AND NUCLEAR PROPERTIES OF MATTER

See table following.

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*Prepared April 1974 by Sherwood Parker and Bernard Sadoulet. Revised April 1976.

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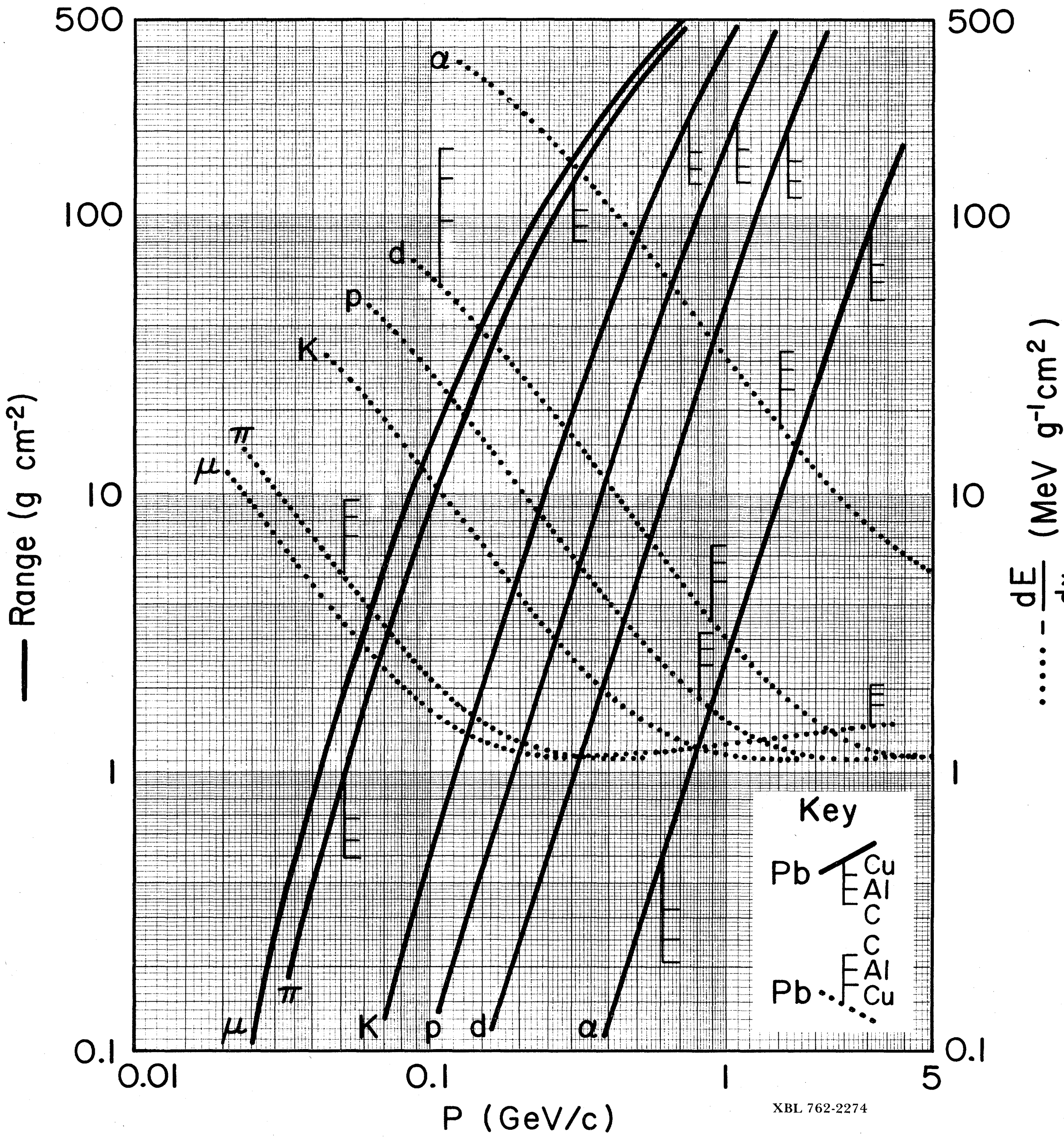
PARTICLE DETECTORS, ABSORBERS, AND RANGES (Cont'd)

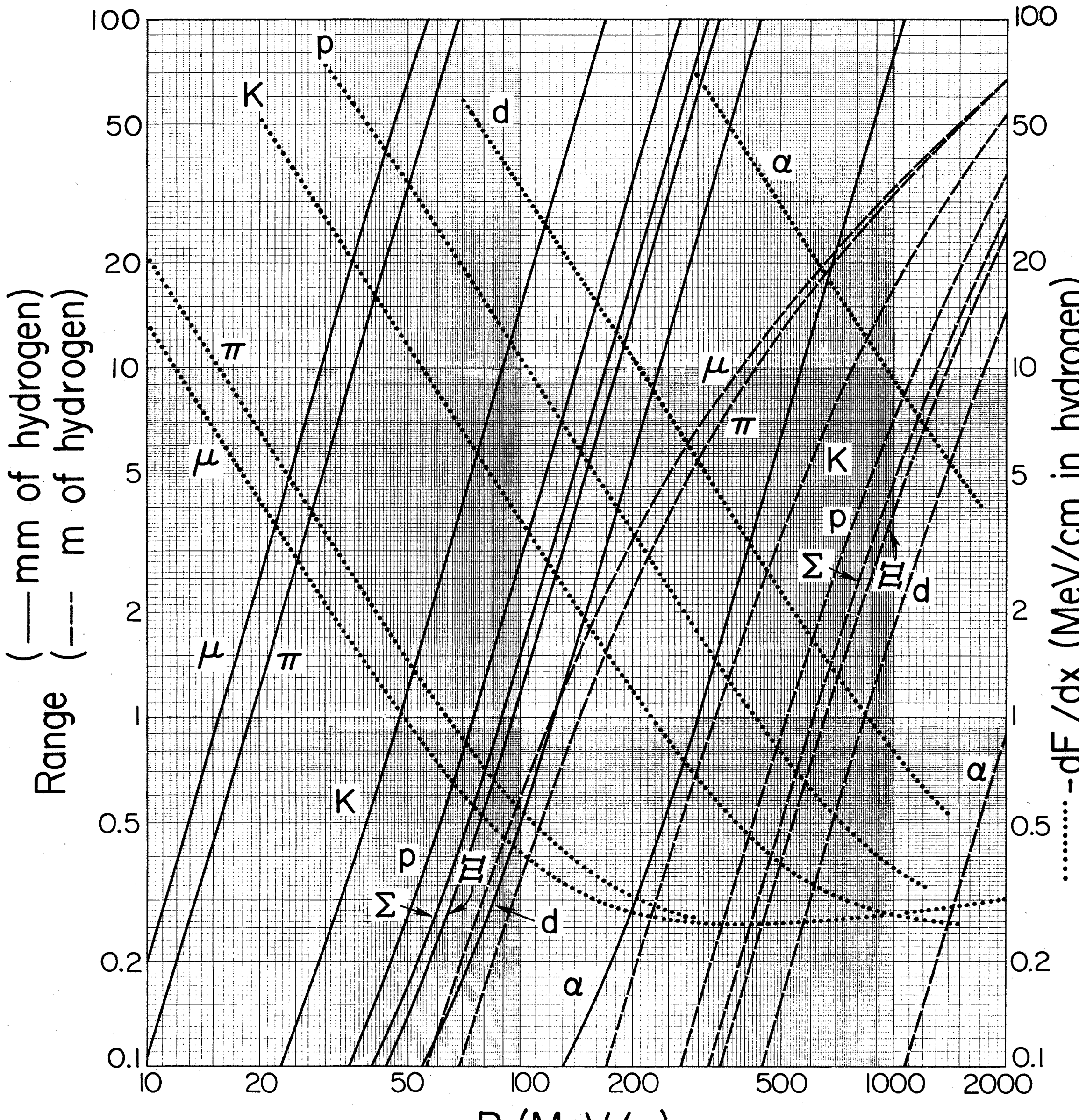
Mean Range and Energy Loss in Lead, Copper, Aluminum, and Carbon



Mean range and energy loss due to ionization for the indicated particles in Pb, with scaling to Cu, Al, and C indicated, using Bethe-Bloch equation (Section C.1 above) with corrections. Calculated using program of Hans Bichsel (UCRL-17538), with density correction added (Hans Bichsel, private communication). See also Joseph F. Janni [Air Force Weapons Laboratory Technical Report No. AFWL-TR-65-150 (1966)]. The average ionization potentials (I) assumed were: Pb (820 eV), Cu (320 eV), Al (166 eV), and C(77.5 eV). Figure indicates total path length; observed range may be smaller (by ~ 1% - 2% in heavy elements) due to multiple scattering, primarily from small energy-loss collisions with nuclei. The functional forms have not been experimentally verified to better than roughly ±1%. For higher energies refer to discussion by Cobb ["A Study of Some Electromagnetic Interactions of High Velocity Particles with Matter," University of Oxford Report HEP/T/55 (1973)] and by Turner ["Penetration of Charged Particles in Matter: A Symposium", National Academy of Sciences, Washington D.C. (1970), p. 48]. Scaling to other beam particles is, to a good approximation, described by the expression on the next page.

PARTICLE DETECTORS, ABSORBERS, AND RANGES (Cont'd)

Mean Range and Energy Loss in Liquid Hydrogen



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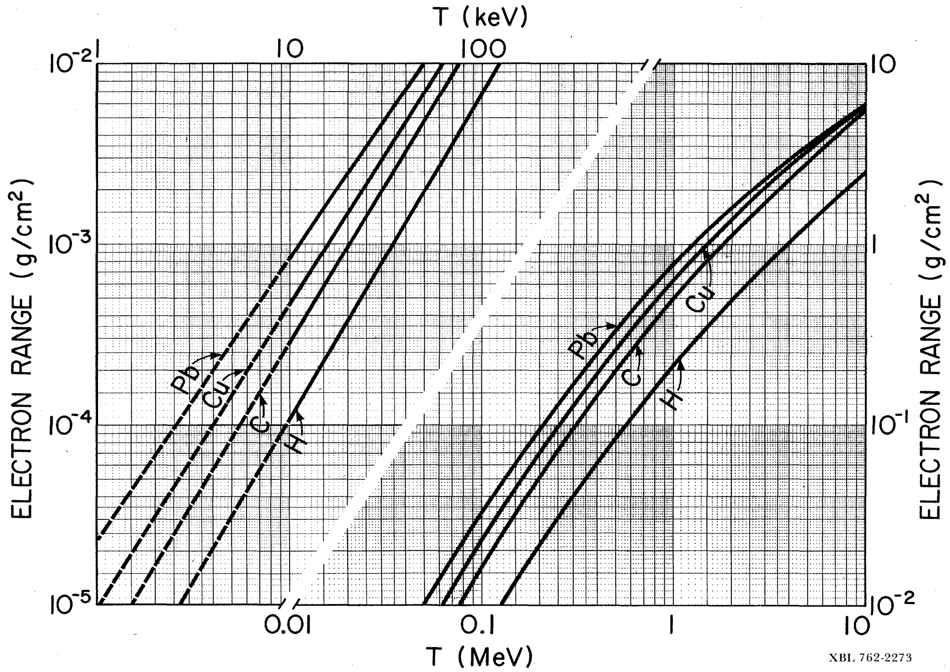
Range and energy loss in liquid hydrogen bubble chamber, based on Bethe-Bloch equation (Section C.1 above), using an average ionization potential for H_2 of I = 20.0 eV, which is an approximate average of the recent experimental result of Garbincius and Hyman [Phys. Rev. A2, 1834 (1970)] and the recent theoretical result of Ford and Browne [Phys. Rev. A7, 418 (1973)]. This is somewhat higher than used in the last edition. Bubble chamber conditions are chosen to be those of Garbincius and Hyman: parahydrogen of density = 0.0625 g/cm^3 (note: range $\propto$ 1/density), with vapor-pressure 60.8 lb/in^2 (absolute) and temperature 26.2°K. The functional dependence of the Bethe-Bloch equation is not experimentally verified to better than about ±1% over large momentum ranges. It should be noted that the number of bubbles per cm of a track in a bubble chamber is nearly proportional to $1/\beta^2$, not dE/dx. For the linear portions of the range curves, $R \propto p^{3.6}$.

Scaling law for particles of other mass or charge (except electrons): for a given medium, the range R_b of any beam particle with mass M_b, charge z_b, and momentum p_b is given in terms of the range R_a of any other particle with mass M_a, charge z_a, and momentum $p_a = p_b M_a/M_b$ (i.e., having the same velocity) by the expression

$$R_b(M_b, z_b, p_b) = \left[\frac{M_b/M_a}{z_b^2 / z_a^2}\right] R_a(M_a, z_a, p_a = p_b M_a/M_b).$$

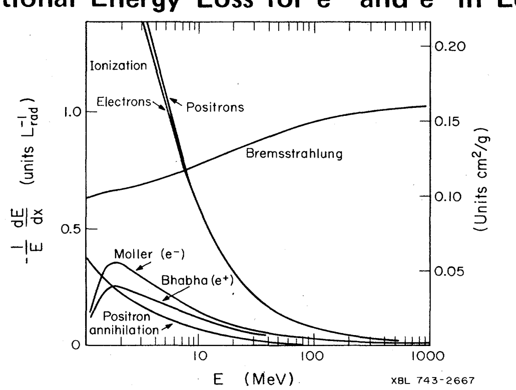
PARTICLE DETECTORS, ABSORBERS, AND RANGES (Cont'd)

Mean Electron Range in Lead, Copper, Carbon, and Liquid Hydrogen



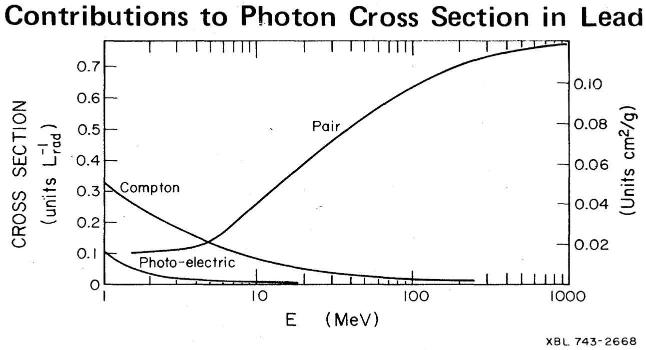
Mean range of electrons in the continuous-slowing-down approximation, taking into account energy loss by collisions with atomic electrons and by bremsstrahlung; strong fluctuations are to be expected for individual tracks. This range is the total path length; the practical range is shorter because of multiple Coulomb scattering, which becomes increasingly important as the electron slows down. E.g., for a fast electron the rms projected angle due to multiple Coulomb scattering reaches 1 radian by the time the electron has slowed to 0.4 MeV in hydrogen, 1.5 MeV in carbon, 9 MeV in copper, and 24 MeV (off scale) in lead. The "critical energy" (above which the energy loss due to bremsstrahlung exceeds that due to ionization and showering becomes important) is 400 MeV for hydrogen, 100 MeV for carbon, 25 MeV for copper, and 10 MeV for lead. The mean positron range may differ from the mean electron range by several percent. See Berger and Seltzer, NASA SP-3012 (1964) and SP-3036, and P. Trower, UCRL-2426, Vol. III Rev. (1966). 1-10 keV range was obtained by linear extrapolation.

Fractional Energy Loss for e^+ and e^- in Lead



Fractional energy loss per radiation length in lead as a function of electron or positron energy. Electron (positron) scattering is considered as ionization when the energy loss per collision is below 0.255 MeV, and as Moller (Bhabha) scattering when it is above.

Contributions to Photon Cross Section in Lead

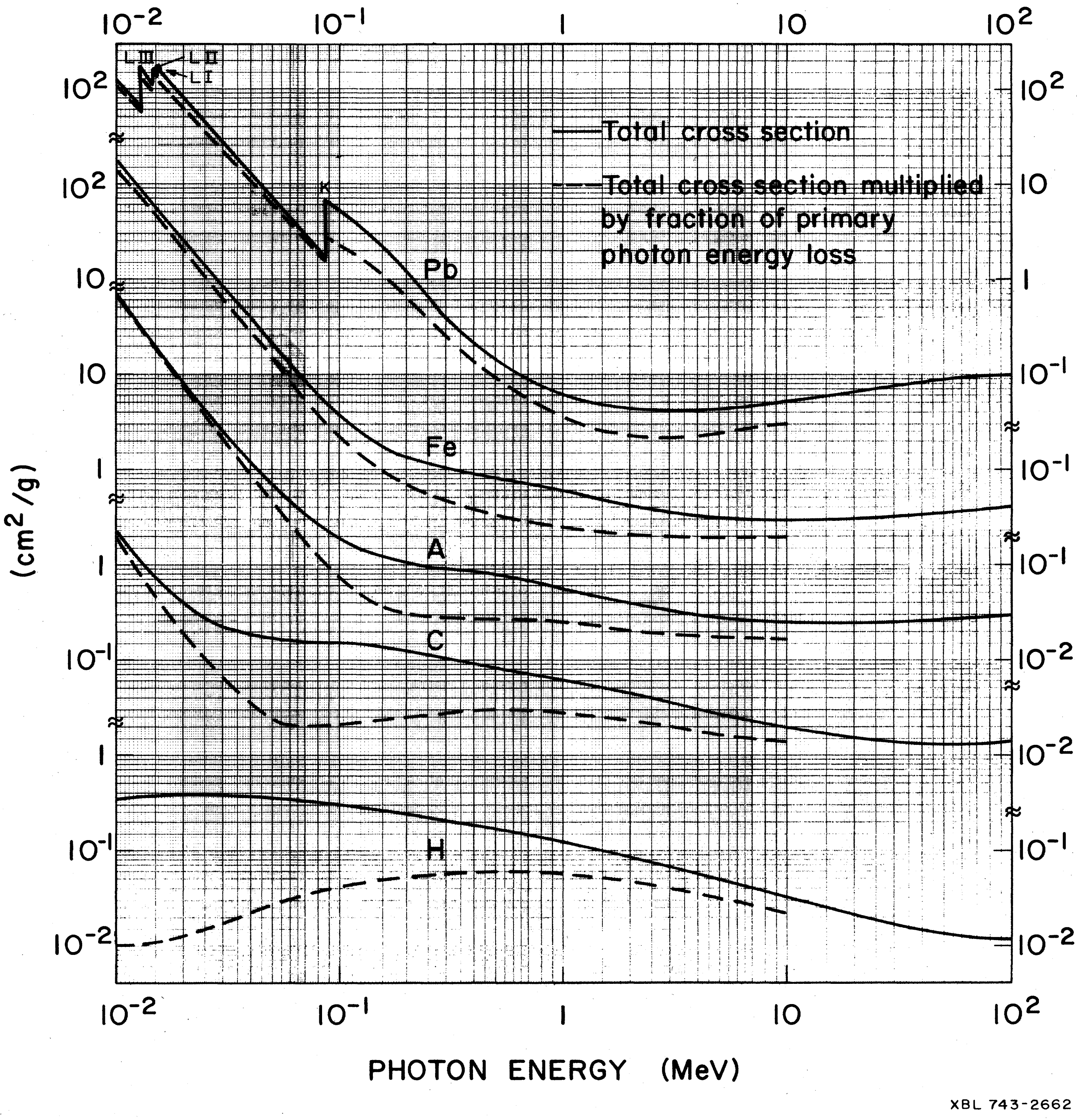


Photon cross section in lead in inverse radiation lengths as a function of photon energy. The intensity of photons can be expressed as $I = I_0 \exp(-\sigma x)$, where σ is read above and x is the path length in radiation lengths. See also figure following.

These figures are adapted from Fig. 3.2 and Fig. 3.3 from Messel and Crawford, Electron-Photon Shower Distribution Function Tables for Lead, Copper and Air Absorbers, Pergamon Press, 1970. Messel and Crawford use L_r (Pb) = 5.82 g/cm², but we have modified the figures to reflect the value given in the Table of Atomic and Nuclear Properties of Materials (following), namely L_r(Pb) = 6.4 g/cm². Note that the development of electron-photon cascades is approximately independent of absorber when the results are expressed in terms of inverse radiation lengths (i.e., scales on left of plots).

PARTICLE DETECTORS, ABSORBERS, AND RANGES (Cont'd)

Photon Cross Sections



The photon cross section as a function of photon energy for various substances. The solid curve for each substance gives the total cross section in (cm^2/g). The dashed curve is the total cross section multiplied by the fraction of energy deposited by the photon (different from solid curve because of Compton scattering and bremsstrahlung of secondary electrons). See J. H. Hubbell, NSRDS-NBS 29 (1969).

PARTICLE DETECTORS, ABSORBERS, AND RANGES (Cont'd)

Atomic and Nuclear Properties of Materials*

Material	Z	A	Nuclear cross section σ[a] [barns]	Nuclear collision length L_{coll}[b] [g/cm²]	Nuclear collision length L_{coll}[b] [cm]	Absorption length λ[b] [cm]	dE/dx min[c] [MeV/(g/cm²)]	dE/dx min[c] [MeV/cm]	Radiation length L_{rad}[d] [g/cm²]	Radiation length L_{rad}[d] [cm]	Density[e] [g/cm³] () is for gas [g/ℓ]	Refractive index n;[e] () is (n−1)×10⁶ for gas
H_2	1	1.01	0.039	43.0	607	790	4.12	0.292	63.05	890	0.0708 (0.090)	1.112 (140)
D_2	1	2.01	0.074	45.1	273	342	2.07	0.342	126.1	764	0.163	1.128
He	2	4.00	0.134	49.6	397	478	1.94	0.243	94.32	755	0.125 (0.178)	1.024 (35)
Li	3	6.94	0.215	53.6	100.4	120.6	1.65	0.881	82.76	155	0.534	–
Be	4	9.01	0.270	55.4	30.0	36.7	1.61	2.97	65.19	35.3	1.848	–
C	6	12.01	0.340	58.7	≈37.8	49.9	1.78	≈2.76	42.70	≈27.5	≈1.55[f]	–
N_2	7	14.01	0.390	59.7	73.8	99.4	1.82	1.47	37.99	47.0	0.808 (1.25)	1.205 (300)
Ne	10	20.18	0.520	64.4	53.7	74.9	1.73	2.08	28.94	24.0	1.207 (0.90)	1.092 (67)
Al	13	26.98	0.650	68.9	25.5	37.2	1.62	4.37	24.01	8.9	2.70	–
A	18	39.95	0.890	74.5	53.2	80.9	1.51	2.11	19.55	14.0	1.40 (1.78)	1.233 (283)
Fe	26	55.85	1.160	79.9	10.2	17.1	1.48	11.6	13.84	1.76	7.87	–
Cu	29	63.54	1.270	83.1	9.3	14.8	1.44	12.9	12.86	1.43	8.96	–
Sn	50	118.69	2.040	96.6	13.2	22.8	1.28	9.4	8.82	1.21	7.31	–
W	74	183.85	2.810	108.6	5.6	10.3	1.17	22.6	6.76	0.35	19.3	–
Pb	82	207.19	3.080	111.7	9.8	18.5	1.13	12.8	6.37	0.56	11.35	–
U	92	238.03	3.380	116.9	≈6.2	12.0	1.09	≈20.7	6.00	≈0.32	≈18.95	–
Air				60.2	50000[g]	67500[g]	1.82	0.0022[g]	36.20	30050[g]	0.001205[g] (1.29)	1.000273[g] (293)
H_2O				58.3	58.3	78.8	2.03	2.03	36.08	36.1	1.00	1.33
H_2 (bubble chamber 26°K)[h]				43.0	≈683	887	4.12	≈0.26	63.05	≈1000	≈0.063[h]	1.112
D_2 (bubble chamber 31°K)[h]				45.1	≈322	403	2.07	≈0.29	126.1	≈900	≈0.140[h]	1.110
H-Ne mixture (50 mole percent)[i]				62.9	154.5	215	1.84	0.75	29.70	73.0	0.407	1.092
Propane (C_3H_8)[j]				55.0	134	176	2.28	0.98	45.38	111	0.41[j] (2.0)	1.25[j] (1005)
Freon 13B1 (CF_3Br)[j]				74.3	≈49.5	73.5	1.52	≈2.3	16.53	≈11	≈1.50[j] (8.71)	1.238[j] (750)
Ilford emulsion				79.5	23.6	39.1	1.44	5.49	11.02	2.94	3.815	–
NaI				91.9	25.0	41.3	1.32	4.84	9.49	2.59	3.67	1.775
LiF				61.1	23.1	30.7	1.69	4.46	39.25	14.9	2.64	1.394
Polyethylene (CH_2)				55.7	≈59.6	78.4	2.09	≈1.95	44.78	≈48	0.92–0.95	–
Mylar ($C_5H_4O_2$)				58.5	42.1	56.1	1.91	2.65	39.95	28.7	1.39	–
Polystyrene, scintillator (CH)[k]				57.0	55.2	68.5	1.97	2.03	43.8	42.9	1.032	1.581
Lucite, Plexiglas ($C_5H_8O_2$)				57.7	≈48.9	65.0	1.97	≈2.32	40.55	≈34.5	1.16–1.20	≈1.49
Spark or proportional chamber[ℓ]				0.05%		0.03%	–	0.073	2.7%		0.046	–
Shielding concrete[m]				64.9	26.0	32.2	1.70	4.25	26.7	10.7	2.5	–
CO_2[n]				60.4	33800	46000	1.82	0.0033	36.2	20210	(1.79)[n]	(410)[n]
Freon 12 (CCl_2F_2)[n]				68.1	13800	20200	1.64	0.0081	23.7	4810	(4.93)[n]	(1080)[n]
Freon 13 ($CClF_3$)[n]				66.0	15000	21400	1.70	0.0072	27.15	6380	(4.26)[n]	(720)[n]
Silica Aerogel[o]				62.3	≈311	430	1.82	≈0.36	30	≈150	0.1–0.3	1.0+0.25ρ

*) Table revised January 1976 by J. Engler and F. Mönnig. For details and references, see CERN NP Internal Report 74–1.

a) σ of neutrons (≈ σ of protons) at 20 GeV from Landolt-Bornstein, New Series I, Vol. 5. Energy dependence for all nuclei ≈ 1/2 percent/GeV (from 5–25 GeV).

b) $L_{coll} = A/(N.\sigma)$. In the absorption length the elastic scattering is subtracted.

c) For a minimum-ionizing, singly-charged particle in the material. From W.H. Barkas and M.J. Berger, Tables of Energy Losses and Ranges of Heavy Charged Particles, NASA-SP-3013 (1964).

d) From Y.S. Tsai, Pair Production and Bremsstrahlung of Charged Leptons, SLAC-PUB-1365 (1974), Table III.6.

e) Values for solids, or the liquid phase at boiling point, except where noted. Values in parentheses for gaseous phase STP (0°C, 1 atm.), except where noted.

f) Density variable.

g) Gas at 20°C.

h) Density may vary about ±3%, depending on operating conditions.

i) Values for typical working condition with H_2 target: 50 mole percent, 29°K, 7 atm.

j) Values for typical chamber working conditions: Propane ~ 57°C, 8–10 atm. Freon 13B1 ~ 28°C, 8–10 atm.

k) Typical scintillator; e.g. PILOT B and NE 102A have an atomic ratio H/C = 1.10.

ℓ) Values for typical construction: 2 layers 50 μm Cu/Be wires, 8 mm gap, 60% argon, 40% isobutane or CO_2; 2 layers 50 μm Mylar/Aclar foils.

m) Standard shielding blocks, typical composition O_2 52%, Si 32.5%, Ca 6%, Na 1.5%, Fe 2%, Al 4% plus reinforcing iron bars. Attenuation length ℓ = 115 ± 5 g/cm², also valid for earth (typical ρ = 2.15) from CERN-LRL-RHEL Shielding exp. UCRL 17841 (1968).

n) Used in Čerenkov counters, value at 26°C and 1 atm. Indices of refraction from E.R. Hayes, R.A. Schluter, and A. Tamosaitis, ANL-6916 (1964).

o) n(SiO_2) + 2n(H_2O) used in Čerenkov counters, ρ = density in g/cm³. From M. Cantin et al., Nucl. Instr. Meth. 118, 177 (1974).

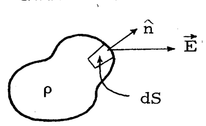
ELECTROMAGNETIC RELATIONS

Maxwell's Equations

Quantity	CGS (statcoul., statamp., sec cm^{-1})	MKSA (coul., amp., ohm)
Potentials:	$V = \sum_{\text{charges}} \frac{q}{r}$,	$V = \frac{1}{4\pi\epsilon_0} \sum_{\text{charges}} \frac{q}{r}$,
	$\vec{A} = \frac{1}{c} \sum_{\text{currents}} \frac{\vec{I}}{r}$;	$\vec{A} = \frac{\mu_0}{4\pi} \sum_{\text{currents}} \frac{\vec{I}}{r}$;
	c = speed of light in vacuum	$\epsilon_0 = \frac{1}{36\pi} 10^{-9}$ MKSA,
		$\mu_0 = 4\pi\ 10^{-7}$ MKSA
Fields:	$\vec{E} = -\vec{\nabla}V,\ \vec{B} = \vec{\nabla}\times\vec{A}$	$\vec{E} = -\vec{\nabla}V,\ \vec{B} = \vec{\nabla}\times\vec{A}$
Materials:	$\vec{D} = \epsilon\vec{E},\ \vec{B} = \mu\vec{H}$	$\vec{D} = \epsilon\vec{E},\ \vec{B} = \mu\vec{H}$
Force:	$\vec{F} = q(\vec{E} + \frac{\vec{v}}{c}\times\vec{B})$	$\vec{F} = q(\vec{E} + \vec{v}\times\vec{B})$
Maxwell:	$\vec{\nabla}\cdot\vec{E} = 4\pi\rho$,	$\vec{\nabla}\cdot\vec{D} = \rho$,
	$\vec{\nabla}\times\vec{E} = -\frac{1}{c}\frac{\partial\vec{B}}{\partial t}$,	$\vec{\nabla}\times\vec{E} = -\frac{\partial\vec{B}}{\partial t}$,
	$\vec{\nabla}\cdot\vec{B} = 0$,	$\vec{\nabla}\cdot\vec{B} = 0$,
	$\vec{\nabla}\times\vec{B} = \frac{4\pi\vec{j}}{c} + \frac{1}{c}\frac{\partial\vec{E}}{\partial t}$	$\vec{\nabla}\times\vec{H} = \vec{j} + \frac{\partial\vec{D}}{\partial t}$

Integral Forms (MKSA)

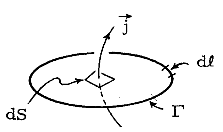
1. Gauss' theorem:



$$\int_{\text{surface}} \vec{E}\cdot\hat{n}\ dS = \int_{\text{volume}} \rho/\epsilon_0\ dV$$

(ρ = charge/volume)

2. Ampere's law:



$$\int_{\Gamma} \vec{H}\cdot d\vec{\ell} = \int_{\text{surface}} \vec{j}\cdot\hat{n}\ dS$$

($\vec{j}$ = surface current density)

Impedances: Alternating Currents (MKSA)

Ohm's law: $V = ZI,\ V = V_0 e^{i\omega t}$

1. Impedance of self-inductance of inductance L : $Z = i\omega L$
2. Impedance of a capacitor of capacitance C : $Z = \frac{1}{i\omega C}$
3. Impedance of a flat conductor of width w at high frequency:

$$Z = \frac{(1+i)\rho}{w\delta};$$

ρ = resistivity $\begin{cases} \sim 1.7\times10^{-8}\ \Omega\text{m for Cu} \\ \sim 2.8\times10^{-8}\ \Omega\text{m for Al} \end{cases}$

δ = effective skin depth

$$= \sqrt{\frac{\rho}{\pi\nu\mu}} \approx \frac{6.6\text{ cm}}{\sqrt{\nu(\sec^{-1})}} \quad \text{for Cu}$$

Capacitance C and Inductance L per Unit Length (MKSA)

1. For flat plates of width w, separated by $d \ll w$:

$$C = \frac{\epsilon w}{d}\ ;\quad L = \mu\frac{d}{w}$$

2. For coax cable of interior and exterior radii r_1 and r_2:

$$C = \frac{2\pi\epsilon}{\ell n(r_2/r_1)}\ ;\quad L = \frac{\mu}{2\pi}\ \ell n(r_2/r_1);$$

ϵ = dielectric constant $\begin{cases} \text{2 to 6 for plastics} \\ \text{4 to 8 for porcelain, glasses} \end{cases}$

μ = magnetic susceptibility

Transmission Lines (No Loss) (MKSA)

Velocity $= 1/\sqrt{LC} = 1/\sqrt{\mu\epsilon}$

Impedance $= \sqrt{L/C}$

L, C are inductance and capacitance per unit length

Synchrotron Radiation (CGS)

Energy loss/revolution $= \frac{4\pi}{3}\frac{e^2}{\rho}\beta^3\gamma^4$, ρ = orbit radius.

For electrons ($\beta \approx 1$), $\frac{\Delta E(\text{MeV})}{\text{rev.}} = 0.0885\ [E(\text{GeV})]^4/\rho(\text{meter})$.

Critical frequency: $\omega_c = 3\gamma^3 c/\rho$

See J.D. Jackson, Classical Electrodynamics, 2nd Ed., John Wiley & Sons, New York, 1975, for more formulae and details. (Prepared April 1974; revised April 1976.)

RADIOACTIVITY AND RADIATION PROTECTION

Unit of activity = Curie:
  1 Ci = 3.7×10^{10} disintegrations/sec
Unit of exposure dose for x and γ radiation = Roentgen:
  1 R = 1 esu/cm^3 = 87.8 erg/g (5.49×10^7 MeV/g) of air
Unit of absorbed dose = rad:
  1 rad = 100 erg/g (6.25×10^7 MeV/g) in any material
Unit of dose equivalent (for protection) = rem:
  rems (Roentgen equivalents for man) = rads$\times$QF,
where QF (quality factor) depends upon the type of radiation and other factors. For γ rays and HE protons, QF $\approx$ 1; for thermal neutrons, QF $\approx$ 3; for fast neutrons, QF ranges up to 10; and for α particles and heavy ions, QF ranges up to 20.
Maximum permissible occupational dose for the whole body:
  5 rem/year (or $\approx$ 100 millirem/week)
Fluxes (per cm^2) to liberate 1 rad in carbon:
  3.5×10^7 minimum ionizing singly charged particles
  1.0×10^9 photons of 1 MeV energy
(These fluxes are correct to within a factor of 2 for all materials.)
Natural background: 120 to 130 millirem/year
  cosmic radiation (charged particles + neutrons) ~25 mrem/yr
  cosmic radiation (γ rays) ~25 mrem/yr
  radiation from rocks and air (γ rays) ~73 mrem/yr
Cosmic ray background in counters: ~1/min/cm^2/ster

C.M. ENERGY AND MOMENTUM VS. BEAM MOMENTUM

$$E_{cm} dE_{cm} = m_p dT_{beam} = m_p v_{beam} dP_{beam} \approx m_p dP_{beam}$$

PBEAM (MEV/C)	C.M. ENERGY (MEV) γp ep	πp	Kp	pp	MOMENTUM IN C.M. (MEV/C) γp ep	πp	Kp	pp
0	939	1078	1432	1877	0	0	0	0
20	958	1079	1432	1877	20	17	13	10
40	977	1083	1433	1877	38	35	26	20
60	996	1089	1434	1877	56	52	39	30
80	1015	1096	1436	1878	74	68	52	40
	T(PI) = PBEAM - 59 MEV							
100	1033	1105	1439	1879	91	85	65	50
120	1051	1116	1441	1880	107	101	78	60
140	1069	1127	1445	1882	123	117	91	70
160	1087	1139	1449	1883	138	132	104	80
180	1104	1152	1453	1885	153	147	116	90
	T(PI) = PBEAM - 92 MEV							
200	1121	1165	1457	1887	167	161	129	99
220	1137	1178	1462	1889	182	175	141	109
240	1154	1192	1468	1892	195	189	153	119
260	1170	1206	1474	1894	209	202	166	129
280	1186	1219	1480	1897	222	215	178	138
	T(PI) = PBEAM - 107 MEV							
300	1201	1233	1486	1900	234	228	189	148
320	1217	1247	1493	1903	247	241	201	158
340	1232	1261	1500	1906	259	253	213	167
360	1247	1274	1507	1910	271	265	224	177
380	1262	1288	1514	1913	282	277	235	186
	T(PI) = PBEAM - 115 MEV							
400	1277	1302	1522	1917	294	288	247	196
420	1292	1315	1530	1921	305	300	258	205
440	1306	1329	1538	1925	316	311	268	214
460	1320	1342	1546	1929	327	322	279	224
480	1335	1356	1554	1933	337	332	290	233
	T(PI) = PBEAM - 120 MEV							
500	1349	1369	1563	1938	348	343	300	242
520	1362	1382	1572	1943	358	353	310	251
540	1376	1395	1580	1947	368	363	321	260
560	1390	1408	1589	1952	378	373	331	269
580	1403	1421	1598	1957	388	383	341	278
	T(PI) = PBEAM - 123 MEV							
600	1416	1434	1607	1962	397	393	350	287
620	1430	1446	1616	1967	407	402	360	296
640	1443	1459	1625	1973	416	412	370	304
660	1456	1472	1634	1978	425	421	379	313
680	1468	1484	1644	1984	434	430	388	322
	T(PI) = PBEAM - 125 MEV							
700	1481	1496	1653	1989	443	439	397	330
720	1494	1509	1662	1995	452	448	406	339
740	1506	1521	1671	2001	461	457	415	347
760	1519	1533	1681	2007	470	465	424	355
780	1531	1545	1690	2013	478	474	433	364
	T(PI) = PBEAM - 127 MEV							
800	1543	1557	1699	2019	486	482	442	372
820	1555	1569	1709	2025	495	490	450	380
840	1567	1580	1718	2031	503	499	459	388
860	1579	1592	1728	2037	511	507	467	396
880	1591	1604	1737	2043	519	515	475	404
	T(PI) = PBEAM - 129 MEV							
900	1603	1615	1747	2049	527	523	483	412
920	1615	1627	1756	2056	535	531	492	420
940	1626	1638	1765	2062	542	538	500	428
960	1638	1649	1775	2069	550	546	508	435
980	1649	1661	1784	2075	558	554	515	443
	T(PI) = PBEAM - 130 MEV							
1000	1660	1672	1794	2082	565	561	523	451
1020	1672	1683	1803	2088	573	569	531	458
1040	1683	1694	1812	2095	580	576	538	466
1060	1694	1705	1822	2102	587	583	546	473
1080	1705	1716	1831	2108	594	591	553	481
	T(PI) = PBEAM - 131 MEV							
1100	1716	1726	1840	2115	601	598	561	488
1120	1727	1737	1850	2122	609	605	568	495
1140	1738	1748	1859	2129	616	612	575	502
1160	1748	1758	1868	2135	622	619	583	510
1180	1759	1769	1877	2142	629	626	590	517
	T(PI) = PBEAM - 131 MEV							
1200	1770	1780	1887	2149	636	633	597	524
1220	1780	1790	1896	2156	643	639	604	531
1240	1791	1800	1905	2163	650	646	611	538
1260	1801	1811	1914	2170	656	653	618	545
1280	1812	1821	1923	2177	663	660	624	552
	T(PI) = PBEAM - 132 MEV							
1300	1822	1831	1932	2184	669	666	631	559
1320	1832	1841	1941	2191	676	673	638	565
1340	1843	1851	1950	2198	682	679	645	572
1360	1853	1862	1959	2205	689	685	651	579
1380	1863	1872	1968	2212	695	692	658	585
	T(PI) = PBEAM - 133 MEV							
1400	1873	1881	1977	2219	701	698	664	592
1420	1883	1891	1986	2226	708	704	671	599
1440	1893	1901	1995	2233	714	711	677	605
1460	1903	1911	2004	2240	720	717	684	612
1480	1912	1921	2013	2247	726	723	690	618
	T(PI) = PBEAM - 133 MEV							

PBEAM (MEV/C)	C.M. ENERGY (MEV) γp ep	πp	Kp	pp	MOMENTUM IN C.M. (MEV/C) γp ep	πp	Kp	pp
1500	1922	1930	2022	2254	732	729	696	624
1520	1932	1940	2031	2261	738	735	702	631
1540	1942	1950	2039	2268	744	741	709	637
1560	1951	1959	2048	2275	750	747	715	643
1580	1961	1969	2057	2282	756	753	721	650
	T(PI) = PBEAM - 133 MEV							
1600	1970	1978	2065	2289	762	759	727	656
1620	1980	1988	2074	2296	768	765	733	662
1640	1989	1997	2083	2304	773	770	739	668
1660	1999	2006	2091	2311	779	776	745	674
1680	2008	2016	2100	2318	785	782	751	680
	T(PI) = PBEAM - 134 MEV							
1700	2018	2025	2109	2325	791	788	756	686
1720	2027	2034	2117	2332	796	793	762	692
1740	2036	2043	2126	2339	802	799	768	698
1760	2045	2053	2134	2346	807	805	774	704
1780	2054	2062	2143	2353	813	810	779	710
	T(PI) = PBEAM - 134 MEV							
1800	2064	2071	2151	2360	818	816	785	716
1820	2073	2080	2159	2367	824	821	791	721
1840	2082	2089	2168	2374	829	827	796	727
1860	2091	2098	2176	2381	835	832	802	733
1880	2100	2107	2184	2388	840	837	808	739
	T(PI) = PBEAM - 134 MEV							
1900	2108	2115	2193	2395	845	843	813	744
1920	2117	2124	2201	2402	851	848	818	750
1940	2126	2133	2209	2409	856	853	824	756
1960	2135	2142	2217	2416	861	859	829	761
1980	2144	2150	2226	2423	867	864	835	767
	T(PI) = PBEAM - 135 MEV							
2000	2153	2159	2234	2430	872	869	840	772
2020	2161	2168	2242	2437	877	874	845	778
2040	2170	2176	2250	2444	882	879	851	783
2060	2179	2185	2258	2451	887	885	856	789
2080	2187	2194	2266	2458	892	890	861	794
	T(PI) = PBEAM - 135 MEV							
2100	2196	2202	2274	2465	897	895	866	799
2120	2204	2211	2282	2472	902	900	872	805
2140	2213	2219	2290	2479	907	905	877	810
2160	2221	2227	2298	2486	912	910	882	815
2180	2230	2236	2306	2493	917	915	887	821
	T(PI) = PBEAM - 135 MEV							
2200	2238	2244	2314	2500	922	920	892	826
2220	2246	2253	2322	2507	927	925	897	831
2240	2255	2261	2330	2514	932	930	902	836
2260	2263	2269	2338	2520	937	934	907	841
2280	2271	2277	2346	2527	942	939	912	846
	T(PI) = PBEAM - 135 MEV							
2300	2280	2286	2353	2534	947	944	917	852
2320	2288	2294	2361	2541	951	949	922	857
2340	2296	2302	2369	2548	956	954	927	862
2360	2304	2310	2377	2555	961	959	932	867
2380	2312	2318	2384	2561	966	963	937	872
	T(PI) = PBEAM - 135 MEV							
2400	2320	2326	2392	2568	970	968	941	877
2420	2328	2334	2400	2575	975	973	946	882
2440	2336	2342	2407	2582	980	977	951	887
2460	2344	2350	2415	2589	984	982	956	892
2480	2352	2358	2423	2595	989	987	960	897
	T(PI) = PBEAM - 136 MEV							
2500	2360	2366	2430	2602	994	991	965	901
2520	2368	2374	2438	2609	998	996	970	906
2540	2376	2382	2445	2616	1003	1001	975	911
2560	2384	2390	2453	2622	1007	1005	979	916
2580	2392	2398	2460	2629	1012	1010	984	921
	T(PI) = PBEAM - 136 MEV							
2600	2400	2405	2468	2636	1017	1014	988	926
2620	2408	2413	2475	2643	1021	1019	993	930
2640	2415	2421	2483	2649	1025	1023	998	935
2660	2423	2429	2490	2656	1030	1028	1002	940
2680	2431	2436	2498	2663	1034	1032	1007	944
	T(PI) = PBEAM - 136 MEV							
2700	2439	2444	2505	2669	1039	1037	1011	949
2720	2446	2452	2512	2676	1043	1041	1016	954
2740	2454	2459	2520	2682	1048	1045	1020	958
2760	2462	2467	2527	2689	1052	1050	1025	963
2780	2469	2474	2534	2696	1056	1054	1029	968
	T(PI) = PBEAM - 136 MEV							
2800	2477	2482	2542	2702	1061	1058	1034	972
2820	2484	2490	2549	2709	1065	1063	1038	977
2840	2492	2497	2556	2715	1069	1067	1042	981
2860	2499	2505	2563	2722	1074	1071	1047	986
2880	2507	2512	2570	2728	1078	1076	1051	990
	T(PI) = PBEAM - 136 MEV							
2900	2514	2520	2578	2735	1082	1080	1056	995
2920	2522	2527	2585	2742	1086	1084	1060	999
2940	2529	2534	2592	2748	1091	1088	1064	1004
2960	2537	2542	2599	2755	1095	1093	1069	1008
2980	2544	2549	2606	2761	1099	1097	1073	1013
	T(PI) = PBEAM - 136 MEV							

PBEAM (GEV/C)	C.M. ENERGY (GEV) γp ep πp	Kp	pp	MOMENTUM IN C.M. (GEV/C) γp ep πp	Kp	pp
3.0	2.56	2.61	2.77	1.10	1.08	1.02
3.2	2.63	2.68	2.83	1.14	1.12	1.06
3.4	2.70	2.75	2.89	1.18	1.16	1.10
3.6	2.77	2.82	2.96	1.22	1.20	1.14
3.8	2.83	2.88	3.02	1.26	1.24	1.18
	T(PI) = PBEAM - .137 GEV					
4.0	2.90	2.95	3.08	1.29	1.27	1.22
4.2	2.96	3.01	3.14	1.33	1.31	1.26
4.4	3.03	3.07	3.19	1.36	1.34	1.29
4.6	3.09	3.13	3.25	1.40	1.38	1.33
4.8	3.15	3.19	3.31	1.43	1.41	1.36
	T(PI) = PBEAM - .138 GEV					
5.0	3.21	3.25	3.36	1.46	1.44	1.40
5.5	3.35	3.39	3.50	1.54	1.52	1.48
6.0	3.49	3.52	3.63	1.61	1.60	1.55
6.5	3.62	3.65	3.75	1.69	1.67	1.63
7.0	3.75	3.78	3.87	1.75	1.74	1.70
	T(PI) = PBEAM - .138 GEV					
7.5	3.87	3.90	3.99	1.82	1.80	1.76
8.0	3.99	4.02	4.11	1.88	1.87	1.83
8.5	4.11	4.14	4.22	1.94	1.93	1.89
9.0	4.22	4.25	4.33	2.00	1.99	1.95
9.5	4.33	4.36	4.44	2.06	2.05	2.01
	T(PI) = PBEAM - .139 GEV					
10.0	4.43	4.46	4.54	2.12	2.10	2.07
11.0	4.64	4.67	4.74	2.22	2.21	2.18
12.0	4.84	4.86	4.93	2.33	2.31	2.28
13.0	5.03	5.05	5.12	2.43	2.41	2.38
14.0	5.21	5.24	5.30	2.52	2.51	2.48
	T(PI) = PBEAM - .139 GEV					
15.0	5.39	5.41	5.47	2.61	2.60	2.57
16.0	5.56	5.58	5.64	2.70	2.69	2.66
17.0	5.73	5.75	5.81	2.79	2.78	2.75
18.0	5.89	5.91	5.97	2.87	2.86	2.83
19.0	6.05	6.07	6.12	2.95	2.94	2.91
	T(PI) = PBEAM - .139 GEV					
20.0	6.20	6.22	6.27	3.03	3.02	2.99
22.0	6.49	6.51	6.56	3.18	3.17	3.14
24.0	6.78	6.79	6.84	3.32	3.31	3.29
26.0	7.05	7.07	7.11	3.46	3.45	3.43
28.0	7.31	7.33	7.37	3.59	3.59	3.56
	T(PI) = PBEAM - .139 GEV					
30.0	7.56	7.58	7.62	3.72	3.71	3.69
32.0	7.81	7.82	7.86	3.85	3.84	3.82
34.0	8.04	8.06	8.10	3.97	3.96	3.94
36.0	8.27	8.29	8.33	4.08	4.08	4.06
38.0	8.50	8.51	8.55	4.20	4.19	4.17
	T(PI) = PBEAM - .139 GEV					
40.0	8.72	8.73	8.77	4.31	4.30	4.28
42.0	8.93	8.94	8.98	4.41	4.41	4.39
44.0	9.14	9.15	9.18	4.52	4.51	4.50
46.0	9.34	9.35	9.39	4.62	4.62	4.60
48.0	9.54	9.55	9.58	4.72	4.72	4.70
	T(PI) = PBEAM - .139 GEV					
50.0	9.73	9.74	9.78	4.82	4.81	4.80
55.0	10.20	10.21	10.25	5.06	5.05	5.04
60.0	10.65	10.66	10.69	5.28	5.28	5.26
65.0	11.08	11.10	11.12	5.50	5.50	5.48
70.0	11.50	11.51	11.54	5.71	5.71	5.69
	T(PI) = PBEAM - .139 GEV					
75.0	11.90	11.91	11.94	5.91	5.91	5.89
80.0	12.29	12.30	12.32	6.11	6.10	6.09
85.0	12.67	12.67	12.70	6.30	6.29	6.28
90.0	13.03	13.04	13.06	6.48	6.48	6.46
95.0	13.39	13.39	13.42	6.66	6.65	6.64
	T(PI) = PBEAM - .139 GEV					
100.0	13.73	13.74	13.76	6.83	6.83	6.82
200.0	19.40	19.40	19.42	9.67	9.67	9.66
300.0	23.75	23.75	23.76	11.85	11.85	11.84
400.0	27.41	27.42	27.43	13.69	13.69	13.68
500.0	30.65	30.65	30.66	15.31	15.31	15.30
	T(PI) = PBEAM - .140 GEV					
600.0	33.57	33.57	33.58	16.77	16.77	16.76
700.0	36.26	36.26	36.27	18.12	18.11	18.11
800.0	38.76	38.76	38.77	19.37	19.37	19.36
900.0	41.11	41.11	41.12	20.54	20.54	20.54
1000.0	43.33	43.33	43.34	21.65	21.65	21.65
	T(PI) = PBEAM - .140 GEV					
1100.0	45.44	45.45	45.45	22.71	22.71	22.71
1200.0	47.46	47.47	47.47	23.72	23.72	23.72
1300.0	49.40	49.40	49.41	24.69	24.69	24.69
1400.0	51.26	51.27	51.27	25.62	25.62	25.62
1500.0	53.06	53.07	53.07	26.52	26.52	26.52
	T(PI) = PBEAM - .140 GEV					
1600.0	54.80	54.81	54.81	27.39	27.39	27.39
1700.0	56.49	56.49	56.50	28.24	28.24	28.23
1800.0	58.13	58.13	58.13	29.06	29.05	29.05
1900.0	59.72	59.72	59.73	29.85	29.85	29.85
2000.0	61.27	61.27	61.28	30.63	30.63	30.62
	T(PI) = PBEAM - .140 GEV					

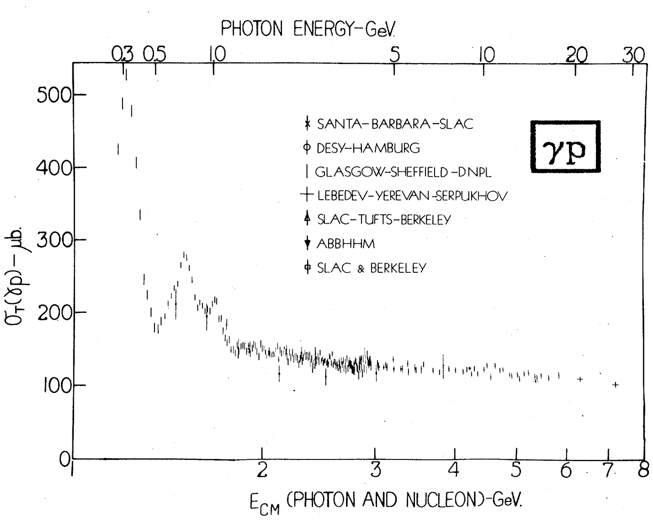
PERIODIC TABLE OF THE ELEMENTS

IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIII	VIII	VIII	IB	IIB	IIIA	IVA	VA	VIA	VIIA	
								1 H 1.008									2 He 4.0026
3 Li 6.94	4 Be 9.0122											5 B 10.81	6 C 12.011	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.17
11 Na 22.9898	12 Mg 24.305											13 Al 26.9815	14 Si 28.086	15 P 30.9738	16 S 32.06	17 Cl 35.453	18 A 39.948
19 K 39.09	20 Ca 40.08	21 Sc 44.956	22 Ti 47.90	23 V 50.941	24 Cr 51.996	25 Mn 54.9380	26 Fe 55.847	27 Co 58.9332	28 Ni 58.71	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.9216	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.906	40 Zr 91.22	41 Nb 92.906	42 Mo 95.94	43 Tc 98.9062	44 Ru 101.07	45 Rh 102.906	46 Pd 106.4	47 Ag 107.868	48 Cd 112.40	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.9045	54 Xe 131.30
55 Cs 132.905	56 Ba 137.34	57–71 Rare Earths	72 Hf 178.49	73 Ta 180.947	74 W 183.85	75 Re 186.2	76 Os 190.2	77 Ir 192.22	78 Pt 195.09	79 Au 196.967	80 Hg 200.59	81 Tl 204.37	82 Pb 207.2	83 Bi 208.981	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.025	89– Acti- nides	104 (261)	105 (262)	106 (263)												

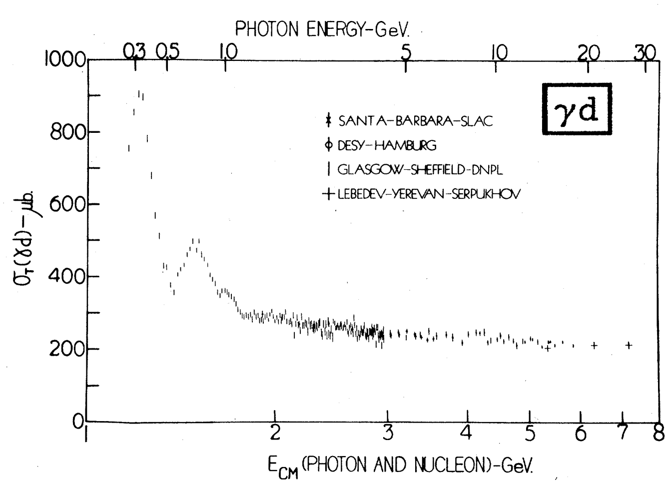
57 La 138.91	58 Ce 140.12	59 Pr 140.908	60 Nd 144.24	61 Pm (145)	62 Sm 150.4	63 Eu 151.96	64 Gd 157.25	65 Tb 158.925	66 Dy 162.50	67 Ho 164.930	68 Er 167.26	69 Tm 168.934	70 Yb 173.04	71 Lu 174.97	Rare earths (Lanthanide series)
89 Ac (227)	90 Th 232.038	91 Pa 231.036	92 U 238.03	93 Np 237.048	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (254)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)	Actinide series

Numbers in parentheses are mass numbers of most stable isotope of that element. Adapted from the *Handbook of Chemistry and Physics, 1975-76.* (Particle Data Group update, April 1976.)

CROSS SECTION PLOTS

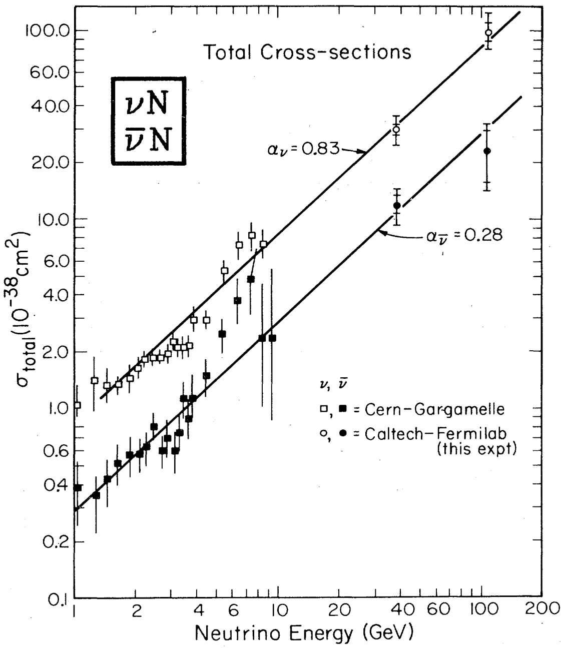


γp total cross section versus photon energy (top scale) and photon-plus-nucleon total center-of-mass energy (lower scale). Courtesy Gething M. Lewis, Glasgow.

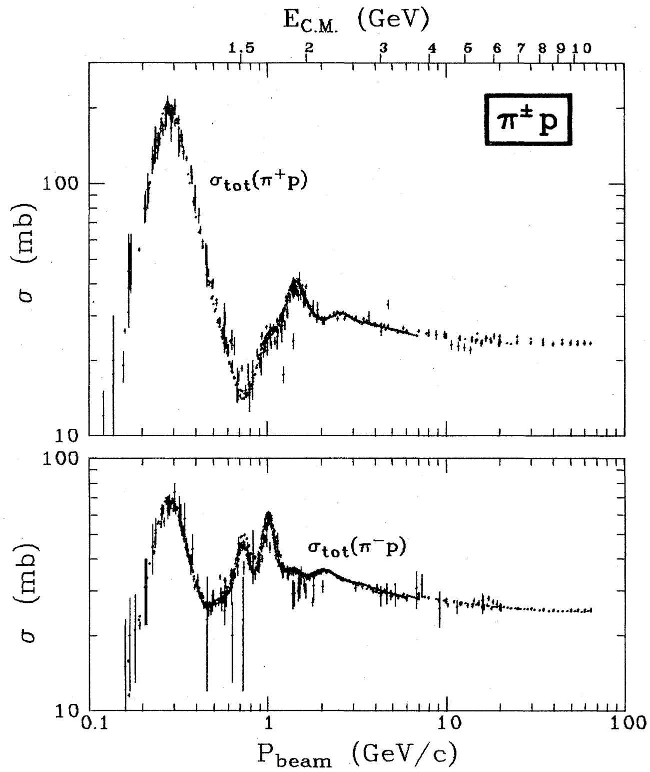


γd total cross section versus photon energy (top scale) and photon-plus-single-nucleon total center-of-mass energy (lower scale). Courtesy Gething M. Lewis, Glasgow.

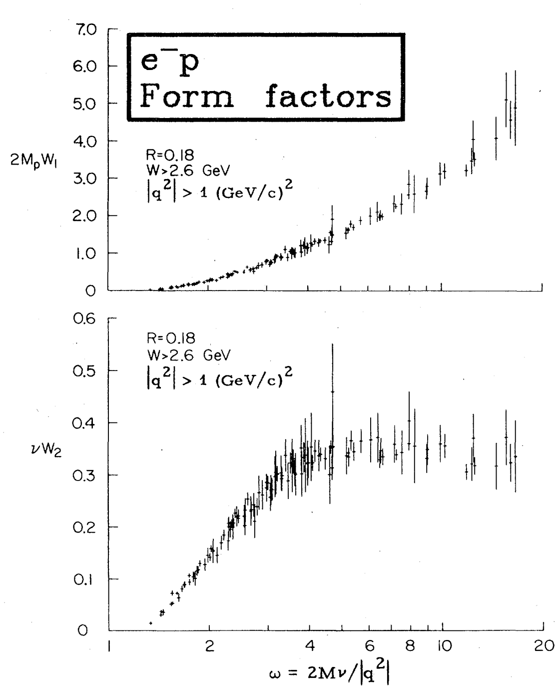
CROSS SECTION PLOTS (Cont'd)



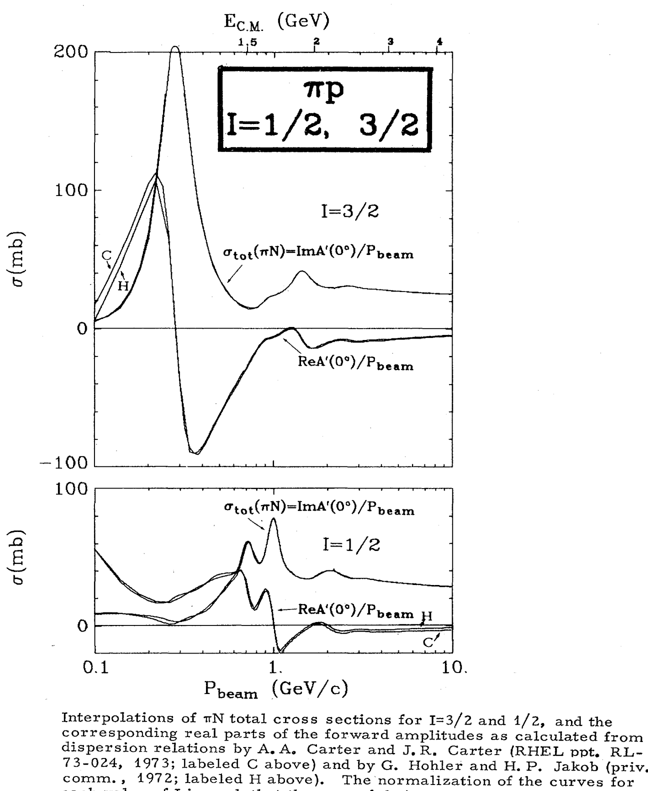
Neutrino and anti-neutrino total cross sections per nucleon [reproduced, with permission, from B.C. Barish et al., Phys. Rev. Lett. 35, 1316 (1975)]. The data are consistent with the form $\sigma_{tot} = \alpha E_{\nu, \bar{\nu}}$.



$\pi^\pm p$ total cross-section data from the Particle Data Group compilation "πN Two-Body Scattering Data," LBL-63 (1973).

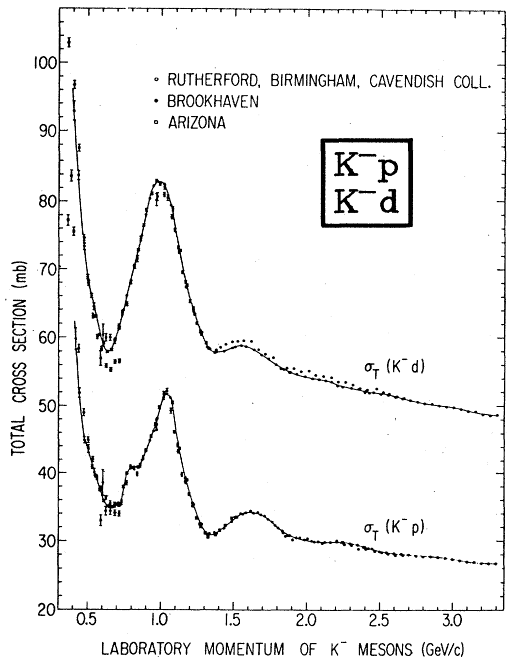


Inelastic electroproduction form factors for a virtual space-like photon scattering on a proton, from SLAC-MIT, Phys. Rev. D5, 528 (1972). $R = \sigma_S/\sigma_T$, the ratio of the longitudinal to transverse cross sections. See L. Hand, Phys. Rev. 129, 1834 (1963).

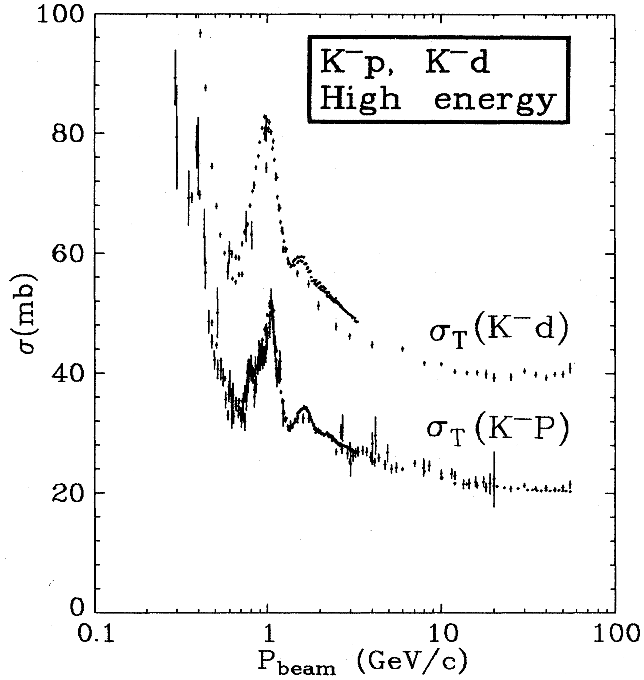


Interpolations of πN total cross sections for I=3/2 and 1/2, and the corresponding real parts of the forward amplitudes as calculated from dispersion relations by A. A. Carter and J. R. Carter (RHEL ppt. RL-73-024, 1973; labeled C above) and by G. Hohler and H. P. Jakob (priv. comm., 1972; labeled H above). The normalization of the curves for each value of I is such that the sum of their squares divided by 19.6 gives $d\sigma/dt$ at 0° in $mb/(GeV/c)^2$.

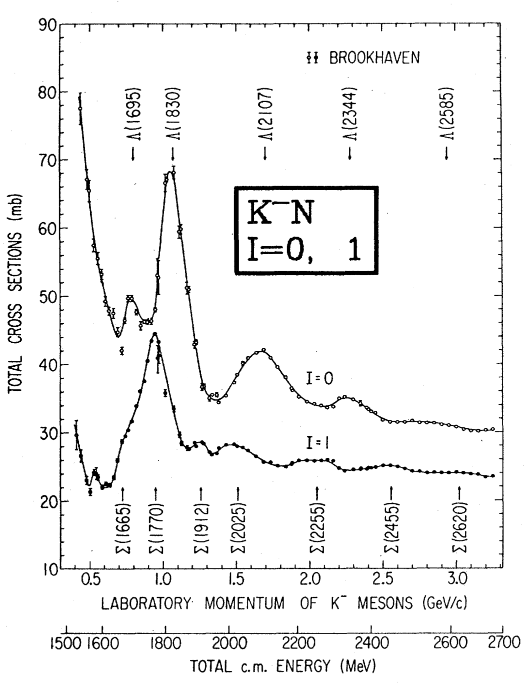
CROSS SECTION PLOTS (Cont'd)



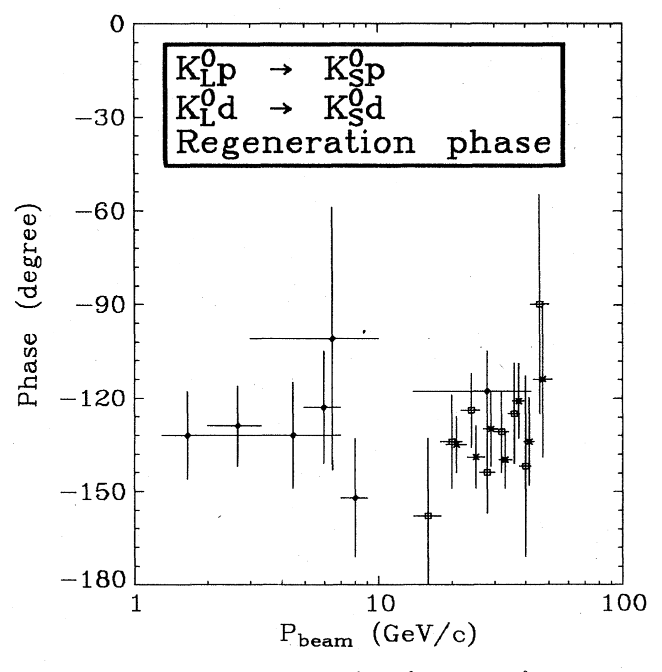
K^-p and K^-d total cross-section data compiled by Li et al., Proc. 1973 Purdue Conf. on Baryon Resonances. The solid curve passes through the Brookhaven data.



K^-p and K^-d total cross-section data. Compilation sources: E. Bracci et al., CERN/HERA 72-2, K^-p; G.R. Lynch, K^-d (< 3 GeV/c); Particle Data Group, K^-d (>3 GeV/c). The new BNL data below 1 GeV/c are not included.

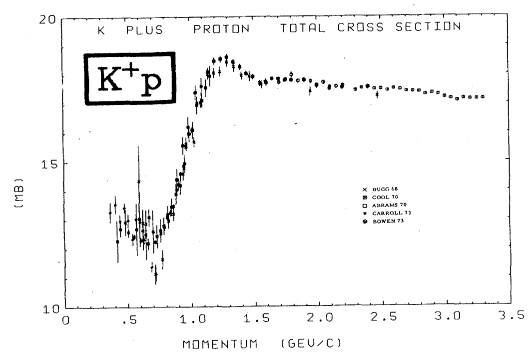


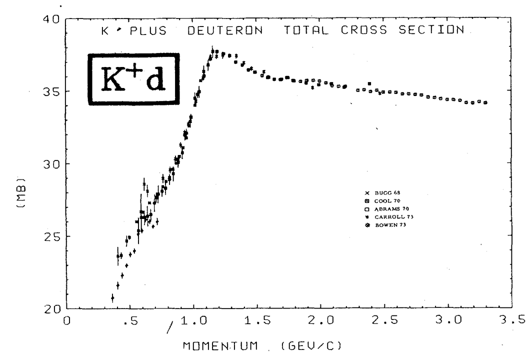
K^-N total cross sections for I = 0 and I = 1 below 3.3 GeV/c. Compiled and unfolded by Li et al., Proc. 1973 Purdue Conf. on Baryon Resonances.



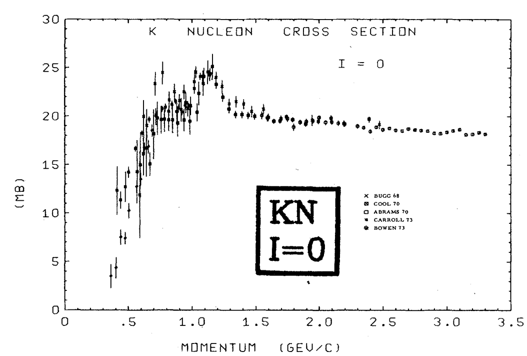
Phases of forward amplitudes for $K^0_Lp \rightarrow K^0_Sp$ (◇,□) and $K^0_Ld \rightarrow K^0_Sd$ (*). The deuterium data are shifted 1 GeV/c higher to avoid overlap with the proton data. ◇-p, compiled by Particle Data Group, LBL-55; □-p, V. Birnlev et al; JINR-E1-6851 (1972); *-d, K.-F. Albrecht et al., Phys. Lett. 48B, 257 (1974).

CROSS SECTION PLOTS (Cont'd)

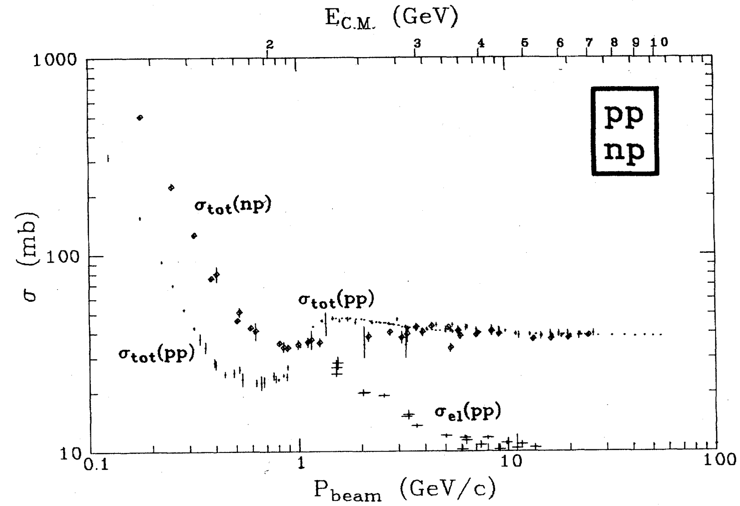




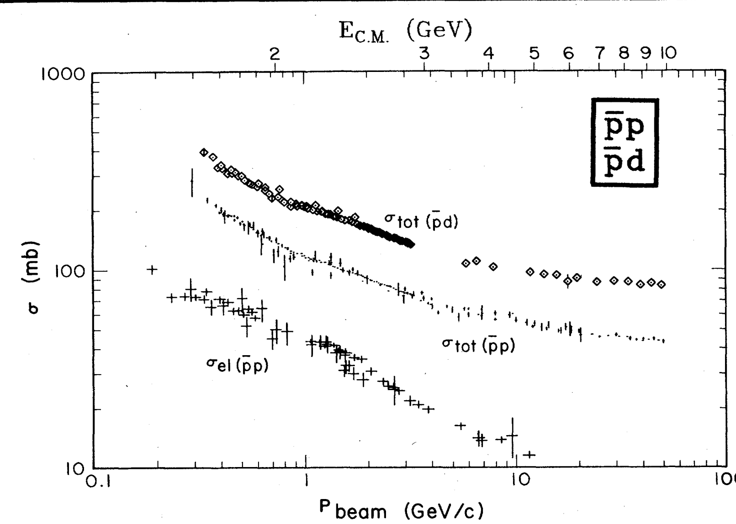
Compilation of recent K^+p and K^+d total cross-section measurements. References can be found in the Baryon Data Card Listings.



Total cross-section for isospin zero KN system. Unfolding of the BUGG 68 and BOWEN 70 and 73 data was done by G. R. Lynch (as in Proc. of 1970 Duke Conference). Tables of σ_0 were provided by the BNL authors. Lynch and BNL use the same method of unfolding; the BOWEN 73 unfolded distribution is obtained by a different method (see plot in Z^* mini-review in the Baryon Data Card Listings).



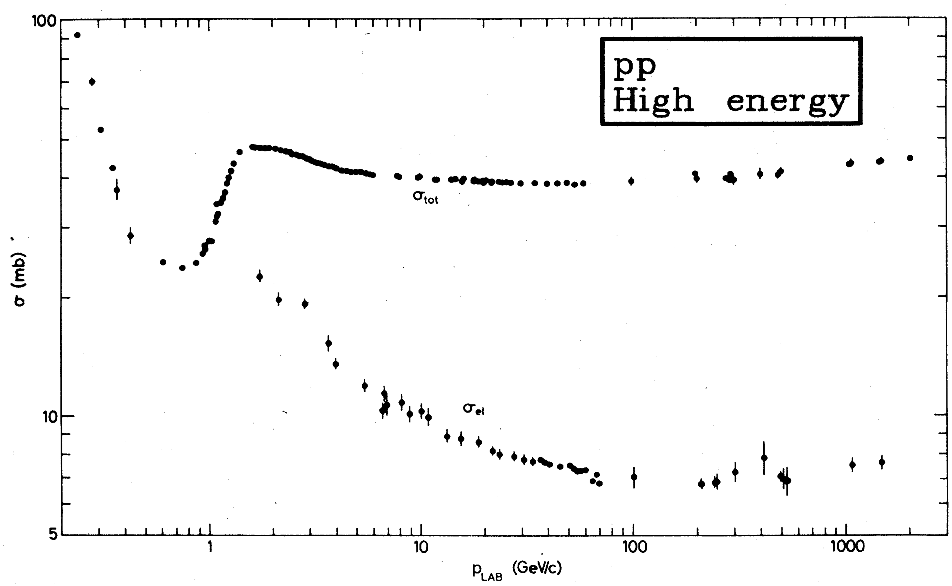
pp and np cross sections from Particle Data Group, "NN and ND Interactions -- A Compilation", UCRL-20 000 NN (August 1970); some points at higher energies added since original compilation.



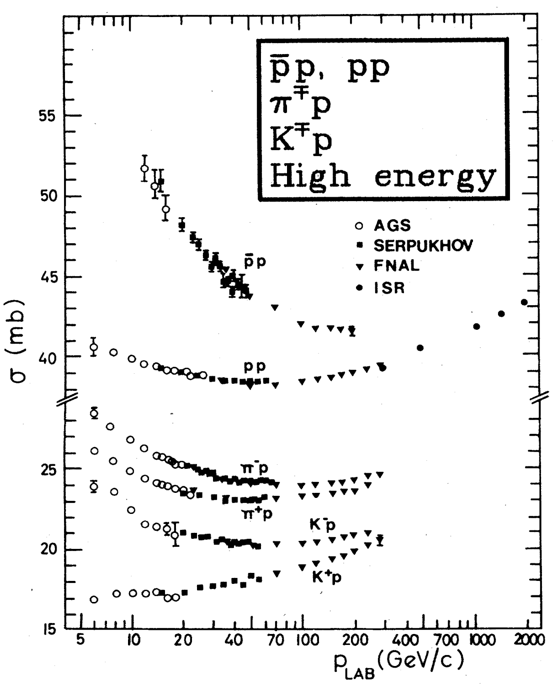
XBL 743-2661

$\bar{p}p$ and $\bar{p}d$ cross sections from Particle Data Group, " A Compilation of $\bar{N}N$ and $\bar{N}D$ Reactions," LBL-58 (1972); some points added since original compilation.

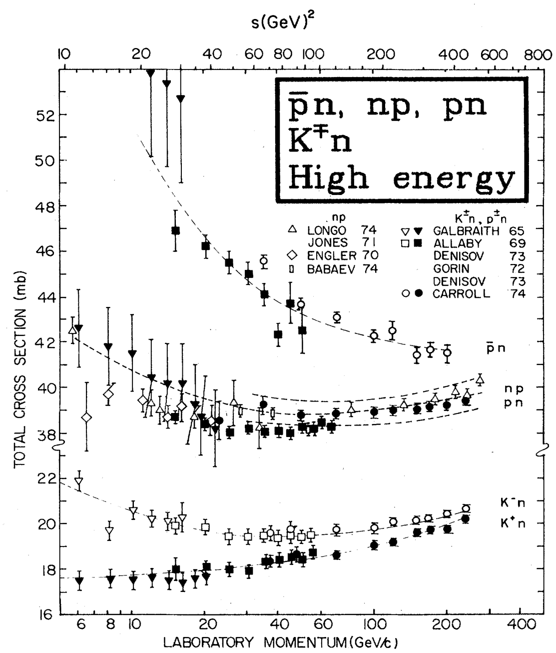
CROSS SECTION PLOTS (Cont'd)



Total and elastic pp cross-section data compiled by U. Amaldi, CERN.



$\bar{p}p$, pp, π^-p, π^+p, K^-p, and K^+p total cross sections versus s($\approx 2m_p p_{lab}$), as compiled by U. Amaldi, CERN.



$\bar{p}n$, np, pn, K^-n, and K^+n total cross sections versus s($\approx 2m_p p_{lab}$), as compiled by G. Giacomelli, CERN.

DATA CARD LISTINGS

Illustrative Key

```
       XX(1200)    74/ XX MESON (1200,JPG=  -)  I=1/
                    ORIGINALLY CALLED XXX/
      ------->      OMITTED FROM TABLE /
------ --------- --------- --------- --------- --------- --------- --------

                       74 /XX(1200) MASS (MEV)/
M/          /1216.  /    11.          /MERRILL  66/HBC    0 3.2 K-P          7/66
M  /L/ /150/1192.)/     (16.)          LYNCH    67 HBC  +-  2.7 PI-P         6/67
M   L    LYNCH DATA HAS QUESTIONABLE BACKGROUND SUBTRACTION
M          1198.      /10.      7./    PIERCE   68/ASPK/+   2.1 K-P          9/68
M         (1208.)                      FENNER   69 HBC   0 4.2 PI+P          9/69
M   S    80 1210.         8.           SMITH    70 MMS  /-/ 3.5 PI-P         2/76*
M   S    SUPERSEDES EARLIER RESULT
M            . . . . . . . . . .
M     AVG    1206.9       5.1      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
------ --------- --------- --------- --------- --------- --------- --------

                       74  XX(1200) WIDTH (MEV)
W               35.       5.           MERRILL  66 HBC   0/3.2 K-P/          7/66
W               50.      10.           PIERCE   68 ASPK +   2.1 K-P          9/68
W               70.      40.           FENNER   69 HBC   0 4.2 PI+P          9/69
W              (60.)   OR LESS         SMITH    70 MMS  -   3.5 PI-P        /2/76*/
W            . . . . . . . . . .
W     AVG      /38.4      6.0/     AVERAGE (ERROR INCLUDES SCALE FACTOR OF/1.3/)
                        (SEE IDEOGRAM BELOW )
```

Name of particle as it appears in table.

Arrow indicates this particle omitted from table.

Quantity tabulated below.

Code for quantity tabulated (M=mass, W=width, etc.)

Symbols used to key together data card and related comments.

Number of events above background.

Measured values (parentheses indicate value not used in average).

± Error in measured value (– field blank if error symmetric; parentheses on error only indicate data not used in average due to problems with error estimation).

Average value (and error) of quantity measured.

Vertical bar indicates average; width of horizontal bar on top is error (scaled) in average.

Value and error for each experiment.

Particle name, and quantum numbers (if known).

Particle code (for internal use only).

General comments on particle.

Abbreviated reference for this result; full reference given below.

Measurement technique (see abbreviations on next page.)

Charge(s) of particle detected.

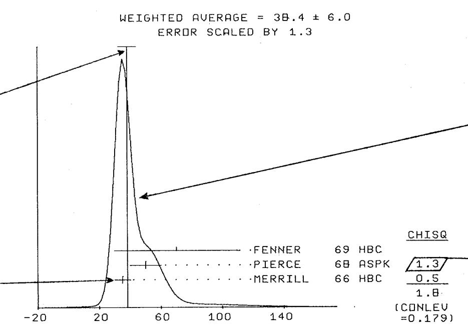
Reaction producing particle, or comments.

Date this result punched (asterisk indicates result added or changed since previous edition).

Scale factor > 1 indicates inconsistent data.

Ideogram to display inconsistent data; curve is sum of Gaussians, one for each experiment (area of Gaussian = 1/error; width of Gaussian = ± error).

Contribution of experiment to χ^2 (if no entry present, experiment not used in calculating χ^2 or scale factor because of large error).

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------ --------- --------- --------- --------- --------- --------- --------

                       74  XX(1200) PARTIAL DECAY MODES
                                                       DECAY MASSES
/P1        XX(1200) INTO 3PI/                          /139+ 139+ 139/
 P2        XX(1200) INTO K KBAR                         493+ 493
------ --------- --------- --------- --------- --------- --------- --------

                       74  XX(1200) BRANCHING RATIOS
/R1        XX(1200) INTO 3PI/TOTAL/                    (P1)
 R1                  .66       .02       MERRILL   66 HBC    0 3.2 K-P       7/66
 R1   L             (.68)     (.03)      LYNCH     67 HBC  +-  2.7 PI-P      6/67
 R1   L   LYNCH DATA HAS QUESTIONABLE BACKGROUND SUBTRACTION
 R1             . . . . . . . . . .
 R1   FIT        /0.675     0.012/ FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

 R2        XX(1200) INTO KKBAR/TOTAL                   (P2)
 R2                  .35       .05       PIERCE    68 ASPK +   2.1 K-P       9/68
 R2             . . . . . . . . . .
 R2   FIT        /0.325     0.012/ FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

 R3        XX(1200) INTO KKBAR/3PI                   /(P2)/(P1)/
 R3                  .50       .03       FENNER    69 HBC   0 4.2 PI+P       9/69
 R3                  .41       .04       SMITH     70 MMS  -  3.5 PI-P       2/76*
 R3             . . . . . . . . . .
 R3   AVG         0.468     0.043   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.8)
 R3   FIT        /0.480     0.026/ FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

****** ********* ********* ********* ********* ********* ********* ********

                          REFERENCES FOR XX(1200)
/MERRILL  66/PRL 16 143     A. MERRILL                   (TORINO+CERN)/IJP/
 LYNCH    67 PR 155 610     B. LYNCH                            (BNL)
 PIERCE   68 PL 27B 230    /N. PIERCE/                          (LRL)
 FENNER   69 NC 61B 372     D. FENNER,B. BEANE            (NYSE+AMEX)
 SMITH    70/PRL 24 14/     J. SMITH                           /(SLAC)/
****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
```

Partial decay mode (labeled by P_i).

Branching ratio (labeled by R_j).

Value (and error) of quantity measured, as determined from constrained fit (using all measured branching ratios for this particle).

References listed by year, then author.

Abbreviated reference form used on data cards above.

Journal, report, preprint, etc. (see abbreviations on next page).

Representative masses of decay products (used for calculating last column of Particle Property Tables)

Branching ratio R_j in terms of partial decay mode fractions P_i above.

Author(s)

Quantum number determinations in this reference

Institution(s) of author(s) (see abbreviations on next page).

Illustrative Key *(cont'd)*

Abbreviations

Journals

APAH	Acta Phys. Acad. Hungarica
ADVP	Advances in Physics
ANP	Annals of Physics
ARNS	Annual Reviews of Nuclear Science
BAPS	Bulletin of the Amer. Phys. Soc.
JETP	English Transl. of Soviet Physics JETP
JETPL	Letters of Soviet Physics JETP
LNC	Letters to Nuovo Cimento
NC	Nuovo Cimento
NP	Nuclear Physics
PL	Physics Letters
PN	Particles and Nuclei
PPSL	Proc. of the Phys. Soc. of London
PR	Physical Review
PRL	Physical Review Letters
PRSL	Proc. of the Royal Soc. of London
RMP	Reviews of Modern Physics
SJNP	Soviet Journal of Nuclear Physics
ZPHY	Zeitschrift für Physik

Measurement techniques

ASPK	Automatic spark chambers	HYBR	Hybrid: BC + electronics
CC	Cloud chamber	IPWA	Energy-independent PWA
CNTR	Counters	MMS	Missing mass spectrometer
DASP	DESY double-arm spectrometer	MPWA	Model-dependent PWA
DBC	Deuterium bubble chamber	OSPK	Optical spark chamber
DPWA	Energy-dependent PWA	PBC	Propane bubble chamber
ELEC	Electronic combination	PLUT	DESY PLUTO detector
EMUL	Emulsions	PWA	Partial-wave analysis
FBC	Freon bubble chamber	RVUE	Review of previous data
FRAB	ADONE $B\bar{B}$ Group detector	SMAG	SPEAR magnetic detector
FRAG	ADONE $\gamma\gamma$ Group detector	SPEC	Spectrometer
FRAM	ADONE MEA Group detector	SPRK	Spark chamber
HBC	Hydrogen bubble chamber	STRC	Streamer chamber
HEBC	Helium bubble chamber	WIRE	Wire chamber
HLBC	Heavy liquid bubble chamber	XEBC	Xenon bubble chamber

Conferences

Conferences are referred to by the location in which they were held (e.g., DUBNA, BOULDER, LUND, etc.).

Institutions

AACH	TECHNISCHE UNIV. AACHEN	AACHEN, GERMANY
AARH	AARHUS UNIV.	AARHUS, DENMARK
AERE	ATOMIC ENERGY RES. ESTAB.	HARWELL, BERKS., ENGLAND
ALBA	STATE UNIV. OF NEW YORK AT ALBANY	ALBANY, N. Y., USA
AMST	UNIV. OF AMSTERDAM	AMSTERDAM, NETHERLANDS
ANKA	MIDDLE EAST TECHNICAL UNIV.	ANKARA, TURKEY
ANL	ARGONNE NAT. LAB.	ARGONNE, ILL., USA
ARIZ	UNIV. OF ARIZONA	TUCSON, ARIZ., USA
ATEN	NUCLEAR RES. CENTRE DEMOKRITOS	ATHENS, GREECE
ATHU	UNIV. OF ATHENS	ATHENS, GREECE
BARC	UNIV. DE BARCELONA	BARCELONA, SPAIN
BARI	UNIV. DI BARI	BARI, ITALY
BELG	INST. INTERUNIV. DES SCI. NUC.	BRUXELLES, BELGIUM
BERG	FYSISK INSTITUTT	BERGEN, NORWAY
BERL	INST. HOCHENERGIEPHYS. DAW	ZEUTHEN/BERLIN, DDR
BERN	UNIV. BERN	BERN, SWITZERLAND
BGNA	UNIV. DI BOLOGNA	BOLOGNA, ITALY
BING	STATE UNIV. OF NEW YORK AT BINGHAMTON	BINGHAMTON, N. Y., USA
BIRM	BIRMINGHAM UNIV.	BIRMINGHAM, ENGLAND
BNL	BROOKHAVEN NATIONAL LAB.	UPTON, L.I., N. Y., USA
BOHR	NIELS BOHR INSTITUTE	COPENHAGEN, DENMARK
BONN	UNIV. BONN	BONN, GERMANY
BORD	UNIV. DE BORDEAUX	BORDEAUX, FRANCE
BOST	BOSTON UNIV.	BOSTON, MASS., USA
BRAN	BRANDEIS UNIV.	WALTHAM, MASS., USA
BRIS	H. H. WILLS PHYS. LAB., U. OF BRISTOL	BRISTOL, ENGLAND
BROW	BROWN UNIV.	PROVIDENCE, R. I., USA
BRUX	UNIV. LIBRE DE BRUXELLES	BRUXELLES, BELGIUM
BUCH	BUCHAREST STATE UNIV.	BUCHAREST, ROMANIA
BUDA	CENTRAL RESEARCH INSTITUTE OF PHYSICS	BUDAPEST, HUNGARY
BUFF	STATE UNIV. OF NEW YORK AT BUFFALO	BUFFALO, N. Y., USA
CAEN	LAB. DE PHYS. CORPUSCULAIRE	CAEN, FRANCE
CANB	AUSTRALIAN NATIONAL UNIV.	CANBERRA, AUSTRALIA
CARL	CARLTON UNIV.	OTTAWA, CANADA
CARN	CARNEGIE-MELLON UNIV.	PITTSBURGH, PA., USA
CASE	CASE WESTERN RESERVE UNIV.	CLEVELAND, OHIO, USA
CAVE	CAVENDISH LAB., CAMBRIDGE UNIV.	CAMBRIDGE, ENGLAND
CCAC	COMMUNITY COLLEGE OF ALLEGHENY COUNTY	PITTSBURGH, PENN., USA
CDEF	COLLEGE DE FRANCE	PARIS, FRANCE
CEA	CAMBRIDGE ELECTRON ACCEL.	CAMBRIDGE, MASS., USA
CERN	EUROPEAN ORG. FOR NUC. RES.	GENEVA, SWITZERLAND
CHIC	UNIV. OF CHICAGO	CHICAGO, ILL., USA
CINC	UNIV. OF CINCINNATI	CINCINNATI, OHIO, USA
CIT	CALIF. INSTITUTE OF TECHNOLOGY	PASADENA, CALIF., USA
CNRC	CANADIAN NATIONAL RESEARCH COUNCIL	OTTAWA, CANADA
COLO	UNIV. OF COLORADO	BOULDER, COLO., USA
COLU	COLUMBIA UNIV.	NEW YORK, N. Y., USA
CORN	CORNELL UNIV.	ITHACA, N. Y., USA
CRAC	INST. FOR NUCLEAR RESEARCH	CRACOW, POLAND
CUNY	CITY UNIV. OF NEW YORK	NEW YORK, N. Y., USA
CURI	LABORATOIRE JOLIOT-CURIE	PARIS, FRANCE
DARE	DARESBURY NUC. PHYS. LAB.	DARESBURY, ENGLAND
DART	DARTMOUTH COLLEGE	HANOVER, N. H., USA
DESY	DEUTSCHES ELEKTRONEN-SYNCH.	HAMBURG, GERMANY
DUKE	DUKE UNIV.	DURHAM, N. C., USA
DURH	UNIV. OF DURHAM	DURHAM, ENGLAND
DUUC	UNIVERSITY COLLEGE	DUBLIN, IRELAND
EDIN	UNIV. OF EDINBURGH	EDINBURGH, SCOTLAND
EFI	ENRICO FERMI INST. FOR NUCL. STUDIES	CHICAGO, ILL., USA
EPOL	ECOLE POLYTECHNIQUE	PARIS, FRANCE
ETHZ	SWISS FEDERAL INST. OF TECHNOLOGY	ZURICH, SWITZERLAND
FIRZ	UNIV. DI FIRENZE	FIRENZE, ITALY
FISK	FISK UNIV.	NASHVILLE, TENN., USA
FLOR	UNIV. OF FLORIDA	GAINSVILLE, FLA., USA
FNAL	FERMI NATIONAL ACCELERATOR LAB.	BATAVIA, ILL., USA
FRAS	LAB. NAZIONALI DEL SINCROTRONE	FRASCATI, ITALY
FSU	FLORIDA STATE UNIV.	TALLAHASSEE, FLA., USA
GENO	UNIV. DI GENOVA	GENOVA, ITALY
GESC	GENERAL ELECTRIC RES. AND DEV. CENTER	SCHENECTADY, N. Y., USA
GEVA	UNIV. DE GENEVE	GENEVA, SWITZERLAND
GLAS	UNIV. OF GLASGOW	GLASGOW, SCOTLAND
GRAZ	UNIV. GRAZ	GRAZ, AUSTRIA
GSCO	GEOLOGICAL SURVEY OF CANADA	OTTAWA, CANADA
HAIF	TECHNION - ISRAEL INST. OF TECHNOLOGY	HAIFA, ISRAEL
HAMB	UNIV. HAMBURG	HAMBURG, GERMANY
HARV	HARVARD UNIV.	CAMBRIDGE, MASS., USA
HAWA	UNIV. OF HAWAII	HONOLULU, HAWAII, USA
HEID	UNIV. HEIDELBERG	HEIDELBERG, GERMANY
HELS	HELSINGIN YLIOPISTO	HELSINKI, FINLAND
IBM	INTERNATIONAL BUSINESS MACHINES	PALO ALTO, CALIF., USA
IIT	ILLINOIS INST. OF TECH.	CHICAGO, ILL., USA
ILL	UNIV. OF ILLINOIS	URBANA, ILL., USA
ILLC	UNIV. OF ILLINOIS AT CHICAGO	CHICAGO, ILL., USA
IND	UNIV. OF INDIANA	BLOOMINGTON, IND., USA
INNS	PHYS. INST., UNIV. INNSBRUCK	INNSBRUCK, AUSTRIA
IOWA	UNIV. OF IOWA	IOWA CITY, IOWA, USA
IPN	INST. DE PHYS. NUCLEAIRE	ORSAY, FRANCE
IPNP	INSTITUT DE PHYSIQUE NUCLEAIRE	PARIS, FRANCE
IPPC	INST. FOR PARTICLE PHYSICS OF CANADA	CANADA
IRAD	INSTITUTE DU RADIUM	PARIS, FRANCE
ISU	IOWA STATE UNIV.	AMES, IOWA, USA
ITEP	INST. FOR TEOR. AND EXP. PHYS.	MOSCOW, USSR
IUPU	INDIANA U. - PURDUE U. AT INDIANAPOLIS	INDIANAPOLIS, IND., USA
JAGL	JAGELLONIAN UNIV.	CRACOW, POLAND
JHU	JOHNS HOPKINS UNIV.	BALTIMORE, MD., USA
JINR	JOINT INST. FOR NUCL. RESEARCH	DUBNA, USSR
KANS	UNIV. OF KANSAS	LAWRENCE, KANSAS, USA
KARL	TECHNISCHE UNIV. KARLSRUHE	KARLSRUHE, GERMANY
KEK	NAT. LAB FOR HIGH ENERGY PHYS., JAPAN	TSUKUBA-GUN, JAPAN
KIAE	KURCHATOV INST. OF ATOMIC ENERGY	MOSCOW, USSR
KNTY	UNIV. OF KENTUCKY	LEXINGTON, KY., USA
LALC	LINEAR ACCELERATOR LAB, ORSAY	ORSAY, FRANCE
LANC	LANCASTER UNIV.	LANCASTER, ENGLAND
LASL	U. C. LOS ALAMOS SCIENTIFIC LAB.	LOS ALAMOS, N. M., USA
LAUS	UNIV. OF LAUSANNE	LAUSANNE, SWITZERLAND
LBL	U. C. LAWRENCE BERKELEY LAB.	BERKELEY, CALIF., USA
LEBD	LEBEDEV PHYSICS INST.	MOSCOW, USSR
LEHI	LEHIGH UNIV.	BETHLEHEM, PA., USA
LEID	INST. LORENTZ	LEIDEN, NETHERLANDS
LINZ	LINZ INSTITUT FUR PHYSIK, KEPLER HOCH.	LINZ, AUSTRIA
LIVP	LIVERPOOL UNIV.	LIVERPOOL, ENGLAND
LOIC	IMPERIAL COL. OF SCI. AND TECH.	LONDON, ENGLAND
LOQM	QUEEN MARY COLLEGE	LONDON, ENGLAND
LOUC	UNIVERSITY COLLEGE	LONDON, ENGLAND
LOWC	WESTFIELD COLLEGE	LONDON, ENGLAND
LPNP	LAB. DE PHYS. NUCL. ET HAUTES ENERGIES	PARIS, FRANCE
LPTP	LAB. DE PHYS. THEOR. ET HAUTES ENERGIES	PARIS, FRANCE
LRL	U. C. LAWRENCE BERKELEY LAB.	BERKELEY, CALIF., USA
LSU	LOUISIANA STATE UNIV.	BATON ROUGE, LA., USA
LUND	UNIV. I LUND	LUND, SWEDEN
MADR	JUNTA DE ENERGIA NUCLEAR	MADRID, SPAIN
MADU	UNIV. AUTONOME DE MADRID	MADRID, SPAIN
MANH	MANHATTAN COLLEGE	NEW YORK, N. Y., USA
MANI	UNIV. OF MANITOBA	WINNIPEG, CANADA
MANZ	UNIV. MAINZ	MAINZ, GERMANY
MASA	UNIV. OF MASSACHUSETTS	AMHERST, MASS., USA
MASB	UNIV. OF MASSACHUSETTS	BOSTON, MASS., USA
MCGI	MCGILL UNIV.	MONTREAL, CANADA
MCHS	UNIV. MANCHESTER	MANCHESTER, ENGLAND
MHCO	MOUNT HOLYOKE COLL.	SOUTH HADLEY, MASS., USA
MICH	UNIV. OF MICHIGAN	ANN ARBOR, MICH., USA
MILA	UNIV. DI MILANO	MILANO, ITALY
MINN	UNIV. OF MINNESOTA	MINNEAPOLIS, MINN., USA
MIOH	MIAMI UNIV.	OXFORD, OHIO, USA
MIT	MASSACHUSETTS INST. OF TECHNOLOGY	CAMBRIDGE, MASS., USA
MODE	ISTITUTO DI FISICA DELLA UNIVERSITA	MODENA, ITALY
MONL	UNIV. DE MONTREAL	MONTREAL, CANADA
MONS	UNIV. DE L'ETAT, MONS	MONS, BELGIUM
MONT	UNIV. DE MONTPELLIER	MONTPELLIER, FRANCE
MPIH	MAX-PLANCK-INST. FUR PHYS.-ASTROPHYS.	HEIDELBERG, GERMANY
MPIM	MAX-PLANCK-INST. FUR PHYS.-ASTROPHYS.	MUNICH, GERMANY
MSNA	INS. DI FISICA DELL UNIV.	MESSINA, ITALY
MSU	MICHIGAN STATE UNIV.	EAST LANSING, MICH., USA
MUNC	UNIV. OF MUNICH	MUNICH, GERMANY
NAGO	NAGOYA UNIV.	NAGOYA, JAPAN
NAPL	UNIV. DI NAPOLI	NAPOLI, ITALY
NDAM	UNIV. OF NOTRE DAME	NOTRE DAME, IND., USA
NEAS	NORTHEASTERN UNIV.	BOSTON, MASS., USA
NEUC	UNIV. DE NEUCHATEL	NEUCHATEL, SWITZERLAND
NEVI	NEVIS LAB.	IRVINGTON-ON-HUDSON, N.Y., USA
NIJM	R. K. UNIV. NIJMEGEN	NIJMEGEN, NETHERLANDS
NORD	NORDISK INS. FOR TEOR. ATOMFYS.	COPENHAGEN, DENMARK
NOVO	INST. OF NUCL. PHYS.	NOVOSIBIRSK, USSR
NRL	NAVAL RESEARCH LABORATORY	WASHINGTON, D.C., USA
NWES	NORTHWESTERN UNIV.	EVANSTON, ILL., USA
NYU	NEW YORK UNIV.	NEW YORK, N. Y., USA
OHIO	OHIO UNIV.	ATHENS, OHIO, USA
OREG	UNIV. OF OREGON	EUGENE, ORE., USA
ORNL	OAK RIDGE NATIONAL LAB.	OAK RIDGE, TENN., USA
ORSA	UNIV. DE PARIS, FAC. DES SCI.	ORSAY, FRANCE
OSLO	OSLO UNIV.	OSLO, NORWAY
OSU	OHIO STATE UNIV.	COLUMBUS, OHIO, USA
OXF	OXFORD UNIV.	OXFORD, ENGLAND
PADO	UNIV. DI PADOVA	PADOVA, ITALY
PATR	UNIV. OF PATRAS	PATRAS, GREECE
PENN	UNIV. OF PENNSYLVANIA	PHILADELPHIA, PA., USA
PISA	UNIV. DI PISA	PISA, ITALY
PITT	UNIV. OF PITTSBURGH	PITTSBURGH, PA., USA
PPA	PRINCETON-PENN. PROTON ACCEL.	PRINCETON, N. J., USA
PRAG	INSTITUTE OF PHYSICS, CSAV	PRAGUE, CZECHOSLOVAKIA
PRIN	PRINCETON UNIV.	PRINCETON, N. J., USA
PURD	PURDUE UNIV.	LAFAYETTE, IND., USA
REHO	WEIZMANN INST. OF SCI.	REHOVOTH, ISRAEL
RHEL	RUTHERFORD HIGH ENERGY LAB.	CHILTON, DID., BERKS., ENGLAND
RISO	RESEARCH ESTAB. RISO	ROSKILDE, DENMARK
RMCS	ROYAL MILITARY COLLEGE OF SCIENCE	SHRIVENHAM, ENGLAND
ROCH	UNIV. OF ROCHESTER	ROCHESTER, N. Y., USA
ROMA	UNIV. DI ROMA	ROMA, ITALY
RUTG	RUTGERS UNIV.	NEW BRUNSWICK, N. J., USA
SACL	CNTR. D'ETUDES NUC. SACLAY	GIF-SUR-YVETTE, FRANCE
SAGA	SAGA UNIV.	SAGA, JAPAN
SEAT	SEATTLE PACIFIC COLLEGE	SEATTLE, WASH., USA
SEIB	RESEARCH CENTER SEIBERSDORF	VIENNA, AUSTRIA
SERP	INST. OF HIGH EN. PHYS.	SERPUKOV, USSR
SETO	SETON HALL UNIV.	SOUTH ORANGE, N. J., USA
SFLA	UNIV. OF SOUTH FLORIDA	TAMPA, FLA., USA
SHEF	UNIV. OF SHEFFIELD	SHEFFIELD, ENGLAND
SHMP	UNIV. OF SOUTHAMPTON	SOUTHAMPTON, ENGLAND
SIN	SWISS INST. FOR NUCLEAR RESEARCH	VILLIGEN, SWITZERLAND
SLAC	STANFORD LINEAR ACCEL. CENTER	STANFORD, CALIF., USA
SOFI	BULGARIAN ACAD. OF SCI.	SOFIA, BULGARIA
STAN	STANFORD UNIV.	STANFORD, CALIF., USA
STEV	STEVENS INST. OF TECH.	HOBOKEN, N. J., USA
STLO	ST. LOUIS UNIV.	ST. LOUIS, MO., USA
STOH	STOCKHOLM UNIV.	STOCKHOLM, SWEDEN
STON	STATE UNIV. OF NEW YORK AT STONYBROOK	STONYBROOK, L.I., N. Y., USA
STRB	CENTRE DES RES. NUCLEAIRES	STRASBOURG, FRANCE
SUSS	SUSSEX UNIV.	SUSSEX, ENGLAND
SYRA	SYRACUSE UNIV.	SYRACUSE, N. Y., USA
TATA	TATA INST. OF FUNDAMENTAL RESEARCH	BOMBAY, INDIA
TELA	UNIV. OF TEL-AVIV	TEL-AVIV, ISRAEL
TEMP	TEMPLE UNIV.	PHILADELPHIA, PA., USA
TENN	UNIV. OF TENNESSEE	KNOXVILLE, TENN., USA
TNTO	UNIV. OF TORONTO	TORONTO, CANADA
TOHO	TOHOKU UNIV.	SENDAI, JAPAN
TOKY	UNIV. OF TOKYO	TOKYO, JAPAN
TORI	UNIV. DI TORINO	TORINO, ITALY
TRST	UNIV. DI TRIESTE	TRIESTE, ITALY
TUFT	TUFTS UNIV.	MEDFORD, MASS., USA
UBC	UNIV. OF BRITISH COLUMBIA	VANCOUVER, CANADA
UCB	UNIV. OF CALIF. AT BERKELEY	BERKELEY, CALIF., USA
UCD	UNIV. OF CALIF. AT DAVIS	DAVIS, CALIF., USA
UCI	UNIV. OF CALIF. AT IRVINE	IRVINE, CALIF., USA
UCLA	UNIV. OF CALIF. AT LOS ANGELES	LOS ANGELES, CALIF., USA
UCND	UNION CARBIDE NUCLEAR DIVISION	OAK RIDGE, TENN., USA
UCR	UNIV. OF CALIF. AT RIVERSIDE	RIVERSIDE, CALIF., USA
UCSB	UNIV. OF CALIF. AT SANTA BARBARA	SANTA BARBARA, CALIF., USA
UCSC	UNIV. OF CALIF. AT SANTA CRUZ	SANTA CRUZ, CALIF., USA
UCSD	UNIV. OF CALIF. AT SAN DIEGO	LA JOLLA, CALIF., USA
UMD	UNIV. OF MARYLAND	COLLEGE PARK, MD., USA
UNCS	UNION COLL.	SCHENECTADY, N. Y., USA
UPNJ	UPSALA COLLEGE	EAST ORANGE, N. J., USA
UTAH	UNIV. OF UTAH	SALT LAKE CITY, UTAH, USA
VAND	VANDERBILT UNIV.	NASHVILLE, TENN., USA
VIEN	INST. FOR HIGH EN. PHYS., A. A. S.	VIENNA, AUSTRIA
VIRG	UNIV. OF VIRGINIA	CHARLOTTESVILLE, VA., USA
VPI	VIRGINIA POLYTECHNIC INST.	BLACKSBURG, VA., USA
WARS	UNIV. OF WARSAW	WARSAW, POLAND
WASH	UNIV. OF WASHINGTON	SEATTLE, WASH., USA
WIEN	UNIV. WIEN	WIEN, AUSTRIA
WILL	COLLEGE OF WILLIAM AND MARY	WILLIAMSBURG, VA., USA
WISC	UNIV. OF WISCONSIN	MADISON, WISC., USA
WOOD	WOODSTOCK COLLEGE	WOODSTOCK, MD., USA
WUSL	WASHINGTON UNIV.	ST. LOUIS, MO., USA
WYOM	UNIV. OF WYOMING	LARAMIE, WYOMING, USA
YALE	YALE UNIV.	NEW HAVEN, CONN., USA
ZEEM	ZEEMAN LAB., UNIV. OF AMSTERDAM	AMSTERDAM, NETHERLANDS

Stable Particles

γ, ν_e, ν_μ, e, μ

Data Card Listings

For notation, see key at front of Listings.

γ

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                      0  GAMMA(0,J=1)

                      0  GAMMA MASS (IN UNITS OF 10**-21 MEV)

M   P      (6.)   OR LESS          PATEL     65         SATELLITE DATA   10/69
M           6.    OR LESS          GINTSBURG 64         SATELLITE DATA  .10/69
M           2.3   OR LESS          GOLDHABER 68         SATELLITE DATA   10/69
M   F      (0.06) OR LESS          FRANKEN   71         LOW FREQ RES CIR  3/72
M          10.    OR LESS          WILLIAMS  71 CNTR    TESTS GAUSS LAW   3/71
M           0.73  OR LESS          HOLLWEG   74         ALFVEN WAVES      7/74*
M   F  VALIDITY QUESTIONABLE ACCORDING TO AUTHORS AND KROLL 71.           3/72
M   P  SEE CRITICISM IN GOLDHABER 71                                      3/72
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                         REFERENCES FOR GAMMA

GINTSBUR 64 SOV. ASTR.AJ7 536 M. A. GINTSBURG            (ACAD SCI,USSR)
PATEL    65 PL    14  105     V. L. PATEL                       (DURHAM)
GOLDHABE 68 PRL   21  567     A. GOLDHABER,M. NIETO        (STONY BROOK)
FRANKEN  71 PRL 26 115        P A FRANKEN, G W AMPULSKI           (MICH)
WILLIAMS 71 PRL 26 721        +FALLER,HILL                    (WESLEYAN)
HOLLWEG  74 PRL 32 961        J V HOLLWEG  (NATL CENTER FOR ATMOS RESRCH)

                         PAPERS NOT REFERRED TO IN DATA CARDS

GOLDHABE 71 RMP 43 277        A S GOLDHABER, M M NIETO   (STON+BOHR+UCSB)
KROLL    71 PRL 26 1395       N M KROLL                           (SLAC)
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ν_e

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                      1  E-NEUTRINO(0,J=1/2)

                      1  E-NEUTRINO MASS (KEV)

M          (0.25) OR LESS          LANGER    52 CNTR ANTI-NEUT.(TRITIUM)
M          (0.50) OR LESS          HAMILTON  53 CNTR ANTI-NEUT.(TRITIUM).11/73
M          (0.55)   (0.28)         FRIEDMAN  58 CNTR ANTI-NEUT.(TRITIUM)
M           4.1   OR LESS  CL=.67  BECK      68 CNTR NEUTRINO(SODIUM 22) 11/73
M   D       0.5   OR LESS  CL=.90  DARIS     69 CNTR ANTI-NEUT.(TRITIUM) 11/73
M           0.32  OR LESS  CL=.90  SALGO     69 CNTR ANTI-NEUT.(TRITIUM) 11/73
M           0.06  OR LESS  CL=.90  BERGKVIS  72 CNT  ANTI-NEUT.(TRITIUM) 11/73
M          (0.008)OR LESS          COWSIK    72 THEOR.LIM.FROM COSMOLOGY  3/74
M           0.086 OR LESS  CL=.90  RODE      72 CNTR ANTI-NEUT.(TRITIUM) 11/73
M   D  DARIS 69 VALUE .075KEV(CL=.67) DISAGREES WITH FIG.6.  WE USE FIG.6. 11/73

M   C     450.    OR LESS  CL=.90  CLARK     74 ASPK KE3 DECAY           11/75*
M   C  LOWEST LIMIT FROM STRANGENESS CHANGING DECAY.                     11/75*

                      1  (E-NEUTRINO) - (E-ANTINEUTRINO) MASS DIFF. (KEV)

DM        450.    OR LESS  CL=.90  CLARK     74 ASPK KE3 DECAY           11/75*
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                         REFERENCES FOR E-NEUTRINO

LANGER   52 PR   88  689      L M LANGER,R J D MOFFAT             (INDIANA)
HAMILTON 53 PR   92  1521     D HAMILTON,W P ALFORD,L GROSS    (PRINCETON)
FRIEDMAN 58 PR 109   2214     LEWIS FRIEDMAN,LINCOLN G SMITH         (BNL)
BECK     68 ZPHY 216 229      F BECK,H DANIEL                       (MPIH)
DARIS    69 NP A138 545       K DARIS,C ST-PIERRE           (LAVAL-QUEBEC)
SALGO    69 NP A138 417       R C SALGO,H H STAUB                 (ZURICH)
BERGKVIS 72 NP B39 317        KARL-ERIK BERGKVIST       (UNIV STOCKHOLM)
COWSIK   72 PRL 29 669        R COWSIK,J MC CLELLAND                 (UCB)
RODE     72 LNC 5 139         B RODE,H DANIEL                (MUNICH+MPIH)
CLARK    74 PR D9 533         +ELIOFF,FRISCH,JOHNSON,KERTH,SHEN+     (LBL)
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ν_μ

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                      2  MU-NEUTRINO(0,J=1/2)

                      2  MU-NEUTRINO MASS (MEV)

M           3.5   OR LESS          BARKAS     56 EMUL
M           4.0   OR LESS          DUDZIAK    59 CNTR
M           3.6   OR LESS          FEINBERG   63 RVUE                     7/66
M           3.0   OR LESS          ALLCOCK    65 RVUE                     7/66
M           2.5   OR LESS          BARDON     65 ASPK
M           2.8   OR LESS  CL=.90  SHAFER     65 CNTR                     5/71
M           1.6   OR LESS  CL=.90  BOOTH      67 CNTR                     3/68
M           2.2   OR LESS  CL=.90  HYMAN      67 HEBC     0. K- HE       11/67
M   B M    (1.2)  OR LESS  CL=.90  BACKENSTO  71 CNTR     M**2=-1.28+-1.24 10/71
M   S       1.15  OR LESS  CL=.90  SHRUM      71 CNTR     M**2=-1.55+-1.14 12/71
M         (8 EV)  OR LESS          COWSIK     72 THEOR.LIM.FROM COSMOLOGY  3/74
M   B M     1.15  OR LESS  CL=.90  BACKENSTO  73 CNTR     M**2=-0.29+-0.90  1/73
M           0.65  OR LESS  CL=.90  CLARK      74 ASPK     KMU3 DECAY        7/74*
M   D M     1.0   OR LESS  CL=.90  DAUM       76 SPEC     M**2= 0.23+-0.54  1/76*
M     M  WE CALCULATE UPPER LIMIT AT CL=.90 FROM M**2.                      1/76*
M   B    BACKENSTOSS 73 REPLACES BACKENSTOSS 71 AND USES THEIR NEW PI- MASS. 1/73
M   S    SHRUM 71 USES SHAFER 67 PI- MASS VALUE AND CRANE 71 MU MASS VALUE.  1/73
M   D    DAUM 76 USES OUR 1974 PI- AND MU MASSES.                           1/76*

                      2  (MU-NEUTRINO) - (MU-ANTINEUTRINO) MASS DIFF. (MEV)

DM         (0.45) OR LESS  CL=.90  CLARK      74 ASPK KMU3 DECAY           11/75*
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                         REFERENCES FOR MU-NEUTRINO

BARKAS   56 PR 101   778      W H BARKAS,W BIRNBAUM,F M SMITH        (LRL)
DUDZIAK  59 PR 114   336      W F DUDZIAK,R SAGANE,J VEDDER          (LRL)
FEINBERG 63 ARNS 13 431       G FEINBERG, L M LEDERMAN          (COLUMBIA)
ALLCOCK  65 PPSL  85  875     G R ALLCOCK                      (LIVERPOOL)
BARDON   65 PRL   14 449      BARDON,NORTON,PEOPLES +  (COLU+STONY BROOK)
SHAFER   65 PRL   14 923      R E SHAFER,CROWE,JENKINS               (LRL)
BOOTH    67 PL 26B  39        BOOTH,JOHNSON,WILLIAMS,WORMALD  (LIVERPOOL)
HYMAN    67 PL 25B 376        +LOKEN,PEWITT,MCKENZIE+      (ANL+CARN+NWES)
BACKENST 71 PL 36B 403        BACKENSTOSS,DANIEL,KOCH+    (CERN,KARL,HEID)
SHRUM    71 PL 37B 114        E V SHRUM,K O H ZIOCK   (UNIV OF VIRGINIA)
COWSIK   72 PRL 29 669        R COWSIK,J MC CLELLAND                 (UCB)
BACKENST 73 PL 43B 539        BACKENSTOSS,DANIEL,KOCH+ (CERN+KARL+MUNICH)
CLARK    74 PR D9 533         +ELIOFF,FRISCH,JOHNSON,KERTH,SHEN +    (LBL)
DAUM     76 PUBL. IN PL B FEB +DUBAL,EATON,FROSCH,MCCULLOCH+   (SIN,ETHZ)
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e

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                      3  ELECTRON(0.5,J=1/2)

                      3  ELECTRON MASS (MEV)

M         (.511006)(.00002)        COHEN     65 RVUE
M         (.5110041(.0000016)      TAYLOR    69 RVUE    USING NEW E/H      7/70
M          .5110034 .0000014       COHEN     73 RVUE                       3/74

                      3  ELECTRON MEAN LIFE (UNITS 10**21 YR)

T            2.0  OR MORE          MOE       65 CNTR                       6/66
T   S        5.3  OR MORE          STEINBERG 75 CNTR                       2/76*
T   S   STEINBERG 75 SENSITIVE TO ALL DECAY MODES IN WHICH DECAY PARTICLES 2/76*
T   S   ESCAPE FROM DETECTOR WITHOUT DEPOSITING ENERGY. TEST OF CHARGE     2/76*
T   S   CONSERVATION.                                                      2/76*

                      3  ELECTRON MAGNETIC MOMENT(E/2ME)

MM      SEE RICH 72 FOR A REVIEW OF THEORY AND EXPERIMENTS.                3/74
MM        (1.0011609)    +-(24)*10**-7 SCHUPP    61 CNTR -
MM        (1.001159622)  +-(27)*10**-9 WILKINSON 63 CNTR -                 8/66
MM        (1.001168)     +-(22)*10**-6 RICH      66 CNTR +  POSITRON       8/66
MM R      (1.001159557)  +-(30)*10**-9 RICH      68 CNTR -                 6/68
MM        (1.0011596389)+-(31)*10**-10TAYLOR     69 RVUE                 . 2/71
MM        (1.001159644)  +-(7)* 10**-9 WESLEY    70 CNTR                   6/70
MM        (1.0011596577)+-(35)*10**-10WESLEY     71 CNTR -                 2/72
MM        (1.0011603)    +-(12)*10**-7 GILLELAND 72 CNTR +                 2/72
MM         1.0011596567 +-(35)*10**-10COHEN      73 RVUE                   3/74
MM R    RICH 68 IS REEVALUATION OF WILKINSON 63.
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                         REFERENCES FOR ELECTRON

SCHUPP   61 PR  121   1       A A SCHUPP,R W PIDD,H R CRANE          (MICH)
WILKINSO 63 PR 130 852        D T WILKINSON,H R CRANE                (MICH)
COHEN    65 RMP 37 537        COHEN,DUMOND  (N.A.AVIATION SCI.CENTER+CIT)
MOE      65 PR 140 B 992      M K MOE,F REINES     (CASE INST TECHNOLOGY)
RICH     66 PRL   17  271     A RICH, H R CRANE                      (MICH)
RICH     68 PRL 20 967        A RICH                                 (MICH)
TAYLOR   69 RMP 41 375        +PARKER,LANGENBERG             (PRIN+UCI+PENN)
WESLEY   70 PRL 24 1320       J C WESLEY,A.RICH                      (MICH)
WESLEY   71 PR A4 1341        J C WESLEY,A RICH                      (MICH)
GILLELAN 72 PR A5 38          J GILLELAND,A RICH                     (MICH)
RICH     72 RMP 44 250        A RICH,J C WESLEY                      (MICH)
COHEN    73 J.PHYS.CHEM.REF.DATA 2, P.663, E.R.COHEN,B.N.TAYLOR
STEINBER 75 PR D12 2582       STEINBERG,KWIATKOWSKI,MAENHAUT,WALL    (UMD)
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μ

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                      4  MUON(106,J=1/2)

                      4  MUON MASS (MEV)

M         (105.659)  (0.002)        FEINBERG  63 RVUE
M         (105.6599) (0.0014)       TAYLOR    69 RVUE    USING NEW E/H      7/70
M    C    (105.6597) (0.0005)       CRANE     71 CNTR INCLUDED IN COHEN73   1/73
M    D    (105.6594) (0.0004)       CROWE     72 CNTR INCLUDED IN COHEN73   2/72
M          105.65948  0.00035       COHEN     73 RVUE                       3/74
M    C  CRANE 71 GIVES MU/ME=206.76878(85).  WE USE ME=.5110041(16)MEV.     1/73
M    D  CROWE 72 GIVES MU/ME=206.7682(5) AND USES ME=.5110041(16)MEV.       1/73
M           . . . . . . . . .
M   FIT    105.65948  0.00035 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*

                      4  MUON MEAN LIFE (UNITS 10**-6)

T            2.198    0.001      0.001 FARLEY    62 CNTR
T            2.203    0.004            LUNDY     62 CNTR   CONLEV=.98      11/67
T            2.202    0.003      0.003 ECKHAUSE  63 CNTR
T            2.197    0.005      0.002 MEYER     63 CNTR +
T            2.198    0.002      0.002 MEYER     63 CNTR -                  7/66
T   W      (2.20026)(0.00081)          WILLIAMS  72 CNTR +                  2/76*
T            2.1973   0.0003           DUCLOS    73 CNTR +                  1/76*
T            2.19711  0.00008          BALANDIN  74 CNTR +                  1/76*
T   W   WILLIAMS 72 MEAN LIFE MEASUREMENT WAS NOT THE PRIMARY PURPOSE OF    1/76*
T   W   THEIR EXPERIMENT AND DISAGREES STRONGLY WITH LATER EXPTS. NOT AVGD. 1/76*
T             . . . . . . . . .
T   AVG      2.197134 0.000077 0.000077 AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)
T   STUDENT 2.197133 0.000084 0.000084 AVG. USING STUDENT10(H/1.11) -- SEE TEXT

                      4  MU+/MU- MEAN LIFE RATIO

DT             1.000     0.001          MEYER     63 CNTR  MEAN LIFE MU+/MU-   7/66

                      4  MUON ANOMALOUS MAGN. MOMENT (10**-6*E/(2*MU MASS))

MM       SEE RICH 72 FOR A REVIEW OF THEORY AND EXPERIMENTS.                3/74
MM         (1162.0)      (5.0)          CHARPAK   62 CNTR +
MM   B     (1165.75)     (0.71)         BAILEY    68 CNTR +  STOR. RINGS     5/69
MM   B     (1166.25)     (0.24)         BAILEY    68 CNTR  - STOR. RINGS     5/69
MM   B      ERRORS STATISTICAL. VALUES COMBINED TO GIVE MU+- VALUE BELOW     5/69
MM          1166.16       0.31          BAILEY    68 CNTR +- STOR. RINGS     5/69
MM          1165.895      0.027         BAILEY    75 CNTR +  STORAGE RING   11/75*
MM          . . . . . . . . . .
MM   AVG    1165.897      0.027    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
MM   STUDENT1165.897      0.029    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

μ

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                    4   MUON TO PROTON MAGNETIC MOMENT RATIO

MMR      THIS RATIO IS USED TO OBTAIN PRECISE VALUES OF THE MUON MASS.          3/72
MMR      SEE CROWE 72.                                                          3/72
MMR        (3.1865)  (.0022)          COFFIN    58 CNTR +  SPIN RESONANCE       2/72
MMR        (3.1830)  (.0011)          LUNDY     58 CNTR +  PRECESSION STROB     2/72
MMR        (3.176)   (.013)           LUNDY     58 CNTR -  PRECESSION STROB     2/72
MMR        (3.1834)  (.0002)          GARWIN    60 CNTR +  PRECESSION PHASE     2/72
MMR        (3.18336) (.00007)         BINGHAM   63 CNTR +  PRECESSION STROB     2/72
MMR        (3.1808)  (.0004)          BINGHAM   63 CNTR -  PRECESSION STROB     2/72
MMR        (3.18338) (.00004)         HUTCHINS  63 CNTR +  PRECESSION PHASE     2/72
MMR D      (3.183351)(.000016)        EHRLICH   69 CNTR    HFS SPLITTING        2/72
MMR C      (3.183314)(.000034)        THOMPSON  69 CNTR    HFS SPLITTING        2/72
MMR        (3.183330)(.000044)        HUTCHINS  70 CNTR +  PRECESSION PHASE     2/72
MMR H      (3.183347)(.000009)        HAGUE     70 CNTR +  PRECESSION PHASE     2/72
MMR  C     (3.183336)(.000013)        CRANE     71 CNTR    HFS SPLITTING        2/72
MMR  D     (3.183349)(.000015)        DEVOE     71 CNTR    HFS SPLITTING        1/73
MMR F      (3.183326)(.000013)        FAVART    71 CNTR    HFS SPLITTING        2/72
MMR  H     (3.1833467(.0000082)       CROWE     72 CNTR +  PRECESSION PHASE     2/72
MMR  R   THE RESULTS THROUGH 1972 ARE INCLUDED IN COHEN 73.                     3/74
MMR  R      3.1833402 .0000072        COHEN     73 RVUE                         3/74
MMR         3.1833299 .0000025        CASPERSON 75 CNTR                         2/76*
MMR C    CRANE 71 SUPERSEDES THOMPSON 69. THIS IS NOT A DIRECT MEASUREMENT.     1/73
MMR H    CROWE 72 SUPERSEDES HAGUE 70.
MMR F    FAVART 71 ASSUMES A ZERO VALUE FOR THE PROTON POLARIZABILITY.          1/73
MMR  D   DEVOE 71 SUPERCEDES EHRLICH 69.  THIS IS NOT A DIRECT MEASUREMENT.     1/73
MMR  D   WE GIVE A NEW VALUE WHICH CONTAINS A THEORETICAL CORRECTION OF         1/73
MMR  D   -7.8+-2.3 PPM, AS DISCUSSED IN FOOTNOTE 35A OF CROWE 72.               1/73
MMR          . . . . . . . . . .
MMR AVG     3.18333100.0000032  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
MMR STUDENT3.18333090.0000026  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    4   MUON PARTIAL DECAY MODES

                                                                DECAY MASSES
P1       MUON INTO E ANTI(E-NEU) (MU-NEU)                       .5+   0+   0
P2       MUON INTO E 2GAMMA                                     .5+   0+   0
P3       MUON INTO 3ELECTRONS                                   .5+  .5+  .5
P4       MUON INTO E GAMMA                                      .5+   0
P5       MUON INTO E (E-NEU) ANTI(MU-NEU)                       .5+   0+   0

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                    4   MUON BRANCHING RATIOS

R1       MUON INTO E+2GAMMA (IN UNITS OF 10**-5)             (P2)/(P1)
R1            1.6    OR LESS  CL=.90   FRANKEL1  63 OSPK +
R1 P          0.4    OR LESS  CL=.90   POUTISSOU 74 CNTR +                     12/75*
R1 P      POUTISSOU 74 LIMIT APPLIES TO SUM OF ALL NEUTRINOLESS MU+ DECAYS.     1/76*

R2       MUON INTO 3E (IN UNITS OF 10**-7)                   (P3)/(P1)
R2 F          5.0    OR LESS  CL=.90   PARKER    62 CNTR
R2 F          1.3    OR LESS  CL=.90   ALIKHANOV 62 OSPK
R2 F          1.5    OR LESS  CL=.90   FRANKEL2  63 CNTR
R2 F          1.2    OR LESS  CL=.90   BABAEV    63 OSPK
R2 K          0.062 OR LESS  CL=.90    KORENCH2  71 OSPK                         2/72
R2 K      KORENCHENKO2 71 ASSUMES A CONSTANT MATRIX ELEMENT.                     2/72
R2 F      FOUR ABOVE EXPERIMENTS EVALUATED UPPER LIMITS ASSUMING A SECOND
R2        ORDER V-A NEUTRINO LOOP DIAGRAM. LIMITS NOT SIGNIFICANTLY CHANGED BY
R2        ASSUMING A CONSTANT MATRIX ELEMENT.

R3       MUON INTO E+GAMMA (IN UNITS OF 10**-8)              (P4)/(P1)
R3            4.3    OR LESS  CL=.90   FRANKEL1  63 OSPK
R3            2.2    OR LESS  CL=.90   PARKER    64 OSPK
R3            2.9    OR LESS  CL=.90   KORENCH1  71 OSPK +                      10/71

R4       MUON+ INTO (E+ (E-ANTINEU) (MU-NEU))                (P5)/(P1)
R4        FORBIDDEN BY ADDITIVE CONSERVATIVATION LAW FOR MUON NUMBER.
R4        MULTIPLICATIVE LAW PREDICTS R4=0.5
R4            0.25   OR LESS  CL=.90   EICHTEN   73 HLBC +                      11/75*

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                    4   MUON DECAY PARAMETERS

         RELATED TEXT SECTION VI A

RHO      RHO PARAMETER                 (V-A THEORY PREDICTS RHO=0.75)
RHO C         (0.741)  (0.027)         DUDZIAK    59 CNTR +  20-53 MEV E+      10/69
RHO  P9213     0.745    0.025          PLANO      60 HBC  +  WHOLE SPECTRUM    10/69
RHO  P   TWO PARAMETER FIT TO RHO AND ETA.
RHO C 2276    (0.751)  (0.034)         BLOCK      62 HEBC  - WHOLE SPECTRUM    10/69
RHO D         (0.64)   (0.04)          BARLOW     64 CNTR  - WHOLE SPECTRUM    10/69
RHO D         (0.661)  (0.016)         BARLOW     64 CNTR +  WHOLE SPECTRUM    10/69
RHO D         (0.867)  (0.035)         PONTECORV 64 CC     -                   10/69
RHO D    RESULTS IN DOUBT.                                                      10/69
RHO C 800K    (0.7503) (0.0026)        PEOPLES    66 ASPK +  20-53 MEV E+      10/69
RHO C 280K    (0.760)  (0.009)         SHERWOOD   67 ASPK +  25-53 MEV E+      10/69
RHO C 170K    (0.762)  (0.008)         FRYBERGER 68 ASPK +   25-53 MEV E+      10/69
RHO C    ETA CONSTRAINED =0. THESE VALUES INCORPORATED INTO A TWO PARAMETER
RHO C    FIT TO RHO AND ETA BY DERENZO 69.
RHO            0.7518   0.0026         DERENZO    69 RVUE                      10/69
RHO        . . . . . . . . . .
RHO AVG        0.7517   0.0026   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
RHO STUDENT    0.7517   0.0028   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

ETA      ETA PARAMETER                 (V-A THEORY PREDICTS ETA=0)
ETA P 9213  (-2.0)     (0.9)           PLANO      60 HBC  +  WHOLE SPECTRUM    10/69
ETA P    TWO PARAMETER FIT TO RHO AND ETA- PLANO 60 DISCOUNTS VALUE FOR ETA    10/69
ETA C 800K   (0.05)    (0.5)           PEOPLES    66 ASPK +  20-53 MEV E+      10/69
ETA C 280K  (-0.7)     (0.6)           SHERWOOD   67 ASPK +  25-53 MEV E+      10/69
ETA C 170K  (-0.7)     (0.5)           FRYBERGER 68 ASPK +   25-53 MEV E+      10/69
ETA C    RHO CONSTRAINED =0.75.
ETA   6346   -0.12      0.21           DERENZO    69 HBC  +  1.6-6.8 MEV E+    10/69

XSI      XSI PARAMETER                 (V-A THEORY PREDICTS XSI=1)
XSI     9K     0.97     0.05           BARDON     59 CNTR    BROMOFORM TARGET 10/69
XSI   8354     0.93     0.06           PLANO      60 HBC  +  8.8 KGAUSS        10/69
XSI A         (0.903)  (0.027)         ALI-ZADE   61 EMUL +  27 KGAUSS         10/69
XSI A    DEPOLARIZATION BY MEDIUM NOT KNOWN SUFFICIENTLY WELL.
XSI G  66K    (0.975)  (0.030)         GUREVICH   64 EMUL    140 KGAUSS        10/69
XSI            0.975    0.014          GUREVICH   67 EMUL                      10/69
XSI G    GUREVICH 67 SUPERSEDES GUREVICH 64                                    10/69
XSI        . . . . . . . . . .
XSI AVG        0.972    0.013    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
XSI STUDENT    0.973    0.014    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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DEL      DELTA PARAMETER                 (V-A THEORY PREDICTS DELTA=0.75)
DEL  8354      0.78     0.05             PLANO      60 HBC  +  WHOLE SPECTRUM    10/69
DEL            0.782    0.031            KRUGER     61                           10/69
DEL   490K     0.752    0.009            FRYBERGER 68 ASPK +   25-53 MEV E+      10/69
DEL      VOSSLER 69 HAS MEASURED THE ASYMMETRY BELOW 10 MEV                      11/69
DEL        . . . . . . . . . .
DEL AVG        0.7551   0.0085   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
DEL STUDENT    0.7550   0.0094   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

HEL      HELICITY OF DECAY ELECTRON.
HEL       (V-A THEORY PREDICTS HELICITY=+-1 FOR E+-, RESPECTIVELY)
HEL       WE HAVE FLIPPED THE SIGN FOR E- SO OUR PROGRAMS CAN AVERAGE
HEL D         (0.28)   (0.16)            DICK       63 CNTR +  ANNIHILATION      10/69
HEL D    IN DOUBT- POSITRONS POSSIBLY DEPOLARIZED IN BE MODERATOR.
HEL            1.05     0.30             BUHLER     63 CNTR +  ANNIHILATION      10/69
HEL            0.94     0.38             BLOOM      64 CNTR +  BREMS TRANSMISS   10/69
HEL            1.04     0.18             DUCLOS     64 CNTR +  BHABHA SCATT      10/69
HEL    29K     0.89     0.28             SCHWARTZ   67 OSPK  - MOLLER SCATT      10/69
HEL        . . . . . . . . . .
HEL AVG        1.00     0.13     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
HEL STUDENT    1.00     0.14     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

GS       SCALAR COUPLING CONSTANT IN MUON DECAY  (IN UNITS OF GV)
GS             0.33  OR LESS             DERENZO    69 RVUE                      10/69

GA       AXIAL VECTOR COUPLING CONSTANT IN MUON DECAY (IN UNITS OF GV)
GA             0.86     0.33     0.11    DERENZO    69 RVUE                      10/69

FAV      PHASE BETWEEN VECTOR AND AXIAL VECTOR COUPLINGS  (DEGREES)
FAV          180.      15.               DERENZO    69 RVUE                      10/69

GT       TENSOR COUPLING CONSTANT IN MUON DECAY    (IN UNITS OF GV)
GT             0.28  OR LESS             DERENZO    69 RVUE                      10/69

GP       PSEUDOSCALAR COUPLING CONSTANT IN MUON DECAY  (IN UNITS OF GV)
GP             0.33  OR LESS             DERENZO    69 RVUE                      10/69

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REFERENCES FOR MUON


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COFFIN    58 PR 109 973           +GARWIN,PENMAN,LEDERMAN,SACHS     (COLUMBIA)
LUNDY     58 PRL 1 38             +SENS,SWANSON,TELEGDI,YOVANOVITCH (CHICAGO)
BARDON    59 PRL   2   56         M BARDON, D BERLEY, L LEDERMAN   (COLUMBIA)
DUDZIAK   59 PR   114  336        W DUDZIAK,R SAGANE, J VEDDER          (LRL)
GARWIN    60 PR 118 271           GARWIN,HUTCHINSON,PENMAN,SHAPIRO (COLUMBIA)
PLANO     60 PR  119 1400         R J PLANO                        (COLUMBIA)
ALI-ZADE 61 JETP  13  313         ALI-ZADE,GUREVICH,NIKOLSKI           (USSR)
KRUGER    61 UCRL-9322 (UNPUB) H KRUGER                                 (LRL)

ALIKHANO 62 CERN CONF 423         A I ALIKHANOV,A BABAEV +     (ITEP MOSCOW)
BLOCK     62 NC    23  1114       BLOCK,FIORINI,KIKUCHI+(DUKE,BOLOGNA,MILANO)
CHARPAK   62 PL     1  16         G CHARPAK,F J M FARLEY,R L GARWIN +  (CERN)
FARLEY    62 CERN CONF 415        FARLEY,MASSAM,MULLER,ZICHICHI        (CERN)
LUNDY     62 PR 125 1686          RICHARD A LUNDY .                     (EFI)
PARKER    62 NC   23  485         S PARKER,S PENMAN                     (EFI)

BABAEV    63 JETP 16 1397         BABAEV,BALATS,KAFTANOV,LANDSBERG +   (ITEP)
BINGHAM   63 NC 27 1352           G.MCD.BINGHAM                         (LRL)
BUHLER    63 PL    7  368         +CABIBBO,FIDECARO,MASSAM,MULLER+     (CERN)
DICK      63 PL    7  150         DICK,FEUVRAIS,SPIGHEL                (CERN)
ECKHAUSE 63 PR 132  422           M ECKHAUSE,T A FILIPPAS +        (CARNEGIE)
FEINBERG 63 ARNS 13 431           GERALD FEINBERG, L M LEDERMAN    (COLUMBIA)
FRANKEL1 63 NC   27  894          S FRANKEL,W FRATI,J HALPERN +        (PENN)
FRANKEL2 63 PR 130  351           S FRANKEL,W FRATI,J HALPERN +        (PENN)
HUTCHINS 63 PR 131 1351           HUTCHINSON,MENES,PATLACH,SHAPIRO (COLUMBIA)
MEYER     63 PR  132  2693        S L MEYER,ANDERSON,BLESER,LEDERMAN+  (COLU)

BARLOW    64 PPS   84  239        +BOOTH,CARROL,COURT,DAVIES,EDWARDS+  (LIVP)
BLOOM     64 PL    8   87         +DICK,FEUVRAIS,HENRY,MACQ,SPIGHEL    (CERN)
DUCLOS    64 PL    9   62         +HEINTZE,DE RUJULA,SOERGEL           (CERN)
GUREVICH 64 PL    11  185         GUREVICH,MAKARIYNA+     (KURCHATOV,MOSCOW)
PONTECOR 64 DUBNA CONF            PONTECORVO,SULYAEV                 (MOSCOW)
PARKER    64 PR 133B 768          S PARKER,H L ANDERSON,C REY           (EFI)

PEOPLES   66 NEVIS-147 (UNPUB) J PEOPLES                           (COLUMBIA)
GUREVICH 67  IAE 1297             GUREVICH,MAKARIYNA,MISHAKOVA+   (KURCHATOV)
SCHWARTZ 67 PR   162 1306         D M SCHWARTZ                          (EFI)
SHERWOOD 67 PR   156 1475         B A SHERWOOD                          (EFI)
BAILEY    68 PL    28B  287       +BARTL,VON BOCHMANN,BROWN,FARLEY+    (CERN)
    ALSO 72 NC 9A 369             +BARTL,VON BOCHMANN,BROWN,FARLEY+    (CERN)
FRYBERGE 68 PR   166 1379         D FRYBERGER                           (EFI)

DERENZO   69 PR   181 1854        S DERENZO                             (EFI)
EHRLICH   69 PRL 23 513           +HOFER,MAGNON,STOWELL,SWANSON+    (CHICAGO)
TAYLOR    69 RMP 41 375           +PARKER,LANGENBERG          (PRIN+UCI+PENN)
THOMPSON 69 PRL 22 163            +AMATO,CRANE,HUGHES,MOBLEY+          (YALE)
HAGUE     70 PRL 25 628           +ROTHBERG,SCHENCK,WILLIAMS+      (WASH+LRL)
HUTCHINS 70 PRL 24 1254           HUTCHINSON,LARSON,SCHOEN,SOBER,+      (PPA)

CRANE     71 PRL 27 474           +CASPERSON,CRANE,EGAN,HUGHES+        (YALE)
DEVOE     71 PRL 25 1779(ER)      +MCINTGRE,MAGNON,STOWELL,SWANSON+ (CHICAGO)
    ALSO 71 PRL 26 213            DEVOE,MCINTGRE,MAGNON,STOWELL+    (CHICAGO)
FAVART    71 PRL 27 1336          +MCINTYRE,STOWELL,TELEGDI,DEVOE+  (CHICAGO)
KORENCH1 71 SJNP 13 190           KORENCHENKO,KOSTIN,MICELMACHER+      (JINR)
KORENCH2 71 SJNP 13 728           KORENCHENKO,KOSTIN,MICELMACHER+      (JINR)

CROWE     72 PR D5 2145           +HAGUE,ROTHBERG,SCHENCK+         (LBL+WASH)
WILLIAMS 72 PR D6 737             R W WILLIAMS,D L WILLIAMS      (WASHINGTON)
COHEN     73 J.PHYS.CHEM.REF.DATA 2, P.663, E.R.COHEN,B.N.TAYLOR
DUCLOS    73 PL 47B 491           +MAGNON,PICARD                       (SACL)
EICHTEN   73 PL 46B 281           +DEDEN+(AACH+BELG+CERN+EPOL+MILA+LALO+LOUC)
BALANDIN 74 JETP 40 811           +GREBENYUK,ZINOV,KONIN,PONOMAREV     (JINR)
POUTISSO 74 NP B80 221            POUTISSOU,FELAWKA,INGRAM +       (MONL+UBC)
BAILEY    75 PL 55B 420           +BORER+(CERN+DARE+BERN+SHEF+MANZ+RMCS+BIRM)
CASPERSO 75 PL 59B 397            D.E.CASPERSON ET AL.

                                  PAPERS NOT REFERRED TO IN DATA CARDS

FISHER    59 PRL  3  349          FISHER,LEONTIC,LUNDBY,MEUNIER,STROOT (CERN)
ASTBURY   60 ROCH CONF 60 542     ASTBURY,HATTERSLEY,HUSSAIN +    (LIVERPOOL)
DEVONS    60 PRL  5  330          DEVONS,GIDAL,LEDERMAN,SHAPIRO    (COLUMBIA)
LATHROP   60 NC   17 109          J LATHROP,R A LUNDY,V L TELEGDI +     (EFI)
LATHROP   60 NC   17 114          J LATHROP,R A LUNDY,S PENMAN +        (EFI)
REITER    60 PRL   5  22          REITER,ROMANOWSKI,SUTTON +       (CARNEGIE)
TELEGDI   60 ROCH CONF 60 713     V L TELEGDI                          (CERN)
CHARPAK   61 PRL   6 128          CHARPAK,FARLEY,GARWIN,MULLER,SENS +  (CERN)
HUTCHINS 61 PRL    7 129          D P HUTCHINSON,J MENES +         (COLUMBIA)
SHAPIRO   62 PR 125 1022          G SHAPIRO,L M LEDERMAN           (COLUMBIA)
FAIRLEY   66 NC 45A 281           FAIRLEY,BAILEY,BROWN,GIESCH +        (CERN)
VOSSLER   69 NC 63A 423           C VOSSLER                             (EFI)
RICH      72 RMP 44 250           A RICH,J C WESLEY                    (MICH)

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Stable Particles

$\pi^{\pm}$, π^0

Data Card Listings

For notation, see key at front of Listings.

$\pi^{\pm}$

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                        8  CHARGED PION(140,JPG=0--) I=1
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                        8  CHARGED PION MASS (MEV)

M            139.37     0.20            CROWE      54 CNTR  -
M            139.68     0.15            BARKAS     56 EMUL  +
M    S      (139.577)  (0.013)          SHAFER     67 CNTR  - MESONIC ATOMS     6/68
M    B      (139.549)  (0.008)          BACKENSTO  71 CNTR  - MESONIC ATOMS    10/71
M    S       139.566    0.013           SHAFER     72 CNTR  - MESONIC ATOMS     1/73
M    B       139.569    0.008           BACKENSTO  73 CNTR  - MESONIC ATOMS     1/73
M    S   SHAFER 72 UPDATES SHAFER67 WITH NEW ALPHA AND NEW CALIB. LINE ENER.    1/73
M    B   BACKENSTOSS 73 CORRECTS BACKENSTOSS 71 WITH NEW VACUUM POL. CALC.      1/73
M           . . . . . . . . .
M    AVG     139.5682   0.0068  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M    STUDENT 139.5682   0.0073  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
M    FIT     139.5688   0.0064 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)   2/76*
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                        8  (PI+) - (MU+) MASS DIFFERENCE (MEV)

D             34.00     0.076           BARKAS     56 EMUL
D             33.89     0.076           BARKAS     56 EMUL
D      145    33.881    0.035           HYMAN      67 HEBC  + K-HE              2/71
D             33.925    0.025           BOOTH      70 CNTR  + MAGNETIC SPECT.   2/71
D           . . . . . . . . .
D    AVG      33.915    0.019   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D    STUDENT  33.915    0.021   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
D    FIT      33.9093   0.0064 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)   2/76*
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                        8  ((PI+) - (PI-))/AVG., MASS DIFFERENCE (PERCENT)

DM             0.02     0.05            AYRES      71 CNTR                      3/71
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                        8  CHARGED PION MEAN LIFE (UNITS 10**-9)

T             25.6      0.5      0.5    CROWE      57 RVUE
T             25.6      0.8      0.8    ANDERSON   60 CNTR
T      8000   25.46     0.32     0.32   ASHKIN     60 CNTR +
T             26.02     0.04            ECKHAUSE   65 CNTR +                    9/66
T             25.6      0.3             BARDON     66 CNTR                      6/66
T             25.9      0.3             DUNAITSEV  66 CNTR                      6/68
T    N       (26.40)   (0.08)           KINSEY     66 CNTR +                    6/66
T    N   SYSTEMATIC ERRORS IN CALIBR.IN THIS EXP.DISCUSSED BY NORDBERG 67       8/67
T             26.67     0.24            LOBKOWICZ  66 CNTR                      9/66
T             26.04     0.05            NORDBERG   67 CNTR +                    8/67
T             26.02     0.04            AYRES      71 CNTR +-                   3/71
T             26.09     0.08            DUNAITSEV  73 CNTR +                    3/74
T           . . . . . . . . .
T    AVG      26.030    0.023    0.023  AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)
T    STUDENT  26.028    0.025    0.025  AVG. USING STUDENT10(H/1.11) -- SEE TEXT
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                        8  ((PI+) - (PI-))/AVG., MEAN LIFE DIFF. (PERCENT)

DT   N   THIS QUANTITY IS A MEASURE OF CPT INVARIANCE IN W.I.

DT             0.23     0.40            LOBKOWICZ 66 CNTR      SEE NOTE L       9/66
DT   L   ABOVE IS THE MOST CONSERVATIVE VALUE QUOTED BY AUTHORS                 9/66
DT             0.4      0.7             BARDON     66 CNTR                      7/66
DT            -0.14     0.29            PETRUKHIN  68 CNTR                      8/68
DT             0.055    0.071           AYRES      71 CNTR                      3/71
DT          . . . . . . . . .
DT   AVG       0.053    0.068   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
DT   STUDENT   0.053    0.073   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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                        8  CHARGED PION PARTIAL DECAY MODES

                                                             DECAY MASSES
P1      CHAR. PION INTO MU (MU-NEU)                         105+   0
P2      CHAR. PION INTO E ( E-NEU)                           .5+   0
P3      CHAR. PION INTO MU (MU-NEU) GAMMA                   105+   0+    0
P4      CHAR. PION INTO PIO E (E-NEU)                       134+  .5+    0
P5      CHAR. PION INTO E NEU GAMMA                          .5+   0+    0
P6      CHAR. PION INTO E NEU E+ E-                          .5+   0+   .5+  .5
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                        8  CHARGED PION BRANCHING RATIOS

R1      CHAR. PION INTO MU NEU GAMMA (UNITS 10**-4)        (P3)/(P1)
R1       26      1.24       0.25           CASTAGNOL 58 EMUL     E(MU).LT.3.38 MV

R2      CHAR. PION INTO E NEU (UNITS 10**-4)               (P2)/(P1)
R2               1.21       0.07           ANDERSON   60 CNTR
R2   D          (1.247)    (0.028)         DI CAPUA   64 CNTR                  11/75*
R2 D             1.274      0.024          BRYMAN     75 RVUE                   9/75*
R2 D    BRYMAN 75 IS A RECALC. OF DICAPUA 64 EXPT USING LATEST PI LIFETIME.    9/75*
R2             . . . . . . . . .
R2   AVG         1.267      0.023   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2   STUDENT     1.268      0.025   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R3      CHAR. PION INTO PIO E NEU (UNITS 10**-8)           (P4)/(P1)
R3   D   52     (1.15)     (.22)          DEPOMMI1   63 CNTR +                  2/72
R3   D  36       0.97       0.20          BARTLETT   64 OSPK +
R3   D  38       1.07       0.21          BACASTOW   65 OSPK +
R3   D           1.10       0.26          BERTRAM    65 OSPK +                  6/66
R3   D  43       1.1        0.2           DUNAITSEV  65 CNTR +                  7/66
R3      332      1.00       0.08    0.10  DEPOMMIER  68 CNTR +                  3/68
R3             . . . . . . . . .
R3   AVG         1.023      0.069   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3   STUDENT     1.023      0.074   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
     D   DEPOMMIER 68 STATES THAT THE RESULT OF DEPOMMIER 63 IS AT LEAST        2/72
     D   10 PERCENT TOO LARGE BECAUSE OF A SYSTEMATIC ERROR IN THE PIO          2/72
     D   DETECTION EFFICIENCY.  THIS MAY BE TRUE OF ALL THE PREVIOUS            2/72
     D   MEASUREMENTS ACCORDING TO DEPOMMIER 68 AND V.SOERGEL, PRIVATE          2/72
     D   COMMUNICATION, 1972.

R4      CHAR. PION INTO E NEU GAMMA (UNITS 10**-8)         (P5)/(P1)
R4      143      3.0        0.5           DEPOMMI2   63 CNTR     GAM KE 50-90 MEV  6/66

R5      CHAR. PION INTO E NEU E+ E- (UNITS 10**-8)         (P6)/(P1)
R5               3.4     OR LESS  CL=.90  KORENCHEN 71 OSPK +                  10/71
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                         REFERENCES FOR CHARGED PION

CROWE     54 PR  96  470      K M CROWE,R H PHILLIPS                         (LRL)
BARKAS    56 PR 101  778      W H BARKAS,W BIRNBAUM,F M SMITH                (LRL)
CROWE     57 NC   5  541      K M CROWE                          (STANFORD HEPL)
CASTAGNO  58 PR 112 1779      C CASTAGNOLI,M MUCHNIK                        (ROMA)

ANDERSON  60 PR 119 2050      H L ANDERSON,T FUJII,R H MILLER +             (EFI)
ASHKIN    60 NC  16  490      ASHKIN,FAZZINI,FIDECARO,LIPMAN +             (CERN)
DEPOMMI1  63 PL   5 61        DEPOMMIER,HEINTZE,RUBBIA,SOERGEL             (CERN)
DEPOMMI2  63 PL   7 285       P DEPOMMIER,HEINTZE,RUBBIA,SOERGEL           (CERN)
BARTLETT  64 PR 136B 1452     BARTLETT,DEVONS,MEYER,ROSEN              (COLUMBIA)
DI CAPUA  64 PR 133B 1333     DI CAPUA,GARLAND,PONDROM,STRELZOFF           (COLU)

BACASTOW  65 PR 139 B407      +GHESQUIERE,WIEGAND,LARSEN             (LRL+SLAC)
BERTRAM   65 PR 139 B 617     BERTRAM,MEYER,CARRIGAN+           (MICH+CARNEGIE)
DUNAITSE  65 JETP 20 58       DUNAITSEV,PETRUKHIN,PROKOSHKIN +          (DUBNA)
ECKHAUSE  65 PL 19 348        ECKHAUSE,HARRIS,SHULER+        (WILLIAM AND MARY)

BARDON    66 PRL 16 775       BARDON,DORE,DORFAN,KRIEGER +          (COLUMBIA)
DUNAITSE  66 PL 23 283        +KUTYIN,PROKOSHKIN,RASUVAEV,SIMONOV   (DUBNA)
KINSEY    66 PR 144     1132  KINSEY,LOBKOWICZ,NORDBERG    (ROCHESTER UNIV)
LOBKOWIC  66 PRL  17   548    LOBKOWICZ,MELISSINOS,NAGASHIMA+       (ROCH+BNL)

HYMAN     67 PL 25B 376       +LOKEN,PEWITT,DERRICK +           (ANL+CARN+NWES)
NORDBERG  67 PL 24B  594      NORDBERG,LOBKOWICZ,BURMAN    (ROCHESTER UNIV)
SHAFER    67 PR 163 1451      ROBERT E. SHAFER                              (LRL)
   ALSO   65 PRL 14 923       SHAFER,CROWE,JENKINS                          (LRL)

DEPOMMIE  68 NP 84 189        DEPOMMIER,DUCLOS,HEINTZE,KLEINKNECHT+(CERN)
PETRUKHI  68 JINR-P1-3862     PETRUKHIN,RYKALIN,KHAZINS,CISEK         (DUBNA)
BOOTH     70 PL 32B 723       +JOHNSON,WILLIAMS,WORMALD                    (LIVP)
AYRES     71 PR 3D 1051       +CORMACK,GREENBERG,KENNEY +            (LRL,UCSB)
   ALSO   67 PR  157  1288    AYRES,CALDWELL,GREENBERG,KENNEY,KURZ+  (LRL)
   ALSO   68 PRL 21 261       AYRES,CORMACK,GREENBERG,KENNEY+        (LRL,UCSB)
   ALSO   69 UCRL-18369       DAVID S AYRES (THESIS)                        (LRL)
   ALSO   69 PRL 23 1267      GREENBERG,AYRES,CORMACK,KENNEY+        (LRL,UCSB)

BACKENST  71 PL 36B 403       BACKENSTOSS,DANIEL,KOCH+      (CERN,KARL,HEID)
   ALSO   70 THESIS           C. VON DER MALSBURG                  (HEIDELBERG)
KORENCHE  71 SJNP 13 189      KORENCHENKO,KOSTIN,MICELMACHER+            (JINR)
SHAFER    72 PRIVATE COMM.    R. SHAFER, 1972                            (FNAL)
BACKENST  73 PL 43B 539       BACKENSTOSS,DANIEL,KOCH+ (CERN+KARL+MUNICH)
   ALSO   73 SUBMITTED TO NP  L. TAUSCHER
DUNAITSE  73 SJNP 16 292      DUNAITSEV,PROKOSHKIN,RAZUVAEV+             (SERP)
BRYMAN    75 PR D11 1337      +PICCIOTTO                     (UNIV OF VICTORIA)

                         PAPERS NOT REFERRED TO IN DATA CARDS

MERRISON  62 ADVP 11 1        A W MERRISON                          (LIVERPOOL)
SHAPIRO   62 PR 125 1022      G SHAPIRO,L M LEDERMAN                 (COLUMBIA)
CZIRR     63 PR 130  341      JOHN B CZIRR                                (LRL)

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                        9  NEUTRAL PION(135,JPG=0--) I=1
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                        9  (PI+-) - (PIO) MASS DIFFERENCE (MEV)

D           (5.37)     (1.0)            PANOFSKY   51 CNTR  -
D            4.50       0.31            CHINOWSKY  54 CNTR  -
D            4.62       0.05            HADDOCK    59 CNTR  -
D            4.60       0.04            HILLMAN    59 CNTR
D            4.55       0.07            CASSELS    59 CNTR
D            4.69       0.07            SAMIOS     60 HBC                        2/72
D            4.6056     0.0055          CZIRR      63 CNTR
D            4.59       0.03            PETRUKHIN  63 CNTR  -
D            4.6034     0.0052          VASILEVSK  66 CNTR  -                    9/66
D          . . . . . . . . .
D    AVG     4.6043     0.0037  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D    STUDENT 4.6043     0.0040  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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                        9  NEUTRAL PICN MEAN LIFE (UNITS 10**-16)

T    N   76   (1.9)     (0.5)    (0.5)  GLASSER    61 EMUL
T    N   45   (2.3)     (1.1)    (1.0)  TIETGE     62 EMUL
T    N   88   (2.8)     (0.9)    (0.9)  KOLLER     63 EMUL     SEE STAMER 66
T              1.05      0.18     0.18  VON DARDE 63 CNTR
T    N   75   (1.7)     (0.5)           SHWE       64 EMUL
T              0.730     0.105          BELLETTIN 65 CNTR                      6/66
T    N   67   (1.6)     (0.6)    (0.5)  EVANS      65 EMUL                     6/66
T    K  232    1.0       0.5            STAMER     66 EMUL                     8/67
T              0.56      0.06           BELLETTIN 70 CNTR     PRIM.EFF. ON NUC  7/70
T              0.9       0.068          KRYSHKIN  70 CNTR     PRIMAKOFF EFFECT 12/70
T    B         0.82      0.04           BROWMAN   74 CNTR     PRIMAKOFF EFFECT  7/75*
T    N   OLD EMULSION MEASUREMENTS NOT USED BECAUSE OF POSSIBLE SYSTEMATIC
T    N   SHIFT TO LARGER MEAN LIFE VALUES.
T    K   INCLUDES EVENTS OF KOLLER 63.                                          8/67
T    B   BROWMAN GIVES PIO WIDTH=8.02+-.42EV.  MEAN LIFE IS HBAR/WIDTH.        11/75*
T          . . . . . . . . .
T    AVG       0.828     0.057    0.053  AVERAGE (ERROR INCL. SCALE FACTOR OF 1.8)
T    STUDENT   0.835     0.038    0.035  AVG. USING STUDENT10(H/1.11) -- SEE TEXT
                                 (SEE IDEOGRAM BELOW )
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                        9  NEUTRAL PION PARTIAL DECAY MODES

                                                             DECAY MASSES
P1      PIO INTO 2GAMMA                                      0+   0
P2      PIO INTO E+ E- GAMMA                                .5+  .5+    0
P3      PIO INTO 4ELECTRONS                                 .5+  .5+   .5+  .5
P4      PIO INTO 3 GAMMA                                     0+   0+    0
P5      PIO INTO 4 GAMMA                                     0+   0+    0+   0
P6      PIO INTO E+ E-                                      .5+  .5
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                        9  NEUTRAL PION BRANCHING RATIOS

R1      PIO INTO (GAMMA E+ E-)/(2GAMMA) (PERCENT)          (P2)/(P1)
R1              (1.196)   THEORET. CALC.  JOSEPH     60         QUANTUM ELECT.   9/66
R1       27      1.17      0.15           BUDAGOV    60 HBC
R1     3071      1.166     0.047          SAMIOS     61 HBC      PI-P TO PIO N
R1   S   SAMIOS VALUE USES PANOFSKY RATIO = 1.62
R1             . . . . . . . . .
R1   AVG         1.166     0.045    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1   STUDENT     1.166     0.048    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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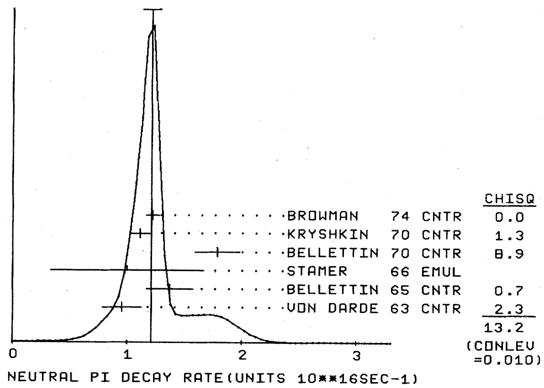
Data Card Listings

For notation, see key at front of Listings.

Stable Particles

π^0, $K^\pm$

WEIGHTED AVERAGE = 1.207 ± 0.080
ERROR SCALED BY 1.8

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R2      PIO INTO (3 GAMMA)/(2 GAMMA) (UNITS 10**-6)          (P4)/(P1)
R2        0    5.0   OR LESS  CL=.90   DUCLOS     65 CNTR                     6/66
R2             5.0   OR LESS  CL=.90   KUTIN      65 CNTR                     3/68

R3      PIO INTO (E+E+E-E-)/(2 GAMMA) (UNITS 10**-5)         (P3)/(P1)
R3      146    3.18      0.30          SAMIOS     62 HBC       SEE NOTE N BELOW  6/66
R3             3.28    THEORET. CALC.  MIYAZAKI   73           QUANTUM ELECT.    2/76*
R3   N   ABOVE VALUE USES PANOFSKY RATIO = 1.62

R4      PIO INTO (4 GAMMA)/(2 GAMMA)   (UNITS 10**-5)        (P5)/(P1)           8/73
R4        0    6.1   OR LESS  CL=.90   ABRAMS     73 ASPK                        8/73

R5      PIO INTO (E+ E-)/TOTAL  (UNITS 10**-6)               (P6)/(P1)          12/75*
R5   D         2.0   OR LESS  CL=.90   DAVIES     74 RVUE                       12/75*
R5   D  DAVIES 74 EXTRACTS THIS INFORMATION FROM BLOCH 75 K+ EXPERIMENT.       12/75*

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REFERENCES FOR NEUTRAL PION


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PANOFSKY 51 PR   81  565       W K H PANOFSKY,R L AAMODT,J HADLEY     (LRL)
CHINOWSK 54 PR   93  586       W CHINOWSKY,J STEINBERGER          (COLUMBIA)
CASSELS  59 PPS  74   92       CASSELS,JONES,MURPHY,O.NEILL      (LIVERPOOL)
HADDOCK  59 PRL   3  478       HADDOCK,ABASHIAN,CROWE,CZIRR            (LRL)
HILLMAN  59 NC   14  887       HILLMAN,MIDDELKOOP,YAMAGATA,ZAVATTINI(CERN)

BUDAGOV  60 JETP 11  755       BUDAGOV,VIKTOR,DZHELEPOV,ERMOLOV +    (JINR)
JOSEPH   60 NC 16 997          D W JOSEPH                             (EFI)
SAMIOS   60 NC 18 154          N P SAMIOS                        (COLUMBIA)
GLASSER  61 PR  123 1014       R G GLASSER,N SEEMAN,B STILLER         (NRL)
SAMIOS   61 PR  121  275       N P SAMIOS                    (COLUMBIA+BNL)
SAMIOS   62 PR 126 1844        SAMIOS,PLANO,PRODELL +        (COLUMBIA+BNL)
TIETGE   62 PR  127 1324       J TIETGE,W PUESCHEL       (MAX PLANCK INST)

CZIRR    63 PR  130  341       JOHN B CZIRR                           (LRL)
KOLLER   63 NC   27 1405       E L KOLLER,S TAYLOR,T HUETTER      (STEVENS)
    ALSO 66 STAMER
PETRUKHI 63 SIENA CONF 208     V I PETRUKHIN,YU D PROKOSHKIN         (JINR)
VON DARD 63 PL    4   51       VON DARDEL,DEKKERS,MERMOD,VAN PUTTEN+(CERN)

SHWE     64 PR  136B 1839      H SHWE,F M SMITH,W H BARKAS            (LRL)
BELLETTI 65 NC 40 A 1139       BELLETTINI,BEMPORAD,BRACCINI+(PISA+FIRENZE)
DUCLOS   65 PL 19 253          DUCLOS,FREYTAG,HEINTZE +  (CERN+HEIDELBERG)
EVANS    65 PR 139 B 982       D A EVANS                           (OXFORD)
KUTIN    65 JETP LETT 2 243    KUTIN,PETRUKHIN,PROKOSHKIN            (JINR)

STAMER   66 PR 151  1108       STAMER,TAYLOR,KOLLER,HUETTER+      (STEVENS)
VASILEVS 66 PL  23  281        VASILEVSKY,VISHNYAKOV,DUNAITSEV +    (DUBNA)
BELLETTI 70 NC 66A 243         BELLETTINI,BEMPORAD,LUBELSMEY+  (PISA+BONN)
KRYSHKIN 70 JETP 30 1037       +STERLIGOV,USOV       (TOMSK POLYTECH.INST.)
ABRAMS   73 PL 45B 66          +CARROLL,KYCIA,LI,MICHAEL,MOCKETT +    (BNL)
MIYAZAKI 73 PR D8 2051         T.MIYAZAKI,E.TAKASUGI                 (TOKY)
BROWMAN  74 PRL 33 1400        +DEWIRE,GITTELMAN,HANSON+        (CORN+BING)
DAVIES   74 NC 24A 324         +GUY,ZIA                    (BIRM+RHEL+SHMP)
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$K^\pm$

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               10   CHARGED K(494,JP=0-) I=1/2

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               10   CHARGED K MASS (MEV)

M            493.9      0.2            COHEN      57 RVUE +
M            493.7      0.3            BARKAS     63 EMUL  -
M            493.78     0.17           GREINER    65 EMUL +   VIA TAU DECAY    7/66
M    A      (493.87)   (0.19)          KUNSELMAN 71 CNTR  - KAONIC ATOMS     10/71
M            493.691    0.040          BACKENSTO 73 CNTR  - KAONIC ATOMS      1/73
M   A        493.662    0.19           KUNSELMAN 74 CNTR  - KAONIC ATOMS      3/74
M   A    KUNSELMAN 74 UPDATES KUNSELMAN 71 WITH IMPROVED KAONIC ATOM CALC.    3/74
M          . . . . . . . . . .
M    AVG     493.702    0.037   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M    STUDENT 493.701    0.040   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
M    FIT     493.707    0.037  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*

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               10   (K+) - (K-) MASS DIFFERENCE (MEV)

DM F  1.5M   -0.032    0.090           FORD       72 ASPK +-                   4/72
DM F    FORD 72 USES M(PI+)-M(PI-) = +28+-70 KEV.                              1/73

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               10   CHARGED K MEAN LIFE (UNITS 10**-8)

T          CHAR. K MEAN LIFE
T    O         (0.95)    (0.36)    (0.25) ILOFF      56 EMUL
T    O    52   (1.60)    (0.3)     (0.3)  EISENBERG  58 EMUL
T               1.21      0.06      0.06  BURROWES   59 CNTR
T    O    33   (1.38)    (0.24)    (0.24) FREDEN     60 EMUL
T    O         (1.25)    (0.22)    (0.17) BARKAS     61 EMUL
T    O    51   (1.27)    (0.36)    (0.23) BHOWMIK    61 EMUL
T        293    1.31      0.08      0.08  NORDIN     61 HBC   -
T              (1.24)    (0.07)           NORDIN     61 RVUE  -
T               1.231     0.011     0.011 BOYARSKI   62 CNTR +
T               1.2443    0.0038          FITCH      65 CNTR +   K AT REST          6/66
T               1.221     0.011           FORD       67 CNTR +-                     8/67
T               1.2272    0.0036          LOBKOWICZ  69 CNTR +   K IN FLIGHT        9/66
T         3M    1.2380    0.0016          OTT        71 CNTR  +   STOPPING  K       2/71
T    O   OLD EXPERIMENTS WITH LARGE ERRORS EXCLUDED FROM AVERAGING                  2/71
T          . . . . . . . . . . .
T    AVG        1.2370    0.0032    0.0032 AVERAGE (ERROR INCL. SCALE FACTOR OF 2.4)
T    STUDENT    1.2374    0.0016    0.0016 AVG. USING STUDENT10(H/1.11) -- SEE TEXT
T    FIT        1.2371    0.0026 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.9)
                          (SEE IDEOGRAM BELOW )
```
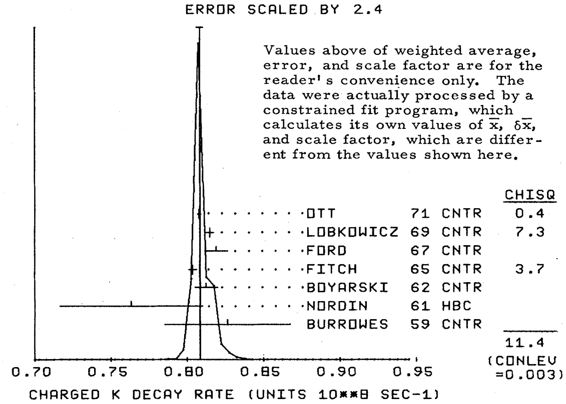

WEIGHTED AVERAGE = 0.8084 ± 0.0021
ERROR SCALED BY 2.4

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               10   ((K+) - (K-))/AVG., MEAN LIFE DIFFERENCE (PERCENT)

DT   N   THIS QUANTITY IS A MEASURE OF CPT INVARIANCE IN W.I.

DT              0.47      0.30              FORD       67 CNTR                8/67
DT              0.090     0.078             LOBKOWICZ  69 CNTR               12/70
DT            . . . . . . . . . .
DT   AVG        0.114     0.093    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
DT   STUDENT    0.112     0.083    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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               10   CHARGED K PARTIAL DECAY MODES

                                                         DECAY MASSES
P1      CHAR. K INTO MU NEU                  K MU2          105+   0
P2      CHAR. K INTO PI PIO                  K PI2          139+ 134
P3      CHAR. K INTO PI PI+ PI-              TAU            139+ 139+ 139
P4      CHAR. K INTO PI 2PIO                 TAU PRIME      139+ 134+ 134
P5      CHAR. K INTO MU PIO NEU              K MU3          105+ 134+   0
P6      CHAR. K INTO E PIO NEU               K E3            .5+ 134+   0
P7      K+ INTO PI+ PI- E+ NEU               K E+ 4         139+ 139+  .5+   0
P8      K+ INTO PI+ PI+ E- NEU               K E- 4         139+ 139+  .5+   0
P9      K+ INTO PI+ PI- MU+ NEU              K+MU+ 4        139+ 139+ 105+   0
P10     K+ INTO PI+ PI+ MU- NEU              K+MU- 4        139+ 139+ 105+   0
P11     CHAR. K INTO E NEU                   K E2            .5+   0
P12     CHAR. K INTO MU NEU GAMMA            K MU RAD       105+   0+   0
P13     CHAR. K INTO PI PIO GAMMA            K PI RAD       139+ 134+   0
P14     CHAR. K INTO PI PI+ PI- GAMMA        TAU RAD        139+ 139+ 139+   0
P15     CHAR. K INTO PI E+ E-                PI E E         139+  .5+  .5
P16     CHAR. K INTO PI MU+ MU-              PI MU MU       139+ 105+ 105
P17     CHAR. K INTO PI GAMMA GAMMA          PI GAM GAM     139+   0+   0
P18     CHAR. K INTO PIO E NEU GAMMA         PI E NEU GAM   134+  .5+   0+   0
P19     K- INTO PI+ E- E-                    PI+E-E-        139+  .5+  .5
P20     CHAR. K INTO PI NEU NEU              PI NEU NEU     139+   0+   0
P21     CHAR. K INTO E NEU GAMMA             K E2 RAD        .5+   0+   0
P22     CHAR. K INTO PI GAMMA                K PI GAM       139+   0
P23     CHAR. K INTO PI 3GAMMA               PI 3GAM        139+   0+   0+   0
P24     CHAR. K INTO PIO PIO E NEU           K E4 2PIO      134+ 134+  .5+   0
P25     K+ INTO PI- E+ MU+                   PI-E+MU+       139+  .5+ 105
P26     K+ INTO PI+ E+ MU-                   PI+E+MU-       139+  .5+ 105
P27     CHAR. K INTO MU NEU NEU NEUBAR       MU 3NEU        105+   0+   0+   0
P28     CHAR. K INTO PIO MU NEU GAMMA        PI MU NEU GAM  134+ 105+   0+   0

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                   CHARGED K CONSTRAINED FIT
          OVERALL FIT OF MEAN LIFE, WIDTHS AND BRANCHING
          RATIOS USES 57 DATA POINTS TO DETERMINE SIX                         2/76*
          QUANTITIES.  OVERALL FIT HAS CHISQ=78.2.  MAIN                      2/76*
          CONTRIBUTION (13.3) COMES FROM R19 OF HAIDT
          71 (WE SEE NO REASON TO REJECT THIS EXPERIMENT
          AT THIS TIME)

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Stable Particles

K±

Data Card Listings

For notation, see key at front of Listings.

<u>FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS</u>

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The <u>diagonal</u> elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the <u>off-diagonal</u> elements are the <u>normalized</u> correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

```
           P 1          P 2          P 3          P 4          P 5          P 6
P 1 .6361+-.0016
P 2   -.7186   .2105+-.0014
P 3   -.1988     -.0362   .0559+-.0003
P 4   -.1859      .0420      .2008   .0173+-.0005
P 5   -.2784     -.2485     -.1118     -.3299   .0320+-.0009
P 6   -.3526     -.1416      .1487      .0230      .2158   .0482+-.0005
```

<u>FITTED PARTIAL DECAY MODE RATES</u>

The matrix below is the branching fraction matrix above, transformed into rate space; i.e., $G_i \equiv \Gamma_i = \Gamma_{total} P_i$, in appropriate units. In analogy to the matrix above, the <u>diagonal</u> elements are $G_i \pm \delta G_i$, where $\delta G_i = \sqrt{\langle \delta G_i \delta G_i \rangle}$, while the <u>off-diagonal</u> elements are the <u>normalized</u> correlation coefficients $\langle \delta G_i \delta G_j \rangle / (\delta G_i \cdot \delta G_j)$. Note that, because of the error in Γ_{total}, the errors and correlations here are not directly derivable from those above.

```
           G 1          G 2          G 3          G 4          G 5          G 6
G 1 .5142+-.0017
G 2   -.2961   .1702+-.0012
G 3   -.1003     -.0015   .0452+-.0002
G 4   -.1062      .0568      .2045   .0140+-.0004
G 5   -.1676     -.2140     -.1189     -.3265   .0258+-.0007
G 6   -.1606     -.0816      .1522      .0289      .2218   .0390+-.0004
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                    10   CHARGED K DECAY RATES

W1      CHAR. K INTO MU NEU (UNITS 10**6 SEC-1)            (G1)
W1             51.2       0.8               FORD       67 CNTR +-                 8/67
W1           . . . . . . . . .
W1  FIT        51.42      0.17   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

W2      CHAR. K INTO PI PI+ PI- (UNITS 10**6 SEC-1)        (G3)
W2  F         (4.496)   (0.030)             FORD       67 CNTR +- SEE NOTE F      8/67
W2  F 3.2M    (4.529)   (0.032)             FORD       70 ASPK    SEE NOTE F     11/70
W2             4.511     0.024              FORD       70 ASPK    SEE NOTE F     11/70
W2  F   THE LAST IS THE COMBINED RESULT OF FORD 67 AND FORD 70
W2           . . . . . . . . .
W2  FIT        4.516     0.023   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

W3      CHAR. K INTO (TAU) - (TAU PRIME) (UNITS 10**6 SEC-1)
W3                                                         (G3-G4)
W3       USED FOR DELTA I = 1/2 TEST.
W3           . . . . . . . . .
W3  FIT        3.117     0.039   FROM FIT

W4      CHAR. K INTO (MU PI0 NEU) + (E PI0 NEU) (UNITS 10**6 SEC-1)
W4                                                         (G5+G6)
W4       USED FOR DELTA I = 1/2 TEST.
W4           . . . . . . . . .
W4  FIT        6.483     0.090   FROM FIT

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                    10   ((K+) - (K-))/AVG., DECAY RATE DIFFERENCE (PERCENT)

D1      DIFFERENCE IN K MU2 RATES      ((G1+)-(G1-))/G1          (PERCENT)
D1            -0.54      0.41               FORD       67 CNTR                    8/67

D2      DIFFERENCE IN TAU RATES        ((G3+)-(G3-))/G3          (PERCENT)
D2            -0.50      0.90               FLETCHER   67 OSPK                    8/67
D2  F        (-0.04)    (0.21)              FORD       67 CNTR    SEE NOTE F      8/67
D2  F 3.2M    (0.10)    (0.14)              FORD       70 ASPK    SEE NOTE F     11/70
D2  F          0.08      0.12               FORD       70 ASPK    SEE NOTE F     11/70
D2  S        (-0.02)    (0.16)              SMITH      73 ASPK +-                11/73
D2  F   SECOND FORD 70 VALUE IS FIRST FORD 70 COMBINED WITH FORD 67.
D2  S   SMITH 73 VALUE OF D2 IS DERIVED FROM SMITH 73 VALUE OF D3.               11/73
D2           . . . . . . . . .
D2  AVG        0.07      0.12    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D2  STUDENT    0.07      0.13    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

D3      DIFFERENCE IN TAU PRIME RATES ((G4+)-(G4-))/AVERAGE      (PERCENT)
D3     1802   -1.1       1.8                HERZO      69 OSPK                    5/70
D3             0.08      0.58               SMITH      73 ASPK +-                11/73
D3           . . . . . . . . .
D3  AVG       -0.03      0.55    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D3  STUDENT   -0.03      0.60    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

D4      DIFFERENCE IN K PI2 RATES      ((G2+)-(G2-))/AVERAGE     (PERCENT)
D4             0.8       1.2                HERZO      69 OSPK                    5/70

D5      DIFFERENCE IN K PI RAD RATES   ((G13+)-(G13-))/AVERAGE (PERCENT)
D5       24    0.0      24.0                EDWARDS    72 OSPK    PI KE 58-90 MEV    8/72
D5     4000    1.0       4.0                ABRAMS     73 ASPK +- PI KE 51-100 MEV   3/74
D5           . . . . . . . . .
D5  AVG        1.0       3.9     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D5  STUDENT    1.0       4.3     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    10   CHARGED K BRANCHING RATIOS

R   O       OLD DATA EXCLUDED

R1      CHAR. K INTO (MU NEU)/TOTAL (UNITS 10**-2)         (P1)
R1  O        (58.5)     (3.0)               BIRGE       56 EMUL +
R1  O        (56.9)     (2.6)               ALEXANDER 57 EMUL +
R1  O   OLD EXPERIMENTS NOT INCLUDED IN AVERAGING                                 1/71
R1      62K   63.24      0.44               CHIANG      72 OSPK +  1.84 GEV/C K+   9/72
R1           . . . . . . . . .
R1  FIT       63.61      0.16    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2      CHAR. K INTO (PI PI0)/TOTAL (UNITS 10**-2)         (P2)
R2  O        (27.7)     (2.7)               BIRGE       56 EMUL +
R2  O        (23.2)     (2.2)               ALEXANDER 57 EMUL +
R2  O   EARLIER EXPERIMENTS NOT AVERAGED
R2           (21.0)     (0.6)               CALLAHAN    65 HLBC    SEE R17
R2           (21.6)     (0.6)               TRILLING    65 RVUE                    6/66
R2      16K   21.18      0.28               CHIANG      72 OSPK +  1.84 GEV/C K+   9/72
R2           . . . . . . . . .
R2  FIT       21.05      0.14    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3      CHAR. K INTO (PI PI+ PI-)/TOTAL (UNITS 10**-2)     (P3)
R3  O         (5.6)     (0.4)               BIRGE       56 EMUL +
R3  O         (6.8)     (0.4)               ALEXANDER 57 EMUL +
R3  O         (5.2)     (0.3)               TAYLOR      59 EMUL +
R3  O   EARLIER EXPERIMENTS NOT AVERAGED
R3             5.7       0.3                ROE         61 HLBC +                  9/66
R3     2332    5.54      0.12               CALLAHAN    64 HLBC +
R3      540    5.1       0.2                SHAKLEE     64 HLBC +                  9/66
R3             5.71      0.15               DE MARCO    65 HBC                     6/66
R3       44    6.0       0.4                YOUNG       65 EMUL +                  6/66
R3  P   693    5.34      0.21               PANDOULAS 70 EMUL +                 10/70
R3   C 2330   (5.56)    (0.20)              CHIANG      72 OSPK +  1.84 GEV/C K+   9/72
R3   C  THIS VALUE IS NOT INDEPENDENT OF CHIANG 72 R1,R2,R4,R5, AND R6             9/72
R3  P   INCLUDES EVENTS OF TAYLOR 59.
R3           . . . . . . . . .
R3  AVG        5.521     0.098   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
R3  STUDENT    5.533     0.089   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R3  FIT        5.587     0.030  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
                         (SEE IDEOGRAM BELOW )
```
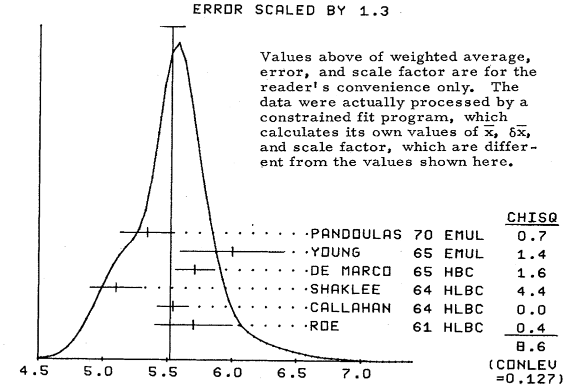

WEIGHTED AVERAGE = 5.521 ± 0.098
ERROR SCALED BY 1.3



CHAR.K TO (PI PI+ PI-)/TOTAL (UN 10**-2)

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R4      CHAR. K INTO (PI 2PI0)/TOTAL (UNITS 10**-2)        (P4)
R4  O         (2.1)     (0.5)               BIRGE       56 EMUL +
R4  O         (2.2)     (0.4)               ALEXANDER 57 EMUL +
R4  O         (1.5)     (0.2)               TAYLOR      59 EMUL +
R4  O   EARLIER EXPERIMENTS NOT AVERAGED
R4             1.7       0.2                ROE         61 HLBC +                 11/67
R4      108    1.8       0.2                SHAKLEE     64 HLBC +                 11/67
R4  P   198    1.53      0.11               PANDOULAS 70 EMUL +                 10/70
R4     1307    1.84      0.06               CHIANG      72 OSPK +  1.84 GEV/C K+   9/72
R4  P   INCLUDES EVENTS OF TAYLOR 59.
R4           . . . . . . . . .
R4  AVG        1.767     0.071   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
R4  STUDENT    1.778     0.063   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R4  FIT        1.731     0.045  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.4)
                         (SEE IDEOGRAM BELOW )
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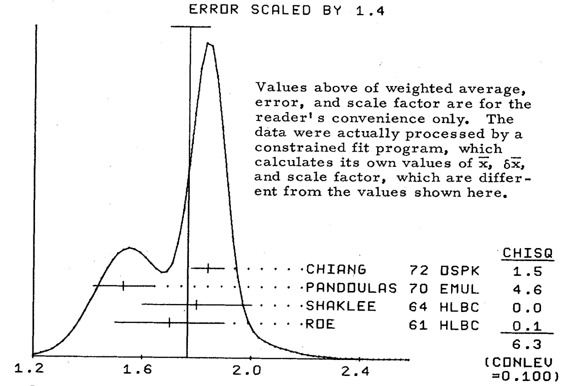
WEIGHTED AVERAGE = 1.767 ± 0.071
ERROR SCALED BY 1.4



CHAR. K INTO (PI 2PI0)/TOTAL (UN 10**-2)

Data Card Listings

Stable Particles

For notation, see key at front of Listings.

$K^{\pm}$

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R5      CHAR. K INTO (MU PIO NEU)/TOTAL (UNITS 10**-2)    (P5)
R5  0        (2.8)     (1.0)           BIRGE      56 EMUL +
R5  0        (5.9)     (1.3)           ALEXANDER 57 EMUL +
R5  0        (2.8)     (0.4)           TAYLOR     59 EMUL +
R5  0   EARLIER EXPERIMENTS NOT AVERAGED
R5    2345   3.33      0.16            CHIANG     72 OSPK +  1.84 GEV/C K+      9/72
R5          . . . . . . . . . .
R5  FIT      3.197     0.087  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.7)

R6      CHAR. K INTO (E PIO NEU)/TOTAL (UNITS 10**-2)     (P6)
R6  0        (3.2)     (1.3)           BIRGE      56 EMUL +
R6  0        (5.1)     (1.3)           ALEXANDER 57 EMUL +
R6  0   EARLIER EXPERIMENTS NOT AVERAGED
R6           5.0       0.5             ROE        61 HLBC +                        11/67
R6     429   4.7       0.3             SHAKLEE    64 HLBC +                        11/67
R6    3516   4.86      0.10            CHIANG     72 OSPK +  1.84 GEV/C K+      9/72
R6          . . . . . . . . . .
R6  AVG      4.849     0.093   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R6  STUDENT  4.85      0.10    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R6  FIT      4.823     0.052  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R7      CHAR. K INTO (PI2 + MU3)/TOTAL (UNITS 10**-2)     (P2+P5)              11/67
R7       WE COMBINE THESE TWO MODES FOR EXPTS MEASURING THEM IN XENON BC
R7       BECAUSE OF DIFFICULTIES OF SEPARATING THEM THERE
R7           23.4      1.1             ROE        61 HLBC +                        11/67
R7     886   25.4      0.9             SHAKLEE    64 HLBC +                        11/67
R7          . . . . . . . . . .
R7  AVG      24.60     0.98    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
R7  STUDENT  24.61     0.83    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R7  FIT      24.25     0.15   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R8      K+ INTO (PI+ PI+ E- NEU)/TOTAL (UNITS 10**-7)     (P8)
R8           20.     OR LESS  CL=.95   BIRGE      65 FBC  +                         8/66
R8       0   6.9     OR LESS  CL=.95   ELY        69 HLBC +                        10/69
R8       0   9.0     OR LESS  CL=.95   SCHWEINBE 71 HLBC +                          9/71

R9      K+ INTO (PI+ PI- MU+ NEU)/TOTAL (UNITS 10**-5)    (P9)
R9       1   0.77      0.54      0.50  CLINE      65 FBC  +                         8/66

R10     K+ INTO (PI+ PI+ MU- NEU)/TOTAL (UNITS 10**-6)    (P10)
R10      0   3.0     OR LESS  CL=.95   BIRGE      65 FBC  +                         8/66

R11     CHAR. K INTO (E NEU)/TOTAL (UNITS 10**-5)         (P11)
R11          160.0   OR LESS  CL=.95   BORREANI   64 HBC  +                        11/67
R11      4   2.1       1.8       1.3   BOWEN      67 OSPK +                         8/67
R11      BOWEN RESULT SHOULD BE CORRECTED TO 1.9(+1.7,-1.2) BECAUSE OF
R11      K+ TO E+ NEU GAMMA DECAYS BEFORE COMPARING WITH BOTTERILL 67 R28

R12     CHAR. K INTO (PI GAMMA GAMMA)/TOTAL (UNITS 10**-4)
R12                                                        (P17)
R12      ALL VALUES GIVEN HERE ASSUME A PHASE SPACE PION ENERGY SPECTRUM       2/72
R12          -0.1      0.6             CHEN       68 OSPK +  T(PI) 60-90 MEV   9/73
R12      0   0.5     OR LESS  CL=.90   KLEMS      71 OSPK +  T(PI)GT 117 MEV   8/71
R12      0   0.35    OR LESS  CL=.90   LJUNG      73 HLBC +  6-102,114-127MEV  9/73

R13     CHAR. K INTO (PI PIO GAMMA)/TOTAL (UNITS 10**-4) (P13)
R13     18   2.2       0.7             CLINE      64 FBC  +  PI+ KE 55-80 MEV  8/66
R13      0   1.9     OR LESS  CL=.90   EMMERSON   69 OSPK    PI+ KE 55-80 MEV 10/69
R13  M   0   1.0     OR LESS           MALTSEV    70 HLBC +  PI+ KE LT 55 MEV 12/75*
R13  A2100   2.71      0.19            ABRAMS     72 ASPK +- PI+ KE 55-90 MEV  1/73
R13     24   2.4       0.8             EDWARDS    72 OSPK    PI+ KE 58-90 MEV  8/72
R13 L       (1.5)     (1.1)     (0.6)  LJUNG      73 HLBC +  PI+ KE 55-80 MEV  9/73
R13 L       (2.6)     (1.5)     (1.1)  LJUNG      73 HLBC +  PI+ KE 55-90 MEV  9/73
R13  L  17   6.8       3.7       2.1   LJUNG      73 HLBC +  PI+ KE 55-102MEV  9/73
R13  M  MALTSEV 70 SELECTS LOW PI+ ENERGY TO ENHANCE DIRECT EMISSION CONTR.  1/76*
R13  L  THE LJUNG 73 VALUES ARE NOT INDEPENDENT.                               9/73
R13  A  ABRAMS 72 OBSERVES DIRECT EMISSION BR. RATIO OF (1.56+-0.35)*10**-5   1/73
R13  A  +-0.5*10**-5 ADDNL. SYST. ERROR  AND INNER BREMSSTRAHLUNG BR. RATIO   1/73
R13  A  OF (2.55+-0.18)*10**-4.  WE QUOTE THE SUM OF THESE BR. RATIOS.         1/73
R13         . . . . . . . . . .
R13 AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R14     CHAR. K INTO (PI PI+ PI- GAMMA)/TOTAL (UNITS 10**-4)
R14                                                        (P14)
R14          1.0       0.4             STAMER     65 EMUL +  EGAM GT 11MEV      8/66

R15     CHAR. K INTO (PI E+ E-)/TOTAL (UNITS 10**-6)      (P15)
R15      1   2.45    OR LESS  CL=.90   CAMERINI   64 FBC  +                         8/66
R15          4.4     OR LESS  CL=.90   BISI       67 DBC  +                        11/67
R15  C      (0.4)    OR LESS           CLINE1     67 FBC  +                       .11/67
R15  C       0.88    OR LESS  CL=.90   CLINE2     67 FBC  +                       . 2/74
R15          32.0    OR LESS  CL=.90   BEIER      72 OSPK +-                        9/72
R15          1.7     OR LESS  CL=.90   CENCE      74 ASPK +  THREE TRACK EVTS 10/74*
R15          0.27    OR LESS  CL=.90   CENCE      74 ASPK +  TWO TRACK EVENTS 10/74*
R15  C  CLINE2 REPLACES CLINE1.  CLINE1 IS NOT FOR CL=.90 .                    2/74

R16     CHAR. K INTO (PI MU+ MU-)/TOTAL (UNITS 10**-6)    (P16)
R16          3.0     OR LESS  CL=.90   CAMERINI   65 FBC  +                         8/66
R16          2.4     OR LESS  CL=.90   BISI       67 DBC  +                        11/67

R17     CHAR. K INTO (PI PIO)/TAU                          (P2)/(P3)
R17    134   3.24      0.34            YOUNG      65 EMUL +                       . 8/66
R17   1045   3.96      0.15            CALLAHAN   66 FBC  +                         9/66
R17         . . . . . . . . . .
R17 AVG      3.84      0.27    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)
R17 STUDENT  3.86      0.16    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R17 FIT      3.768     0.033  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R18     CHAR. K INTO (PI 2PIO)/TAU                         (P4)/(P3)
R18   2027   0.303     0.009           BISI       65 H+HL +                       . 8/66
R18     17   0.393     0.099           YOUNG      65 EMUL +                         8/66
R18         . . . . . . . . . .
R18 AVG      0.3037    0.0090  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R18 STUDENT  0.3037    0.0097  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R18 FIT      0.3098    0.0079 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R19     CHAR. K INTO (MU PIO NEU)/TAU                      (P5)/(P3)
R19   2845   0.632     0.035           BISI 1     65 H+HL +                       . 8/66
R19     38   0.90      0.16            YOUNG      65 EMUL +                         8/66
R19 H 1505  (0.510)   (0.017)          EICHTEN    68 HLBC +                        11/68
R19  H1505   0.503     0.019           HAIDT      71 HLBC +                        12/70
R19  H  HAIDT 71 IS A REANALYSIS OF EICHTEN 68.
R19         . . . . . . . . . .
R19 AVG      0.536     0.054   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 3.2)
R19 STUDENT  0.527     0.025   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R19 FIT      0.572     0.016  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.8)
                       (SEE IDEOGRAM BELOW )
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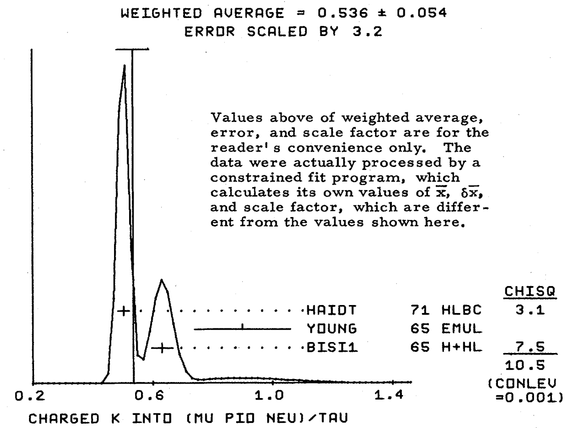


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R20     CHAR. K INTO (E PIO NEU)/TAU                       (P6)/(P3)
R20    230   0.90      0.06            BORREANI   64 HBC  +                       . 8/66
R20     37   0.90      0.16            YOUNG      65 EMUL +                       . 8/66
R20    854   0.94      0.09            BELLOTT2   67 HLBC                          11/67
R20 H 4385  (0.846)   (0.021)          EICHTEN    68 HLBC +                        11/68
R20  H4385   0.850     0.019           HAIDT      71 HLBC +                        12/70
R20   2827   0.856     0.040           BRAUN      75 HLBC +                        12/75*
R20  H  HAIDT 71 IS A REANALYSIS OF EICHTEN 68.
R20         . . . . . . . . . .
R20 AVG      0.858     0.016   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R20 STUDENT  0.858     0.018   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R20 FIT      0.8632    0.0098 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R21     K+ INTO (PI+ PI- E+ NEU)/TAU (UNITS 10**-4)        (P7)/(P3)
R21     69   6.7       1.5             BIRGE      65 FBC  +                         8/66
R21    269   5.83      0.63            ELY        69 HLBC +                        11/68
R21    500   7.36      0.68            BOURQUIN   71 ASPK                          12/71
R21    106   7.0       0.9             SCHWEINBE 71 HLBC +                          9/71
R21         . . . . . . . . . .
R21 AVG      6.64      0.40    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R21 STUDENT  6.66      0.48    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R22     K+ INTO (PI+ PI- MU+ NEU)/TAU (UNITS 10**-4)       (P9)/(P3)
R22      1  (2.5)    APPROX            GREINER    64 EMUL +                         8/66
R22      7   2.57      1.55            BISI       67 DBC  +                        11/67

R23     CHAR. K INTO (E PIO NEU)/(MU2+PI2) (UNITS 10**-2)(P6)/(P1+P2)
R23   1679   5.89      0.21            CESTER     66 OSPK +                         8/67
R23   5110   6.16      0.22            ESCHSTRUT 68 OSPK +                          3/68
R23         . . . . . . . . . .
R23 AVG      6.02      0.15    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R23 STUDENT  6.02      0.17    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R23 FIT      5.697     0.067  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R24     CHAR. K INTO (PI PIO)/(MU NEU)                     (P2)/(P1)
R24  A4517   0.3277    0.0065          AUERBACH   67 OSPK +                         1/74
R24   1600   0.305     0.018           ZELLER     69 ASPK +                        10/69
R24    25K   0.328     0.005           WEISSENBE 74 STRC +                          7/74*
R24  A  AUERBACH 67 CHANGED FROM .3253+-.0065.  SEE COMMENT WITH RATIO R26.  1/74
R24         . . . . . . . . . .
R24 AVG      0.3268    0.0039  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R24 STUDENT  0.3269    0.0042  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R24 FIT      0.3309    0.0029 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R25     CHAR. K INTO (E PIO NEU)/(MU NEU)                  (P6)/(P1)
R25  A 295   0.0791    0.0054          AUERBACH   67 OSPK +                         1/74
R25    960    .0775     .0033          BOTTERI1   68 ASPK +                         5/68
R25    561   0.069     0.006           GARLAND    68 OSPK +                         4/68
R25    350   0.069     0.006           ZELLER     69 ASPK +                        10/69
R25  A  AUERBACH 67 CHANGED FROM .0797+-.0054.  SEE COMMENT WITH RATIO R26.  1/74
R25  A  THE VALUE .0785+-.0025 GIVEN IN AUERBACH 67 IS AN AVERAGE OF          3/74
R25  A  AUERBACH 67 R25 AND CESTER 66 R23.                                     3/74
R25         . . . . . . . . . .
R25 AVG      0.0752    0.0024  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R25 STUDENT  0.0753    0.0027  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R25 FIT      0.07582   0.00091 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R26     CHAR. K INTO (MU PIO NEU)/(MU NEU)                 (P5)/(P1)
R26  A 307   0.0486    0.0040          AUERBACH   67 OSPK +                         1/74
R26  G 424   0.0480    0.0037          GARLAND    68 OSPK                           1/74
R26    240   0.054     0.009           ZELLER     69 ASPK +                        10/69
R26  A  AUERBACH 67 CHANGED FROM .0602+-.0046 BY ERRATUM WHICH BRINGS THE     1/76*
R26  A  MU-SPECTRUM CALCULATION INTO AGREEMENT WITH GAILLARD 70 APPENDIX B.  1/74
R26  G  GARLAND 68 CHANGED FROM .055+-.004 IN AGREEMENT WITH MU-SPECTRUM      1/74
R26  G  CALCULATION OF GAILLARD 70 APPENDIX B.  L.G.PONDROM, PRIV.COMM.(73)  1/74
R26         . . . . . . . . . .
R26 AVG      0.0488    0.0026  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R26 STUDENT  0.0487    0.0028  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R26 FIT      0.0503    0.0014 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.7)

R27     CHAR. K INTO (MU NEU)/TAU                          (P1)/(P3)
R27 R  427  (10.38)   (0.82)           YOUNG      65 EMUL +                         9/66
R27 R   DELETED FROM OVERALL FIT BECAUSE YOUNG 65 CONSTRAINS HIS RESULTS.
R27 R   TO ADD UP TO 1.  ONLY YOUNG MEASURED MU2 DIRECTLY.
R27         . . . . . . . . . .
R27 FIT      11.385    0.072  FROM FIT

R28     CHAR. K INTO (E NEU)/(MU NEU) (UNITS 10**-5)       (P11)/(P1)
R28     10   1.9       0.7       0.5   BOTTERILL 67 ASPK +                         11/67
R28      8   1.8       0.8       0.6   MACEK      69 ASPK +                         4/69
R28    112   2.42      0.42            CLARK      72 OSPK +                         1/73
R28    534   2.37      0.17            HEARD2     75 SPEC +                        11/75*
R28    404   2.51      0.15            HEINTZE    76 SPEC +                         2/76*
R28         . . . . . . . . . .
R28 AVG      2.42      0.11    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R28 STUDENT  2.42      0.12    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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Stable Particles

$K^{\pm}$

Data Card Listings

For notation, see key at front of Listings.

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R29    CHAR. K INTO (MU PIO NEU)/(E PIO NEU)                 (P5)/(P6)
R29  C1509    0.703    0.056          CALLAHA1  66 HLBC                     6/68
R29   5601    0.667    0.017          BOTTERI2  68 ASPK +                   6/68
R29 H 1398   (0.604)  (0.022)         EICHTEN   68 HLBC                    10/68
R29 H        (0.596)  (0.025)         HAIDT     71 HLBC +                  12/70
R29  D3480    0.698    0.025          CHIANG    72 OSPK +  1.84 GEV/C K+    9/72
R29  L 554    0.705    0.063          LUCAS2    73 HBC  -  DALITZ PRS ONLY 11/73
R29 B 1585   (0.608)  (0.014)         BRAUN     75 HLBC +                   1/76*
R29                COMMENTS
R29  C  FROM CALLAHAN1 66 WE USE ONLY THE MU3/E3 RATIO AND DO NOT
R29  C  INCLUDE IN THE FIT THE RATIOS MU3/TAU AND E3/TAU, SINCE THEY SHOW
R29  C  LARGE DISAGREEMENTS WITH THE REST OF THE DATA.
R29 H   HAIDT 71 IS A REANALYSIS OF EICHTEN 68.
R29 H   ONLY INDIVIDUAL RATIOS INCLUDED IN FIT (SEE R19 AND R20).          11/68
R29  D  CHIANG 72 R29 IS STATISTICALLY INDEPENDENT OF CHIANG 72 R5 AND R6.  9/72
R29  L  LUCAS 73 GIVES N(MU3)=554+-7.6PCT, N(E3)=786+-3.1PCT.  WE DIVIDE.  11/73
R29 B   BRAUN 75 VALUE IS FROM FORM FACTOR FIT.  ASSUMES MU-E UNIVERSALITY.  1/76*
R29          . . . . . . . . . .
R29 AVG       0.680    0.013   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R29 STUDENT   0.680    0.015   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R29 FIT       0.663    0.018  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.7)

R30    CHAR. K INTO (PIO E NEU GAMMA)/(PIO E NEU) (UNITS 10**-2)
R30                                                          (P18)/(P6)
R30           1.2      0.8            BELLOTT1  67 HLBC +  EGAM GT 30MEV   11/67
R30  R  13    0.76     0.28           ROMANO    71 HLBC    EGAM GT 10MEV   10/71
R30 R        (0.53)   (0.22)          ROMANO    71 HLBC +  EGAM GT 30 MEV   9/73
R30  L  16    0.48     0.20           LJUNG     73 HLBC +  EGAM GT 30 MEV   9/73
R30 L        (0.22)   (0.15)   (0.10) LJUNG     73 HLBC +  EGAM GT 30 MEV   9/73
R30 L   FIRST LJUNG VALUE IS FOR COS(ELECT-GAMMA)L.T. 0.9, SECOND VALUE IS  9/73
R30 L   FOR COS(ELECT-GAMMA) BETW 0.6 AND 0.9 FOR COMPARISON WITH ROMANO.   9/73
R30 R   BOTH ROMANO VALUES ARE FOR COS(ELECT-GAMMA) BETW 0.6 AND 0.9.       9/73
R30 R   SECOND VALUE IS FOR COMPARISON WITH SECOND LJUNG VALUE.             9/73
R30 R   WE USE LOWEST EGAM CUT FOR TABLE VALUE. SEE ROMANO FOR EGAM DEPEND. 9/73
R30          . . . . . . . . . .
R30 AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R31    K- INTO (PI+ E- E-)/TOTAL (UNITS 10**-5)          (P19)
R31     TEST OF LEPTON NUMBER CONSERVATION.
R31           1.5   OR LESS           CHANG     68 HBC  -                   3/68

R32    CHAR. K INTO (PI NEU NEU)/TOTAL (UNITS 10**-6)    (P20)
R32 C        (1.4)  OR LESS  CL=.90   KLEMS     71 OSPK +  T(PI) 117-127MEV  3/74
R32 C        (0.94) OR LESS  CL=.90   CABLE     73 CNTR +  T(PI) 60-105 MEV  2/74
R32  C        0.56  OR LESS  CL=.90   CABLE     73 CNTR +  T(PI) 60-127 MEV  2/74
R32  L   0   57.0   OR LESS  CL=.90   LJUNG     73 HLBC +                   9/73
R32  C  KLEMS 71 AND CABLE 73 ASSUME PI SPECTRUM SAME AS KE3 DECAY.         3/74
R32  C  SECOND CABLE LIMIT COMBINES CABLE AND KLEMS DATA FOR VECTOR INT.    2/74
R32  L  LJUNG 73 ASSUMES VECTOR INTERACTION.                                9/73

R33    CHAR. K INTO (E NEU GAMMA)/TOTAL  (UNITS 10**-5) (P21)
R33  M        7.1   OR LESS           MACEK     70 OSPK +  P(E) 234 TO 247  12/70
R33  M  ABOVE IS MEASUREMENT OF STRUCTURE-DEPENDENT DECAY ONLY.

R34    CHAR. K INTO (PI GAMMA)/TOTAL (UNITS 10**-6)      (P22)
R34           4.0   OR LESS  CL=.90   KLEMS     71 OSPK +                   8/71

R35    CHAR. K INTO (TAU)/(TAU PRIME)                    (P3/P4)
R35     USED FOR DELTA I=1/2 TEST.
R35          . . . . . . . . . .
R35 FIT       3.227    0.083   FROM FIT

R36    CHAR. K INTO (PI 3GAMMA)/TOTAL (UNITS 10**-4)     (P23)
R36           3.0   OR LESS  CL=.90   KLEMS     71 OSPK +  T(PI) GT 117MEV   8/71

R37    K+ INTO (PI+ PI+ E- NEU)/(PI+ PI- E+ NEU)         (P8)/(P7)          2/72
R37     0     0.013 OR LESS  CL=.95   BOURQUIN  71 ASPK                    12/71

R38    CHAR. K INTO (PIO PIO E NEU)/KE3 (UNITS 10**-4)   (P24)/(P6)
R38     0    37.0   OR LESS  CL=.90   ROMANO    71 HLBC +                  12/71
R38     2     3.8      5.0     1.2    LJUNG     73 HLBC +                   9/73

R39    K+ INTO (PI- E+ MU+)/TOTAL (UNITS 10**-8)         (P25)
R39    K- INTO (PI+ E- MU-)/TOTAL IS ALSO INCLUDED HERE
R39           2.8   OR LESS  CL=.90   BEIER     72 OSPK +-                  9/72

R40    K+ INTO (PI+ E+ MU-)/TOTAL (UNITS 10**-8)         (P26)
R40    K- INTO (PI- E- MU+)/TOTAL IS ALSO INCLUDED HERE
R40           1.4   OR LESS  CL=.90   BEIER     72 OSPK +-                  9/72

R41    CHAR. K INTO (MU 3NEU)/TOTAL (UNITS 10**-6)       (P27)
R41  P   0    6.0   OR LESS  CL=.90   PANG      73 CNTR +                  11/73
R41  P  PANG 73 ASSUMES MU SPECTRUM FROM NEU-NEU INTERACTION OF BARDIN 70.  3/74

R42    CHAR. K INTO (PIO MU NEU GAM)/TOTAL(UNITS 10**-5)(P28)              9/73
R42     0     6.1   OR LESS  CL=.90   LJUNG     73 HLBC +  EGAM GT 30 MEV   9/73

R43    CHAR. K INTO (E PIO NEU)/(PI PIO)                 (P6)/(P2)
R43  L 786    0.221    0.012          LUCAS2    73 HBC  -  DALITZ PRS ONLY 11/73
R43  L  LUCAS 73 GIVES N(E3)=786+-3.1PCT, N(PI2)=3564+-3.1PCT.  WE DIVIDE.  11/73
R43          . . . . . . . . . .
R43 FIT       0.2291   0.0031 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R44    CHAR. K INTO (PI 2PIO)/(PI PIO)                   (P4)/(P2)
R44  L 574    0.081    0.005          LUCAS2    73 HBC  -  DALITZ PRS ONLY 11/73
R44  L  LUCAS 73 GIVES N(PI 2PIO)=574+-5.9 PCT, N(PI2)=3564+-3.1 PCT.       11/73
R44  L  WE QUOTE 0.5*N(PI 2PIO)/N(PI2) WHERE 0.5 IS BECAUSE ONLY DALITZ     11/73
R44  L  PAIR PIO'S WERE USED.                                              11/73
R44          . . . . . . . . . .
R44 FIT       0.0822   0.0022 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R45    CHAR. K INTO(MU NEU GAMMA)/TOTAL  (UNITS 10**-3) (P12)              7/74*
R45     12    5.8      3.5            WEISSENBE 74 STRC +  E-GAMMA GT 9 MEV 7/74*

R46    CHAR. K INTO (PI E+ E-)/(PI+ PI- E NEU) (UNITS 10**-3)  (P15)/(P7)
R46  B  41    7.0      1.3            BLOCH     75 SPEC +                  11/75*
R46  B  BLOCH 75 QUOTES THIS RESULT MULTIPLIED BY OUR 1974 KE4 BR.FRAC.    11/75*

R47    CHAR. K INTO (E NEU GAM)/(E NEU)                   (P21)/(P11)
R47  H  56    1.05     0.25    0.30 HEARD1      75 SPEC +  P(E) 236 TO 247 11/75*
R47  H  ABOVE IS SENSITIVE ONLY TO STRUCTURE DECAY TERM.                   11/75*

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```

Note on Slope Parameter for $K \to 3\pi$ Decays

As was discussed in Section VI B.1 of the text, for the 3π decays of the K mesons we list the slope parameter "g" which is defined, as in that section, by

$$|M|^2 \propto 1 + g\,\frac{(s_3 - s_0)}{m^2_{\pi^+}} + h\left(\frac{s_3 - s_0}{m^2_{\pi^+}}\right)^2 + j\,\frac{(s_2 - s_1)}{m^2_{\pi^+}} + k\left(\frac{s_2 - s_1}{m^2_{\pi^+}}\right)^2 + \ldots, \qquad (1)$$

where

$$s_i = (p_K - p_i)^2 = (m_K - m_i)^2 - 2m_K T_i \qquad (2)$$

$$s_0 = \frac{1}{3}\sum s_i = \frac{1}{3}\,(m_K^2 + m_1^2 + m_2^2 + m_3^2) \qquad (3)$$

p_K, p_i are the four-vectors for the K and the i^{th} pion, and the index 3 refers to the odd pion, i.e., the third pion in the decays listed below. (4)

We refer to the three possible charged decays as τ, τ', and τ^0:

$\tau^{\pm}$	$K^{\pm} \to \pi^{\pm}\pi^{\pm}\pi^{\mp}$
$\tau'^{\pm}$	$K^{\pm} \to \pi^0\pi^0\pi^{\pm}$
τ^0	$K^0_L \to \pi^+\pi^-\pi^0$

The measurements of g vary considerably beyond the authors' quoted errors as can be seen in the ideograms associated with the GT+, GT-, and GTP subsections of the $K^{\pm}$ Data Card Listings and the GT0 subsection of the K^0_L Listings. Appendix I discusses tests of the $\Delta I = 1/2$ rule utilizing these slopes.

There is no indication of a CP-violating asymmetry in K^0_L decay as measured by the asymmetry parameter $\sigma_{\pm}$ (equivalent to j) given in subsection A of the K^0_L Listings.

There is conflicting evidence regarding the presence or absence of the second order terms in Eq. (1), even when only the high-statistics experiments are considered. In $K^0_L \to \pi^+\pi^-\pi^0$, MESSNER 74 find a significant h and k, while others find them smaller or consistent with zero. The results on h for the high-statistics experiments are as follows:

Data Card Listings

For notation, see key at front of Listings.

Stable Particles

$K^{\pm}$

Experiment	Number of events	Value of h
MESSNER 74	509 K	$+0.079 \pm 0.007$
BUCHANAN 75	56 K	$+0.041 \pm 0.024$
BUCHANAN 70	36 K	consistent with 0
ALBROW 70	29 K	-0.009 ± 0.016
BISI 74	20 K	0.000 ± 0.009

All values other than MESSNER 74 have been converted by us from the authors' parametrizations into the parametrization of Eq. (1) above.

FORD 72 (1.5M events) have studied $K^{\pm} \to \pi^{\pm}\pi^{\pm}\pi^{\mp}$ and find that the χ^2/DF goes from 1.38 to 1.20 for DF $\approx$ 150 when the second order and the CP violation terms are added. However, the authors state that since their Coulomb correction is larger than the experimental errors and is not well known, it is difficult to interpret these results. LUCASI 73 (81K $K^- \to \pi^-\pi^-\pi^+$ events) note a quadratic behavior in their data, but find that it can be explained by normal measurement error and subsequent fitting, which together result in a depletion of events in the center of the Dalitz plot and a bunching of events near the kinematic limit. Because of this they state that it is not appropriate for them to quote a value of the quadratic coefficient. MAST 69 (51K $K^- \to \pi^-\pi^-\pi^+$ events), HOFFMASTER 72 (40K $K^+ \to \pi^+\pi^+\pi^-$ events) and SMITH 75 (27K $K^{\pm} \to \pi^0\pi^0\pi^{\pm}$ events) also find no evidence for quadratic behavior.

HEUSSE 70 have studied the $K_L^0 \to \pi^0\pi^0\pi^0$ decay where only a second order term could explain deviation from uniformity of the Dalitz plot. They also get results consistent with a zero coefficient.

We list the value of g obtained when the quadratic terms were dropped from the fit unless otherwise noted in the data card footnotes.

In the literature other definitions of slope parameters have appeared. We have converted to the definition of g in Eq. (1) whatever experimental quantity has been reported. We give the conversion to the definition (1) for the most widely used parametrizations and tabulate the conversion factors for the reader's convenience.

a) For analysis of charged K's the expression often used is:

$$|M|^2 = 1 + a_y Y$$

with

$$Y = \frac{3T_3 - Q}{Q} , \qquad Q = m_K - \sum m_i .$$

The relevant formulae are:

$$Y = -\frac{3}{2}\,\frac{s_3 - s_0}{m_K Q} + \Delta$$

with

$$\Delta = \frac{m_1 - m_3}{Q}\left(2 - \frac{m_3 + m_1}{m_K}\right)$$

and

$$\boxed{g = \frac{-c_y a_y}{1 + a_y \Delta}} , \qquad \text{with} \quad c_y = \frac{3}{2}\,\frac{m_{\pi^+}^2}{m_K Q} .$$

b) For the analysis of K^0 decay the expression often used is:

$$|M|^2 = 1 + 2a_t \frac{m_K}{m_{\pi^+}^2}(2T_3 - T_{3max})$$

with

$$T_{3max} = \frac{m_K^2 + m_3^2 - 4m_{12}^2}{2m_K} - m_3 .$$

The relevant transformations are

$$T_3 = -\frac{s_3 - s_0}{2m_K} + \frac{Q}{3}(1 + \Delta)$$

and

$$\boxed{g = \frac{-2a_t}{1 + a_t c_t}} ,$$

with

$$c_t = \frac{2m_K}{m_{\pi^+}^2}\left[\frac{2}{3}Q(1+\Delta) - T_{3max}\right] .$$

c) Other K^0 authors use the same form of matrix element as given in b) above, but define

$$T_{3max} = \frac{2}{3}Q .$$

Stable Particles

$K^{\pm}$

Data Card Listings

For notation, see key at front of Listings.

The relevant transformation is then

$$\boxed{g = \frac{-2a_u}{1 + a_u c_u}} \quad , \text{ with } \quad c_u = \frac{4m_K}{3m_{\pi^+}^2} Q\Delta \ .$$

d) Older K^0 analyses were done using

$$|M|^2 = 1 + a_v \frac{T_3}{m_K} \ .$$

The relevant transformation is then

$$\boxed{g = \frac{-c_v a_v}{1 + d_v a_v}} \quad , \text{ with } \quad c_v = \frac{m_{\pi^+}^2}{2m_K^2}$$

and

$$d_v = \frac{Q}{3m_K}(1 + \Delta) \ .$$

For the reader's convenience we give a table of numerical values for Q, T_{3max}, Δ, c_y, and c_t, obtained using the masses from the current edition.

	$\tau^{\pm}$	$\tau'^{\pm}$	τ^0
Q	75.00	84.21	83.60
T_{3max}	48.10	53.22	53.91
Δ	0.0	−0.0789	0.0798
c_y	0.7891	0.7028	0.7023
c_t	0.0963	−0.0768	0.3204
c_u	0.0	−0.2247	0.2272
c_v	0.0400	0.0400	0.0393
d_v	0.0506	0.0524	0.0605

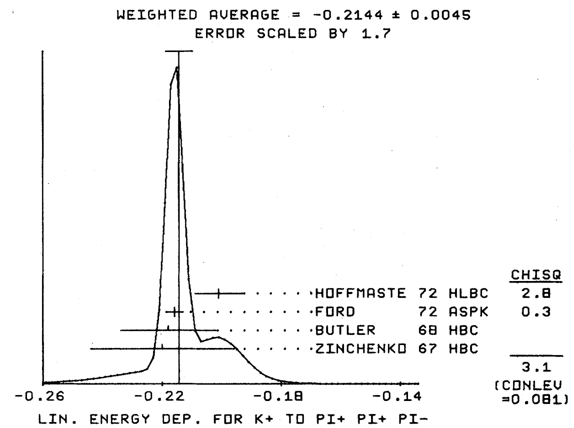
10 CHARGED K ENERGY DEPENDENCE OF DALITZ PLOT

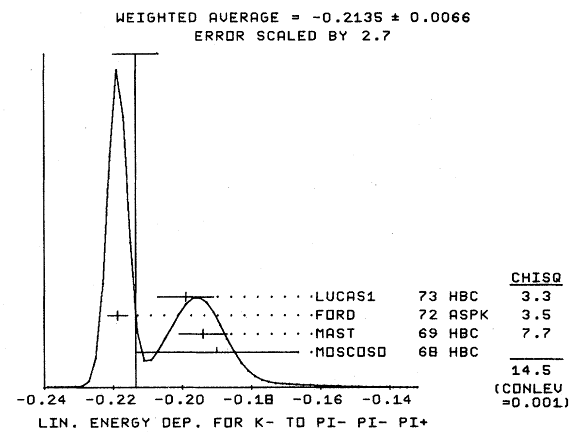
RELATED TEXT SECTION VI B.1, APPENDIX I, AND MINI-REVIEW ABOVE

MATRIX ELEMENT SQUARED = 1 + G (S3-S0)/(MPI+**2)

```
GT+  LINEAR ENERGY DEPENDENCE (G) FOR TAU DECAYS  K+ INTO PI+ PI+ PI-
GT+     THESE EXPTS FIT M**2=1+AY*Y. WE LIST G IN THE MAIN LISTING AND
GT+     GIVE AY AT RIGHT. G=-1.5*AY*(MPI**2)/(MK*Q). SEE NOTE ABOVE.
GT+Z  5428   -0.22     0.024           ZINCHENKO 67 HBC  +  AY=0.28+-.03       10/69
GT+   9994   -0.218    0.016           BUTLER    68 HBC  +  AY=0.277+-.020     10/69
GT+ G17898  (-0.196)  (0.012)          GRAUMAN   70 HLBC +  AY=0.228+-.030      8/70
GT+Q  750K   -0.2158   0.0028          FORD      72 ASPK +  AY=0.2734+-.0035    4/72
GT+  39819   -0.201    0.008           HOFFMASTE 72 HLBC +  INCLUDES GRAUMAN    1/71
GT+ Q   THIS VALUE OF AY IS FROM A QUADRATIC FIT WITH Y**2 COEF=.030+-.010.     4/72
GT+ Q   A LINEAR FIT IS QUOTED ONLY FOR THEIR COMBINED K+ AND K- SAMPLE.        4/72
GT+ Q   IT GIVES AY=0.2737+-.0032 .  THE QUADRATIC FIT TO THE COMBINED          4/72
GT+ Q   SAMPLE GIVES AY=0.2752+-.0033 AND Y**2 COEFF=0.025+-.010 .              4/72
GT+ Q   (CHISQ/DF)=1.38 FOR LINEAR FIT AND 1.20 FOR QUADRATIC FIT.              1/73
GT+ G   EMULS. DATA ADDED - ALL EVENTS INCLUDED BY HOFFMASTER 72                1/71
GT+ Z   ALSO INCLUDES DBC EVENTS.
GT+          . . . . . . . . .
GT+ AVG      -0.2144   0.0045  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)
GT+ STUDENT  -0.2146   0.0029  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                              (SEE IDEOGRAM BELOW )

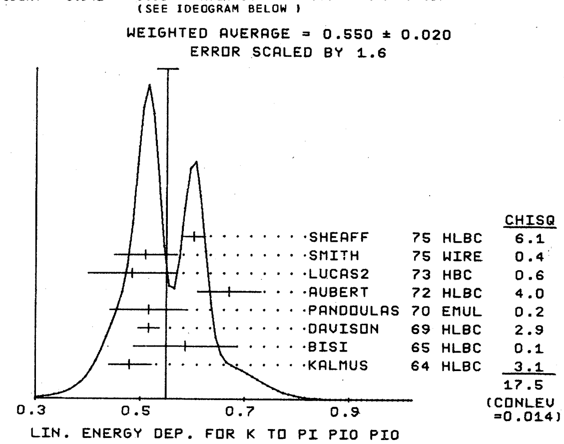
GT-  LINEAR ENERGY DEPENDENCE (G) FOR TAU DECAYS  K- INTO PI- PI- PI+
GT-     FOR DEFINITION OF AY SEE NOTE IN ABOVE SECTION GT+.
GT- F 1347  (-0.220)  (0.035)          FERRO-LUZ 61 HBC  -  AY=0.28+-.045      10/69
GT-M  5778   -0.190    0.023           MOSCOSO   68 HBC  -  AY=0.242+-.029     10/69
GT-  50919   -0.194    0.007           MAST      69 HBC  -  AY=0.247+-.009     10/69
GT-Q  750K   -0.2187   0.0028          FORD      72 ASPK -  AY=0.2770+-.0035    4/72
GT-    81K   -0.199    0.008           LUCAS1    73 HBC  -  AY=0.252+-.011     10/72
GT- Q   THIS VALUE OF AY IS FROM A QUADRATIC FIT WITH Y**2 COEF=.020+-.010.     4/72
GT- Q   SEE ALSO THE NOTE Q IN THE GT+ SECTION ABOVE.                           4/72
GT- F   NO RADIATIVE CORRECTIONS INCLUDED.
GT- M   ALSO INCLUDES DBC EVENTS.
GT-          . . . . . . . . . .
GT- AVG      -0.2135   0.0066  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.7)
GT- STUDENT  -0.2142   0.0039  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                              (SEE IDEOGRAM BELOW )
```






```
DG   ((GT+)-(GT-))/((GT+)+(GT-)) IN PERCENT
DG       A NON-ZERO VALUE FOR THIS QUANTITY INDICATES CP VIOLATION
DG     3.2M   -0.70     0.53           FORD      70 ASPK                       11/70

GTP  LINEAR ENERGY DEPENDENCE (G) FOR TAU PRIME DECAY CHA.K INTO PI PIOPIO
GTP    1792    0.48     0.04           KALMUS    64 HLBC +                     10/69
GTP    1874    0.586    0.098          BISI      65 HLBC +  ALSO HBC           10/69
GTP    4048    0.516    0.020          DAVISON   69 HLBC +  ALSO EMUL          10/69
GTP     198    0.516    0.074          PANDOULAS 70 EMUL +                     10/70
GTP  A1365     0.67     0.06           AUBERT    72 HLBC                        1/73
GTP     574    0.484    0.084          LUCAS2    73 HBC  -  DALITZ PRS ONLY     9/73
GTP  S 27K     0.510    0.060          SMITH     75 WIRE +                     12/75*
GTP    5635    0.602    0.021          SHEAFF    75 HLBC +                      2/76*
GTP  A  WE GIVE LINEAR TERM OF HIGHER ORDER FIT. EQ.I OF APP.II,AUBERT 72.      1/73
GTP  S  SMITH 75 MEASURES QUADRATIC COEFFICIENT H=0.009+-0.040.                12/75*
GTP          . . . . . . . . . .
GTP AVG        0.550    0.020   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.6)
GTP STUDENT    0.542    0.019   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                               (SEE IDEOGRAM BELOW )
```



Data Card Listings

For notation, see key at front of Listings.

Stable Particles

$K^{\pm}$

Note on $K^{\pm}_{\ell 3}$ and $K^0_{\ell 3}$ Form Factors

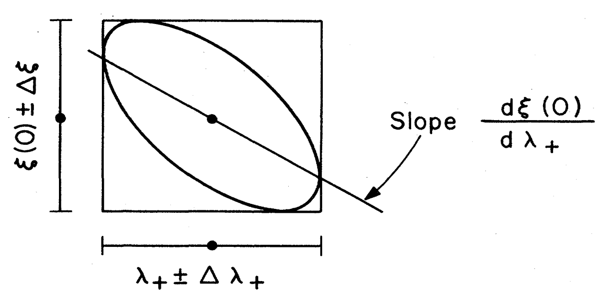
Definitions of the parameters λ_+, $\xi(0)$, λ_0, $|f_S/f_+|$ and $|f_T/f_+|$ and a general discussion of the methods of analysis are given in Section VI B.2 of the text.

This note describes the contents of the Data Card Listings for the two $K_{\mu 3}$ parametrizations, $(\lambda_+, \xi(0))$ and (λ_+, λ_0), which were discussed in the text. Problems related to our data entries for individual experiments are discussed and a comparison of results is given.

$K_{\mu 3}$ Experiments

The matrix element for $K_{\mu 3}$ decay, assuming a pure vector current, is given by Eq. (2) in Section VI B.2 of the text. Most experiments appear to be compatible with the assumption that f_+ depends linearly on t and that f_- is constant. Only DALLY 72 ($K^0_{\mu 3}$) appears to require $\lambda_- \neq 0$ (by about three standard deviations). A single data bin at low q^2 seems to be responsible. The effect is not observed in the high-statistics experiment of DONALDSON2 74 (also $K^0_{\mu 3}$).

λ_+, $\xi(0)$ Parametrization: λ_+ data from $K_{\mu 3}$ decay are entered into the $K^{\pm}$ and K^0_L sections of the Data Card Listings in subsection L+M. The corresponding $\xi(0)$ values are entered in subsection XIA, XIB, or XIC, depending on whether Method A, B, or C, discussed below and in the text, was used. The data cards contain the values, one-standard-deviation errors $\Delta\lambda_+$ and $\Delta\xi(0)$, as well as the correlation $d\xi(0)/d\lambda_+$, all indicated on the $e^{-1/2}$ likelihood contour below. The correlations are given on the right side of the $\xi(0)$ data cards.



XBL 743-2682

λ_+, λ_0 Parametrization: This parametrization is used in recent $K_{\mu 3}$ analyses. To facilitate comparison between experiments, we convert earlier experiments from the $(\lambda_+, \xi(0))$ parametrization to (λ_+, λ_0) whenever possible (i.e., when λ_+ and $\xi(0)$ values, errors, and correlations are given). The transformation between these parametrizations is:

$$\lambda_0 = \lambda_+ + a\xi(0) ,$$

$$\Delta\lambda_0^2 = (1 + 2a \frac{d\xi(0)}{d\lambda_+}) \Delta\lambda_+^2 + a^2\Delta\xi^2 ,$$

$$\frac{d\lambda_0}{d\lambda_+} = 1 + a \frac{d\xi(0)}{d\lambda_+} ,$$

where $a = m_\pi^2/(m_K^2 - m_\pi^2)$. The λ_0 value, the one-standard-deviation error $\Delta\lambda_0$, and the correlation $d\lambda_0/d\lambda_+$ are given in subsection L0 of the data cards.

We also convert (λ_+, λ_0) results into the $(\lambda_+, \xi(0))$ parametrization whenever possible so that subsection L0 is essentially equivalent to the three subsections XIA, XIB, and XIC.

Individual analyses have used a variety of parametrizations. Problems arise when trying to express their results in terms of the parametrizations used here. The discussion of these problems is divided into three sections corresponding to the three methods of analyses discussed in the text.

Method A: Dalitz plot analyses and pion spectrum analyses usually determine λ_+ and $\xi(0)$ (or λ_0) values, errors, and correlation. Such measurements are entered in the L+M, XIA, and L0 subsections. They give rise to the error ellipses shown in Figs. 1 and 2.

Some analyses of this type fix λ_+ and determine $\xi(0)$, e.g., CARPENTER 66 and PEACH 73 (both $K^0_{\mu 3}$). We enter $\xi(0)$ and $d\xi(0)/d\lambda_+$ in the XIA section and give the fixed λ_+ value in the data card footnote. The $\xi(0)$ error is parenthesized because it does not include the uncertainty in the value of λ_+. These results, transformed to λ_0 measurements, give rise to bands in Fig. 2.

In some cases, we alter an error from its published value in order to obtain an error ellipse with a width which matches the error in $\xi(0)$ for

Stable Particles

$K^{\pm}$

Data Card Listings

For notation, see key at front of Listings.

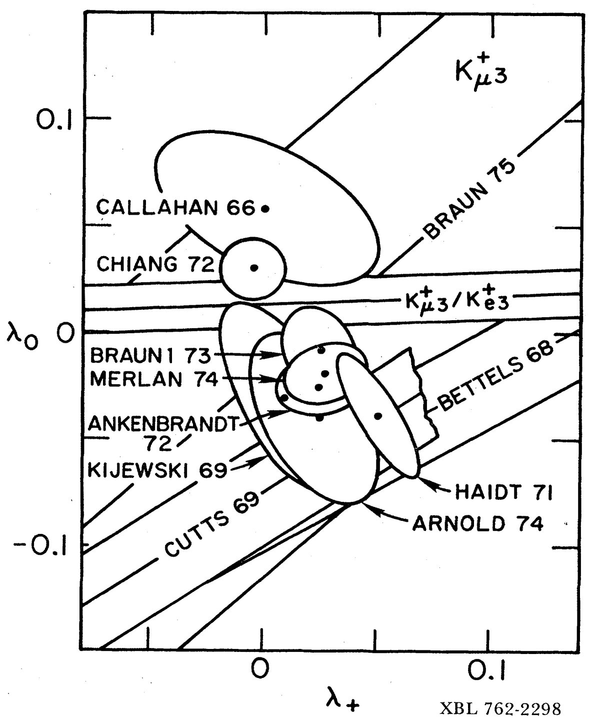


Fig. 1. One-standard-deviation ($e^{-1/2}$) likelihood contours in the (λ_+,λ_0) plane for $K^+_{\mu3}$.

fixed λ_+. These adjustments are noted in the $\xi(0)$ data card footnotes, e.g., for CALLAHAN1 66 and HAIDT 71 (K^+ subsection XIA), where the published errors and correlation violate the constraint $|c_{\lambda\xi}| < 1$ on the normalized correlation coefficient $c_{\lambda\xi}$ given by

$$c_{\lambda\xi} = \frac{\Delta\lambda_+}{\Delta\xi}\;\frac{d\xi(0)}{d\lambda_+} \;.$$

In some cases, e.g., BRAUN1 73, the parametrization used is λ_+, $\xi(0)$, $\xi(t^*)$, where t^* is the weighted average of t with weighting according to the sensitivity to ξ. In this case we do not use $\xi(0)$. It is a badly determined parameter comparable to λ_- or the slope of $\xi(t)$. Instead, we use

$$\xi(0) = \xi(t^*)(1 + \lambda_+ t^*) \quad ,$$

$$\frac{d\xi(0)}{d\lambda_+} = \frac{d\xi(t^*)}{d\lambda_+}(1 + \lambda_+ t^*) + \xi(t^*)t^* \quad .$$

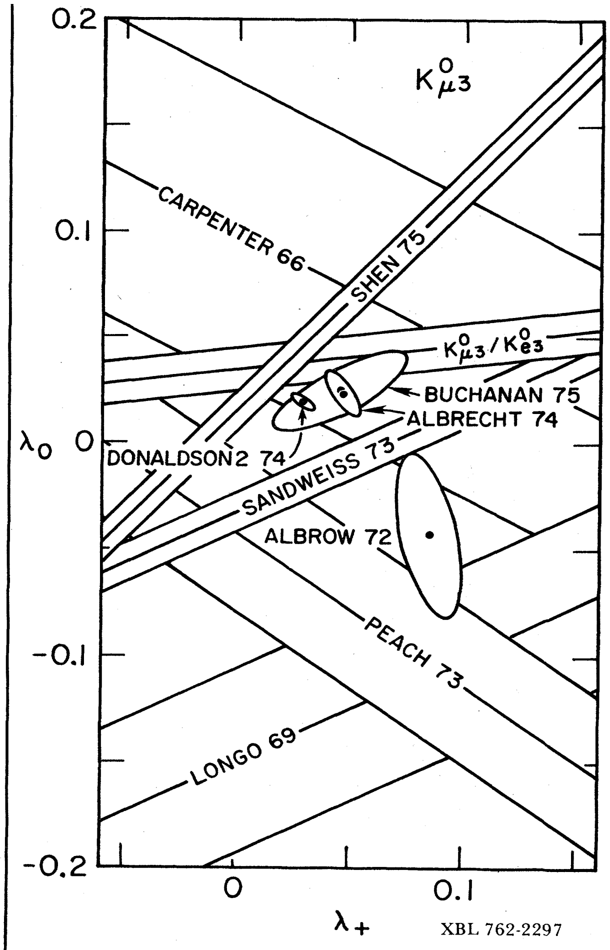


Fig. 2. One-standard-deviation ($e^{-1/2}$) likelihood contours in the (λ_+,λ_0) plane for $K^0_{\mu3}$.

With the BRAUN1 73 values, $\lambda_+ = 0.027$, $\xi(6.6) = -0.34 \pm 0.20$, and $d\xi(6.6)/d\lambda_+ = -14$, we obtain

$$\xi(0) = (-0.40 \pm 0.24) - 19(\lambda_+ - 0.027) \;;$$

or for their fitted $\lambda_+ = 0.025 \pm 0.017$, we get $\xi(0) = -0.36 \pm 0.40$.

Method B: Branching ratio experiments cannot determine λ_+ and $\xi(0)$ simultaneously, but simply fix a relationship between them, given in Section VI B.2 of the text. Results are usually quoted as values of $\xi(0)$ at fixed λ_+. We list these results in subsection XIB, but we do not average them because the λ_+ values differ. Instead, we compute a combined result by using the relations in the

Data Card Listings

For notation, see key at front of Listings.

Stable Particles

$K^{\pm}$

text and our fitted values of $\Gamma(K^{\pm}_{\mu 3})/\Gamma(K^{\pm}_{e3})$ and $\Gamma(K^{0}_{\mu 3})/\Gamma(K^{0}_{e3})$, which include the branching ratios from these experiments. The branching ratios from our current edition and the results for $\xi(0)$ and λ_0 evaluated at $\lambda_+ = 0.030$ are

	$K^{\pm}$	K^0_L
$\Gamma(K_{\mu 3})/\Gamma(K_{e3})$	0.663 ± .018(S=1.7)	0.696 ± .017
$\xi(0)$	−0.20 ± .15 (S=1.7)	+0.09 ± .13
$d\xi(0)/d\lambda_+$	−11.9	−10.3
λ_0	+0.014 ± .012(S=1.7)	+0.038 ± .011
$d\lambda_0/d\lambda_+$	+0.04	+0.12

The scale factor S is the amount by which the error has been multiplied in order to compensate for discrepancies in the branching ratios. These λ_0 results give rise to the $K_{\mu 3}/K_{e3}$ bands in Figs. 1 and 2.

Method C: Polarization experiments measure $\langle\xi(t)\rangle$, the weighted average of $\xi(t)$ over the t range of the experiment, where the weighting accounts for the variation with t of the sensitivity to $\xi(t)$. Such measurements are entered in subsection XIC.

To reinterpret these results in the $(\lambda_+,\xi(0))$ parametrization, we recognize that $\lambda_+ = 0$ corresponds to $\xi(t)$ constant (always assuming $\lambda_- = 0$) so that

$$\xi(0)\Big|_{\lambda_+=0} \equiv \langle\xi(t)\rangle \ .$$

The correlation with λ_+ is given by the following relations (valid for small λ_+):

$$\xi(0) \approx \langle\xi(t)\rangle\left(1 + \lambda_+\left\langle\frac{t}{m_\pi^2}\right\rangle\right) \ ,$$

$$\frac{d\xi(0)}{d\lambda_+} \approx \langle\xi(t)\rangle\left\langle\frac{t}{m_\pi^2}\right\rangle \ ,$$

where $\langle t/m_\pi^2\rangle$ is the average value of t weighted by the sensitivity to $\xi(t)$. These results, transformed to λ_0 and $d\lambda_0/d\lambda_+$ values, are entered in subsection L0 and give rise to bands in Figs. 1 and 2.

In Figs. 1 and 2, we disregard those polarization measurements for which $d\xi(0)/d\lambda_+$ is not obtainable. Also we disregard MERLAN 73 because the signs of $\xi(0)$ and $d\xi(0)/d\lambda_+$ are opposite, whereas the above equation requires them to be the same (since $t > 0$).

Comparison of $K_{\mu 3}$ Experiments: Figures 1 and 2 show the likelihood contours in the (λ_+,λ_0) plane for $K^+_{\mu 3}$ and $K^0_{\mu 3}$ respectively.

The $K^+_{\mu 3}$ Dalitz plot results (ellipses) shown are fairly consistent and appear to cluster between the $K_{\mu 3}/K_{e3}$ result and the polarization results of BETTELS 68 and CUTTS 69. The $K^0_{\mu 3}$ results are much less consistent with a small cluster appearing in the neighborhood of the DONALDSON2 74 result.

χ^2 fits to the results shown in Fig. 1 and Fig. 2 yield the following values for λ_+ and λ_0. The corresponding values of $\xi(0)$ are also given.

	$K^+_{\mu 3}$	$K^0_{\mu 3}$
λ_+	+0.027 ± .008*	+0.034 ± .006*
λ_0	−0.009 ± .007*	+0.021 ± .006*
$d\lambda_0/d\lambda_+$	−0.15	−0.24
χ^2/DF	34/18	72/12
S	1.4	2.5
. . . .	. . . .	. . . .
$\xi(0)$	−0.45 ± .14*	−0.17 ± .10*
$d\xi(0)/d\lambda_+$	−14.	−15.

*All errors have been increased by the scale factor $S = (\chi^2/DF)^{1/2}$ to take into account the discrepancies between measurements.

In view of the large χ^2/DF of these fits, especially $K^0_{\mu 3}$, the fit results should be taken with a grain of salt. The largest contributors to χ^2 in the $K^+_{\mu 3}$ case are CHIANG 72 with 10.4, and the polarization results, BETTELS 68 with 5.4 and CUTTS 69 with 4.2. In the $K^0_{\mu 3}$ case the largest contributors are the polarization results of SANDWEISS 73 with 17, LONGO 69 with 14, and SHEN 75 with 12, and the Dalitz plot results of ALBROW 72 with 11, ALBRECHT 74 with 7.3, and PEACH 73 with 5.3. All other χ^2 values were less than 4.

The DONALDSON2 74 result

$$\lambda_+ = .030 \pm .003$$

$$\lambda_0 = .019 \pm .004$$

Stable Particles

$K^{\pm}$

Data Card Listings

For notation, see key at front of Listings.

clearly dominates the statistics in the $K^0_{\mu 3}$ case. The λ_+ value is consistent with the K_{e3} value of λ_+, and with the pole approximation

$$f_+(t) = f_+(0)\,\frac{m^2_{K^*}}{m^2_{K^*} - t} \quad .$$

Their $f_0(t)$ extrapolates linearly to the Callan-Treiman point. It is less than two standard deviations from the $K_{\mu 3}/K_{e3}$ result.

K_{e3} Experiments

The f_- term of the matrix element [Eq. (2) text Section VI B.2] can be neglected for K_{e3} because it is proportional to the lepton mass. The f_+ term is usually assumed to be linear in $t = q^2 = (P_K - P_\pi)^2$, the square of the four-momentum transfer, i.e., the effective mass of the lepton pair. We quote the linear coefficient λ^e_+ (L+E on the data cards). There has been some suggestion of departure from linearity [CHIEN 71 (K^0_{e3}) and Chounet, Gaillard, and Gaillard[1]—Review] but no compelling evidence. The λ_+ results are fairly consistent and the average values are

$$K^+_{e3}: \quad \lambda_+ = 0.0285 \pm 0.0043$$

$$K^0_{e3}: \quad \lambda_+ = 0.0288 \pm 0.0028 \quad (S = 1.4)$$

where the K^0_{e3} error has been multiplied by the scale factor 1.4 to compensate for inconsistencies (see ideogram in K^0_L section L+E).

Many of the changes in this section were stimulated by the comments and criticism of L. M. Chounet, and by the excellent reviews of Gaillard and Chounet[1] and Chounet, Gaillard, and Gaillard.[2]

References

1. M. K. Gaillard and L. M. Chounet, $K_{\ell 3}$ Form Factors, CERN 70-14 (May 1970), and Phys. Letters 32B, 505 (1970).
2. L. M. Chounet, J. M. Gaillard, and M. K. Gaillard, Physics Reports 4C, 199 (1972).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                10  CHARGED K FORM FACTORS                                    8/67

       RELATED TEXT SECTION VI B.2 AND MINI-REVIEW ABOVE.

       IN THE FORM FACTOR COMMENTS, THE FOLLOWING ABBREVIATIONS ARE USED.
       F+ AND F- ARE FORM FACTORS FOR THE VECTOR MATRIX ELEMENT.
       FS AND FT REFER TO THE SCALAR AND TENSOR TERM.
       FO = (F+) + (F-)*T/(MK**2-MPI**2)
       L+, L- AND LO ARE THE LINEAR EXPANSION COEFFS. OF F+, F- AND FO.
       L+ REFERS TO THE KMU3 VALUE EXCEPT IN THE KE3 SECTIONS.
       DXI/DL IS THE CORRELATION BETWEEN XI(0) AND L+ IN KMU3.
       DLO/DL+ IS THE CORRELATION BETWEEN LO AND L+ IN KMU3.
       T  = MOMENTUM TRANSFER TO THE PI IN UNITS OF MPI**2.
       DP = DALITZ PLOT ANALYSIS
       PI = PI SPECTRUM ANALYSIS
       MU = MU SPECTRUM ANALYSIS
       POL= MU POLARIZATION ANALYSIS
       BR = KMU3/KE3 BRANCHING RATIO ANALYSIS
       E  = POSITRON OR ELECTRON SPECTRUM ANALYSIS
       RC = RADIATIVE CORRECTIONS

XIA    XIA = F-/F+ (DETERMINED FROM SPECTRA)   ---------------------------
XIA    76  (+1.8)     (0.6)            BROWN     62 XEBC +  DP+BR, L+=0        1/74
XIA    87  (+0.7)     (0.5)            GIACOMELL 64 EMUL +  MU+BR RVUE, L+=0   1/74
XIA J      (-0.08)    (0.7)            JENSEN    64 XEBC +  DP+BR(KMU3,KE3)    1/74
XIA  2648   (0.0)     (1.1)     (0.9)  CALLAHA1  66 FRBC +  MU, L+=0, T UNKN   1/74
XIA C 444   +0.72      0.93            CALLAHA1  66 FRBC +  PI, DXI/DL=-17     1/74
XIA    78  (-0.5)     (0.9)            EISLER    68 HLBC +  PI,L+=0,NO DX/DL   1/74
XIA  K2041  -0.5       0.8             KIJEWSKI  69 OSPK +  PI, DXI/DL=-26     1/74
XIA  H3240  -1.1       0.56            HAIDT     71 HLBC +  DP, DXI/DL=-29     1/74
XIA  A4025  -0.62      0.28            ANKENBRAN 72 ASPK +  PI, DXI/DL=-12     1/74
XIA  B3480  +0.45      0.28            CHIANG    72 OSPK +  DP, DXI/DL=-15     1/74
XIA  D1897  -0.36      0.40            BRAUN1    73 HLBC +  DP, DXI/DL=-19     3/74
XIA  N 490  -0.8       0.8             ARNOLD    74 HLBC +  DP, DXI/DL=-20    11/75*
XIA  M6527  -0.57      0.24            MERLAN    74 ASPK +  DP, DXI/DL= -9     3/74
XIA J   JENSEN 64 GIVES L+M=L+E=-.020+-.027. DXI/DL UNKNOWN. INCLUDES         1/74
XIA J   SHAKLEE 64 XIB(KMU3/KE3).                                             1/74
XIA  C  CALLAHAN 66 TABLE 1 (PI ANAL) GIVES DXI/DL=(.72-.05)/(0-.04)=-17,     1/74
XIA  C  ERROR RAISED FROM .80 TO AGREE WITH DXIO=.37 FOR FIXED L+.            1/74
XIA  K  KIJEWSKI 69 FIG. 17 WAS USED TO OBTAIN DXI/DL AND ERRORS.             1/74
XIA  H  HAIDT 71 TABLE 8 (DP ANAL) GIVES DXI/DL=(-1.1+0.5)/(.050-.029)=-29,   1/74
XIA  H  ERROR RAISED FROM .50 TO AGREE WITH DXIO=.20 FOR FIXED L+.            1/74
XIA  A  ANKENBRANDT 72 FIG. 3 WAS USED TO OBTAIN DXI/DL.                      1/74
XIA  B  CHIANG 72 FIG. 10 WAS USED TO OBTAIN DXI/DL.                          1/74
XIA  B  FIT HAD L-=L+ BUT WOULD NOT CHANGE FOR L-=0.  L.PONDROM,PRIV.COM.74   1/74
XIA  D  BRAUN1 73 GIVES XI(T)=-.34+-.20, DXI(T)/DL+=-14 FOR L+=.027, T=6.6.   3/74
XIA  D  WE CALCULATE ABOVE XI(0) AND DXI(0)/DL+ FOR THEIR L+=.025+-.017 .     3/74
XIA  N  ARNOLD 74 FIG. 4 WAS USED TO OBTAIN XIA AND DXI/DL.                  11/75*
XIA  M  MERLAN 74 FIG.5 WAS USED TO OBTAIN DXI/DL.                            3/74
XIA        . . . . . . . . .
XIA FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS ABOVE.

XIB    XIB = F-/F+ (DETERMINED FROM KMU3/KE3)   ---------------------------
XIB     THE KMU3/KE3 BRANCHING RATIO FIXES A RELATIONSHIP BETWEEN XI(0)       1/74
XIB     AND L+.  WE QUOTE THE AUTHORS XI(0) AND ASSOCIATED L+ BUT DO NOT      1/74
XIB     AVERAGE BECAUSE THE L+ VALUES DIFFER.  THE FIT RESULT AND SCALE       1/74
XIB     FACTOR GIVEN IN THE ABOVE NOTE ON KL3 FORM FACTORS ARE NOT OBTAINED   2/76*
XIB     FROM THESE XIB VALUES.  INSTEAD THEY ARE OBTAINED DIRECTLY FROM THE   2/76*
XIB     FITTED KMU3/KE3 RATIO (R29).                                          2/76*
XIB         -0.17      0.75      0.99  SHAKLEE   64 XEBC +  BR, L+=0           1/74
XIB         +0.6       0.5             BISI 1    65 HBC  +  BR, L+=0           1/74
XIB    500  +0.8       0.6             CUTTS     65 OSPK +  BR, L+=0           1/74
XIB    636  +0.4       0.4             CALLAHA1  66 FRBC +  BR, L+=0           1/74
XIB    306  +0.75      0.50            AUERBACH  67 OSPK +  BR, L+=0           1/74
XIB B 5601 (-0.08)    (0.15)           BOTTERIL2 68 ASPK +  BR,L+=.023+-.008   1/74
XIB E 1398 (-0.60)    (0.20)           EICHTEN   68 HLBC +  BR, SEE NOTE E     1/74
XIB    986  +1.0       0.6             GARLAND   68 OSPK +  BR, L+=0           1/74
XIB         +0.91      0.82            ZELLER    69 ASPK +  BR, L+=.023        1/74
XIB  B      -0.35      0.22            BOTTERIL  70 OSPK +  BR,L+=.045+-.015   1/74
XIB  E1505  -0.81      0.27            HAIDT     71 HLBC +  BR,L+=.028,FIG.8   1/74
XIB   5825   0.0       0.15            CHIANG    72 OSPK +  BR,L+=.03,FIG.10   1/74
XIB  B  BOTTERIL 70 IS REEVALUATION OF BOTTERIL 2 68 WITH DIFFERENT L+.       1/74
XIB E   EICHTEN 68 HAS L+=.023+-.008, T=4, INDEP. OF L-. REPL. BY HAIDT 71.   1/74
XIB        . . . . . . . . .
XIB FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS ABOVE.

XIC    XIC = F-/F+ (DETERMINED FROM MU POLARIZATION IN KMU3)   ------------
XIC     THE MU POLARIZATION IS A MEASURE OF XI(T). NO ASSUMPTIONS ON L+-
XIC     NECESSARY, T (WEIGHTED BY SENSITIVITY TO XIO) SHOULD BE SPECIFIED.
XIC    IN L+,XI(0) PARAMETERIZATION THIS IS XI(0) FOR L+=0.  DXI/DL=XI*T.
XIC     FOR RAD. CORR. TO MUON POLARIZATION IN KMU3 SEE GINSBERG 71.
XIC T 2100  (+1.2)    (2.4)     (1.8)  BORREANI  65 HLBC +  POLARIZATION       8/67
XIC T  500 BTWN -4.0 AND +1.7          CUTTS     65 OSPK +  LONG. POL.         1/74
XIC T  397  (-1.4)    (1.8)            CALLAHA1  66 FRBC +  TOTAL POL.         8/67
XIC T 2950  (-0.7)    (0.9)     (3.3)  CALLAHA1  66 FRBC +  LONG. POL.         8/67
XIC  B6000  -1.0       0.3             BETTELS   68 HLBC +  TOTAL POL. T=4.9   1/74
XIC  C3133  -0.95      0.3             CUTTS     69 OSPK +  TOTAL POL. T=4.0   1/74
XIC M  40K (-0.64)    (0.27)           MERLAN    74 ASPK +  POL,DXI/DL=+1.7    3/74
XIC  D1585  -0.25      1.20            BRAUN     75 HLBC +  POL. T=4.2         1/76*
XIC T   T VALUE NOT GIVEN.
XIC  B  BETTELS 68 DXI/DL=XI*T=-1.0*4.9=-4.9 .
XIC  C  CUTTS 69 T=4.0 WAS CALCULATED FROM FIG.8. DXI/DL=XI*T=-.95*4=-3.8 .  1/74
XIC M   MERLAN 74 POLARIZATION RESULT (FIG.5) NOT POSSIBLE.  SEE DISCUSSION   1/76*
XIC M   OF POLARIZATION EXPERIMENTS IN NOTE ON KL3 FORM FACTORS ABOVE.        1/76*
XIC  D  BRAUN 75 DXI/DL=XI*T=-.25*4.2=-1.0 .                                  1/76*
XIC        . . . . . . . . .
XIC FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS ABOVE.

IXI          IMAGINARY PART OF XI (TEST OF T REVERSAL)   -------------------
IXI   2648   0.0       1.0             CALLAHA1  66 FRBC +  MU                 1/74
IXI    397  +1.6       1.3             CALLAHA1  66 FRBC +  TOTAL POL.         1/74
IXI   2950   0.5       1.4       0.5   CALLAHA1  66 FRBC +  LONG. POL.         1/74
IXI   6000  -0.1       0.3             BETTELS   68 HLBC +  TOTAL POL.         1/74
IXI   3133  -0.3       0.3       0.4   CUTTS     69 OSPK +  TOTAL POL. FIG.7   1/74
IXI        . . . . . . . . .
IXI AVG     -0.09      0.21    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
IXI STUDENT -0.10      0.23    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

L+M    LAMBDA +  (LINEAR ENERGY DEPENDENCE OF F+ IN KMU3 DECAY)   ---------
L+M     SEE ALSO THE CORRESPONDING ENTRIES AND FOOTNOTES IN SECTIONS XIA,
L+M     XIC, AND LO.
L+M     FOR RAD.COR. OF KMU3 DP SEE GINSBURG 70 AND BECHERRAWY 70.            3/74
L+M    444    0.0       0.05           CALLAHA1  66 FRBC +  PI                 1/74
L+M   2041    0.009     0.026          KIJEWSKI  69 OSPK +  PI                 1/74
L+M   3240    0.050     0.018          HAIDT     71 HLBC +  DP                 1/74
L+M  A4025    0.024     0.019          ANKENBRAN 72 ASPK +  PI                 1/74
L+M   3480   -0.006     0.015          CHIANG    72 OSPK +  DP                 1/74
L+M   1897    0.025     0.017          BRAUN1    73 HLBC +  DP                 3/74
L+M    490    0.025     0.030          ARNOLD    74 HLBC +  DP                 7/74*
L+M   6527    0.027     0.019          MERLAN    74 ASPK +  DP                 3/74
L+M  A  ANKENBRANDT 72 L+ FROM FIG.3 TO MATCH DXI/DL. TEXT GIVES .024+-.022   1/74
L+M        . . . . . . . . .
L+M FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS ABOVE.
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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

$K^{\pm}$

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LO      LAMBDA 0 (LINEAR ENERGY DEPENDENCE OF F0 IN KMU3 DECAY)   ----------
LO      WHEREVER POSSIBLE, WE HAVE CONVERTED THE ABOVE VALUES OF XI(0) INTO
LO      VALUES OF LO USING THE ASSOCIATED L+M AND DXI/DL.
LO W    444   +0.058     0.036           CALLAHA1  66 FRBC +  PI,DLO/DL+=-0.37  1/74
LO L   6000   -0.081    (0.024)          BETTELS   68 HLBC +  POL,DLO/DL+=+.60  1/74
LO W   2041   -0.031     0.045           KIJEWSKI  69 OSPK +  PI,DLO/DL+=-1.10  1/74
LO L   3133   -0.077    (0.024)          CUTTS     69 OSPK +  POL,DLO/DL+=+.69  1/74
LO W   3240   -0.039     0.029           HAIDT     71 HLBC +  DP,DLO/DL+=-1.34  1/74
LO W   4025   -0.026     0.013           ANKENBRAN 72 ASPK +  PI,DLO/DL+=+0.03  1/74
LO W   3480   +0.030     0.014           CHIANG    72 OSPK +  DP,DLO/DL+=-0.21  1/74
LO    D1897   -0.008     0.020           BRAUN1    73 HLBC +  DP,DLO/DL+=-0.53  1/76*
LO      490   -0.040     0.040           ARNOLD    74 HLBC +  DP,DLO/DL+=-0.62  7/74*
LO  B        (-0.017)   (0.011)          BRAUN     74 HLBC +  KMU3/KE3 VS. T   11/75*
LO M   6527   -0.019     0.015           MERLAN    74 ASPK +  DP,DLO/DL+=+0.27  3/74
LO L   1585   -0.020     0.097           BRAUN     75 HLBC +  POL,DLO/DL+=+.92  1/76*
LO W     LO CALCULATED BY US FROM XI0, L+M, AND DXI/DL.                          1/74
LO L     LO VALUE IS FOR L+=0.  CALCULATED BY US FROM XI0 AND DXI/DL.            1/74
LO    D  THIS VALUE AND ERROR ARE TAKEN FROM BRAUN 75 BUT CORRESPOND TO THE      1/76*
LO    D  BRAUN1 73 L+M RESULT.  DLO/DL+ IS FROM BRAUN1 73 DXI/DL IN XIA ABV.     1/76*
LO  B    BRAUN 74 IS A COMBINED KMU3-KE3 RESULT.  IT IS NOT INDEPENDENT OF      11/75*
LO  B    BRAUN1 73 (KMU3) AND BRAUN2 73 (KE3) FORM FACTOR RESULTS.              11/75*
LO M     MERLAN 74 LO AND DLO/DL+ WERE CALCULATED BY US FROM XIA, L+M, AND       3/74
LO M     DXI/DL.  THEIR FIG.6 GIVES LO=-0.025+-0.012 AND NO DLO/DL+.             3/74
LO              . . . . . . . .
LO  FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS ABOVE.

L+E     LAMBDA +  (LINEAR ENERGY DEPENDENCE OF F+ IN KE3 DECAY)   ---------
L+E     FOR RAD.COR. OF KE3 DP SEE GINSBURG 67 AND BECHERRAWY 70.               3/74
L+E     217   +0.036     .045            BROWN     62 XEBC +  PI, NO RC
L+E     407   -0.010     .029            JENSEN    64 XEBC +  PI, NO RC         8/67
L+E     230   -0.04      .05             BORREANI  64 HBC  +  E+, NO RC         8/67
L+E     854    0.045     0.017   0.018 BELLOTT2  67 FBC  +  DP, USES RC       11/67
L+E    1393   +0.016     .016            IMLAY     67 OSPK +  DP, NO RC         8/67
L+E     515   +0.028     .013     .014 KALMUS    67 FBC  +  E+, PI, NO RC     8/67
L+E     960    .08       .04             BOTTERIL1 68 ASPK +  E+, USES RC     . 6/68
L+E      90   -0.02      0.08     0.12 EISLER    68 HLBC +  PI, USES RC       6/68
L+E    1458    .045      .015            BOTTERIL  70 OSPK    PI, USES RC      10/69
L+E    2707    0.027     0.010           STEINER   71 HLBC +  DP, USES RC      11/71
L+E    4017    0.029     0.011           CHIANG    72 OSPK +  DP, RC NEGLIGBLE  9/72
L+E   A        0.027     0.008           BRAUN2    73 HLBC +  DP, NO RC         3/74
L+E B         (0.025)   (0.007)          BRAUN     74 HLBC +  KMU3/KE3 VS. T   11/75*
L+E   A  BRAUN2 73 STATES THAT RC OF GINSBERG 67 WOULD LOWER L+E BY .002 BUT    3/74
L+E   A  THAT RC OF BECHERRAWY DISAGREES AND WOULD RAISE L+E BY .005 .           1/76*
L+E B    BRAUN 74 IS A COMBINED KMU3-KE3 RESULT.  IT IS NOT INDEPENDENT OF      11/75*
L+E B    BRAUN1 73 (KMU3) AND BRAUN2 73 (KE3) FORM FACTOR RESULTS.              11/75*
L+E             . . . . . . . .
L+E AVG        0.0285    0.0043   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
L+E STUDENT    0.0284    0.0047   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

FS      FS/F+  RATIO OF SCALAR TO F+ COUPLINGS FOR KE3 DECAY(ABS. VALUE)----
FS             .18  OR LESS  CL=.90     BELLOTT2  67 HLBC                      10/69
FS             .30  OR LESS  CL=.95     KALMUS    67 HLBC +                    10/69
FS             0.23 OR LESS  CL=.90     BOTTERIL1 68 ASPK                       8/66
FS     2707    0.14      0.03     0.04  STEINER   71 HLBC +  L+,FS,FT,PHI FIT  2/72
FS     4017    0.13 OR LESS  CL=.90     CHIANG    72 OSPK +                     9/72
FS     2827    0.00      0.10           BRAUN     75 HLBC +                    12/75*
FS              . . . . . . . .
FS  AVG        0.125     0.044    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
FS  STUDENT    0.126     0.037    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

FT      FT/F+  RATIO OF TENSOR TO F+ COUPLINGS FOR KE3 DECAY(ABS. VALUE)----
FT             .58  OR LESS  CL=.90     BELLOTT2  67 HLBC                      10/69
FT             1.1  OR LESS  CL=.95     KALMUS    67 HLBC +                    10/69
FT             0.58 OR LESS  CL=.90     BOTTERIL1 68 ASPK                       8/66
FT     2707    0.24      0.16     0.14  STEINER   71 HLBC +  L+,FS,FT,PHI FIT  2/72
FT     4017    0.75 OR LESS  CL=.90     CHIANG    72 OSPK +                     9/72
FT     2827    0.07      0.37           BRAUN     75 HLBC +                    12/75*
FT              . . . . . . . .
FT  AVG        0.22      0.14     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
FT  STUDENT    0.22      0.15     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

FTM     FT/F+  RATIO OF TENSOR TO F+ COUPLINGS FOR KMU3 DECAY   -----------
FTM    1585    0.02      0.12           BRAUN     75 HLBC                       1/76*

KE4     KE4 DECAY FORM FACTORS ARE GIVEN IN THE FOLLOWING PAPERS
KE4                                     BASILE    71 ASPK +                    11/75*
KE4                                     BEIER     73 OSPK +-                   11/75*

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REFERENCES FOR CHARGED K


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BIRGE    56 NC    4   834      BIRGE,PERKINS,PETERSON,STORK,WHITEHEA (LFL)
ILOFF    56 PR 102   927       ILOFF,GOLDHABER,LANNUTTI,GILBERT +    (LRL)
ALEXANDE 57 NC    6   478      ALEXANDER,JOHNSTON,OCEALLAIGH (DUBLIN INST)
COHEN    57 FUND.CONS.PHYS.    +CROWE,DUMOND      (ATOMICS INTER.+LRL+CIT)
EISENBER 58 NC    8  663       EISENBERG,KOCH,LOHRMANN,NIKOLIC +    (BERN)
BURROWES 59 PRL   2  117       BURROWES,CALDWELL,FRISCH,HILL +       (MIT)
TAYLOR   59 PR 114   359       S TAYLOR,HARRIS,OREAR,LEE,BAUMEL (COLUMBIA)

FREDEN   60 PR 118   564       S C FREDEN,F C GILBERT,R S WHITE      (LRL)
BARKAS   61 PR 124 1209        BARKAS,DYER,MASON,NORRIS,NICKOLS,SMIT (LRL)
BHOWMIK  61 NC  20   857       B BHOWMIK,P C JAIN,P C MATHUR (DELHI UNIV)
FERRO-LU 61 NC    22  1087     FERRO-LUZZI,MILLER,MURRAY,ROSENFELD+  (LRL)
NORDIN   61 PR 123 2166        PAUL NORDIN JR                        (LRL)
ROE      61 PRL   7  346       ROE,SINCLAIR,BROWN,GLASER +      (MICH+LRL)
BOYARSKI 62 PR 128 2398        BOYARSKI,LOH,NIEMELA,RITSON           (MIT)
BROWN    62 PRL   8  450       BROWN,KADYK,TRILLING,ROE+        (LRL,MICH)
BARKAS   63 PRL 11    26       W H BARKAS,J N DYER,H H HECKMAN       (LRL)

BORREANI 64 PL    12 123       G BORREANI,G RINAUDO,A WERBROUCK    (TURIN)
CALLAHAN 64 PR   136 B 1463    A CALLAHAN,R MARCH,R STARK      (WISCONSIN)
CAMERINI 64 PRL   13 318       CAMERINI,CLINE,FRY,POWELL   (WISCONSIN+LRL)
CLINE    64 PRL   13 101       D CLINE, W F FRY                (WISCONSIN)
GIACOMEL 64 NC 34   1134       GIACOMELLI,MONTI,QUARENI+ (BOLOGNA,MUNICH)
GREINER  64 PRL   13 284       D GREINER, W OSBORNE, W BARKAS        (LRL)
JENSEN   64 PR   136 B1431     JENSEN,SHAKLEE,ROE,SINCLAIR          (MICH)
KALMUS   64 PRL    13   99     +KERNAN,PU,POWELL,DOWD           (LRL,WISC)
SHAKLEE  64 PR   136 B 1423    SHAKLEE,JENSEN,ROE,SINCLAIR          (MICH)

BIRGE    65 PR 139 B 1600      BIRGE,ELY,GIDAL,CAMERINI,CLINE + (LRL+WISC)
BISI     65 NC    35   768     BISI,BORREANI,CESTER,FERRARO +     (TORINO)
BISI 1   65 PR 139 B 1068      BORREANI,MARZARI-CHIESA,RINAUDO+   (TORINO)
BORREANI 65 PR 140 B1686       BORREANI,GIDAL,RINAUDO,CAFORIO+ (BARI,TORI)
CALLAHAN 65 PRL   15   129     A CALLAHAN,D CLINE              (WISCONSIN)
CAMERINI 65 NC 37 1795         +CLINE,GIDAL,KALMUS,KERNAN       (WISC+LRL)
CLINE    65 PL    15   293     A CLINE,W F FRY                 (WISCONSIN)
CUTTS    65 PR 138 B969        CUTTS,ELIOFF,STIENING                 (LRL)

DE MARCO 65 PR 140 B 1430      DE MARCO,GROSSO,RINAUDO       (TORINO+CERN)
FITCH    65 PR 140 B 1088      FITCH,QUARLES,WILKINS(PRINCETON+MT HOLYOKE)
GREINER  65 ARNS  15   67      QUOTED BY BARKAS                      (LRL)
STAMER   65 PR   138 B 440     STAMER,HUETTER,KOLLER,TAYLOR,GRAUMAN (STEV)
TRILLING 65 UCRL 16473         GEORGE H TRILLING                     (LRL)
    UPDATED FROM 1965 ARGONNE  CONF., PAGE 5.
YOUNG    65 UCRL 16362         POH-SHIEN YOUNG (THESIS,BERKELEY)     (LRL)
    ALSO 67 PR 156 1464        P-S YOUNG,W.Z.OSBORNE,W.H.BARKAS      (LRL)

CALLAHA1 66 PR 150 1153        CALLAHAN,CAMERINI+(WISC,LRL,RIVERSIDE,BARI)
CALLAHAN 66 NC   44A 90        A C CALLAHAN                    (WISCONSIN)
CESTER   66 PL 21 343          CESTER,ESCHSTRUTH,ONEILL+  (PRINCETON-PENN)
    ALSO 67 AUERBACH, FOOTNOTE 1.

AUERBACH 67 PR 155  1505       +DOBBS,MANN,MCFARLANE,WHITE+    (PENN,PRIN)
    ALSO 74 PR D9 3216         ERRATUM
BELLOTT1 67 HEIDELBERG CONF    BELLOTTI,PULLIA                     (MILAN)
BELLOTT2 67 NC 52A  1287       BELLOTTI,FIORINI,PULLIA             (MILAN)
    ALSO 66 PL  20  690        BELLOTTI,FIORINI,PULLIA+            (MILAN)
BISI     67 PL 25B  572        BISI,CESTER,CHIESA,VIGONE          (TORINO)
BOTTERIL 67 PRL  19  982       BOTTERILL,BROWN,CORBETT,CULLIGAN + (OXFORD)
    ALSO 68 BOTTERIL
BOWEN    67 PR 154 1314        BOWEN,MANN,MCFARLANE,HUGHES+(PENN-PRINCETO)

CLINE1   67 HEIDELBERG CONF    CLINE,HAGGERTY,SINGLETON,FRY+   (WISCONSIN)
CLINE2   67 HERCEG NOVI TBL.4 D.CLINE,PROC.INTL.SCH.ON ELEM.PART.PHYSICS
FLETCHER 67 PRL   19  98       FLETCHER,BEIER,EDWRADS,+         (ILLINOIS)
FORD     67 PRL 18 1214        +LEMONICK,NAUENBERG,PIROUE      (PRINCETON)
IMLAY    67 PR 160  1203       IMLAY,ESCHSTRUTH,FRANKLIN+      (PRINCETON)
KALMUS   67 PR   159  1187     KALMUS,KERNAN                         (LRL)
ZINCHENK 67 RUTGERS(THESIS)    ZINCHENKO                         (RUTGERS)

BETTELS  68 NC 56A 1106        AACHEN-BARI-BERGEN-CERN-EP-NIJMEGEN-ORSAY+
    ALSO 71 HAIDT
BOTTERIL 68 PR 171 1402        BOTTERILL,BROWN,CLEGG,CORBETT +    (OXFORD)
BOTTERI1 68 PR 174 1661        BOTTERILL,BROWN,CLEGG,CORBETT +    (OXFORD)
BOTTERI2 68 PRL 21 766         BOTTERILL,BROWN,CLEGG,CORBETT +    (OXFORD)
BUTLER   68 UCRL-18420         +BLAND,GOLDHABER,GOLDHABER,HIRATA+    (LRL)
CHANG    68 PRL 20  510        CHANG,YODH,EHRLICH,PLAND+(MARYLAND,RUTGERS)

CHEN     68 PRL 20 73          CHEN,CUTTS,KIJEWSKI,STIENING +    (LRL,MIT)
EICHTEN  68 PL 27B 586         AACHEN-BARI-CERN-EP-ORSAY-PADOVA-VALENCIA
EISLER   68 PR  169  1090      EISLER,FUNG,MARATECK,MEYER,PLANO  (RUTGERS)
ESCHSTRU 68 PR  165  1487      ESCHSTRUTH,FRANKLIN,HUGHES+(PRINCETON,PENN)
GARLAND  68 PR  167  1225      +TSIPIS,DEVONS,ROSEN+  (COLUMBIA,RUTG,WISC)
MOSCOSO  68  THESIS            M L MOSCOSO             (UNIV PARIS ORSAY)

CUTTS    69 PR 184 1380        +STIENING,WIEGAND,DEUTSCH         (LRL,MIT)
    ALSO 68 PRL  20 955        CUTTS,STIENING,WIEGAND,DEUTSCH    (LRL,MIT)
DAVISON  69 PR   180 1333      +BACASTOW,BARKAS,EVANS,FUNG,PORTER+   (UCR)
ELY      69 PR   180 1319      ELY,GIDAL,HAGOPIAN,KALMUS+ (LOUC+WISC+LRL)
EMMERSON 69 PRL 23 393         EMMERSON,QUIRK                     (OXFORD)

HERZO    69 PR 186 1403        +BANNER,BEIER,BERTRAM,EDWARDS +       (ILL)
KIJEWSKI 69 UCRL-18433 THESIS P K KIJEWSKI                          (LBL)
LOBKOWIC 69 PR 185 1676        +MELISSINOS,NAGASHIMA,TEWKSBURY+ (ROCH,BNL)
    ALSO 66 PRL 17 548         LOBKOWICZ,MELISSINOS,NAGASHIM+   (ROCH+BNL)
MACEK    69 PRL   22   32      MACEK,MANN,MC FARLANE,ROBERTS+(PENN,TEMPLE)
MAST     69 PR   183 1200      +GERSHWIN,ALSTON-GARNJOST,BANGERTER+  (LRL)
ZELLER   69 PR   182 1420      ZELLER,HADDOCK,HELLAND,PAHL+     (UCLA,LRL)

BOTTERIL 70 PL 31B 325         +BROWN,CLEGG,CORBETT,CULLIGAN+        (OXF)
FORD     70 PRL 25 1370        +PIROUE,REMMEL,SMITH,SOUDER          (PRIN)
GRAUMAN  70 PR D1 1277         +KOLLER,TAYLOR,PANDOULAS+  (STEV,SETO,LEHI)
    ALSO 69 PRL 23 737         +KOLLER,TAYLOR,PANDOULAS+  (STEV,SETO,LEHI)
MACEK    70 PR D1 1249         +MANN,MCFARLANE,ROBERTS              (PENN)
MALTSEV  70 SJNP 10 678        +PESTOVA,SOLODOVNIKOVA,FADEEV +      (JINR)
PANDOULA 70 PR D2 1205         +TAYLOR,KOLLER,GRAUMAN +        (STEV,SETO)

BASILE   71 PL  36B 619        +BREHIN,DIAMANT-BERGER,KUNZ+    (SACL+GEVA)
BOURQUIN 71 PL  36B 615        +BOYMOND,EXTERMANN,MARASCO+     (GEVA,SACL)
HAIDT    71 PR D3 10           AACHEN+BARI+CERN+EP+NIJMEGEN+ORSAY+PADOVA+
    ALSO 69 PL   29B 691       +(AACH,BARI,CERN,EPOL,NIJM,ORSAY,PADO,TORI)
KLEMS    71 PR D4 66           +HILDEBRAND,STIENING             (CHIC,LRL)
    ALSO 70 PRL 24 1086        KLEMS,HILDEBRAND,STIENING        (LRL,CHIC)
    ALSO 70 PRL 25 473         KLEMS,HILDEBRAND,STIENING        (LRL,CHIC)

KUNSELMA 71 PL 34B 485         R. KUNSELMAN                      (WYOMING)
OTT      71 PR D3 52           OTT,PRITCHARD                        (LOQM)
ROMANO   71 PL 36B 525         +RENTON,AUBERT,BURBAN-LUTZ (BARI,CERN,ORSA)
SCHWEINB 71 PL 36B 246         AACHEN+BELGIUM+CERN+NIJMEGEN+PADOVA COLLAB
STEINER  71 PL 36B 521         AACHEN+BARI+CERN+EPOL+ORSA+NIJM+PADO+TORIN

ABRAMS   72 PRL 29 1118        +CARROLL,KYCIA,LI,MENES,MICHAEL +     (BNL)
ANKENBRA 72 PRL 28 1472        ANKENBRANDT,LARSEN+   (BNL+LASL+FNAL+YALE)
AUBERT   72 NC 12A 509         +HEUSSE,PASCAUD,VIALLE+    (ORSA+BRUX+EPOL)
BEIER    72 PRL 29 678         +BUCHHOLZ,MANN,PARKER        (PENNSYLVANIA)
CHIANG   72 PR D6 1254         +ROSEN,SHAPIRO,HANDLER,OLSEN+   (ROCH+WISC)

CLARK    72 PRL 29 1274        +CORK,ELIOFF,KERTH,MCREYNOLDS,NEWTON+ (LBL)
EDWARDS  72 PR D5 2720         +BEIER,BERTRAM,HERZO,KOESTER +        (ILL)
FORD     72 PL 38B 335         +PIROUE,REMMEL,SMITH,SOUDER     (PRINCETON)
HOFFMAST 72 NP B36 1           HOFFMASTER,KOLLER,TAYLOR+  (STEV+SETO+LEHI)

ABRAMS   73 PRL 30 500         +CARROLL,KYCIA,LI,MENES,MICHAEL +     (BNL)
BACKENST 73 PL 43B 431         BACKENSTOSS,BAMBERGER+(CERN+KARL+HEID+STOH)
BEIER    73 PRL 30 399         +BUCHHOLZ,MANN,PARKER,ROBERTS        (PENN)
BRAUN1   73 PL 47B 182         AACHEN+BARI+BRUSSELS+CERN COLLABORATION
    ALSO 75 BRAUN
BRAUN2   73 PL 47B 185         AACHEN+BARI+BRUSSELS+CERN COLLABORATION
    ALSO 75 BRAUN
CABLE    73 PR D8 3807         +HILDEBRAND,PANG,STIENING         (EFI+LBL)

LJUNG    73 PR D8 1307         D.LJUNG,D.CLINE                      (WISC)
    ALSO 72 PRL 28 523         D.LJUNG                              (WISC)
    ALSO 72 PRL 28 1287        D.CLINE,D.LJUNG                      (WISC)
    ALSO 69 PRL 23 326         CAMERINI,LJUNG,SHEAFF,CLINE          (WISC)
LUCAS1   73 PR D8 719          LUCAS,TAFT,WILLIS                    (YALE)
LUCAS2   73 PR D8 727          LUCAS,TAFT,WILLIS                    (YALE)
PANG     73 PR D8 1989         +HILDEBRAND,CABLE,STIENING   (EFI+ARIZ+LBL)
    ALSO 72 PL 40B 699         CABLE,HILDEBRAND,PANG,STIENING    (EFI+LBL)
SMITH    73 NP B60 411         +BOOTH,RENSHALL,JONES+ (GLAS+LIVP+OXF+RHEL)
ARNOLD   74 PR D9 1221         C L ARNOLD,B P ROE,D SINCLAIR        (MICH)
BRAUN    74 PL 51B 393         +CORNELSSEN,MARTYN +  (AACH+BARI+BRUX+CERN)
CENCE    74 PR D10 776         +HARRIS,JONES,MORGADO +     (HAWA+LBL+WISC)
    ALSO 73 THESIS (UNPUBL.)   D B CLARKE                           (WISC)
KUNSELMA 74 PR C9 2469         R.KUNSELMAN                          (WYOM)
MERLAN   74 PR D9 107          +KASHA,WANDERER,ADAIR+      (YALE+BNL+LASL)
WEISSENB 74 PL 48B 474         WEISSENBERG,EGOROV,MINERVINA +  (ITEP+LEBD)
BLOCH    75 PL 56B 201         +BREHIN,BUNCE,DEVAUX+           (SACL+GEVA)
BRAUN    75 NP B89 210         +CORNELSSEN,MARTYN+   (AACH+BARI+BRUX+CERN)
HEARD1   75 PL 55B 324         +HEINTZE,HEINZELMANN+           (CERN+HEID)
HEARD2   75 PL 55B 327         +HEINTZE,HEINZELMANN+           (CERN+HEID)
SHEAFF   75 PR D12 2570        M. SHEAFF                            (WISC)
SMITH    75 NP B91 45          +BOOTH,RENSHALL,JONES+ (GLAS+LIVP+OXF+RHEL)
HEINTZE  76 PL (TO BE PUBL.)   +HEINZELMANN,IGO-KEMENES,MUNDHENKE+  (HEID)

     QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN THE DATA CARDS

BLOCK    62 CERN CONF 371      BLOCK,LENDINARA,MONARI       (NWES+BOLOGNA)

                               PAPERS NOT REFERRED TO IN DATA CARDS

BRENE    61 NP 22 553          BRENE,EGARDT,QVIST                   (NORD)
BIRGE    63 PRL  11  35        BIRGE,ELY,GIDAL,CAMERINI +  (LRL+WISC+BARI)
ADAIR    64 PL 12  67          ADAIR,LEIPUNER                   (YALE,BNL)
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Stable Particles

$K^{\pm}$, K^0, K^0_S

Data Card Listings

For notation, see key at front of Listings.


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CABIBBO  64 PL   9 352          CABIBBO,MAKSYMOWICZ                   (CERN)
    ALSO 64 PL  11 360          CABIBBO,MAKSYMOWICZ                   (CERN)
    ALSO 65 PL  14  72          CABIBBO,MAKSYMOWICZ                   (CERN)
CABIBBO  66 BERKELEY CONF 33    CABIBBO                               (CERN)
GINSBERG 67 PR 162  1570        EDWARD S GINSBERG         (U. MASS BOSTON)
WILLIS   67 HEIDELBERG 273      W J WILLIS -RAPPORTEUR TALK           (YALE)
CRONIN   68 VIENNA CONF 241     RAPPORTEUR TALK                  (PRINCETON)
HAIDT 2  69 PL 29B 696          + (AACH,BARI,CERN,EPOL,NIJM,ORSA,PADO,TORI)
BARDIN   70 PL 32B 121          BARDIN,BILENKY,PONTECORVO             (JINR)
BECHERRA 70 PR D1 1452          T.BECHERRAWY                          (ROCH)
FEARING  70 PR D3 542           +FISCHBACK,SMITH                 (STON+BOHR)
GAILLARD 70 CERN 70-14          M K GAILLARD, L M CHOUNET        (CERN+ORSA)
GINSBERG 70 PR D1 229           E S GINSBERG                     (IIT HAIFA)
GINSBERG 71 PR D4 2893          E S GINSBERG                           (MIT)
CHOUNET  72 PL 4C 199           (PHYS. REPTS.)CHOUNET,2*GAILLARD(ORSA+CERN)
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K^0 11 NEUTRAL K(498,JP=0-) I=1/2

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                11  NEUTRAL K MASS (MEV)

M              498.1      0.4            CHRISTENS 64 OSPK
M      2223   497.44      0.33           KIM       65 HBC    KO FROM PBAR P   6/66
M      4500   498.9       0.5            BALTAY    66 HBC    KO FROM PBAR P   6/66
M             497.44      0.50           FITCH     67 OSPK                   11/67
M              . . . . . . . . .
M   AVG       497.87      0.32    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
M   STUDENT   497.83      0.26    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
M   FIT       497.70      0.13   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)  2/76*
                          (SEE IDEOGRAM BELOW )
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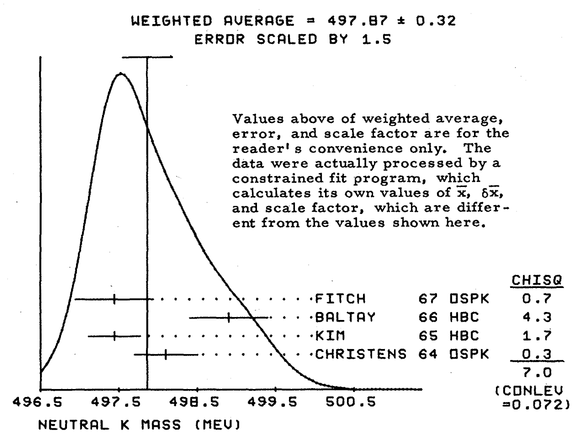


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              11  (KO) - (K+-) MASS DIFFERENCE (MEV)

D              3.9       0.6             ROSENFELD 59 HBC  -
D              5.4       1.1             CRAWFORD  59 HBC  +
D         9    3.90      0.25            BURNSTEIN 65 HBC  -
D         7    3.71      0.35            KIM       65 HBC  -  K- P TO KO N      6/68
D       417    3.95      0.21            HILL      68 DBC  +  K+D TO KOPP       3/68
D             . . . . . . . . .
D   AVG        3.92      0.14    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D   STUDENT    3.91      0.15    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
D   FIT        3.99      0.13   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)  2/76*

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REFERENCES FOR NEUTRAL K


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CRAWFORD 59 PRL   2  112       CRAWFORD,CRESTI,GOOD,STEVENSON,TICHO  (LRL)
ROSENFEL 59 PRL   2  110       A H ROSENFELD,F SOLMITZ,R D TRIPP     (LRL)
CHRISTEN 64 PRL 13 138         CHRISTENSON,CRONIN,FITCH,TURLAY (PRINCETON)
BURNSTEI 65 PR  138 B 895      R A BURNSTEIN,H A RUBIN          (MARYLAND)
KIM      65 PR 140 B 1334      J K KIM,L KIRSCH,D MILLER        (COLUMBIA)
BALTAY   66 PR 142   932       BALTAY,SANDWEISS,STONEHILL +     (YALE+BNL)
FITCH    67 PR 164  1711       FITCH,ROTH,RUSS,VERNON          (PRINCETON)
HILL     68 PR 168  1534       HILL,ROBINSON,SAKITT,CANTER  (BNL,CARNEGIE)
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K^0_S 12 SHORT-LIVED NEUTRAL K(498, JP=0-) I=1/2

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Note on the K^0_S Mean Life

From 1968 until 1972 our average value for the K^0_S mean life was $(0.862 \pm 0.006) \times 10^{-10}$ second. Since then three high-precision experiments, SKJEGGESTAD 72 (Oslo, CERN, Saclay), GEWENIGER 74 (CERN, Heidelberg), and CARITHERS 75 (Columbia, NYU) have obtained results compatible with each other which average $(0.8930 \pm 0.0023) \times 10^{-10}$ second. This is about five standard deviations above the previous average. The origin of this discrepancy is not known.

The corrections for systematic biases in SKJEGGESTAD 72 and HILL 68 (including the correction for the new value of η_{+-}) amount to +1% and 0.7%, respectively. Similar corrections, if applied to the older bubble chamber results, would probably increase the old average by only about one standard deviation and would not account for the discrepancy.

The two experiments which contribute most to the χ^2 (see ideogram below) are KIRSCH 66 and DONALD 68. The combined result of all other experiments is $(0.8914 \pm 0.0021) \times 10^{-10}$ second with a χ^2 of 11.5 for 10 degrees of freedom. This value does not differ significantly from the average of the newer (post-1971) experiments.

Since the newer experiments are in principle superior — that is, they have higher statistics, better acceptance, and easier trigger conditions — we have chosen to average them separately from the older experiments as is seen in the Data Card Listings below. In the Stable Particle Table, we quote the new value, but give the old value in a warning footnote.

```
                    12  KOS MEAN LIFE (UNITS 10**-10 SEC)

T      KOS MEAN LIFE (PRE-1971 EXPERIMENTS)
T   O   90   (1.07)   (0.13)   (0.13) BOLDT      58 CC
T      512    0.94     0.05     0.05  CRAWFORD   59 HBC
T   O   63   (1.09)   (0.18)   (0.15) BOWEN      60 CC
T   O   OLD EXPTS WITH LOW STATISTICS NOT INCLUDED IN AVERAGE.            6/68
T      378    0.94     0.05     0.05  BERTANZA   62 HBC
T      503    0.87     0.05           CHRETIEN   63 HLBC
T      545    0.86     0.04           KREISLER   64 OSPK
T             0.866    0.016          ALFF-STEI  66 OSPK                  9/66
T      572    0.90     0.06     0.05  AUERBACH   66 OSPK                  8/67
T     4500    0.92     0.04           BALTAY     66 HBC                   6/66
T   B        (0.904)  (0.024)         BOTT-BODE  66 OSPK                  9/66
T     5000    0.843    0.013          KIRSCH     66 HBC                   6/66
T    19994    0.856    0.008          DONALD     68 HBC                   6/68
T  H 20000    0.872    0.009          HILL       68 DBC                  11/72
T              . . . . . . . . .
T   AVG       0.8641   0.0065   0.0065 AVERAGE (ERROR INCL. SCALE FACTOR OF 1.3)
T   STUDENT   0.8642   0.0060   0.0059 AVG. USING STUDENT10(H/1.11) -- SEE TEXT
                       (SEE IDEOGRAM BELOW )

T      KOS MEAN LIFE (POST-1971 EXPERIMENTS)
T       THESE VALUES ARE USED TO DETERMINE THE STABLE PARTICLE TABLE
T       VALUES OF THE KOS MEAN LIFE AND RATES.
T  H   50K    0.8958   0.0045         SKJEGGEST  72 HBC                   1/73
T   F 2173   (0.867)  (0.024)         FACKLER    73 OSPK                 11/73
T       6M    0.8937   0.0048         GEWENIGER  74 ASPK                  3/74
T  C          0.8913   0.0032         CARITHERS  75 SPEC                  7/75*
T              . . . . . . . . .
T   AVG       0.8930   0.0023   0.0023 AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)
T   STUDENT   0.8930   0.0025   0.0025 AVG. USING STUDENT10(H/1.11) -- SEE TEXT
T   FIT       0.8930   0.0023 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
                       (SEE IDEOGRAM BELOW )

                    COMMENTS
T  H    HILL 68 HAS BEEN CHANGED BY THE AUTHORS FROM THE PUBLISHED VALUE    11/72
T  H    (0.865+-0.009) BECAUSE OF A CORRECTION IN THE SHIFT DUE TO ETA+-.   11/72
T  H    SKJEGGESTAD 72 AND HILL 68 GIVE DETAILED DISCUSSIONS OF SYSTEMATICS
T  H    ENCOUNTERED IN THIS TYPE OF EXPERIMENT.
T  B    KOS MEAN LIFE NOT THE PRIMARY QUANTITY MEASURED IN THIS EXPT.        6/68
T  F    FACKLER 73 DOES NOT INCLUDE SYSTEMATIC ERRORS.                      11/73
T  C    CARITHERS 75 VALUE IS FOR KOL-KOS MASS DIFFERENCE DM=.5348+-.0021.  11/75*
T  C    THE DM DEPENDENCE OF THE TOTAL DECAY RATE (INVERSE MEAN LIFE) IS    11/75*
T  C    GAMMA(KOS)=((1.122+-.004)+.16*(DM-.5348)/DM)*10**10 /SEC.           11/75*
T  C    VALUE WOULD NOT CHANGE WITH OUR CURRENT DM=.5349+-.0022.             2/76*
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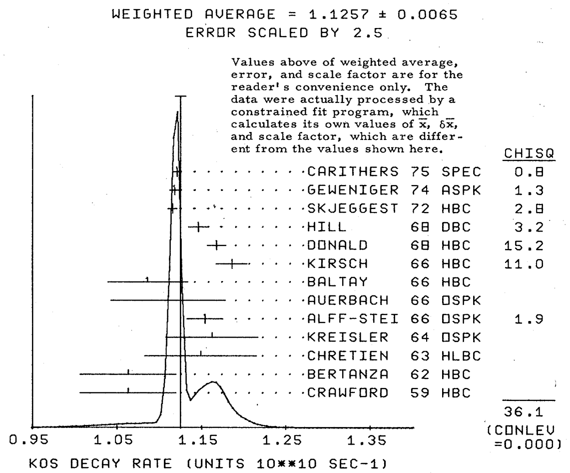
Data Card Listings

For notation, see key at front of Listings.

Stable Particles

K^0_S

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                   12  KOS PARTIAL DECAY MODES

                                                        DECAY MASSES
P1      KOS INTO PI+ PI-                               139+ 139
P2      KOS INTO PIO PIO                               134+ 134
P3      KOS INTO MU+ MU-                               105+ 105
P4      KOS INTO E+ E-                                  .5+  .5
P5      KOS INTO PI+ PI- GAMMA                         139+ 139+   0
P6      KOS INTO GAMMA GAMMA                             0+   0
P7      KOS INTO 3PIO                                  134+ 134+ 134

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                   12  KOS BRANCHING RATIOS

R1      KOS INTO (PI+ PI-)/TOTAL                         (P1)
R1               0.68       0.04         CRAWFORD  59 HBC
R1               0.70       0.08         COLUMBIA  60 HBC
R1   U          (0.740)    (0.024)       ANDERSON  62 HBC
R1 U  1648       0.670      0.010        DOYLE     69 HBC     PI- P TO LAM KO   1/76*
R1   U  ANDERSON RESULT NOT PUBLISHED, EVENTS ADDED TO DOYLE SAMPLE             2/71
R1            . . . . . . . . . .
R1   AVG         0.6710     0.0096  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1   STUDENT     0.671      0.010   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R1   FIT         0.6867     0.0025 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R2      KOS INTO (PIO PIO)/TOTAL                         (P2)
R2               0.27       0.11         CRAWFORD  59 HBC
R2               0.26       0.06         BAGLIN    60 HLBC
R2               0.30       0.035        BROWN     61 HLBC
R2     1066      0.335      0.014        BROWN     63 HLBC
R2      198      0.288      0.021        CHRETIEN  63 HLBC
R2            . . . . . . . . . .
R2   AVG         0.316      0.014   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
R2   STUDENT     0.316      0.014   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R2   FIT         0.3133     0.0025 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
                            (SEE IDEOGRAM BELOW )
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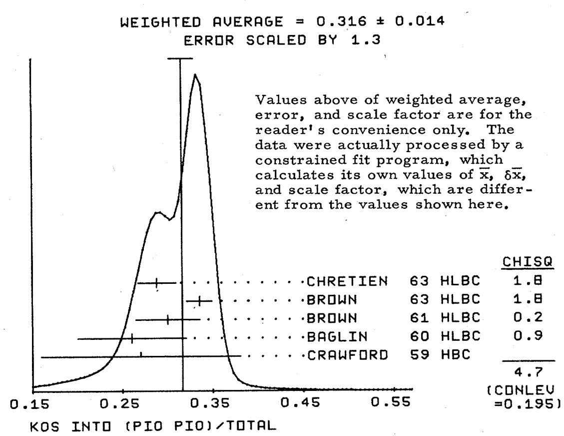


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R3      KOS INTO (PI+ PI-)/(PIO PIO)                     (P1)/(P2)
R3   N  267     (2.12)    (0.17)        BOZOKI     69 HLBC                      5/70
R3   G 3016     (2.285)   (0.055)       GOBBI      69 OSPK     K+N TO KOP       5/69
R3     3700      2.10      0.06         MORFIN     69 HLBC     K+N TO KOP      10/69
R3 G   7944      2.282     0.043        MOFFETT    70 OSPK     K+N TO KOP       2/72
R3 B   6150      2.22      0.095        BALTAY     71 HBC   K-P TO KO +NEUTRALS 12/71
R3 A   3068      2.22      0.10         ALITTI     72 HBC      K+P TO PI+ P KO  6/72
R3     6380      2.22      0.08         MORSE      72 DBC      K+N TO KOP       2/72
R3 N    701      2.10      0.11         NAGY       72 HLBC     K+N TO KOP       1/73
R3     4799      2.16      0.08         HILL       73 DBC      K+D TO KO P P    9/73
R3      16K      2.169     0.094        COWELL     74 OSPK     PI- P TO LAM KO  7/75*
R3 N    NAGY 72 IS A FINAL RESULT WHICH INCLUDES BOZOKI 69.                    11/73
R3 G    MOFFETT 70 IS A FINAL RESULT WHICH INCLUDES GOBBI 69.                   2/72
R3 B    THE DIRECTLY MEASURED QUANTITY IS KS TO PI+PI-/ALL KOBAR=.345+-.005 12/71
R3 A    THE DIRECTLY MEASURED QUANTITY IS KOS TO PI+ PI-/ALL KO=.345+-.005   6/72
R3            . . . . . . . . . .
R3  AVG          2.204     0.027    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
R3  STUDENT      2.201     0.032    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R3  FIT          2.192     0.026   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R4      (KOS INTO PI+ PI- PIO, CP VIOLATING)/(KOL INTO PI+ PI- PIO)
R4       TEST OF CP VIOLATION - SEE TEXT SECTION VI B.3A FOR DEFINITIONS
R4       CPT ASSUMED VALID - (I.E. RE(A)=0) - ONLY (IMA)**2 QUOTED HERE
R4       18   (3.8)   OR LESS  CL=.90   ANDERSON  65 HBC                       10/69
R4             0.45   OR LESS  CL=.90   BEHR      66 HLBC                       8/66
R4       53   (1.7)   OR LESS  CL=.90   WEBBER    70 HBC                        8/70
R4 C     71    0.8    OR LESS  CL=.90   WEBBER    70 HBC                        8/70
R4       99    1.2    OR LESS  CL=.90   CHO       71 DBC                        4/71
R4  J    98   (1.0)   OR LESS  CL=.90   JAMES     71 HBC                        6/71
R4  M    50   (1.2)   OR LESS  CL=.95   MEISNER   71 HBC     CL=.9 NOT AVAIL.   2/71
R4 J    180    0.66   OR LESS  CL=.90   JAMES     72 HBC                        1/73
R4       99    1.2    OR LESS  CL=.90   JONES     72 OSPK                      10/72
R4      384    0.12   OR LESS  CL=.90   METCALF   72 ASPK                       2/74
R4      148    0.71   OR LESS  CL=.90   MALLARY   73 OSPK    RE(A)=-.05+-.17    8/73
R4      192    1.2    OR LESS  CL=.90   BALDOCEOL 75 HLBC                      12/75*
R4 C     THIS IS THE COMBINED RESULT OF ANDERSON 65 AND WEBBER 70
R4 J     JAMES 72 IS A FINAL RESULT WHICH INCLUDES JAMES 71.                   11/73
R4  M    THESE AUTHORS FIND REAL(A)= 2.75+-.65, ABOVE VALUE AT RE(A)=0          2/71

R5      KOS INTO (MU+ MU-)/CHARGED (UNITS 10**-5)        (P3)/(P1)
R5            10.0    OR LESS  CL=.90   BOTT-BODE 67 OSPK                       8/67
R5            20.0    OR LESS  CL=.90   BOHM      69 OSPK                       2/71
R5             1.07   OR LESS  CL=.90   HYAMS     69 OSPK                      10/69
R5    S       32.6    OR LESS  CL=.90   STUTZKE   69 OSPK                       5/69
R5             0.047  OR LESS  CL=.90   GJESDAL   73 ASPK                       7/73
R5    S  VALUE CALCULATED BY US, USING 2.3 INSTEAD OF 1 EVENT, 90 PERC.CL

R6      KOS INTO (PI+ PI- GAMMA)/(PI+ PI-) (UN.10**-3)    (P5)/(P1)
R6       27        NO RATIO GIVEN       BELLOTTI  66 HBC     PG GT 50 MEV/C    10/69
R6       10     3.3        1.2          WEBBER    70 HBC     PG GT 50 MEV/C    10/69
R6 B            2.8        0.6          BURGUN    73 HBC     PG GT 50 MEV/C    11/73
R6 C     29    (3.0)      (0.6)         BOBISUT   74 HLBC    PG GT 40 MEV/C    12/75*
R6 B     BURGUN 73 ESTIMATES THAT DIRECT EMISSION CONTRIBUTION IS .3+-.6 .     11/73
R6 C     BOBISUT 74 NOT INCLUDED IN AVERAGE BECAUSE P(GAMMA) CUT DIFFERS.       1/76*
R6 C     ESTIMATES DIRECT EMISSION CONTRIBUTION TO BE 0.5 OR LESS, CL=.95.      1/76*
R6            . . . . . . . . . .
R6  AVG         2.90       0.54     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R6  STUDENT     2.90       0.58     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R7      KOS INTO (E+ E-)/CHARGED (UNITS 10**-5)          (P4)/(P1)
R7            50.0    OR LESS  CL=.90   BOHM      69 OSPK                       2/71

R8      KOS INTO 2 GAMMA/TOTAL (UNITS 10**-3)            (P6)
R8 R      0   21.0    OR LESS  CL=.90   BANNER    69 OSPK                      12/71
R8 R      0    2.2    OR LESS  CL=.90   REPELLIN  71 OSPK                      12/71
R8 R      0    0.71   OR LESS  CL=.90   BANNER    72 OSPK                       8/72
R8        0    2.0    OR LESS  CL=.90   MORSE     72 DBC                        2/72
R8        0    0.4    OR LESS  CL=.90   BARMIN2   73 HLBC                       2/74
R8 R     THESE LIMITS ARE FOR MAXIMUM INTERFERENCE IN KS-KL TO 2 GAMMAS        12/71

R9      (KOS INTO PI+ PI- PIO, CP CONSERVING)/(KOL INTO PI+ PI- PIO)
R9      384    0.42   OR LESS  CL=.90   METCALF   72 ASPK                      11/72

R10     (KOS INTO 3PIO,CP VIOLATING)/(KOL INTO 3PIO)
R10     SEE COMMENTS UNDER BRANCHING RATIO R4
R10      22    1.2    OR LESS  CL=.90   BARMIN1   73 HLBC                      11/73
R10  G         0.28   OR LESS  CL=.90   GJESDAL   74 SPEC                      11/75*
R10  G  GJESDAL 74 USES K2PI, KMU3 AND KE3 DECAY RESULTS AND UNITARITY.        11/75*
R10  G  CALCULATES ABS(ETA000)=.26+-.20.  WE CONVERT TO CL=.90 UPPER LIMIT.    11/75*

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REFERENCES FOR KOS


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BOLDT     58 PRL    1  150        E BOLDT,D O CALDWELL,Y PAL                  (MIT)
CRAWFORD 59 PRL    2  266        CRAWFORD,CRESTI,DOUGLASS,GOOD,TICHO + (LRL)

BAGLIN    60 NC    18 1043        BAGLIN,BLOCH,BRISSON,HENNESSY +        (EPOL)
BOWEN     60 PR   119 2030        BOWEN,HARDY,REYNOLDS,SUN,MOORE+  (PRIN+BNL)
COLUMBIA 60 ROCH CONF 727        M SCHWARTZ +                          (COLUMBIA)

BROWN     61 NC    19 1155        BROWN,BRYANT,BURNSTEIN,GLASER,KADYK+ (MICH)
ANDERSON 62 CERN CONF 836        J A ANDERSON,F S CRAWFORD +                (LRL)
BERTANZA 62  PREPRINT D105       BERTANZA,CONNOLLY,CULWICK,EISLER +        (BNL)
    UNPUBLISHED, BUT RECERTIFIED BY AUTHORS, AUGUST 66.

CHRETIEN 63 PR   131 2208        CHRETIEN+       (BRANDEIS+BROWN+HARVARD+ MIT)
BROWN     63 PR   130  769        BROWN,KADYK,TRILLING,ROE +         (LRL+MICH)
KREISLER 64 PR   136 B 1074      M KREISLER,O OVERSETH,J CRONIN  (PRINCETON)
ANDERSON 65 PRL 14 475           +CRAWFOR,GOLDEN,STERN,BINFORD +  (LRL+WISC)

ALFF-STE 66 PL 21 595            ALFF-STEINBERGER,HEUER,KLEINKNECHT + (CERN)
AUERBACH 66 PR 149 1052          AUERBACH,DOBBS,LANDE,MANN,SCIULLI+    (PENN)
    ALSO 65 AUERBACH
BALTAY    66 PR 142   932         BALTAY,SANDWEISS,STONEHILL +       (YALE+BNL)
BEHR      66 PL   22  540         BEHR,BRISSON,PETIAU+ (EPOL,MILA,PADO,ORSAY)
BELLOTTI 66 NC 45A 737           +PULLIA,BALDO-CEOLIN +           (MILAN+PADUA)
BOTT-BOD 66 PL   23 277          BOTT-BODENHAUSEN,DE BOUARD +               (CERN)
KIRSCH    66 PR   147  939        L KIRSCH,P SCHMIDT                    (COLUMBIA)

BOTT-BOD 67 PL 24B 194           BOTT-BODENHAUSEN,DE BOUARD,CASSEL+    (CERN)
DONALD    68 PL 27B  58           DONALD,EDWARDS,NISAR+ (LIVP,CERN,IPNP,CDEF)
HILL      68 PR 171 1418          HILL,ROBINSON,SAKITT +          (BNL,CARNEGIE)

BANNER    69 PR 188 2033          +CRONIN,LIU,PILCHER                  (PRINCETON)
BOHM      69 THESIS               A. BOHM                                    (AACH)
BOZOKI    69 PL 30B 498           +FENYVES,GOMBOSI,NAGY,SURANYI+     (BUDAPEST)
DOYLE     69 UCRL 18139-THESIS J.C. DOYLE                                   (LRL)
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Stable Particles

K^0_S, K^0_L

Data Card Listings

For notation, see key at front of Listings.


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GOBBI     69 PRL 22 682           GOBBI,GREEN,HAKEL,MOFFETT,ROSEN+(ROCHESTER)
HYAMS     69 PL   29B 521         +KOCH,POTTER,VON LINDERN,LORENZ+ CERN(MPIM)
MORFIN    69 PRL    23  660       MORFIN,SINCLAIR                      (MICH)
STUTZKE   69 PR    177  2009      +ABASHIAN,JONES,MANTSCH,ORR,SMITH(ILLINOIS)

MOFFETT   70 BAPS 15 512          +GOBBI,GREEN,HAKEL,ROSEN       (ROCHESTER)
WEBBER    70 PR D1 1967           +SOLMITZ,CRAWFORD,ALSTON-GARNJOST     (LRL)
     ALSO 69 UCRL 19226 THESIS B R WEBBER                              (LRL)
BALTAY    71 PRL 27 1678          +BRIDGEWATER,COOPER,GERSHWIN,HABIBI+ (COLU)
     ALSO 71 NEVIS-187 THESIS     WILLIAM A. COOPER                (COLUMBIA)
CHO       71 PR D3 1557           +DRALLE,CANTER,ENGLER,FISK+ (CARN+BNL+CASE)
JAMES     71 PL 35B 265           +MONTANET,PAUL,PAULI+       (CERN+SACL+OSLO)
MEISNER   71 PR D3 59             +MANN,HERTZBACH,KOFLER +     (MASA+BNL+YALE)
REPELLIN  71 PL 36B 603           +WOLFF,CHOLLET,GAILLARD,JANE+    (ORSA+CERN)

ALITTI    72 PL 39B 568           J ALITTI,E LESQUOY,A MULLER         (SACLAY)
BANNER    72 PRL 29 237           +CRONIN,HOFFMAN,KNAPP,SHOCHET    (PRINCETON)
JAMES     72 NP B49 1             +MONTANET,PAUL,SAETRE+      (CERN+SACL+OSLO)
JONES     72 NC 9A 151            +ABASHIAN,GRAHAM,MANTSCH,ORR,SMITH+    (ILL)

METCALF   72 PL 40B 703           +NEUHOFER,NIEBERGALL+        (CERN+IPN+WIEN)
MORSE     72 PRL 28 388           +NAUENBERG,BIERMAN,SAGER+    (COLO+PRIN+UMD)
NAGY      72 NP B47 94            +TELBISZ,VESZTERGOMBI              (BUDAPEST)
     ALSO 69 PL 30B 498           BOZOKI,FENYVES,GOMBOSI,NAGY+       (BUDAPEST)
SKJEGGES  72 NP B48 343           SKJEGGESTAD,JAMES,MONTANET+(OSLO+CERN+SACL)

BARMIN1   73 PL 46B 465           +BARYLOV,DAVIDENKO,DEMIDOV+            (ITEP)
BARMIN2   73 PL 47B 463           +BARYLOV,DAVIDENKO,DEMIDOV+            (ITEP)
BURGUN    73 PL 46B 481           +BERTRANET,LESQUOY,MULLER,PAULI+(SACL+CERN)
FACKLER   73 PRL 31 847           +FRISCH,MARTIN,SMOOT,SOMPAYRAC          (MIT)
GJESDAL   73 PL 44B 217           +PRESSER,STEFFEN,STEINBERGER+    (CERN+HEID)
HILL      73 PR D8 1290           +SAKITT,SAMIOS,BURRIS,ENGLER+     (BNL+CARN)
MALLARY   73 PR D7 1953           +BINNIE,GALLIVAN,GOMEZ,PECK,SCIULLI+  (CIT)
BOBISUT   74 LNC 11 646           +HUZITA,MATTIOLI,PUGLIERIN             (PADO)
COWELL    74 PR D10 2083          +LEE-FRANZINI,ORCUTT,FRANZINI + (STON+COLU)
GEWENIGE  74 PL 48B 487           GEWENIGER,GJESDAL,PRESSER+       (CERN+HEID)
GJESDAL   74 PL 52B 119           +PRESSER,STEFFEN,STEINBERGER +   (CERN+HEID)
BALDOCEO  75 NC 25A 688           BALDO-CEOLIN,BOBISUT,CALIMANI+   (PADO+WISC)
CARITHER  75 PRL 34 1244          CARITHERS,MODIS,NYGREN,PUN +      (COLU+NYU)

                                  PAPERS NOT REFERRED TO IN DATA CARDS

BIRGE     60 ROCH CONF 601        R W BIRGE,P P ELY +          (LRL+WISCONSIN)
MULLER    60 PRL    4  418        MULLER,BIRGE,FOWLER,GOOD,PICCIONI+(LRL+BNL)
FITCH     61 NC    22 1160        V FITCH,P PIROUE,R PERKINS       (PRIN+LASL)
GOOD      61 PR   124 1223        GOOD,MATSEN,MULLER,PICCIONI +          (LRL)
CRAWFORD  62 CERN CONF 827        F S CRAWFORD                           (LRL)
AUERBACH  65 PRL 14 192           AUERBACH,LANDE,MANN,SCIULLI,UTO +     (PENN)
TRILLING  65 UCRL 16473           GEORGE H TRILLING                      (LRL)
    UPDATED FROM 1965 ARGONNE CONF., PAGE 115.
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K^0_L   13 LONG-LIVED NEUTRAL K(498, JP=0-) I=1/2

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                 13  (KOL) - (KOS) MASS DIFFERENCE
     WE GIVE (KOL-KOS MASS DIFFERENCE / HBAR) IN UNITS OF 10**10 SEC-1

D  TX         (2.20)   (0.35)           FITCH     61 CNTR
D   X         (0.84)   (0.29)    (0.22)GOOD      61 HLBC
D  TXC        (1.02)   (0.23)           CAMERINI  62 HLBC                   8/67
D  TX         (0.55)   (0.24)           AUBERT    65 HLBC                   6/66
D   X         (0.26)   (0.36)    (0.26)BALDO-CEO 65 HLBC    ASSUMES CP CONS.
D  TXA        (0.64)   (0.12)           CHRISTENS 65 OSPK                   6/66
D  TX         (0.70) OR LESS            FITCH     65 OSPK    CF. MEISNER 66  7/66
D   V  130    (0.89)   (0.15)           VISHNEVSK 65 OSPK    CU AND AL REGEN 8/67
D   X         (0.514)  (0.039)          ALFF-STEI 66 OSPK                   6/66
D   X   84    (0.42)   (0.24)    (0.36) BALDO-CEO 66 HLBC    KO+N INTO HYPER. 8/67
D   B         (0.531)  (0.027)          BOTT-BODE 66 OSPK    C REGEN         9/66
D  TX   77    (0.58)   (0.17)           CAMERINI  66 HBC, DBC KO+N INTO HYPER 8/67
D   N   72   (+0.64)   (0.18)           CANTER    66 DBC     KO SCATTER IN D2 11/66
D   X   95    (0.62)   (0.10)    (0.16) CHANG     66 HBC     KO+P INTO HYPER. 8/67
D   X         (0.81)   (0.17)           FUJII     66 OSPK    IRON REGENERATOR 9/66
D   X   59    (0.74)   (0.34)           MEISNER1  66 HBC                    6/66
D           + SIGN FAVORED              MEISNER2  66 HBC                    9/66
D   X         (0.38)   (0.16)           JOVANOVIC 66 OSPK    C+URANIUM REGEN. 11/66
D  TX  136   (+0.64)   (0.19)           CANTER    67 DBC     KO+D INTO HYPER. 11/67
D   X         (0.65)   (0.11)           MISCHKE   67 OSPK                  .11/67
D   X  590    (0.59)   (0.13)           BALATZ    68 OSPK    AL REGENERATOR  3/68
D   X         (0.520)  (0.044)          CARNEGIE  68 HBC     GAP METHOD      3/68
D  TX        (+0.487)  (0.046)          MELHOP    68 OSPK    ST.STEEL REGEN  6/68
D  BX         (0.547)  (0.024)          BOTT-BODE 69 OSPK    C REGEN         1/71
D  FX         (0.555)  (0.020)          FAISSNER  69 ASPK    REGEN IN CU    10/69
D              0.542    0.006           CULLEN    70 CNTR                   1/71
D   R         (0.542)  (0.006)          ARONSON   70 ASPK    GAP METHOD      1/71
D   X         (0.481)  (0.052)  (0.075)BALATS    71 OSPK                   9/71
D   R         (0.534)  (0.007)          CARNEGIE  71 ASPK    GAP METHOD      8/71
D  TH  119   (+0.67)   (0.14)           HILL      71 DBC                   10/71
D   S 1757    (0.557)  (0.038)          FACKLER   73 OSPK                  11/73
D              0.5340   0.0030          GEWENIG3  74 SPEC    GAP METHOD     11/75*
D              0.5334   0.0040          GJESDAL1  74 SPEC    CHG ASYMMETRY  11/75*
D           . . . . . . . . .
D   AVG        0.5349   0.0022  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D   STUDENT    0.5348   0.0025  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                      COMMENTS
D   X   NO ATTEMPT HAS BEEN MADE TO CORRECT OLDER EXPERIMENTS WITH LARGE  11/75*
D   X   ERRORS FOR THE SUBSEQUENT CHANGES IN THE KOS MEAN LIFE OR IN ETA+-. 2/76*
D  T    A KOS MEAN LIFE OF 0.862 10**-10 SEC WAS USED IN CONVERTING THE      1/71
D  T    MASS DIFFERENCE FROM UNITS OF INVERSE KOS MEAN LIVES TO ABSOLUTE     1/71
D  T    UNITS. VALUES NOT BEARING THIS FOOTNOTE EITHER WERE GIVEN IN         1/71
D  T    ABSOLUTE UNITS OR WERE CONVERTED USING THE AUTHORS' VALUE OF THE     1/71
D  T    KOS MEAN LIFE.                                                       1/71
D    C  CAMERINI 62 VALUE CHANGED FROM 1.7 (SEE TABLE 1 OF CAMERINI 66)      8/67
D    A  CHRISTENSON 65 CORRECTED FOR INTERFERENCE BY FITCH 65 FOOTNOTE.      1/71
D   V   VISHNEVSKY 65 NOT CORRECTED FOR INTERFERENCE EFFECTS.                3/68
D   N   CANTER 66 ERROR IGNORES UNCERTAINTY OF PHASE SHIFTS.  THESE EVENTS 10/71
D   N   ARE USED IN HILL 71.                                                10/71
D  B    BOTT-BODENHAUSEN 69 IS A REEVALUATION OF BOTT-BODENHAUSEN 66.        1/71
D  F    FAISSNER 69 HAS ADDNL. SYSTEMATIC ERROR LESS THAN TWO PERCENT.       1/71
D   R   ARONSON 70 AND CARNEGIE 71 USE KOS MEAN LIFE=.862+-.006 E-10 SEC.  11/75*
D   R   WE HAVE NOT ATTEMPTED TO ADJUST THESE VALUES FOR THE SUBSEQUENT     2/76*
D   R   CHANGE IN THE KOS MEAN LIFE OR IN ETA+-.                            2/76*
D   H   HILL 71 PRIMARY RESULT IS THAT DM IS POSITIVE.                      10/71
D   H   THE MAGNITUDE MAY HAVE AN ADDITIONAL SYSTEMATIC ERROR OF ABOUT 0.12 10/71
D   S   NOT AVERAGED BECAUSE ERROR IS LARGE AND SYSTEMATICS NOT DISCUSSED.  2/76*
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                 13  KOL MEAN LIFE (UNITS 10**-8 SEC)

T        KOL MEAN LIFE
T      34    8.1        3.2        2.4    BARDON     58 CNTR
T      ASSUMED DS=DQ AND DELTA I=1/2 CRAWFORD   59 HBC
T      15    5.1        2.4        1.3    DARMON     62 FBC
T            5.3        0.6               FUJII      64 OSPK
T    1700    6.1        1.5        1.2    ASTBURY3   65 CNTR
T            5.15       0.14              DEVLIN     67 CNTR
T   L       (5.0)      (0.5)              LOWYS      67 HLBC
T     .4M    5.154      0.044             VOSBURGH   72 CNTR                2/71
T   L   SUM OF PARTIAL DECAY RATES.
T        . . . . . . . . .
T   AVG      5.158      0.042      0.042  AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)
T   STUDENT  5.158      0.046      0.045  AVG. USING STUDENT10(H/1.11) -- SEE TEXT
T   FIT      5.181      0.040    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
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                 13  KOL PARTIAL DECAY MODES

                                                         DECAY MASSES
P1     KOL INTO 3PIO                     TAU 0 PRIME    134+ 134+ 134
P2     KOL INTO PI+ PI- PIO              TAU 0          139+ 139+ 134
P3     KOL INTO PI MU NEUTRINO           KL MU3         139+ 105+  .0
P4     KOL INTO PI E NEUTRINO            KL E3          139+  .5+   0
P5     KOL INTO PI+ PI-                  KL PI+ PI-     139+ 139
P6     KOL INTO MU+ MU-                  KL 2MU         105+ 105
P7     KOL INTO E+ E-                    KL 2E           .5+  .5
P8     KOL INTO E MU                     KL EMU          .5+ 105
P9     KOL INTO TWO GAMMAS               KL 2GAMMA        0+   0
P10    KOL INTO PI+ PI- GAMMA            KL PI+-G       139+ 139+   0
P11    KOL INTO PIO PIO                  KL 2PIO        134+ 134
P12    KOL INTO PI E NEU GAMMA           KL E3GAM       139+  .5+  0+   0
P13    KOL INTO PIO TWO GAMMAS           KL PI2GAMMA    134+   0+   0
P14    KOL INTO E+ E- GAMMA              KL 2EGAM        .5+  .5+   0
P15    KOL INTO MU+ MU- GAMMA            KL 2MUGAM      105+ 105+   0
P16    KOL INTO MU+ MU- PIO              KL 2MUPIO      105+ 105+ 134
P17    KOL INTO PI+ PI- E+ E-            KL 2PI2E       139+ 139+  .5+  .5
P18    KOL INTO PIO PI+- E-+ NEU         KL 2PIENEU     134+ 139+  .5+   0
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              NEUTRAL K CONSTRAINED FIT
          OVERALL FIT OF MEAN LIFE, WIDTHS AND BRANCHING
          RATIOS USES 62 DATA POINTS TO DETERMINE SIX                      2/76*
          QUANTITIES.  OVERALL FIT HAS CHI-SQUARED=67.7                    2/76*
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<u>FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS</u>

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The <u>diagonal</u> elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the <u>off-diagonal</u> elements are the <u>normalized</u> correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

```
        P 1         P 2         P 3         P 4         P 5         P11
 P 1 .2140+-.0067
 P 2  -.4051  .1225+-.0019
 P 3  -.5365    .0677  .2710+-.0047
 P 4  -.6408    .0893    -.2416  .3896+-.0053
 P 5  -.2195    .5350     .0342    .0453  .0020+-.0001
 P11   .1476   -.0732    -.0938   -.1119    -.0396  .0009+-.0002
```

<u>FITTED PARTIAL DECAY MODE RATES</u>

The matrix below is the branching fraction matrix above, transformed into rate space; i.e., $G_i \equiv \Gamma_i = \Gamma_{total} P_i$, in appropriate units. In analogy to the matrix above, the <u>diagonal</u> elements are $G_i \pm \delta G_i$, where $\delta G_i = \sqrt{\langle \delta G_i \delta G_i \rangle}$, while the <u>off-diagonal</u> elements are the <u>normalized</u> correlation coefficients $\langle \delta G_i \delta G_j \rangle / (\delta G_i \cdot \delta G_j)$. Note that, because of the error in Γ_{total}, the errors and correlations here are not directly derivable from those above.

```
        G 1         G 2         G 3         G 4         G 5         G11
 G 1 .0413+-.0014
 G 2  -.2195  .0236+-.0004
 G 3  -.3386    .1977  .0523+-.0010
 G 4  -.3854    .2367    -.0345  .0752+-.0011
 G 5  -.1255    .5630     .1098    .1315  .0004+-.0000
 G11   .1569   -.0445    -.0644   -.0733    -.0254  .0002+-.0000
```

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                 13  KOL DECAY RATES

W1     KOL INTO PIO PIO PIO (UNITS 10**6 SEC-1)         (G1)
W1       54    5.22      1.03      0.84  BEHR      66 HLBC    ASSUMES CP      8/66
W1          . . . . . . . . .
W1   FIT       4.13      0.14     FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

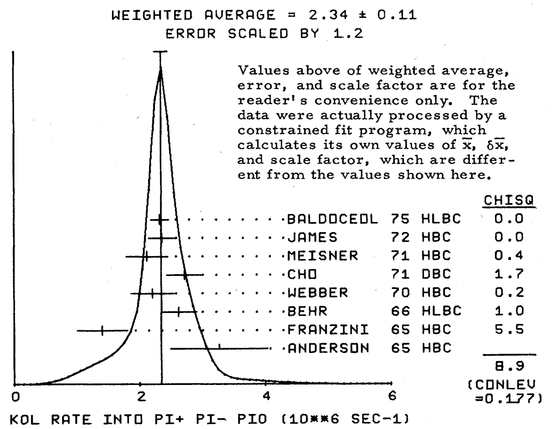
W2     KOL INTO PI+ PI- PO (UNITS 10**6 SEC-1)          (G2)
W2       18    3.26      0.77            ANDERSON  65 HBC                     8/66
W2       14    1.4       0.4             FRANZINI  65 HBC                     6/66
W2      136    2.62      0.28      0.27  BEHR      66 HLBC    ASSUMES CP      8/66
W2       53    2.20      0.35            WEBBER    70 HBC     ASSUMES CP     10/71
W2       99    2.71      0.28            CHO       71 DBC     ASSUMES CP    . 4/71
W2  J    98   (2.5)     (0.3)            JAMES     71 HBC     ASSUMES CP      6/71
W2       50    2.12      0.33            MEISNER   71 HBC     ASSUMES CP     10/71
W2 J    180    2.35      0.20            JAMES     72 HBC     ASSUMES CP      1/73
W2      192    2.32      0.13      0.15  BALDOCEOL 75 HLBC    ASSUMES CP      1/76*
W2      IN THE OVERALL FIT THIS RATE IS WELL DETERMINED BY THE MEAN LIFE AN
W2      THE BRANCHING RATIO R2. FOR THIS REASON THE DISCREPANCY BETWEEN THE
W2      W2 MEASUREMENTS DOES NOT AFFECT THE SCALE FACTOR OF THE OVERALL FIT
W2 J    JAMES 72 IS A FINAL MEASUREMENT AND INCLUDES JAMES 71.               11/73
W2          . . . . . . . . .
W2   AVG       2.34      0.11     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
W2   STUDENT   2.35      0.10     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
W2   FIT       2.364     0.039    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
                                  (SEE IDECGRAM BELOW )
```

Data Card Listings

For notation, see key at front of Listings.

Stable Particles

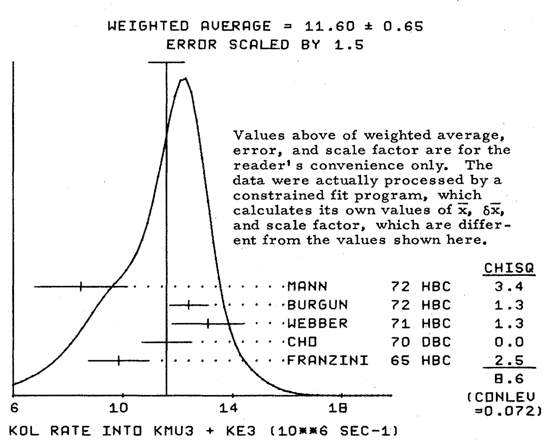
K^0_L




```
W3      KOL INTO PI E NEUTRINO (UNITS 10**6 SEC-1)          (G4)
W3             7.52     0.85     0.72  AUBERT     65 HLBC    DS=DQ,CP ASSUMED  8/67
W3      620    7.81     0.56           CHAN       71 HBC                       2/72
W3           . . . . . . . . .
W3  AVG        7.71     0.46    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W3  STUDENT    7.71     0.49    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
W3  FIT        7.52     0.11   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

W4      KOL INTO CHARGED (3-BODY) (UNITS 10**6 SEC-1)     (G2+G3+G4)
W4       98   15.1      1.9            AUERBACH   66 OSPK                      8/67
W4           . . . . . . . . .
W4  FIT       15.11     0.16   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

W5      KOL INTO LEPTONIC (KMU3+KE3) (UNITS 10**6 SEC-1) (G3+G4)
W5   D 109     9.85     1.15     1.05  FRANZINI   65 HBC                       2/72
W5  C  335   (10.3)    (0.8)           HILL       67 DBC     K+N TO KO P       8/67
W5   D 393    11.6      0.9            CHO        70 DBC     K+N TO KOP       10/70
W5   D 252    13.1      1.3            WEBBER     71 HBC     K- P TO KOBAR N   2/72
W5   D 410    12.4      0.7            BURGUN     72 HBC     K+P TO KOPPI+     1/73
W5   D 126     8.47     1.69           MANN       72 HBC     K- P TO KOBAR N   9/72
W5  C  CHO 70 INCLUDES EVENTS OF HILL 67
W5   D  ASSUMES DS=DQ RULE
W5           . . . . . . . . .
W5  AVG       11.60     0.65    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
W5  STUDENT   11.66     0.54    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
W5  FIT       12.75     0.15   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
                        (SEE IDEOGRAM BELOW )
```




```
W6      KOL INTO PI MU NEUTRINO UNITS 10**6 SEC-1)          (G3)
W6       19    4.54     1.24     1.08  LOWYS      67 HLBC                      8/67
W6           . . . . . . . . .
W6  FIT        5.230    0.099  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

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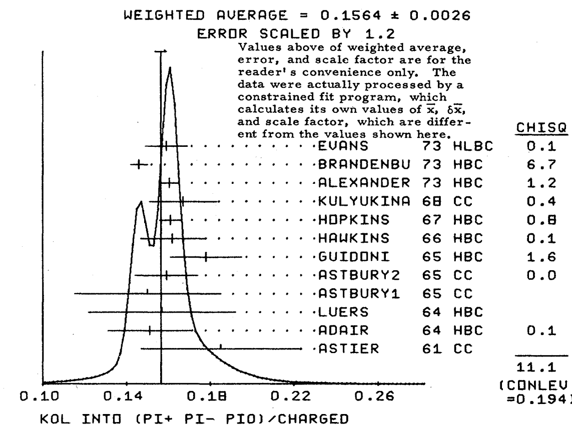
```

13 KOL BRANCHING RATIOS

```
R1      KOL INTO (PIO PIO PIO)/CHARGED                      (P1)/(P2+P3+P4)
R1       24    0.24     0.08           ANIKINA    64 CC                        6/66
R1      549    0.251    0.014          BUDAGOV    68 HLBC    ORSAY MEASUR.    10/68
R1      444    0.277    0.021          BUDAGOV    68 HLBC    EC. POLYTEC.MEAS 10/68
R1       29    0.31     0.07     0.06  KULYUKINA  68 CC                        2/71
R1           . . . . . . . . .
R1  AVG        0.260    0.011   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  STUDENT    0.2[illegible]0    0.013   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R1  FIT        0.273    0.011  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)
```

```
R2      KOL INTO (PI+ PI- PIO)/CHARGED                        (P2)/(P2+P3+P4)
R2       59    0.185    0.038          ASTIER     61 CC                        8/66
R2       79    0.151    0.020          ADAIR      64 HBC                       8/66
R2       75    0.157    0.03     0.04  LUERS      64 HBC                       8/66
R2       66    0.15     0.03     0.04  ASTBURY1   65 CC                        8/66
R2      326    0.159    0.015          ASTBURY2   65 CC                        6/66
R2      566    0.178    0.017          GUIDONI    65 HBC                       6/66
R2     1729   (0.144)  (0.004)         HOPKINS    65 HBC     SEE HOPKINS 67    6/66
R2      126    0.162    0.015          HAWKINS    66 HBC                       6/66
R2             0.161    0.005          HOPKINS    67 HBC                       8/67
R2     1402    0.167    0.016          KULYUKINA  68 CC                        2/71
R2     1590    0.1605   0.0038         ALEXANDER  73 HBC                       1/74
R2     3200    0.146    0.004          BRANDENBU  73 HBC                       1/74
R2      558    0.159    0.010          EVANS      73 HLBC                      1/73
R2           . . . . . . . . .
R2  AVG        0.1564   0.0026  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
R2  STUDENT    0.1578   0.0029  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R2  FIT        0.1564   0.0022 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
                        (SEE IDEOGRAM BELOW )
```




```
R3      KOL INTO (PI MU NEUTRINO)/CHARGED                     (P3)/(P2+P3+P4)
R3  C  251   (0.356)  (0.07)           LUERS      64 HBC
R3  C  172   (0.39)   (0.08)   (0.10)  ASTBURY1   65 CC                        7/66
R3  C  330   (0.335)  (0.055)          KULYUKINA  68 CC                        2/71
R3  C THIS MODE NOT MEASUREC INDEPENDENTLY FROM R2 AND R4
R3           . . . . . . . . .
R3  FIT        0.3461   0.0051 FROM FIT

R4      KOL INTO (PI E NEUTRINO)/CHARGED                      (P4)/(P2+P3+P4)
R4       24    0.46     0.11           NEAGU      61 CC                        2/76*
R4      153    0.487    0.05           LUERS      64 HBC
R4      202    0.46     0.08     0.10  ASTBURY1   65 CC                        7/66
R4      500    0.498    0.052          KULYUKINA  68 CC                        2/71
R4           . . . . . . . . .
R4  AVG        0.485    0.032   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R4  STUDENT    0.485    0.034   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R4  FIT        0.4975   0.0052 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R5      KOL INTO (PI E NEU)/((PI E NEU)+(PI MU NEU))          (P4)/(P3+P4)
R5      320    0.415    0.120          ASTIER     61 CC
R5           . . . . . . . . .
R5  FIT        0.5898   0.0059 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R6      KOL INTO (PI+ PI- PIO)/TOTAL                          (P2)
R6
R6           . . . . . . . . .
R6  FIT        0.1225   0.0019 FROM FIT

R7      KOL INTO (LEPTON PI NEUTRINO)/TOTAL                   (P3+P4)
R7
R7           . . . . . . . . .
R7  FIT        0.6606   0.0062 FROM FIT

R8      KOL INTO (2 GAMMA)/TOTAL (UN. 10**-4)                 (P9)
R8  C         (1.3)    (0.6)           CRIEGEE    66 OSPK                      8/66
R8       32    6.7      2.2            TODOROFF   67 OSPK    REPL.  CRIEGEE66 11/68
R8  K    33   (7.4)    (1.6)           CRONIN 1   67 OSPK                     11/67
R8       90    5.5      1.1            KUNZ       68 OSPK    NORM.TO 3PI(C+N)  2/71
R8       23    4.5      1.0            ENSTROM    71 OSPK    KOL 1.5-9 GEV/C   2/72
R8 R           5.0     (1.0)           REPELLIN   71 OSPK                     11/71
R8 B           4.54     0.84           BANNER2    72 OSPK                      8/72
R8 B     THIS VALUE USES (E00/E+-)**2=1.05+-0.14. IN GENERAL, S13R8 =          8/72
R8 B     (4.32+-0.55)*(10**-4)*((E00/E+-)**2).                                 8/72
R8 R     ASSUMES REGEN AMPL IN COPPER AT 2GEV IS 22  MB. TO EVALUATE          11/71
R8 R     FOR A GIVEN REGEN AMPL AND ERROR, MULTIPLY BY (REGEN AMPL/22MB)**2   11/71
R8  C       CRIEGEE 66 REPLACED BY TODOROFF 67                                11/68
R8  K       CRONIN1 67 REPLACED BY KUNZ 68.                                    2/71
R8           . . . . . . . . .
R8  AVG        4.89     0.54    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R8  STUDENT    4.88     0.59    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R9      KOL INTO (PI+ PI-)/CHARGED (UNIT 10**-3)              (P5)/(P2+P3+P4)
R9  O    45   (2.0)    (0.4)           CHRISTENS 64 OSPK ETA +- = 1.95+-0.20  2/76*
R9  O    54   (2.08)   (0.35)          GALBRAITH 65 OSPK ETA +- = 1.99+-0.16  2/76*
R9  O         (1.93)   (0.26)          BASILE    66 OSPK ETA +- = 1.92+-0.13. 2/76*
R9  O         (1.993)  (0.080)         BOTT-BODE 66 OSPK ETA +- = 1.95+-0.04  2/76*
R9  M 4200    (2.60)   (0.07)          MESSNER   73 ASPK ETA +- = 2.23+-0.05  6/73
R9  O    OLD EXPERIMENTS EXCLUDED FROM FIT.  SEE SUBSECTION E+- BELOW FOR     2/76*
R9  O    AVERAGE ETA+- OF THESE EXPERIMENTS AND FOR NOTE ON DISCREPANCY.      2/76*
R9  M    FROM SAME DATA AS R27 MESSNER 73,BUT WITH DIFFERENT NORMALIZATION.   6/73
R9           . . . . . . . . .
R9  FIT        2.565    0.073  FROM FIT
```

Stable Particles

K_L^0

Data Card Listings

For notation, see key at front of Listings.

```
R10     KOL INTO (PI MU NEU)/(PI E NEU)                          (P3)/(P4)
R10             0.81     0.19           ADAIR     64 HBC                         6/66
R10             0.82     0.10           DEBOUARD  67 OSPK                       11/67
R10     273     0.7      0.2            HAWKINS   67 HBC                         8/67
R10             0.81     0.08           HOPKINS   67 HBC                         8/67
R10     770     0.71     0.05           BUDAGOV   68 HLBC                       10/68
R10 K          (0.67)   (0.13)          KULYUKINA 68 CC                        . 3/74
R10 B   569    (0.71)   (0.04)          BEILLIERE 69 HLBC                       10/69
R10    1309    (0.648)  (0.030)         EVANS     69 HLBC REPL. BY EVANS 73      1/73
R10    3548     0.68     0.08           BASILE    70 OSPK                       10/70
R10    6700     0.741    0.044          BRANDENBU 73 HBC                         1/74
R10    1309     0.662    0.030          EVANS     73 HLBC                        1/73
R10     10K     0.662    0.037          WILLIAMS  74 ASPK                       10/74*
R10 K   KULYUKINA 68 R10 IS NOT MEASURED INDEPENDENTLY FROM R2 AND R4.           1/74
R10 B  BEILLIERE 69 IS A SCANNING EXPT USING SAME EXPOSURE AS BUDAGOV 68
R10          . . . . . . . . .
R10 AVG         0.695    0.019   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
R10 STUDENT     0.695    0.021   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R10 FIT         0.696    0.017  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R11     KOL INTO (MU+MU-)/CHARGED (UNITS 10**-6)                 (P6)/(P2+P3+P4)
R11           100.0   OR LESS           ANIKINA   65 CC                          6/66
R11           250.0   OR LESS  CL=.90   ALFF-STEI 66 OSPK                        9/66
R11             2.0   OR LESS  CL=.90   BOTT-BODE 67 OSPK                        8/67
R11            35.0   OR LESS  CL=.90   FITCH     67 OSPK                        3/68

R12     KOL INTO (PI+ PI- GAMMA)/TOTAL (UNITS 10**-3)      (P10)
R12            15.0   OR LESS           ANIKINA   65 CC                          6/66
R12       0     5.0   OR LESS           BELLOTTI  66 HLBC   GAM KE 40-130 MV     8/67
R12       1     3.0   OR LESS           NEFKENS   66 OSPK   GAM KE 120 MEV       6/66
R12             0.4   OR LESS  CL=.90   THATCHER  68 OSPK   GAM KE 20-170 MV     2/71
R12             3.2   OR LESS  CL=.90   BOBISUT   74 HLBC   GAM KE GT 40 MEV    12/75*
R12  D   24     0.062    0.021          DONALDS1  74 SPEC                       10/74*
R12             0.46  OR LESS  CL=.90   WOO       74 SPEC                       12/75*
R12  D  USES KOL TO PI+PI-PIO/ALL KOL DECAYS = 0.126                            10/74*

R13     KOL INTO (E+ E-)/CHARGED (UNITS 10**-6)                  (P7)/(P2+P3+P4)
R13          1000.0   OR LESS           ANIKINA   65 CC                          6/66
R13           200.0   OR LESS  CL=.90   ALFF-STEI 66 OSPK                        6/66
R13            23.0   OR LESS  CL=.90   BOTT-BODE 67 OSPK                        8/67

R14     KOL INTO (E MU)/CHARGED (UNITS 10**-4)                   (P8)/(P2+P3+P4)
R14            10.0   OR LESS           ANIKINA   65 CC                          6/66
R14             1.0   OR LESS  CL=.90   CARPENTER 66 OSPK                        8/66
R14             0.1   OR LESS  CL=.90  'BOTT-BODE 67 OSPK                        8/67
R14             0.08  OR LESS  CL=.90   FITCH     67 OSPK                        3/68

R15     KOL INTO (E+ PI- NEU)/(E- PI+ NEU)
R15 O    97    (0.90)   (0.18)          NEAGU     61 CC
R15 O          (1.01)   (0.16)          LUERS     64 HBC                         8/66
R15 O   894    (0.99)   (0.023)         KULYUKINA 66 CC                          9/66
R15 O 1539     (1.06)   (0.05)          VERHEY    66 OSPK                        8/67
R15 O   LOW PRECISION EXPTS NOT AVERAGED.  FOR MORE PRECISE VALUE,
R15 O   SEE S13A2 (BENNETT 70, MARX 70)

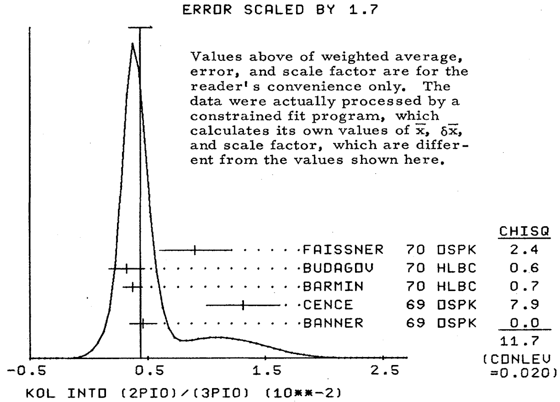
R16     KOL INTO (MU+ PI- NEU)/(MU- PI+ NEU)
R16      1M    1.0081   0.0027          DORFAN    67 OSPK                       11/67
R16     SEE ALSO S13A2 AND S13AL IN THE CP VIOLATION SECTION                     2/71

R17     KOL INTO (PIO PIO)/TOTAL (UNITS 10**-3)                  (P11)
R17 C     7    (1.2)    (1.5)    (1.2)  CRIEGEE   66 OSPK                        7/66
R17 C   CRIEGEE EXPT NOT DESIGNED TO MEASURE 2 PIO DECAY MODE
R17 G   189    (2.5)    (0.8)           GAILLARD  69 OSPK   E00=3.6+-0.6         5/69
R17 G   LATEST RESULT OF THIS EXPERIMENT GIVEN BY FAISSNER 70 R19                1/71
R17          . . . . . . . . .
R17 FIT         0.94     0.19   FROM FIT

R18     KOL INTO (3PIO)/(PI+PI-PIO)                              (P1)/(P2)
R18     188     2.0      0.6            ALEKSANYA 64 FBC                         9/66
R18    1010     1.80     0.13           BUDAGOV   68 HLBC                       10/68
R18     883    (1.65)   (0.07)          BARMIN2   72 HLBC   ERROR STAT. ONLY     3/74
R18          . . . . . . . . .
R18 AVG         1.81     0.13    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R18 STUDENT     1.81     0.14    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R18 FIT         1.747    0.070  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R19     KOL INTO (2PIO)/(3PIO) (UNITS 10**-2)                    (P11)/(P1)
R19 C   109    (1.89)   (0.31)          CRONIN 1  67 OSPK   ETA00=4.9+-0.5       8/67
R19 C          (1.36)   (0.18)          CRONIN 2  67 OSPK   ETA00=3.92+-0.3     11/67
R19 C      CRONIN2 IS FURTHER ANALYSIS OF CRONIN1 ,NOW BOTH WITHDRAWN           11/68
R19      NO EVENTS SEEN                 BARTLETT  68 OSPK   SEE E00 BELOW       11/68
R19      57     0.46     0.11           BANNER    69 OSPK   ETA00=2.2+-0.3       2/72
R19     133     1.31     0.31           CENCE     69 OSPK   ETA00=3.7+-0.5      10/69
R19      29     0.37     0.08           BARMIN    70 HLBC   ETA00=2.02+-0.23    12/70
R19      30     0.32     0.15           BUDAGOV   70 HLBC   ETA00=1.9+-0.5      10/70
R19   F 172     0.90     0.30           FAISSNER  70 OSPK   ETA00=3.2+-0.5      12/70
R19   F FAISSNER 70 CONTAINS SAME 2PIO EVENTS AS GAILLARD 69 R17
R19          . . . . . . . . .
R19 AVG         0.439    0.098   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)
R19 STUDENT     0.425    0.065   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R19 FIT         0.439    0.088  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.5)
                        (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 0.439 ± 0.098
ERROR SCALED BY 1.7



Values above of weighted average, error, and scale factor are for the reader's convenience only. The data were actually processed by a constrained fit program, which calculates its own values of $\overline{x}$, $\delta\overline{x}$, and scale factor, which are different from the values shown here.

```
R20     KOL INTO (PI+ PI-)/(KE3 + KMU3) (UNITS 10**-3)   (P5)/(P3+P4)
R20 O  309    (2.51)    (0.23)          DEBOUARD  67 OSPK   ETA+-=2.00+-0.09  2/76*
R20 O  525    (2.35)    (0.19)          FITCH     67 OSPK   ETA+-=1.94+-0.08  2/76*
R20 O   OLD EXPERIMENTS EXCLUDED FROM FIT.  SEE SUBSECTION E+- BELOW FOR      2/76*
R20 O   AVERAGE ETA+- OF THESE EXPERIMENTS AND FOR NOTE ON DISCREPANCY.       2/76*
R20          . . . . . . . . .
R20 FIT        3.041     0.090  FROM FIT

R21     KOL INTO (2GAMMA)/(3 PIO) (UNITS 10**-3)            (P9)/(P1)
R21      16    2.5       0.7            ARNOLD    68 HLBC   VACUUM DECAY     11/68
R21 $   BANNER 69 IS NEW EXPT. NOT TO BE CONF WITH R8 OF CRONIN1 67            2/72
R21     115    2.24      0.28           BANNER    69 OSPK                    11/68
R21      28    2.13      0.43           BARMIN    71 HLBC                     8/71
R21          . . . . . . . . .
R21 AVG        2.24      0.22    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R21 STUDENT    2.24      0.24    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
```

Note on the $K_L^0 \to \mu^+\mu^-$ Controversy

The $K_L^0 \to \mu^+\mu^-$ branching ratio upper limit of CLARK 71 does not agree with the results of subsequent experiments.

A total of twelve examples of this decay have been observed in three experiments: CARITHERS1 73 (Columbia-CERN-NYU), CARITHERS2 73 (Columbia-BNL-CERN), and FUKUSHIMA 76 (Princeton-Univ. of Mass.-Amherst). Background from all sources (primarily from $K_L^0 \to \pi\mu\nu$ with the pion either penetrating the muon counter or decaying to $\mu\nu$ in flight) has been estimated to be negligible for these experiments. The rates from these three experiments and the upper limits of FOETH 69 and DARRIULAT 70 are all quite consistent (see subsection R22 below). The combined result of these five experiments is

$$R = \frac{\Gamma(K_L^0 \to \mu^+\mu^-)}{\Gamma(K_L^0 \to \pi^+\pi^-)} = (5.0^{+1.6}_{-1.4}) \times 10^{-6} ,$$

where we have divided the observed number $(12^{+3.8}_{-3.3})$ by the sum of the effective denominators (which include the $\pi\pi/\mu\mu$ relative acceptances) given in the data card comments field.

CLARK 71 found no events and obtained the limit $R < 1.53 \times 10^{-6}$ at 90% confidence level. This result is from the FIELD 74 reanalysis of the experiment. The reanalysis uncovered no major flaws, but did find a few problems which increased the upper limit from 1.2×10^{-6} to the above. The combined result of the other five experiments leads us to expect 7.5 events for the sensitivity of the CLARK 71 experiment (9.5 events before reanalysis).

The theoretical lower limit for $\Gamma(K_L^0 \to \mu^+\mu^-)/\Gamma(K_L^0 \to \pi^+\pi^-)$ based on unitarity considerations is 3×10^{-6},[1] in agreement with the combined result, but above the CLARK 71 upper limit.

Data Card Listings

For notation, see key at front of Listings.

Stable Particles

K^0_L

In the Stable Particle Table we quote the above combined value, but warn in a footnote that the value does not include CLARK 71.

Reference

1. C. Quigg and J. D. Jackson, UCRL-18487 (1968).

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R22     KOL INTO (MU+MU-)/(PI+PI-) (UNITS 10**-6)           (P6)/(P5)
R22       0  140.    OR LESS  CL=.90   FOETH      69 SPEC EFF.DENOM.=  16000   5/70
R22       0   18.    OR LESS  CL=.90   DARRIULAT  70 SPEC EFF.DENOM.= 125000  11/70
R22 A     0  (1.53)  OR LESS  CL=.90   CLARK      71 SPEC EFF.DENOM.(1500000)  2/76*
R22  C    6   6.7      6.1       3.1   CARITHE1   73 SPEC EFF.DENOM.= 893000   2/76*
R22  C    3   4.5      6.        3.    CARITHE2   73 SPEC EFF.DENOM.= 667000   2/76*
R22 C     9  (5.8)    (4.)      (2.)   CARITHE2   73 SPEC EFF.DENOM.(1560000)  2/76*
R22  F    3   4.2      5.1       2.6   FUKUSHIMA  76 SPEC EFF.DENOM.= 714000   2/76*
R22 A   CLARK 71 LIMIT RAISED FROM 1.2 E-06 BY FIELD 74 REANALYSIS.            2/76*
R22 A   NOT IN AGREEMENT WITH THREE SUBSEQUENT EXPTS. SO NOT AVERAGED.         2/76*
R22  C  CARITHERS ERRORS ARE AT CL=90 PERCENT.  SECOND CARITHERS2 VALUE IS     2/76*
R22  C  AVERAGE OF CARITHERS1 73 VALUE AND FIRST CARITHERS2 73 VALUE.          2/76*
R22  F  FUKUSHIMA 76 ERRORS ARE AT CL=90 PERCENT.                              2/76*
R22          . . . . . . . . .
R22      12   5.0      1.6       1.4   COMBINED (CL=.68) EFF.DENOM.=2415000    2/76*

R23     KOL INTO (E+ E- )/(PI+PI-) (UNITS 10**-5)           (P7)/(P5)
R23       0  10.0    OR LESS  CL=.90   FOETH      69 ASPK                      5/70
R23           0.10   OR LESS  CL=.90   CLARK      71 ASPK                      6/71

R24     KOL INTO (E MU)/(PI+PI-) (UNITS 10**-5)             (P8)/(P5)
R24           0.10   OR LESS  CL=.90   CLARK      71 ASPK                      6/71

R25     KOL INTO (PI E NEU GAM)/(KL E3) (UNITS 10**-2)    (P12)/(P3)
R25      10   3.3      2.0             PEACH      71 HLBC GAM KE GT 15 MEV     6/71

R26     KOL INTO (PIO TWO GAMMAS)/(3PIO) (UNITS 10**-3)   (P13)/(P1)
R26       0   1.1    OR LESS  CL=.90   BANNER     69 OSPK                      2/72

R27     KOL INTO (PI+ PI-)/TAU (UNITS 10**-2)               (P5)/(P2)          6/73
R27    4200   1.64     0.04            MESSNER    73 ASPK    ETA +- = 2.23     6/73
R27          . . . . . . . . .
R27 FIT       1.640    0.040  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R28     KOL INTO (E+ E- GAMMA)/(3PIO) (UNITS 10**-4)      (P14)/(P1)
R28       0   1.3    OR LESS  CL=.90   BARMIN1    72 HLBC                      3/74

R29     KOL INTO (MU+ MU- GAMMA)/TOTAL (UNITS 10**-6)     (P15)              12/75*
R29           7.81   OR LESS  CL=.90   DONALDS3   74 SPEC                    12/75*

R30     KOL INTO (MU+ MU- PIO)/TOTAL    (UNITS 10**-5)    (P16)              12/75*
R30           5.66   OR LESS  CL=.90   DONALDS3   74 SPEC                    12/75*

R31     KOL INTO (PI+PI-E+E-) /TOTAL    (UNITS 10**-6)    (P17)              12/75*
R31           7.2    OR LESS  CL=.90   DONALDS3   74 SPEC                    12/75*

R32     KOL INTO (PIO PI+- E-+ NEU)/TOTAL (UNITS 10**-3) (P18)              12/75*
R32           2.2    OR LESS  CL=.90   DONALDS3   74 SPEC                    12/75*

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13 KOL ENERGY DEPENDENCE OF DALITZ PLOT

RELATED TEXT SECTION VI B.1, APPENDIX I, AND MINI-REVIEW ON SLOPE PARAMETERS IN THE CHARGED K SECTION OF THE DATA CARD LISTINGS ABOVE

MATRIX ELEMENT SQUARED = 1 + G (S3-SO)/(MPI+**2)

```
GTO  LINEAR ENERGY DEPENDENCE (G) FOR TAU DECAYS  KLONG INTO PI+ PI- PIO
GTO     79     0.55      0.23           ADAIR     64 HBC  AV=-7.6 +- 1.7     . 3/71
GTO     77     0.51      0.20           LUERS     64 HBC  AV=-7.3 +- 1.6       3/71
GTO     66     0.32      0.13           ASTBURY1  65 CC   AV=-5.5 +- 1.5       3/71
GTO    310     0.51      0.09           ASTBURY2  65 CC   AV=-(7.3 +.6 -.8)    3/71
GTO    280     0.64      0.17           ANIKINA   66 CC   AV=-(8.2 +.9 -1.3)   3/71
GTO    126     0.70      0.12           HAWKINS   66 HBC  AV=-8.6 +- 0.7       3/71
GTO   1350     0.649     0.044          HOPKINS   67 HBC  AT=-0.294 +- .018   10/69
GTO   1198     0.428     0.055          NEFKENS   67 OSPK AU=-0.204 +- .025    3/71
GTO   2446     0.400     0.045          BASILE2   68 OSPK AT=-0.188 +- .020    3/71
GTO  29000     0.651     0.012          ALBROW    70 ASPK AY=-0.862 +- .015    1/71
GTO  B 36K     0.593     0.022          BUCHANAN  70 SPEC AU=-0.278 +- .010    2/76*
GTO   4400     0.656     0.058          SMITH     70 OSPK AT=-0.297 +- .024    3/71
GTO    180     0.50      0.11           JAMES     72 HBC                       1/73
GTO   1486     0.608     0.043          KRENZ     72 HLBC AT=-0.277 +- .018   11/72
GTO    384     0.688     0.074          METCALF   72 ASPK AT=-0.31  +- .03    11/72
GTO            0.612     0.032          ALEXANDER 73 HBC                       2/76*
GTO   3200     0.73      0.04           BRANDENBU 73 HBC                       1/74
GTO  C 20K     0.619     0.027          BISI      74 ASPK AT=-0.282 +- .011   10/74*
GTO  M509K     0.677     0.010          MESSNER   74 ASPK AY=-0.917+-.013      7/75*
GTO  S         0.714     0.023          SLONE     74 STRC                     12/75*
GTO    192     0.69      0.07           BALDOCEOL 75 HLBC                     12/75*
GTO    56K     0.590     0.022          BUCHANAN  75 SPEC AU=-0.277 +- .010    7/75*
GTO  B  BUCHANAN 70 RESULT REVISED BY BUCHANAN 75 TO INCLUDE RADIATIVE COR.  2/76*
GTO  B  AND TO USE MORE RELIABLE KL MOM.SPECT. OF 2ND EXPT.(HAD SAME BEAM).  2/76*
GTO  C  BISI 74 VALUE COMES FROM QUADRATIC FIT WITH QUAD. TERM CONSISTENT   11/75*
GTO  C  WITH ZERO.  GTO ERROR IS THUS LARGER THAN IF LINEAR FIT WERE USED.  11/75*
GTO  M  MESSNER 74 FINDS NONLINEAR TERMS H=.079+-.007, J=0, K=.0097+-.0018.  1/76*
GTO  S  SLONE 74 VALUE IS FROM A FIT TO A LINEAR MATRIX ELEMENT, NOT TO A   12/75*
GTO  S  LINEAR SPECTRUM.  HIS FIT TO A LINEAR SPECTRUM GIVES                12/75*
GTO  S  GTO=0.630+-0.017 WITH A POOR CHI-SQUARED.                           12/75*
GTO         . . . . . . . . .
GTO AVG        0.646     0.014   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.5)
GTO STUDENT    0.6462    0.0095  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                                 (SEE IDEOGRAM BELOW )
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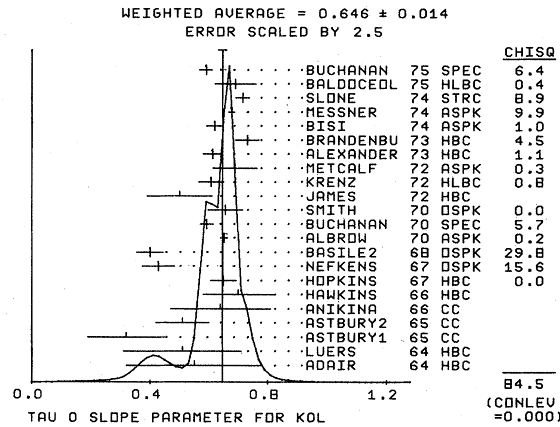


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13 KOL FORM FACTORS

RELATED TEXT SECTION VI B.2 AND MINI-REVIEW ON FORM FACTORS IN THE CHARGED K SECTION OF THE DATA CARD LISTINGS ABOVE.

IN THE FORM FACTOR COMMENTS, THE FOLLOWING ABBREVIATIONS ARE USED.
F+ AND F- ARE FORM FACTORS FOR THE VECTOR MATRIX ELEMENT.
FS AND FT REFER TO THE SCALAR AND TENSOR TERM.
FO = (F+) + (F-)*T/(MK**2-MPI**2)
L+, L- AND LO ARE THE LINEAR EXPANSION COEFFS. OF F+, F- AND FO.
L+ REFERS TO THE KMU3 VALUE EXCEPT IN THE KE3 SECTIONS.
DXI/DL IS THE CORRELATION BETWEEN XI(0) AND L+ IN KMU3.
DLO/DL+ IS THE CORRELATION BETWEEN LO AND L+ IN KMU3.
T = MOMENTUM TRANSFER TO THE PI IN UNITS OF MPI**2.
DP = DALITZ PLOT ANALYSIS
PI = PI SPECTRUM ANALYSIS
MU = MU SPECTRUM ANALYSIS
POL= MU POLARIZATION ANALYSIS
BR = KMU3/KE3 BRANCHING RATIO ANALYSIS
E = POSITRON OR ELECTRON SPECTRUM ANALYSIS
RC = RADIATIVE CORRECTIONS

```
XIA     XIA = F-/F+ (DETERMINED FROM SPECTRA)   ---------------------------
XIA  L1341   +1.2     (0.8)              CARPENTER 66 OSPK   DP, DXI/DL=-18     1/74
XIA B 3140  (-3.9)    (0.4)              BASILE    70 OSPK   DP, INDEP OF L+    1/74
XIA C  16K  (-0.68)   (0.12)    (0.20)   CHIEN     70 ASPK   DP, DXI/DL=-26     1/74
XIA  A9086   -1.5      0.7               ALBROW    72 ASPK   DP, DXI/DL=-28     1/74
XIA C  16K  (+0.50)   (0.61)             DALLY     72 ASPK   DP, DXI/DL UNKN.   1/74
XIA  P1385   -1.00    (0.45)             PEACH     73 HLBC   DP, DXI/DL=-20     1/74
XIA  D 82K   -0.26     0.21              ALBRECHT  74 WIRE   DP, DXI/DL=-24    11/75*
XIA D  82K  (-2.41)   (0.17)             ALBRECHT  74 WIRE   DP, DXI/DL=-9.4   11/75*
XIA  E1.6M   -0.11     0.07              DONALDS2  74 SPEC   DP, DXI/DL=-17    11/75*
XIA  F 32K   -0.25     0.22              BUCHANAN  75 SPEC   DP, DXI/DL=-5.9    2/76*
XIA  L  CARPENTER 66 XI(0) IS FOR L+=0.  DXI/DL IS FROM FIG. 9.                 1/74
XIA B   BASILE 70 IS INCOMPATIBLE WITH ALL OTHER RESULTS.  AUTHORS SUGGEST      1/74
XIA B   THAT EFFICIENCY ESTIMATES MIGHT BE RESPONSIBLE.                         1/74
XIA  A  ALBROW 72 FIT HAS L- FREE, GETS L-=-.030+-.060 OR LAM=+.15+.17-.11.    1/74
XIA C   CHIEN 70 ERRORS ARE STATISTICAL ONLY.  DXI/DL FROM FIG.4.               1/74
XIA  C  DALLY 72 IS A REANALYSIS OF CHIEN 70.  THE DALLY 72 RESULT IS           1/74
XIA  C  NOT COMPATIBLE WITH ASSUMPTION L-=0 SO NOT INCLUDED IN OUR FIT.         2/76*
XIA  C  THE NON-ZERO L- VALUE AND THE RELATIVELY LARGE L+ VALUE FOUND BY        1/74
XIA  C  DALLY 72 COME MAINLY FROM A SINGLE LOW T BIN (FIGS.1,2).                1/74
XIA  C  THE (F+,XI) CORRELATION WAS IGNORED.                                    1/74
XIA  C  WE ESTIMATE FROM FIG. 2 THAT FIXING L-=0 WOULD GIVE XI(0)=-1.4+-0.3     1/74
XIA  C  AND WOULD ADD 10 TO CHI SQUARED.  DXI/DL IS NOT GIVEN.                  1/74
XIA  D  ALBRECHT 74 IS CALCULATED BY US FROM LO, L+ AND DLO/DL+.  THEY FIND   11/75*
XIA  D  TWO SOLUTIONS.  THE FIRST HAS L+=.046+-.008 IN AGREEMENT WITH KE3.      3/74
XIA  P  PEACH 73 GIVES XIO=-.95+-.45 FOR L+=L-=.025 .  THE ABOVE VALUE IS       1/74
XIA  P  FOR L-=0.  K.PEACH, PRIVATE COMMUNICATION(1974).                        1/74
XIA  E  DONALDSON2 74 GIVES XI=-.11+-.02 NOT INCLUDING SYSTEMATICS.  ABOVE    11/75*
XIA  E  ERROR AND DXI/DL WERE CALCULATED BY US FROM LO AND L+ ERRORS (WHICH   11/75*
XIA  E  INCLUDE SYSTEMATICS) AND DLO/DL+.                                     11/75*
XIA  F  BUCHANAN 75 IS CALCULATED BY US FROM LO, L+ AND DLO/DL+ BECAUSE         2/76*
XIA  F  THEIR APPENDIX A VALUE -.20+-22 ASSUMES XI(T) CONSTANT, I.E. L-=L+.     2/76*
XIA          . . . . . . . . .
XIA FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS IN K+- SECTION OF DATA CARDS.

XIB     XIB = F-/F+ (DETERMINED FROM KMU3/KE3)   ---------------------------
XIB      THE KMU3/KE3 BRANCHING RATIO FIXES A RELATIONSHIP BETWEEN XI(0)        1/74
XIB      AND L+.  WE QUOTE THE AUTHORS XI(0) AND ASSOCIATED L+ BUT DO NOT       1/74
XIB      AVERAGE BECAUSE THE L+ VALUES DIFFER.  THE FIT RESULT AND SCALE        1/74
XIB      FACTOR GIVEN IN THE NOTE ON KL3 FORM FACTORS IN THE K+- SECTION OF     2/76*
XIB      THE DATA CARDS ARE NOT OBTAINED FROM THESE XIB VALUES.  INSTEAD        2/76*
XIB      THEY ARE OBTAINED DIRECTLY FROM THE FITTED KMU3/KE3 RATIO (R10).       2/76*
XIB    389   +1.1      1.1               ADAIR     .64 HBC    BR, L+=0          1/74
XIB          +0.66     0.9       1.3     LUERS      64 HBC    BR, L+=0          1/74
XIB          +0.2      0.8       1.2     KULYUKINA  68 CC     BR, L+=0        . 1/74
XIB    569   +0.45     0.28              BEILLIERE  69 HLBC   BR, L+=0          1/74
XIB E 1309  (-0.22)   (0.30)             EVANS      69 HLBC   BR, L+=.02+-.015  1/74
XIB   3548   -0.5      0.5               BASILE     70 OSPK   BR, L+=.02        1/74
XIB   6700    0.5      0.4               BRANDENBU  73 HBC    BR,L+=.019+-.013  1/74
XIB  E1309   -0.08     0.25              EVANS      73 HLBC   BR, L+=.02        1/74
XIB  E  EVANS 73 REPLACES EVANS 69.                                             1/74
XIB          . . . . . . . . .
XIB FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS IN K+- SECTION OF DATA CARDS.
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Stable Particles

K_L^0

Data Card Listings

For notation, see key at front of Listings.

```
XIC     XIC = F-/F+ (DETERMINED FROM MU POLARIZATION IN KMU3)   ------------
XIC     THE MU POLARIZATION IS A MEASURE OF XI(T). NO ASSUMPTIONS ON L+-
XIC     NECESSARY, T (WEIGHTED BY SENSITIVITY TO XI0) SHOULD BE SPECIFIED.
XIC     IN L+,XI(0) PARAMETERIZATION THIS IS XI(0) FOR L+=0.  DXI/DL=XI*T.
XIC      FOR RAD. CORR. TO MUON POLARIZATION IN KMU3, SEE GINSBERG 73.        2/72
XIC T 2608  (-1.2)    (0.5)              AUERBACH  66 OSPK    POLARIZATION     8/67
XIC T  638  (-1.6)    (0.5)              ABRAMS    68 OSPK    POLARIZATION     5/69
XIC  L        -1.81     0.50      0.26   LONGO     69 CNTR    POL. T=3.3       1/74
XIC  S2.2M   -0.385     0.105            SANDWEISS 73 CNTR    POL,DXI/DL=-6    1/74
XIC  H350K   +0.178     0.105            SHEN      75 SPEC    POL,DXI/DL=+.68  1/76*
XIC T   T VALUE NOT GIVEN.                                                      1/74
XIC  L  LONGO 69 T=3.3 CALC. FROM DXI/DL=-6.0 (TABLE 1) DIVIDED BY XI=-1.81     1/74
XIC  S  SANDWEISS 73 IS FOR L+=0 AND T=0.                                       1/74
XIC  H  SHEN 75 T=+3.80, DXI/DL=XT*T=.178*3.80=+.68 .                           1/76*
XIC        . . . . . . . . .
XIC FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS IN K+- SECTION OF DATA CARDS.

IXI       IMAGINARY PART OF XI  (TEST OF T REVERSAL)  -------------------
IXI          -0.2       0.6                  ABRAMS    68 OSPK    POLARIZATION    10/69
IXI          -0.02      0.08                 LONGO     69 CNTR    POL. T=3.3      11/69
IXI   2.2M   -0.060     0.045                SANDWEISS 73 CNTR    POL, T=0         1/74
IXI        . . . . . . . . .
IXI AVG      -0.051     0.039   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
IXI STUDENT  -0.051     0.042   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

L+M     LAMBDA +  (LINEAR ENERGY DEPENDENCE OF F+ IN KMU3 DECAY)   ---------
L+M      SEE ALSO THE CORRESPONDING ENTRIES AND NOTES IN SECTION XIA AND LO.
L+M      FOR RAD.COR. OF KMU3 DP SEE GINSBURG 70 AND BECHERRAWY 70.             3/74
L+M C  16K   (0.07)    (0.02)           CHIEN     70 ASPK    DP                1/74
L+M  A9086    0.085     0.015           ALBROW    72 ASPK    DP                1/74
L+M C  16K   (0.11)    (0.04)           DALLY     72 ASPK    DP                1/74
L+M  D 82K    0.046     0.008           ALBRECHT  74 WIRE    DP               11/75*
L+M D  82K   (0.076)   (0.004)          ALBRECHT  74 WIRE    DP               11/75*
L+M   1.6M    0.030     0.003           DONALDS2  74 SPEC    DP               10/74*
L+M    32K    0.046     0.030           BUCHANAN  75 SPEC    DP                9/75*
L+M C   CHIEN 70 VALUE AND ERROR HAVE BEEN CHANGED FROM 0.08 +- 0.01 TO        3/71
L+M C   INCLUDE SYSTEMATIC EFFECTS. DALLY 72 IS A REANALYSIS OF CHIEN 70.      3/71
L+M C   SEE NOTE IN SECTION XIA.                                                1/74
L+M  D  ALBRECHT 74 FINDS TWO SOLUTIONS.  THE FIRST AGREES WITH KE3.           11/75*
L+M        . . . . . . . . .
L+M FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS IN K+- SECTION OF DATA CARDS.

LO      LAMBDA 0 (LINEAR ENERGY DEPENDENCE OF F0 IN KMU3 DECAY)   ----------
LO       WHEREVER POSSIBLE, WE HAVE CONVERTED THE ABOVE VALUES OF XI(0) INTO
LO       VALUES OF LO USING THE ASSOCIATED L+M AND DXI/DL.
LO L  1371   +0.10     (0.07)           CARPENTER 66 OSPK    DP,DLO/DL+=-0.54  1/74
LO L         -0.155    (0.043)  (0.022)LONGO      69 CNTR    POL,DLO/DL+=+.49  1/74
LO  B 3140  (-0.333)   (0.034)          BASILE    70 OSPK    DP,DLO/DL+=+1.    1/74
LO A  9086   -0.043     0.052           ALBROW    72 ASPK    DP,DLO/DL+=-1.39  1/74
LO  C  16K  (-0.067)   (0.227)          DALLY     72 ASPK    DP,DLO/DL+ UNKN.  1/74
LO  R 6700  (+0.06)    (0.03)           BRANDENBU 73 HBC     BR,L+=.019+-.013  1/74
LO P  1385   -0.060    (0.038)          PEACH     73 HLBC    DP,DLO/DL+=-0.71  1/74
LO L  2.2M   -0.033    (0.009)          SANDWEISS 73 CNTR    POL,DLO/DL+=+.49  1/74
LO   D 82K   +0.024     0.011           ALBRECHT  74 WIRE    DP,DLO/DL+=-1.06 11/75*
LO  D  82K  (-0.130)   (0.014)          ALBRECHT  74 WIRE    DP,DLO/DL+=+0.20 11/75*
LO E 1.6M     0.019     0.004           DONALDS2  74 SPEC    DP,DLO/DL+=-0.47 10/74*
LO   F 32K   +0.025     0.019           BUCHANAN  75 SPEC    DP,DLO/DL+=+0.5   2/76*
LO L  350K   +0.015    (0.009)          SHEN      75 SPEC    POL,DLO/DL+=1.06  1/76*
LO L    LO VALUE IS FOR L+=0.  CALCULATED BY US FROM XI0 AND DXI/DL.           1/74
LO  B   BASILE 70 LO IS FOR L+=0.  CALCULATED BY US FROM XIA WITH DXI/DL=0.    1/74
LO  B   BASILE 70 IS INCOMPATIBLE WITH ALL OTHER RESULTS.  AUTHORS SUGGEST     1/74
LO  B   THAT EFFICIENCY ESTIMATES MIGHT BE RESPONSIBLE.                         1/74
LO A    ALBROW 72 LO IS CALCULATED BY US FROM XIA,L+ AND DXI/DL.  THEY GIVE    1/74
LO A    LO=-.043+-.039 FOR L-=0.  WE USE OUR LARGER CALCULATED ERROR.          1/74
LO  C   DALLY 72 GIVES F0=1.20+-.35, LO=-.080+-.272, LOPRIME=-.006+-.045,      1/74
LO  C   BUT WITH A DIFFERENT DEFINITION OF LO.  OUR QUOTED LO IS HIS LO/F0.    1/74
LO  C   WE CANNOT CALCULATE TRUE LO ERROR WITHOUT HIS (LO,F0) CORRELATIONS.    1/74
LO  C   SEE ALSO NOTE C IN SECTION XIA.                                         1/74
LO P    PEACH 73 ASSUMES L+=0.025.  CALCULATED BY US FROM XI0 AND DXI0/DL+.    1/74
LO  R   FIT FOR LO DOES NOT INCLUDE THIS VALUE BUT INSTEAD INCLUDES THE        2/76*
LO  R   KMU3/KE3 RESULT FROM THIS EXPERIMENT.                                   2/76*
LO   D  ALBRECHT 74 FINDS TWO SOLUTIONS.  THE FIRST HAS L+=.046+-.008 IN       11/75*
LO   D  AGREEMENT WITH KE3.  DLO/DL+ OBTAINED FROM FIG.2C.
LO E    DONALDSON2 74 DLO/DL+ OBTAINED FROM FIG. 18.                           11/75*
LO   F  BUCHANAN 75 VALUE IS FROM THEIR APPENDIX A AND USES ONLY KMU3 DATA.    2/76*
LO   F  DLO/DL+ WAS OBTAINED BY PRIVATE COMMUNICATION, C.BUCHANAN, 1976.       2/76*
LO         . . . . . . . . .
LO  FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS IN K+- SECTION OF DATA CARDS.

L+E     LAMBDA +  (LINEAR ENERGY DEPENDENCE OF F+ IN K0 E3 DECAY)   ------
L+E     FOR RAD.COR. OF KE3 DP SEE GINSBURG 67 AND BECHERRAWY 70.               3/74
L+E    153   +0.07      .06             LUERS     64 HBC     DP, NO RC
L+E    577   +0.15      .08             FISHER    65 OSPK    DP, NO RC         8/67
L+E    762   -0.01      .02             FIRESTONE 67 HBC     DP, NO RC         8/67
L+E    531   +0.01      .015            KADYK     67 HBC     E,PI, NO RC       8/67
L+E    240   +0.08      .10       .08   LOWYS     67 FBC     PI, USES RC       8/67
L+E   1000    0.02     0.013            ARONSON   68 OSPK    PI                5/69
L+E   4800   +0.023    0.012            BASILE    68 OSPK    DP, NO RC         3/68
L+E    42K    0.023    0.005            BISI      71 ASPK    DP, USES RC      12/71
L+E    16K    0.05     0.01             CHIEN     71 ASPK    DP, NO RC         6/71
L+E   1910    0.022    0.014            NEUHOFER  72 ASPK    PI, USES RC       1/73
L+E   5600    0.045    0.014            ALBROW    73 ASPK    DP, USES RC       9/73
L+E   1871    0.019    0.013            BRANDENBU 73 HBC     PI TRANSV., RC    1/74
L+E Z 500K   (0.031)  (0.0025)          GJESDAL   73         DP                3/74
L+E   2171    0.040    0.012            WANG      74 OSPK    DP, USES RC       7/74*
L+E    25K    0.0270   0.0028           BLUMENTHA 75 SPEC    DP                7/75*
L+E    24K    0.044    0.006            BUCHANAN  75 SPEC    DP, USES RC       7/75*
L+E Z   PRELIMINARY.                                                            3/74
L+E        . . . . . . . . .
L+E AVG       0.0288   0.0028  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
L+E STUDENT   0.0280   0.0024  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                               (SEE IDEOGRAM BELOW )

FS      FS/F+  RATIO OF SCALAR TO F+ COUPLINGS FOR KE3 DECAY(ABS. VALUE)----
FS             0.15  OR LESS  CL=.68   KULYUKINA 67 CC                        10/69
FS     5600    0.19  OR LESS  CL=.95   ALBROW    73 ASPK                       9/73
FS      25K    0.04  OR LESS  CL=.68   BLUMENTHA 75 SPEC                       7/75*

FT      FT/F+  RATIO OF TENSOR TO F+ COUPLINGS FOR KE3 DECAY(ABS. VALUE)----
FT             1.0   OR LESS  CL=.68   KULYUKINA 67 CC                        10/69
FT     5600    1.0   OR LESS  CL=.95   ALBROW    73 ASPK                       9/73
FT      25K    0.23  OR LESS  CL=.68   BLUMENTHA 75 SPEC                       7/75*

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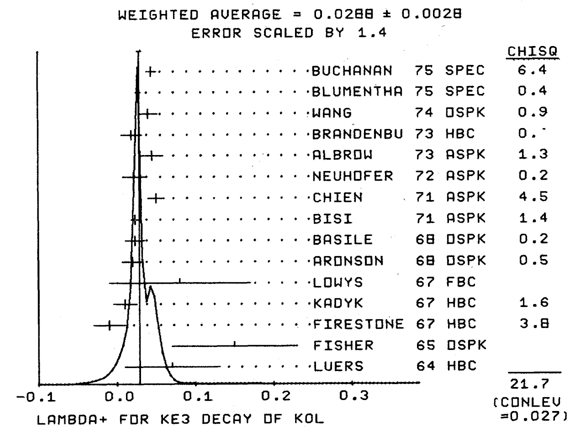


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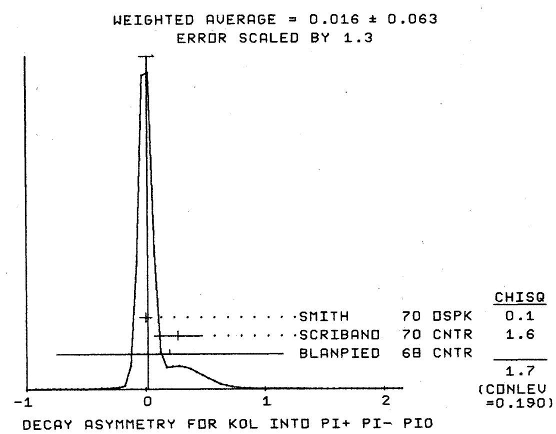
          13  CP VIOLATION PARAMETERS IN KOL DECAYS

     RELATED TEXT SECTION VI B.3 AND MINI-REVIEW BELOW

--------------------13 CHARGE ASYMMETRY IN TAU DECAYS---------------------
TEXT SECTION VI B.3 B

      SEE SCRIBANO 70 FOR DEFINITION (HIS SIGMA+-). A=1 FOR MAX ASYMMETRY
      (M)**2 = 1+ SIG+- (2/SQRT(3) *((T+)-(T-))/ TMAX)  AS SCRIBANO 70

A      DECAY ASYMMETRY PARAMETER FOR PI+ PI- PI0   (UNITS 10**-2)
A       .3M     0.2       0.95             BLANPIED  68 CNTR              . 4/70
A        3M     0.27      0.2              SCRIBANO  70 CNTR              .12/70
A      4400     0.000     0.050            SMITH     70 OSPK              .10/70
A             . . . . . . . . .
A    AVG        0.016     0.063   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
A    STUDENT    0.015     0.053   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                                  (SEE IDEOGRAM BELOW )
```

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--------------------13  CHARGE ASYMMETRY IN LEPTONIC DECAYS (PERCENT)------
TEXT SECTION VI B.3 C

     SUCH ASYMMETRY VIOLATES CP . IT IS RELATED TO REAL(EPSILON).

A1     KOL INTO (MU+PI-NU)-(MU-PI+NU)/(MU+PI-NU)+(MU-PI+NU)     (PERCENT)
A1  D   1M    (0.403)  (0.134)        DORFAN    67 OSPK   DERIVED FROM R16 11/67
A1 D    1M     0.57     0.17          PACIOTTI  69 OSPK                     1/73
A1    7.7M     0.278    0.051         PICCIONI  72 ASPK                     1/73
A1    4.1M     0.60     0.14          MCCARTHY  73 CNTR                     6/73
A1     15M     0.313    0.029         GEWENIG1  74 ASPK                     7/74*
A1 D    PACIOTTI 69 IS A REANALYSIS OF DORFAN 67 AND IS CORRECTED FOR       1/73
A1 D    MU+ MU- RANGE DIFFERENCE IN MC CARTHY 72.                           1/73
A1           . . . . . . . . .
A1  AVG        0.319    0.038   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
A1  STUDENT    0.316    0.027   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

A2     KOL INTO (E+PI-NU)-(E-PI+NU)/(E+PI-NU)+(E-PI+NU)          (PERCENT)
A2  B  10M    (0.224)  (0.036)        BENNETT   67 CNTR                    11/67
A2 B   10M     0.246    0.059         SAAL      69 CNTR                    10/70
A2     10M     0.346    0.033         MARX      70 CNTR                    10/70
A2    600K     0.36     0.18          ASHFORD   72 ASPK                     2/72
A2     40M     0.318    0.038         FITCH     73 ASPK                    12/73
A2     34M     0.341    0.018         GEWENIG1  74 ASPK                     7/74*
A2  B SAAL 69 IS A REANALYSIS OF BENNETT 67
A2           . . . . . . . . .
A2  AVG.       0.333    0.014   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
A2  STUDENT    0.334    0.016   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
```
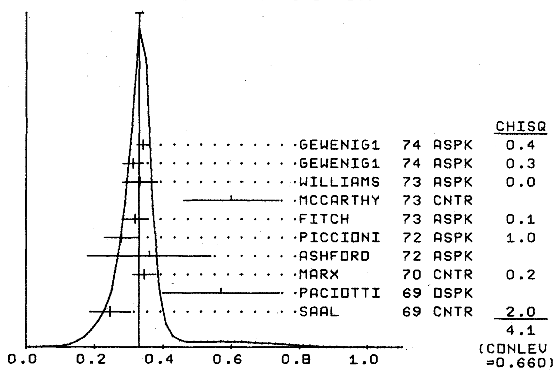

Data Card Listings

For notation, see key at front of Listings.

AL		KOL INTO ((L+)-(L-))/((L+)+(L-)) (COMBINED A1 AND A2) (PERCENT)							
AL B	10M	0.246	0.059	SAAL	69	CNTR	KE3	2/71
AL D	1M	0.57	0.17	PACIOTTI	69	OSPK	KMU3	1/73
AL	10M	0.346	0.033	MARX	70	CNTR	KE3	2/71
AL	600K	0.36	0.18	ASHFORD	72	ASPK	KE3	2/72
AL	7.7M	0.278	0.051	PICCIONI	72	ASPK	KMU3	1/73
AL	40M	0.318	0.038	FITCH	73	ASPK	KE3	12/73
AL	4.1M	0.60	0.14	MCCARTHY	73	CNTR	KMU3	6/73
AL	33M	0.333	0.050	WILLIAMS	73	ASPK	KMU3+KE3	12/73
AL	15M	0.313	0.029	GEWENIG1	74	ASPK	KMU3	7/74*
AL	34M	0.341	0.018	GEWENIG1	74	ASPK	KE3	7/74*
AL	SEE FOOTNOTES IN SECTIONS A1 AND A2 ABOVE.							1/73
AL	. . . .							
AL	AVG	0.330	0.012	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)				
AL	STUDENT	0.330	0.013	AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT (SEE IDEOGRAM BELOW)				

WEIGHTED AVERAGE = 0.330 ± 0.012
ERROR SCALED BY 1.0



CHARGE ASYMMETRY FOR KOL INTO LEPTONS

--------------------13 PARAMETERS FOR KOL INTO 2PI DECAY------------------
TEXT SECTION VI 8.3 D

ETA+- = A(KL TO PI+PI-)/A(KS TO PI+PI-)
ETA00 = A(KL TO PIOPIO)/A(KS TO PIOPIO)

Note on $|\eta_{+-}|$

There is a very large discrepancy between old and new results for $|\eta_{+-}|$, the ratio of amplitudes $A(K^0_L \to \pi^+\pi^-)/A(K^0_S \to \pi^+\pi^-)$. The average of the older $|\eta_{+-}|$ results of CHRISTENSON 64, GALBRAITH 65, BASILE 66, BOTT-BODENHAUSEN 66, DE BOUARD 67, and FITCH 67 (see subsections R9, R20, and E+- of the K^0_L Data Card Listings) is

$$|\eta_{+-}| = (1.95 \pm 0.03) \times 10^{-3}$$

with very good consistency.

In 1973 a CERN-Heidelberg K^0_L, K^0_S interference experiment and a Colorado-SLAC-Santa Cruz branching ratio measurement gave the following results:

$$|\eta_{+-}| = (2.30 \pm 0.035) \times 10^{-3} \quad \text{GEWENIGER2 74,}$$

$$|\eta_{+-}| = (2.23 \pm 0.05\ ) \times 10^{-3} \quad \text{MESSNER 73,}$$

which are around 11 standard deviations above the previous average but are in good agreement with each other. GEWENIGER2 74 also made a check measurement in order to confirm their interference result by measuring the branching ratio $K^0_L \to \pi^+\pi^-/K^0_L \to \pi e\nu$. They obtained the result $|\eta_{+-}| = (2.30 \pm 0.06)\times 10^{-3}$, which, although systematically less reliable than the interference result, is in good agreement with it. A Columbia experiment[1] and two Chicago experiments (Cronin group[2] and Telegdi group[3]) have also yielded unpublished measurements which corroborate the higher values of $|\eta_{+-}|$.

The origin of the discrepancy between old and new results is not known. The effect of the change in the K^0_S mean life value (see note in K^0_S section of the Stable Particle Data Card Listings) is insufficient to explain it, raising $|\eta_{+-}|$ by only about 2%. The MESSNER 73 result above was evaluated for the old K^0_S mean life and branching fractions for $K^0_S \to \pi^+\pi^-$ and $K^0_L \to \pi^+\pi^-\pi^0$. The new K^0_S mean life and the current branching fractions increase the MESSNER 73 $|\eta_{+-}|$ value slightly to $(2.246 \pm 0.032) \times 10^{-3}$.

We are troubled by this large unexplained discrepancy. We feel that our normal procedure of averaging and increasing the error by a scale factor S to account for the discrepancy is not adequate for this case. The two new results, when combined with the average of the earlier results by that procedure, give 2.15 ± 0.11 ($S = 6.0$). While this value-and-error makes some sense in that it nearly spans both incompatible sets of data, we choose not to quote it. Instead, since the newer experiments are in principle superior (higher statistics, better acceptance, easier trigger conditions), we have chosen to average them separately from the earlier experiments as is seen in the E+- subsection of the Data Card Listings below.

The entry referenced as GKL/GKS 71 is the average of all seven experiments before 1971. This average is determined from the branching ratios quoted for these experiments in subsections R9 and R20 above. It was quoted by us as the $|\eta_{+-}|$ value in our 1971 edition. The average and fit values at the end of the E+- subsection below do not include

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For notation, see key at front of Listings.

the pre-1971 $|\eta_{+-}|$ results. The reader may thus utilize the pre-1971 and post-1971 results as desired.

The fitted values in the EOS, E+-, and ER subsections below are the result of a fit to the unparenthesized values of $|\eta_{00}|$, $|\eta_{+-}|$, and $|\eta_{00}/\eta_{+-}|$ in these subsections. We quote the fitted values of $|\eta_{+-}|$ and $|\eta_{00}|$ in the Addendum to the Stable Particle Table but warn in a footnote that they exclude pre-1971 $|\eta_{+-}|$ results.

See also D. Nygren's "Review of K^0 Decays"[4] for additional discussion of this and other K^0 controversies.

References

1. D. R. Nygren, private communication.
2. R. DeVoe, private communication.
3. S. Aronson, private communication to D. Nygren reported in reference 4.
4. D. R. Nygren, Review of K^0 Decays, presented at the Berkeley A.P.S. Meeting of the Division of Particles and Fields, Berkeley, California, August 13-17, 1973; LBL-2407.


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THE FITTED VALUES OF ETA+- AND ETA00 GIVEN BELOW ARE THE RESULTS
OF A FIT TO ETA+-, ETA00 AND ETA00/ETA+- RESULTS.  THE VALUES LISTED
BELOW WHICH ARE NOT PARENTHESIZED ENTER THE FIT AS SHOWN.  THE
VALUES WHICH ARE PARENTHESIZED AND BEAR THE FOOTNOTE X DO NOT ENTER
THE FIT AS SHOWN.  THESE EXPERIMENTS GIVE BRANCHING RATIOS AND ENTER
THE FIT VIA THE QUANTITY ACTUALLY MEASURED -- BRANCHING RATIOS
R9, R20 AND R27 (ETA+-) AND R17 AND R19 (ETA00).  THESE BRANCHING
RATIOS ARE COMBINED WITH CURRENT NORMALIZATIONS AND CURRENT KL AND KS
MEAN LIVES TO OBTAIN PI PI RATES.  THE ETA+- AND ETA00 VALUES OBTAINED
FROM THESE RATES ARE ENTERED BELOW WITH THE NAME 'GKL/GKS'.

EOS      (ETA00)**2 = (A(KL TO 2PI0)/A(KS TO 2PI0))**2  (UNITS 10**-6)   ---
EOS X     0  (-2.)      (7.0)          BARTLETT  68 OSPK                         10/69
EOS X    57   (4.9)     (1.2)          BANNER    69 OSPK                          2/72
EOS X   133  (14.1)     (3.4)          CENCE     69 OSPK                         10/69
EOS XF  180  (13.)      (4.)           GAILLARD  69 OSPK                         10/69
EOS X    29   (4.08)    (0.9)          BARMIN    70 HLBC                         12/70
EOS X    30   (3.61)    (1.9)          BUDAGOV   70 HLBC                         10/70
EOS  C         8.7       3.7           CHOLLET   70 OSPK   CU REG.,4 GAMMAS       2/72
EOS XF  172   (9.9)     (3.4)          FAISSNER  70 OSPK                         12/70
EOS  C   56    7.4       2.0           WOLFF     71 OSPK   CU REG.,4GAMMAS       12/71
EOS  X         5.2       1.1           GKL/GKS   76 RVUE BR SCALE FACTOR=1.5      2/76*
EOS X   SEE NOTE ABOVE REGARDING FITTED VALUES OF ETA+- AND ETA00.
EOS  C  CHOLLET 70 GIVES ETA00=(1.23+-0.24)*(REGEN AMPL,2GEV/C CU)/10000MB        2/72
EOS  C  WOLFF 71   GIVES ETA00=(1.13+-0.12)*(REGEN AMPL,2GEV/C CU)/10000MB        2/72
EOS  C  WE COMPUTE BOTH ETA00**2 VALUES FOR (REGEN AMPL,2GEV/C CU)=24+-2MB.       2/72
EOS  C  THIS REGEN AMPL RESULTS FROM AVERAGING OVER FAISSNER 69,                  2/72
EOS  C  EXTRAPOLATED USING OPTICAL MODEL CALCULTIONS OF BOHM ET AL.               2/72
EOS  C  PL 27B 594 (1968) AND THE DATA OF BALATS 71. (FROM H. FAISSNER,           2/72
EOS  C  PRIVATE COMMUNICATION)                                                    2/72
EOS  F  FAISSNER 70 CONTAINS SAME 2PI0 EVENTS AS GAILLARD 69
EOS           . . . . . . . . . .
EOS AVG       5.90      0.93   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
EOS STUDENT   5.9       1.1    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
EOS FIT       5.41      0.22  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)       2/76*
E00 THIS FIT VALUE CORRESPONDS TO ETA00=2.325+-0.093                              2/76*

E+-     ETA+-  = A(KL TO PI+PI-)/A(KS TO PI+PI-) UNITS 10**-3  -------------
E+- X   45   (1.95)   (0.20)           CHRISTENS 64 OSPK                          2/76*
E+- X   54   (1.99)   (0.16)           GALBRAITH 65 OSPK                          2/76*
E+- X        (1.92)   (0.13)           BASILE    66 OSPK                          2/76*
E+- X        (1.95)   (0.04)           BOTT-BODE 66 OSPK                          2/76*
E+- X        (2.00)   (0.09)           DEBOUARD  67 OSPK                          2/76*
E+- X        (1.94)   (0.08)           FITCH     67 OSPK                          2/76*
E+- AX       (1.95)   (0.03)           GKL/GKS   71 RVUE    EXPTS. BEFORE 71      2/76*
E+- A   AVERAGE OF ABOVE EXPTS.  EXCLUDED FROM FIT.  SEE TYPED NOTE ABOVE.        2/76*
E+- X 4200   (2.23)   (0.05)           MESSNER   73 ASPK                         11/75*
E+-          2.30     0.035            GEWENIG2  74 ASPK                          3/74
E+-B X       2.246    0.032            GKL/GKS   76 RVUE    BR EXP. AFTER 71      2/76*
E+-B    CURRENTLY INCLUDES ONLY MESSNER 73 + NEW KL TAU AND KS PI+PI- RATES       2/76*
E+- X   SEE NOTE ABOVE REGARDING FITTED VALUES OF ETA+- AND ETA00.
E+-           . . . . . . . . . .
E+- AVG      2.271    0.027   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
E+- STUDENT  2.270    0.027   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
E+- FIT      2.272    0.023  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)        2/76*
                              (SEE IDEOGRAM BELOW )

ER     RATIO OF ETA00 OVER ETA+-
ER     124   1.03     0.07             BANNER1   72 OSPK                          8/72
ER     167   1.00     0.06             HOLDER    72 ASPK                          8/72
ER            . . . . . . . . . .
ER  AVG      1.013    0.046   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
ER  STUDENT  1.013    0.049   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
ER  FIT      1.023    0.040  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)        2/76*
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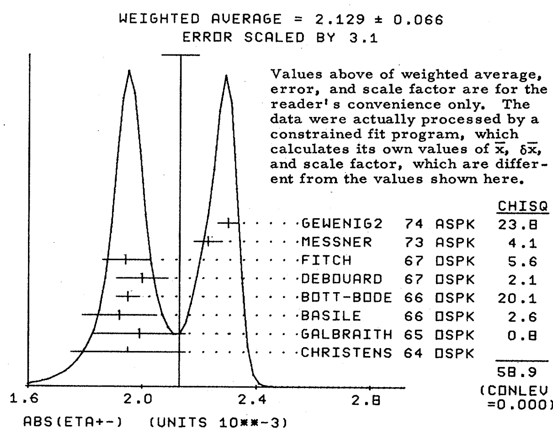

Note on $K^0_L \to 2\pi$ and K_S Regeneration

Some experiments obtain ϕ_{+-} (the phase of η_{+-}) using K_S, $K_L \to \pi^+\pi^-$ interference behind a regenerator. In these interference experiments the measured quantity is the difference of ϕ_{+-} and the regeneration phase ϕ_R, as shown in the expression below. After the regenerator, the intensity of the $\pi^+\pi^-$ decays in the forward direction is

$$I(t,p) = S(p)\Big[|R(p)|^2 e^{-\Gamma_S t} + |\eta_{+-}|^2 e^{-\Gamma_L t} + 2|R(p)||\eta_{+-}| \times e^{-(\Gamma_S+\Gamma_L)t/2} \times \cos(\Delta m t + \phi_R(p) - \phi_{+-})\Big] , \qquad (1)$$

where:

- t is the decay time in the K^0 rest frame,
- $\Delta m = m_L - m_S$, and $m_L, \Gamma_L, m_S, \Gamma_S$ are the masses and decay rates of the long- and short-lived K^0,
- $\eta_{+-} = |\eta_{+-}|e^{i\phi_{+-}}$ is the ratio of decay amplitudes $A(K_L \to \pi^+\pi^-)/A(K_S \to \pi^+\pi^-)$,
- $S(p)$ is proportional to the K_L momentum spectrum, and
- $R(p) = |R(p)|e^{i\phi_R(p)}$ is the transmission-regenerated K_S amplitude (relative to the K_L):

$$R(p) = \pi N \Lambda i \, \frac{[f_0(p) - \bar{f}_0(p)]}{p} \left\{ \frac{1 - e^{-\frac{1}{2}\Gamma_S \ell(p)[1 - 2i\Delta m/\Gamma_S]}}{\frac{1}{2}\Gamma_S[1 - 2i\Delta m/\Gamma_S]} \right\}, \qquad (2)$$

where

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For notation, see key at front of Listings.

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$\ell(p)$ is the thickness of regenerator measured in units of the mean decay length of K_S,

N is the number of nuclei per cubic centimeter,

Λ is the K_S mean decay length, and

$f_0(p)$, $\bar{f}_0(p)$ are the forward scattering amplitude of K^0 and $\bar{K}^0$.

From (1) above it is clear that the value of ϕ_{+-} is highly correlated with the value of Δm and ϕ_R. In addition, a less obvious but significant correlation exists between ϕ_{+-} and Γ_S. Usually Δm is a parameter of the fit and ϕ_R is determined by some other means (optical model calculations, time dependence of the charge asymmetry in K_{e3} decay, etc.).

We list ϕ_{+-} and give in comment cards both the value of ϕ_R used by the authors and the Δm dependence of ϕ_{+-}.

```
F+-     PHASE OF ETA +-           (DEGREES)    ------------------------------
F+-      THE DEPENDENCE OF THE PHASE ON THE KOL-KOS MASS DIFFERENCE
F+-      IS GIVEN FOR EACH EXPERIMENT IN THE COMMENTS BELOW, WHERE DM IS
F+-      (MASS DIFF./HBAR) IN UNITS 10**10 SEC-1.  WE HAVE EVALUATED THESE
F+-      MASS DEPENDENCES USING OUR APRIL 1976 VALUE, DM=0.5349+-0.0022
F+-      TO OBTAIN THE VALUES AND AVERAGE QUOTED BELOW.
F+- O        (45.0)    (50.0)          FITCH     65 OSPK    BE REGEN        11/67
F+- O        (30.0)    (45.0)          FIRESTONE 66 HBC                     11/67
F+- O        (70.0)    (21.0)          BOTT-BODE 67 OSPK    C REGEN         11/67
F+- O        (25.0)    (35.0)          MISCHKE   67 OSPK    CU REGEN         7/68
F+- O    OLD EXPERIMENTS WITH LARGE ERRORS NOT INCLUDED IN AVERAGE.          2/76*
F+- N        (51.0)    (11.0)          BENNETT2  68 CNTR    CU REG. USES     8/68
F+-  C        34.2      10.0           BENNETT   69 CNTR    CU REGEN         2/71
F+-  B        45.3      12.0           BOHM      69 OSPK    VACUUM REGEN     2/71
F+-  F        45.2       7.4           FAISSNER  69 ASPK    CU REGEN         2/71
F+-  J        40.6       4.2           JENSEN    70 ASPK    VACUUM REGEN     2/71
F+-  D        37.2      12.0           BALATS    71 OSPK    CU REGEN         9/71
F+-  P        36.2       6.1           CARNEGIE  72 ASPK    CU REGEN         1/73
F+-  G        46.5       1.6           GEWENIG2  74 ASPK    VACUUM REGEN     3/74
F+-  H        45.5       2.8           CARITHERS 75 SPEC    C REGEN          7/75*
F+-         . . . . . . . . .
F+- AVG       45.0       1.3     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
F+- STUDENT   45.1       1.4     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
F+- FIT       45.0       1.2    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*
                         COMMENTS
F+-  N  BENNETT 69 IS A REEVALUATION OF BENNETT2 68.                        11/69
F+-  C  BENNETT 69 USES MEASUREMENT OF (F+-)-(PHIF) OF ALFF-STEINBERGER 66.  2/71
F+-  C  BENNETT 69  F+-=(34.9+-10.0)+ 69*(DM-.545) DEG.  FR=-49.9+-5.4 DEG.  2/71
F+-  B  BOHM 69     F+-=(41.0+-12.0)+479*(DM-.526) DEG.                      2/71
F+-  F  FAISSNER 69 ERROR ENLARGED TO INCLUDE ERROR IN REGENERATOR PHASE.   11/69
F+-  F  FAISSNER 69 F+-=(49.3+-7.4)+205*(DM-.555) DEG.   FR=-42.7+-5.0 DEG.  2/71
F+-  J  JENSEN 70   F+-=(42.4+-4.0)+576*(DM-.538) DEG.                       2/71
F+-  D  BALATS 71   F+-=(39.0+-12.0)+198*(DM-.544) DEG.  FR=-43.0+-4.0 DEG.  9/71
F+-  P  CARNEGIE 72 F+- IS INSENSITIVE TO DM.            FR=-56.2+-5.2 DEG.  1/73
F+-  G  GEWENIG2 74 F+-=(49.4+-1.0)+565*(DM-.540) DEG.                       3/74
F+-  H  CARITHER 75 F+-=(45.5+-2.8)+224*(DM-.5348) DEG.  FR=-40.9+-2.6 DEG. 11/75*

FOO      PHASE OF ETA 00     (DEGREES)       ------------------------------
FOO          FIRST QUADRANT PREFERRED   GOBBI      69 OSPK                  11/69
FOO  C          51.0       30.0         CHOLLET    70 OSPK   CU REG.,4 GAMMAS 10/70
FOO  W  56      38.0       25.0         WOLFF      71 OSPK   CU REG.,4 GAMMAS 12/71
FOO  C  CHOLLET 70 USES REGENERATOR PHASE FR=-46.5+-4.4 DEG.                  1/73
FOO  W  WOLFF 71   USES REGENERATOR PHASE FR=-48.2+-3.5 DEG.                  1/73
FOO          . . . . . . . . .
FOO AVG         43.3       19.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
FOO STUDENT     43.3       20.7     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
FOO FIT         48.3       13.2    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*

DF       PHASE DIFFERENCE FOO - F+-      (DEGREES)-------------------------
DF B             7.6       18.0         BARBIELLI 73 ASPK                     7/73
DF B       INDEPENDENT OF REGENERATOR MECHANISM,DM,AND LIFETIMES.             7/73
DF           . . . . . . . . .
DF  FIT          3.3       13.1    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*
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Superweak Model Predictions for $\phi_{\eta_{+-}}$ and $\mathrm{Re}\,\varepsilon$

The superweak model of Wolfenstein, Phys. Letters 13, 562 (1964) predicts that

$$\phi_{+-} = \phi_{00} = \tan^{-1}\left(\frac{2\Delta m\tau_s}{\hbar}\right)$$

and

$$\mathrm{Re}\,\varepsilon = |\eta_{+-}|\left[1 + \left(\frac{2\Delta m\tau_s}{\hbar}\right)^2\right]^{-1/2} .$$

These expressions and the values of the $K_L^0 - K_{S_1}^0$ mass difference $\Delta M = (0.5349\pm0.0022)\times10^{10}\,\hbar\ \mathrm{sec}^{-1}$, the K_S^0 mean life $\tau_S = (0.8930\pm0.0023)\times10^{-10}$ sec, and the magnitude of the $K_L^0 \to \pi^+\pi^-/K_S^0 \to \pi^+\pi^-$ amplitude ratio $|\eta_{+-}| = (2.272\pm0.023)\times10^{-3}$, all from the current edition, result in the preditions that

$$\phi_{+-} = \phi_{00} = (43.69\pm0.13)^\circ$$

and

$$\mathrm{Re}\,\varepsilon = (1.643\pm0.017)\times10^{-3} .$$

These can be compared with the experimental values

$$\phi_{+-} = (45.0\pm1.2)^\circ$$

$$\phi_{00} = (48.3\pm13.2)^\circ$$

$$\mathrm{Re}\,\varepsilon = (1.624\pm0.088)\times10^{-3} ,$$

where $\mathrm{Re}\,\varepsilon$ has been computed using the relation

$$\mathrm{Re}\,\varepsilon = \frac{\delta}{2}\left(\frac{|1-x|^2}{1-|x|^2}\right) ,$$

and our current values of the charge asymmetry parameter for leptonic K_L^0 decay $\delta = (0.330\pm0.012)\%$ and the $\Delta S = -\Delta Q$ amplitude $(\mathrm{Re}x, \mathrm{Im}x) = (0.008\pm0.020, -0.003\pm0.027)$.

The superweak predictions are in good agreement with the data.

The values of τ_S and $|\eta_{+-}|$ have undergone major revision in the past few years (see notes on these parameters in the K_S^0 and K_L^0 sections of the Data Card Listings). We have utilized only the post-1971 experimental values of these parameters and have made necessary changes in the related parameters ΔM and ϕ_{+-} (see footnotes in the related data card subsections D and F+- above).

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Stable Particles

K^0_L

Data Card Listings

For notation, see key at front of Listings.

```
13  X = (DS=-DQ AMPLITUDE)/(DS=+DQ AMPLITUDE)

    RELATED TEXT SECTION VI B.4

REX        REAL PART OF X
REX   C 152      0.06       0.18       0.44  BALDO-CE   65 HLBC    K+ CHARGE EXCHNG 11/67
REX     196      0.035      0.11       0.13  AUBERT     65 HLBC    K+ CHARGE EXCHNG 11/67
REX   F 109     -0.08       0.16       0.28  FRANZINI   65 HBC     PBAR P           11/67
REX     116      0.17       0.16       0.35  FELDMAN    67 OSPK    PI-P TO KO LMBDA 11/67
REX N   335     (0.17)     (0.10)            HILL       67 DBC     K+D YIELDS KOPP  11/67
REX B           (0.03)     (0.03)            BENNETT1   68 CNTR                      7/68
REX     121      0.09       0.07       0.09  JAMES      68 HBC     PBAR P            5/69
REX   B         -0.020      0.025            BENNETT    69 CNTR    CHAR ASYM+ CU RE 10/69
REX     686      0.09       0.14       0.16  LITTENBER  69 OSPK    K+N TO KOP        4/69
REX   N 215      0.12       0.09             CHO        70 DBC     K+D TO KOPP      10/70
REX U   222     (0.04)     (0.07)     (0.08) BURGUN     71 HBC     K+P TO KOPPI+     2/72
REX     252      0.25        .07        .09  WEBBER     71 HBC     K-P TO KBAR N    10/69
REX   U 410      0.03       0.06       0.06  BURGUN     72 HBC     K+P TO KOPPI+     1/73
REX     126      0.26       0.10       0.14  MANN       72 HBC     K-P TO KOBAR N    9/72
REX G   342    (-0.13)     (0.11)            MANTSCH    72 OSPK    KE3  FROM KO LMB  2/72
REX G   100     (0.04)     (0.10)     (0.13) GRAHAM     72 OSPK    KMU3 FROM KO LMB  2/72
REX   G 442     -0.05       0.09             GRAHAM     72 OSPK    PI-P TO KO LMBDA  2/72
REX    1757     -0.008      0.044            FACKLER    73 OSPK    KE3 FROM KO       9/73
REX    1367     -0.03       0.07             HART       73 OSPK    KE3 FROM KO LMB   2/74
REX    1079     -0.070      0.036            MALLARY    73 OSPK    KE3 FROM KO LM +  6/73
REX    4724      0.04       0.03             NIEBERGA   74 ASPK    K+P TO KOPPI+     7/74*
REX   C  BALDO-CE 65 GIVES X AND THETA.CONVERTED BY US TO REX AND IMX.              11/67
REX   F  FRANZINI 65 GIVES X AND THETA.FOR REX AND IMX SEE SCHMIDT 67.              11/67
REX N    CHO 70 IS ANALYSIS OF UNAMBIGUOUS EVENTS IN NEW DATA AND HILL 67.
REX   U  BURGUN 72 IS A FINAL RESULT WHICH INCLUDES BURGUN 71.                       11/73
REX   B  BENNETT 69 IS A REANALYSIS OF BENNETT1 68
REX G    SECOND GRAHAM 72 VALUE IS FIRST GRAHAM 72 VALUE COMBINED WITH               2/72
REX G    MANTSCH 72.                                                                  2/72
REX         . . . . . . . . . .
REX AVG          0.008      0.020    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
REX STUDENT      0.007      0.017    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                            (SEE IDEOGRAM BELOW )
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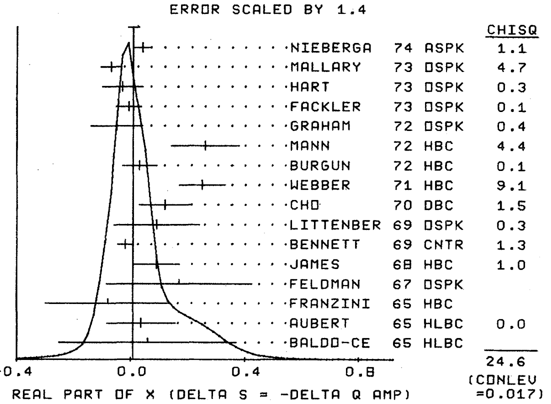
WEIGHTED AVERAGE = 0.008 ± 0.020
ERROR SCALED BY 1.4

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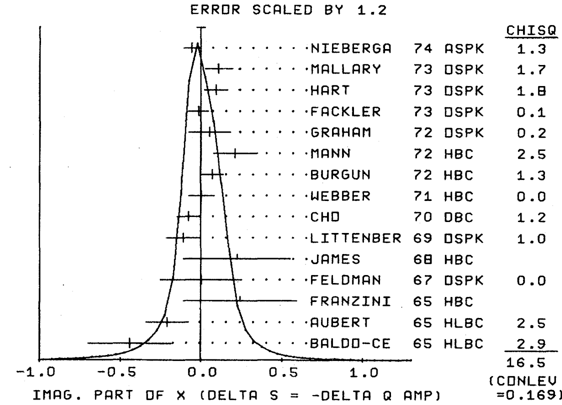
IMX        IMAGINARY PART OF X (ASSUMES M(KL)-M(KS) POSITIVE -- SEE S13D)
IMX   C 152     -0.44       0.32       0.19  BALDO-CE   65 HLBC    K+ CHARGE EXCHNG  3/68
IMX     196     -0.21       0.11       0.15  AUBERT     65 HLBC    K+ CHARGE EXCHNG  3/68
IMX   F 109     +0.24       0.40       0.30  FRANZINI   65 HBC     PBAR P            3/68
IMX     116      0.0        0.25             FELDMAN    67 OSPK    PI-P TO KO LMBDA 11/67
IMX N   335    (-0.20)     (0.10)            HILL       67 DBC     K+D YIELDS KOPP  11/67
IMX     121     +0.22       0.37       0.29  JAMES      68 HBC     PBAR P            5/69
IMX     686     -0.11       0.10       0.11  LITTENBER  69 OSPK    K+N TO KOP        4/69
IMX   N 215     -0.08       0.07             CHO        70 DBC     K+D TO KOPP      10/70
IMX U   222     (0.12)     (0.08)     (0.09) BURGUN     71 HBC     K+P TO KOPPI+     2/72
IMX     252      0.0        .08              WEBBER     71 HBC     K-P TO KBAR N    10/69
IMX   U 410      0.07       0.06       0.07  BURGUN     72 HBC     K+P TO KOPPI+     1/73
IMX     126      0.21       0.15       0.12  MANN       72 HBC     K-P TO KOBAR N    9/72
IMX G   342    (-0.04)     (0.16)            MANTSCH    72 OSPK    KE3  FROM KO LMB  2/72
IMX G   100     (0.12)     (0.17)     (0.16) GRAHAM     72 OSPK    KMU3 FROM KO LMB  2/72
IMX   G 442      0.05       0.13             GRAHAM     72 OSPK    PI-P TO KO LMBDA  2/72
IMX    1757     -0.017      0.060            FACKLER    73 OSPK    KE3 FROM KO       9/73
IMX    1367      0.09       0.07             HART       73 OSPK    KE3 FROM KO LMB   2/74
IMX    1079      0.107      0.092     0.074  MALLARY    73 OSPK    KE3 FROM KO LM +  6/73
IMX    4724     -0.06       0.05             NIEBERGA   74 ASPK    K+P TO KOPPI+     7/74*
IMX   C  BALDO-CE 65 GIVES X AND THETA.CONVERTED BY US TO REX AND IMX.              11/67
IMX   F  FRANZINI 65 GIVES X AND THETA.FOR REX AND IMX SEE SCHMIDT 67.              11/67
IMX N    FTNOTE 10 OF HILL 67 SHOULD READ +0.58, NOT -0.58 (PRIV.COMM.).             3/68
IMX N    CHO 70 IS ANALYSIS OF UNAMBIGUOUS EVENTS IN NEW DATA AND HILL 67.
IMX   U  BURGUN 72 IS A FINAL RESULT WHICH INCLUDES BURGUN 71.                       11/73
IMX G    SECOND GRAHAM 72 VALUE IS FIRST GRAHAM 72 VALUE COMBINED WITH               2/72
IMX G    MANTSCH 72.                                                                  2/72
IMX         . . . . . . . . . .
IMX AVG         -0.003      0.027    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
IMX STUDENT     -0.003      0.027    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                            (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = -0.003 ± 0.027
ERROR SCALED BY 1.2



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REFERENCES FOR KOL


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BARDON   58 ANP 5 156             M BARDON,K LANDE,L LEDERMAN  (COLUMBIA+BNL)
CRAWFORD 59 PRL 2 361             CRAWFORD,CRESTI,DOUGLASS,GOOD +        (LRL)
ASTIER   61 AIX CONF 1 227        ASTIER,BLASKOVIC,RIVET,SIAUD +        (EPOL)
FITCH    61 NC  22 1160           V FITCH,P PIROUE,R PERKINS       (PRINCETON)
GOOD     61 PR 124 1223           GOOD,MATSEN,MULLER,PICCIONI,POWELL +  (LRL)
NEAGU    61 PRL  6  552           NEAGU,OKONOV,PETROV,ROSANOVA,RUSAKOV (JINR)
   ALSO  61 JETP 13 1138          NYAGU,OKONOV,PETROV,ROZANOVA,RUSAKOV (JINR)

CAMERINI 62 PR 128 362            CAMERINI,FRY,GAIDOS,BIRGE,ELY +  (WISC+LRL)
DARMON   62 PL 3 57               J DARMON,A ROUSSET,J SIX              (EPOL)

ADAIR    64 PL 12 67              R K ADAIR,L B LEIPUNER            (YALE+BNL)
ALEKSANY 64 DUBNA 2 102           ALEKSANYAN,ALIKHANYAN,VARTAZARYAN+ (EREVAN)
   ALSO  64 JETP 19 1019          ALEKSANYAN+    (LEBEDEV+MOS ENG PHYS+EREVAN)
ANIKINA  64 JETP 19 42            ANIKINA,ZHURAVLEVA+ (GEORG ACAD SCI+ DUBNA)
CHRISTEN 64 PRL 13 138            CHRISTENSON,CRONIN,FITCH,TURLAY (PRINCETON)
FUJII    64 DUBNA 2 146           FUJII,JOVANOVICH,TURKOT+ (BNL,MARYLAND,MIT)
LUERS    64 PR 133 B 1276         LUERS,MITTRA,WILLIS,YAMAMOTO           (BNL)

ANIKINA  65 JINR P 2488           ANIKINA,VARDENGA,ZHURAVLEVA,KOTLYA+ (DUBNA)
ANDERSON 65 PRL 14 475            ANDERSON,CRAWFORD,GOLDEN,STERN + (LRL+WISC)
ASTBURY1 65 PL 16 80              ASTBURY,FINOCCHIARO,BEUSCH +  (CERN+ZURICH)
   ALSO  65 HELV.PH.AC.39 523 M PEPIN
ASTBURY2 65 PL  18 175            ASTBURY,MICHELINI,BEUSCH +    (CERN+ZURICH)
ASTBURY3 65 PL 18 178             ASTBURY,MICHELINI,BEUSCH +    (CERN+ZURICH)
AUBERT   65 PL 17 59              AUBERT,BEHR,CANAVAN,CHOUNET+   (EPOL+ORSAY)
   ALSO  67 LOWYS
BALDO-CE 65 NC 38 684             BALDO-CEOLIN,CALIMANI,CIAMPOLILLO +  (PADO)

CHRISTEN 65 PR 140 B 74           CHRISTENSON,CRONIN,FITCH,TURLAY (PRINCETON)
FISHER   65 ANL 7130 83           FISHER,ABASHIAN,ABRAMS,CARPENTER+      (ILL)
FITCH    65 PRL 15 73             FITCH,ROTH,RUSS,VERNON           (PRINCETON)
FRANZINI 65 PR 140 B 127          FRANZINI,KIRSCH,PLANO +  (COLUMBIA+RUTGERS)
GALBRAIT 65 PRL 14 383            GALBRAITH,MANNING,JONES +  (AERE+BRIS+RHEL)
GUIDONI  65 ARGONNE CONF 49       +BARNES,FOELSCHE,FERBEL,FIRESTO+ (BNL+YALE)
HOPKINS  65 ARGONNE CONF 67       H W K HOPKINS,BACON,EISLER   (VAND+RUTGERS)
VISHNEVS 65 PL  18   339          VISHNEVSKY,GALANINA,SEMENOV +         (ITEP)

ALFF-STE 66 PL 21 595             ALFF-STEINBERGER,HEUER,RUBBIA +       (CERN)
ANIKINA  66 SJNP 2 339            ANIKINA, VARDENGA, ZHURAVLEVA+        (JINR)
AUERBACH 66 PRL  17  980          AUERBACH,MANN,MCFARLANE,SCIULLI       (PENN)
AUERBACH 66 PR  149 1052          AUERBACH,DOBBS,LANDE,MANN,SCIULLI+    (PENN)
   ALSO  65 PRL  14  192          +LANDE,MANN,SCIULLI,UTO,WHITE,YOUNG   (PENN)
BALDO-CE 66 NC  45A  733          BALDO-CEOLIN,CALIMANI,CIAMPOLILLO+   (PADUA)
BASILE   66  BALATON CONF         BASILE,CRONIN,THEVENET +            (SACLAY)

BEHR     66 PL  22 540            +BRISSON,BALDO-CEOLIN,AUBERT+   (PADO,EPOL)
BELLOTTI 66 NC  45A  737          BELLOTTI,PULLIA,BALDO-CEOLIN+ (MILAN,PADUA)
BOTT-BOD 66 PL  23  277           BOTT-BODENHAUSEN,DE BOUARD,CASSEL+    (CERN)
CAMERINI 66 PR  150 1148          CAMERINI,CLINE,ENGLISH,FISCHBEIN+WISCONSIN
CANTER   66 PRL 17 942            +CHO,ENGLER,FISK,HILL +      (CARNEGIE+BNL)
CARPENTE 66 PR  142  871          CARPENTER,ABASHAN,ABRAMS,FISHER  (ILLINOIS)
CHANG    66 PL  23  702           CHANG,BASSANO,KIKUCHI,DODD+ (SYRACUSE,BNL)

CRIEGEE  66 PRL 17 150            +FOX,FRAUENFELDER,HANSON,MOSCAT+ (ILLINOIS)
FIRESTON 66 PRL 16 556            FIRESTONE,KIM,LACH,SANDWEISS+    (YALE,BNL)
FIRESTON 66 PRL 17 116            FIRESTONE,KIM,LACH,SANDWEISS+    (YALE,BNL)
FUJII    66 PRL 13 253            FUJII,JOVANOVICH,TURKOT,ZORN (BNL+MARYLAND)
   FUJII 66 IS THE CORRECTED VALUE GIVEN BY JOVANOVICH+ 66
HAWKINS  66 PL 21 238             C J B HAWKINS                         (YALE)
   ALSO  67 PR  156  1444         C J B HAWKINS                         (YALE)

JOVANOVI 66 PRL 17 1075           JOVANOVICH,FUJII,TURKOT,ZORN +(BNL+UMD+MIT)
KULYUKIN 66  BERKELEY 2B          KULYUKINA,MESTVIRISHVILI,NEAGU,PETR+ (JINR)
MEISNER1 66 PRL 16 278            G W MEISNER,B B CRAWFORD,F CRAWFORD    (LRL)
MEISNER2 66 PRL  17  492          G MEISNER,B CRAWFORD,F CRAWFORD        (LRL)
NEFKENS  66 PL 19 706             NEFKENS,ABASHIAN,ABRAMS,CARPENTER+     (ILL)
VERHEY   66 PRL 17 669            VERHEY,NEFKENS, ABASHIAN+              (ILL)

BENNETT  67 PRL  19  993          BENNETT,NYGREN,SAAL,STEINBERGER +(COLUMBIA)
BOTT-BOD 67 PL  24B  194          BOTT-BODENHAUSEN,DEBOUARD,CASSEL +    (CERN)
BOTT-BOD 67 PL  24B  438          BOTT-BODENHAUSEN,DEBOUARD,DEKKERS+    (CERN)
   ALSO  66 PL  20  212           BOTT-BODENHAUSEN,DEBOUARD,CASSEL+     (CERN)
   ALSO  66 PL  23  277           BOTT-BODENHAUSEN,DEBOUARD,CASSEL+     (CERN)
CANTER   67 THESIS                J.M. CANTER                       (CARNEGIE)
CRONIN 1 67 PRL 18 25             +KUNZ,RISK,WHEELER               (PRINCETON)
CRONIN 2 67 PRINC CONF(11/67)     +KUNZ,RISK,WHEELER               (PRINCETON)
DEBOUARD 67 NC  52A  662          DEBOUARD,DEKKERS,JORDAN,MERMOD +      (CERN)
   ALSO  65 PL  15  58            DE BOUARD,DEKKERS,SCHARFF+ (CERN+ORSA+MPIM)

DEVLIN   67 PRL 18 54             DEVLIN,SOLOMON,SHEPARD,BEALL+     (PRIN+UMD)
   ALSO  68 PR 169 1045           SAYER,BEALL,DEVLIN,SHEPHARD+ (UMD+PPA+PRIN)
DORFAN   67 PRL  19  987          DORFAN,ENSTROM,RAYMOND,SCHWARTZ +(SLAC+LRL)
FELDMAN  67 PR  155  1611         FELDMAN,FRANKEL,HIGHLAND,SLOAN        (PENN)
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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

K_L^0, η

FIRESTON 67 PRL 18 176 FIRESTONE,KIM,LACH,SANDWEISS,+ (YALE,BNL)
FITCH 67 PR 164 1711 FITCH,ROTH,RUSS,VERNON (PRINCETON)
HAWKINS 67 PR 156 1444 C J B HAWKINS (YALE)
HILL 67 PRL 19 668 HILL,LUERS,ROBINSON,CANTER+ (BNL,CARNEGIE)

HOPKINS 67 PRL 19 185 HOPKINS,BACON,EISLER (BNL)
KADYK 67 PRL 19 597 KADYK,CHAN,DRIJARD,OREN,SHELDON (LRL)
KULYUKIN 67 PREPRINT KULYUKINA+MESTVIRISHVILI+NEAGU + (JINR)
LOWYS 67 PL 24B 75 LOWYS,AUBERT,CHOUNET,PASCAUD+ (EPOL,ORSA)
MISCHKE 67 PRL 18 138 MISCHKE,ABASHIAN,ABRAMS+ (ILLINOIS)
NEFKENS 67 PR 157 1233 +ABASHIAN,ABRAMS,CARPENTER,FISHER+ (ILL)
TODOROFF 67 THESIS JOHN A TODOROFF (ILLINOIS)

ABRAMS 68 PR 176 1603 +ABASHIAN,MISCHKE,NEFKENS,SMITH+ (ILLINOIS)
ARNOLD 68 PL 28B 56 ARNOLD,BUDAGOV,CUNDY,AUBERT+ (CERN+ORSAY)
ARONSON 68 PRL 20 287 S.H.ARONSON, K.W.CHEN (PRINCETON)
ALSO 69 PR 175 1708 S H ARONSON, K W CHEN (PRINCETON)
BALATZ 68 PL 26B 320 BALATZ,BEREZIN,VISHNEVSKY,GALANINA+ (ITEP)
BARTLETT 68 PRL 21 558 BARTLETT,CARNEGIE,FITCH+ (PRINCETON)

BASILE 68 PL 26B 542 BASILE,CRONIN,THEVENET,TURLAY+ (SACLAY)
BASILE2 68 PL 28B 58 +CRONIN,THEVENET,TURLAY,ZYLBERAJCH+(SACLAY)
BENNETT1 68 PL 27B 244 BENNETT,NYGREN,STEINBERGER+ (COLUMBIA+CERN)
BENNETT2 68 PL 27B 248 BENNETT,NYGREN,STEINBERGER+ (COLUMBIA+CERN)
BLANPIED 68 PRL 21 1650 BLANPIED,LEVIT,ENGELS+ (CASE+HARV+MCGI)
BUDAGOV 68 NC 57A 182 BUDAGOV,BURMEISTER,CUNDY+ (CERN,ORSA,IPNP)
ALSO 68 PL 28B 215 +CUNDY,MYATT,NEZRICK+ (CERN,ORSA,EPOL)

CARNEGIE 68 PRINC TR44 THESIS R.K.CARNEGIE (PRINCETON)
JAMES 68 NP B8 365 F JAMES, H BRIAND (IPNP,CERN)
ALSO 68 PRL 21 257 HELLAND,LONGO,YOUNG (UCLA,MICH)
KULYUKIN 68 JETP 26 20 KULYUKINA,MESTVIRISHVILI,NEAGU+ (JINR)
KUNZ 68 THESIS (PU 46) P F KUNZ (PRINCETON)
MELHOP 68 PR 172 1613 MELHOP MURTY BOWLES,BURNETT+ (LA JOLLA)
THATCHER 68 PR 174 1674 THATCHER,ABASHIAN,ABRAMS,CARPENTER + (ILL)

BANNER 69 PR 188 2033 +CRONIN,LIU,PILCHER (PRINCETON)
ALSO 68 PRL 21 1103 BANNER,CRONIN,LIU,PILCHER (PRINCETON)
ALSO 68 PRL 21 1107 BANNER CRONIN,LIU,PILCHER (PRINCETON)
BEILLIER 69 PL 30B 202 BEILLIERE,BOUTANG,LIMON (EPOL)
BENNETT 69 PL 29B 317 +NYGREN,SAAL,STEINBERGER+ (COLU,BNL)
BOHM 69 NP B9 605 +DARRIULAT,GROSSO,KAFTANOV+ (CERN)
ALSO 68 PL 27B 321 BOHM,DARRIULAT,GROSSO,KAFTANOV (CERN)

BOTT-BOD 69 CERN 69-7 329 BOTT-BODENHAUSEN,DE BOUARD,CASSEL+ (CERN)
CENCE 69 PRL 22 1210 CENCE,JONES,PETERSON,STENGER+ (HAWAII,LRL)
EVANS 69 PRL 23 427 EVANS,GOLDEN,MUIR,PEACH+ (EDINBURGH,CERN)
FAISSNER 69 PL 30B 204 +FOETH,STAUDE,TITTEL+ (AACH,CERN,TORI)
FOETH 69 PL 30B 282 +HOLDER,RADERMACHER + (AACHEN,CERN,TORINO)

GAILLARD 69 NC 59A 453 +GALBRAITH,HUSSRI,JANE+ (CERN,RHEL,AACHEN)
ALSO 67 PRL 18 20 +KRIENEN,GALBRAITH,HUSSRI+ (CERN+RHEL+AACH)
GOBBI 69 PRL 22 685 +GREEN,HAKEL,MOFFETT,ROSEN,GOZ+ (ROCH+RUTG)
LITTENBE 69 PRL 22 654 LITTENBERG,FIELD,PICCIONI,MEHLHOP+ (UCSD)
LONGO 69 PR 181 1808 M J LONGO,K K YOUNG,J A HELLAND (MICH,UCLA)
PACIOTTI 69 THESIS,UCRL 19446 M A PACIOTTI (LRL)
SAAL 69 THESIS H J SAAL (COLUMBIA)

ALBROW 70 PL 33B 516 +ASTON,BARBER,BIRD,ELLISON + (MCHS+DARE)
ARONSON 70 PRL 25 1057 +EHRLICH,HOFER,JENSEN+ (EFI,ILLC,SLAC)
BARMIN 70 PL 33B 377 +BARYLON,BORISOV,BYSHEVA+ (ITEP,JINR)
BASILE 70 PR D2 78 +CRONIN,THEVENT,TURLAY,ZYLBERAJCH + (SACL)
BUCHANAN 70 PL 33B 623 +DRICKEY,RUDNICK,SHEPARD+ (SLAC,JHU,UCLA)
ALSO PRIVATE COMMUNICATION, B. COX, FEB. 71
BUDAGOV 70 PR D2 815 +CUNDY,MYATT,NEZRICK+ (CERN, ORSA,EPOL)
ALSO 68 PL 28B 215 +CUNDY,MYATT,NEZRICK+ (CERN,ORSA,EPOL)

CHIEN 70 PL 33B 627 C-Y.CHIEN,COX,ETTLINGER + (JHU+SLAC+UCLA)
ALSO PRIVATE COMMUNICATION, B. COX, FEB. 71.
CHO 70 PR D1 3031 +DRALLE,CANTER,ENGLER,FISK+ (CARN,BNL,CASE)
ALSO 67 PRL 19 668 HILL,LUERS,ROBINSON,SAKITT + (BNL,CARN)
CHOLLET 70 PL 31B 658 +GAILLARD,JANE,RATCLIFFE,REPELLIN + (CERN)
CULLEN 70 PL 32B 523 +DARRIULAT,DEUTSCH,FOETH + (AACH,CERN,TORI)

DARRIULA 70 PL 33B 249 +FERRERO,GROSSO,HOLDER + (AACH,CERN,TORI)
FAISSNER 70 NC 70A 57 +REITHLER,THOME,GAILLARD+ (AACH,CERN,RHEL)
JENSEN 70 THESIS D.A. JENSEN (EFI)
ALSO 69 PRL 23 615 JENSEN,ARONSON,EHRLICH,FRYBERGER+ (EFI,ILL)
MARX 70 PL 32B 219 +NYGREN,PEOPLES,STEINBERGER+(COLU,HARV,CERN)
ALSO 70 THESIS,NEVIS 179 JAY MARX (COLUMBIA)

SCRIBANO 70 PL 32B 224 +MANNELLI,PIERAZZINI,MARX+ (PISA,COLU,HARV)
SMITH 70 PL 32B 133 +WANG,WHATLEY,ZORN,HORNBOSTEL (UMD,BNL)
WEBBER 70 PR D1 1967 +SOLMITZ,CRAWFORD,ALSTON-GARNJOST (LRL)
ALSO 69 UCRL 19226 THESIS B R WEBBER (LRL)

BALATS 71 SJNP 13 53 +BEREZIN,VISHNEVSKII,GALANINA+ (ITEP)
BARMIN 71 PL 35B 604 +BARYLOV,VESELOVSKY,DAVIDENKO+ (ITEP)
BISI 71 PL 36B 533 +DARRIULAT,FERRERO,RUBBIA+ (AACH,CERN,TORI)
BURGUN 71 LNC 2 1169 +LESQUOY,MULLER,PAULI+ (SACL+CERN+OSLO)
CARNEGIE 71 PR D4 1 +CESTER,FITCH,STROVINK,SULAK (PRIN)
CHAN 71 LBL-350 THESIS J.HIONG-SING CHAN (LBL)
CHIEN 71 PL 35B 261 +COX,ETTLINGER,RESVANIS+ (JHU,SLAC,UCLA)
ALSO 72 DALLY

CHO 71 PR D3 1557 +DRALLE,CANTER,ENGLER,FISK+ (CARN,BNL,CASE)
CLARK 71 PRL 26 1667 +ELIOFF,FIELD,FRISCH,JOHNSON,KERTH+ (LRL)
ALSO 70 UCRL 19709-THESIS ROLLAND JOHNSON (LRL)
ALSO 71 UCRL 20264-THESIS HENRY FRISCH (LRL)
ALSO 74 SLAC-PUB-1498 R.C.FIELD (SLAC)
ENSTROM 71 PR D4 2629 +AKAVIA,COOMBES,DORFAN+ (SLAC,STAN)
ALSO 70 THESIS (SLAC 125) J E ENSTROM (STANFORD)

HILL 71 PR D4 7 +SAKITT,SKJEGGESTAD,CANTER+ (BNL,CARN,CASE)
JAMES 71 PL 35B 265 +MONTANET,PAUL,PAULI+ (CERN+SACL+OSLO)
MEISNER 71 PR D3 59 +MANN,HERTZBACH,KOFLER + (MASA+BNL+YALE)
PEACH 71 PL 35B 351 +EVANS,MUIR,BUDAGOV,HOPKINS+ (EDIN,CERN)

REPELLIN 71 PL 36B 603 +WOLFF,CHOLLET,GAILLARD,JANE+ (ORSA,CERN)
WEBBER 71 PR D3 64 +SOLMITZ,CRAWFORD,ALSTON-GARNJOST (LRL)
ALSO 68 PRL 21 498 WEBBER,SOLMITZ,CRAWFORD,ALSTONGARNJOST(LRL)
ALSO 69 UCRL 19266-THESIS B R WEBBER (LRL)
WOLFF 71 PL 36B 517 +CHOLLET,REPELLIN,GAILLARD+ (ORSA,CERN)

ALBROW 72 NP B44 1 +ASTON,BARBER,BIRD,ELLISON+ (MCHS+DARE)
ASHFORD 72 PL 38B 47 +BROWN,MASEK,MAUNG,MILLER,RUDERMAN+ (UCSD)
BANNER1 72 PRL 28 1597 +CRONIN,HOFFMAN,KNAPP,SHOCHET (PRINCETON)
BANNER2 72 PRL 29 237 +CRONIN,HOFFMAN,KNAPP,SHOCHET (PRINCETON)
BARMIN1 72 SJNP 15 636 +DAVIDENKO,DEMIDOV,DOLGOLENKO+ (ITEP)
BARMIN2 72 SJNP 15 638 +BARYLOV,DAVIDENKO,DEMIDOV+ (ITEP)
BURGUN 72 NP B50 194 +LESQUOY,MULLER,PAULI,+ (SACL+CERN+OSLO)
CARNEGIE 72 PR D6 2335 +CESTER,FITCH,STROVINK,SULAK (PRINCETON)

DALLY 72 PL 41B 647 +INNOCENTI,SEPPI,CHIEN,COX+ (SLAC+JHU+UCLA)
ALSO 70 CHIEN
ALSO 71 CHIEN
GRAHAM 72 NC 9A 166 +ABASHIAN,JONES,MANTSCH,ORR+ (ILL+NEAS)
HOLDER 72 PL 40B 141 +RADERMACHER,STAUDE+ (AACH+CERN+TORI)
JAMES 72 NP B49 1 +MONTANET,PAUL,SAETRE+ (CERN+SACL+OSLO)
KRENZ 72 LNC 4 213 +HOPKINS,EVANS,MUIR,PEACH (AACH+CERN+EDIN)

MANN 72 PR D6 137 +KOFLER,MEISNER,HERTZBACH+ (MASA+BNL+YALE)
MANTSCH 72 NC 9A 160 +ABASHIAN,GRAHAM,JONES,ORR+ (ILL+NEAS)
METCALF 72 PL 40B 703 +NEUHOFER,NIEBERGALL+ (CERN+IPN+WIEN)
NEUHOFER 72 PL 41B 642 +NIEBERGALL,REGLER,STIER+ (CERN+ORSA+VIEN)
PICCIONI 72 PRL 29 1412 +COOMBES,DONALDSON,DORFAN,FRYBERGER+ (SLAC)
ALSO 74 PR D9 2939 PICCIONI,DONALDSON + (SLAC+UCSC+COLO)
VOSBURGH 72 PR D6 1834 +DEVLIN,ESTERLING,GOZ,BRYMAN + (RUTG,MASA)
ALSO 71 PRL 26 866 VOSBURGH,DEVLIN,ESTERLING,GOZ + (RUTG,MASA)

ALBROW 73 NP B58 22 +ASTON,BARBER,BIRD,ELLISON+ (MCHS+DARE)
ALEXANDE 73 NP B65 301 ALEXANDER,BENARY,BOROWITZ,LANDE+(TELA+HEID)
BARBIELL 73 PL 43B 529 BARBIELLINI,DARRIULAT,FAINBERG+ (CERN)
BRANDENB 73 PR D8 1978 BRANDENBURG,JOHNSON,LEITH,LOOS+ (SLAC)
CARITHE1 73 PRL 30 1336 +MODIS,NYGREN,PUN,SCHWARTZ+ (COLU+CERN+NYU)
CARITHE2 73 PRL 31 1025 CARITHERS,NYGREN,GORDON+ (COLU+BNL+CERN)
EVANS 73 PR D7 36 +MUIR,PEACH,BUDAGOV+ (EDINBURGH+CERN)
ALSO 69 PRL 23 427 EVANS,GOLDEN,MUIR,PEACH+ (EDINBURGH+CERN)

FACKLER 73 PRL 31 847 +FRISCH,MARTIN,SMOOT,SOMPAYRAC (MIT)
FITCH 73 PRL 31 1524 +HEPP,JENSEN,STROVINK,WEBB (PRINCETON)
ALSO 72 COO-3072-13 R.C.WEBB (THESIS) (PRINCETON)
GJESDAL 73 2ND AIX CONF +KAMAE,PRESSER,STEFFEN,STEINBER+(CERN+HEID)
HART 73 NP B66 317 +HUTTON,FIELD,SHARP,BLACKMORE+ (CAVE+RHEL)
MALLARY 73 PR D7 1953 +BINNIE,GALLIVAN,GOMEZ,PECK,SCIULLI + (CIT)
ALSO 70 PRL 25 1214 SCIULLI,GALLIVAN,BINNIE,GOMEZ + (CIT)

MCCARTHY 73 PR D7 687 +BREWER,BUDNITZ,ENTIS,GRAVEN,MILLER+ (LBL)
ALSO 72 PL 42B 291 MCCARTHY,BREWER,BUDNITZ,ENTIS,GRAVEN+ (LBL)
ALSO 71 THESIS LBL-550 R.L.MCCARTHY (LBL)
MESSNER 73 PRL 30 876 +MORSE,NAUENBERG,HITLIN + (COLO+SLAC+UCSC)
PEACH 73 PL 43B 441 +EVANS,MUIR,HOPKINS,KRENZ (EDIN+CERN+AACH)
SANDWEIS 73 PRL 30 1002 +SUNDERLAND,TURNER,WILLIS,KELLER (YALE+ANL)
WILLIAMS 73 PRL 31 1521 +LARSEN,LEIPUNER,SAPP,SESSOMS+ (BNL+YALE)

ALBRECHT 74 PL 48B 393 DUBNA+BERLIN+BUDAPEST+PRAGUE+SERPUKH+SOFIA
BISI 74 PL 50B 504 BISI,FERRERO (TORI)
BOBISUT 74 LNC 11 646 +HUZITA,MATTIOLI,PUGLIERIN (PADO)
DONALDS1 74 PRL 33 554 DONALDSON,HITLIN,KENNELLY,KIRKBY + (SLAC)
ALSO 74 DONALDSON 3
DONALDS2 74 PR D9 2960 DONALDSON,FRYBERGER,HITLIN,LIU+ (SLAC+UCSC)
ALSO 73 PRL 31 337 DONALDSON,FRYBERGER,HITLIN,LIU+ (SLAC+UCSC)
DONALDS3 74 SLAC 184-THESIS GREGORY J. DONALDSON (SLAC)

GEWENIG1 74 PL 48B 483 GEWENIGER,GJESDAL,KAMAE,PRESSER+(CERN+HEID)
ALSO 74 CERN INT. REPT. VERA LUTH (THESIS-INT. REPT. 74-4) (HEID)
GEWENIG2 74 PL 48B 487 GEWENIGER,GJESDAL,PRESSER + (CERN+HEID)
ALSO 74 PL 52B 119 GJESDAL,PRESSER,STEFFEN + (CERN+HEID)
GEWENIG3 74 PL 52B 108 GEWENIGER,GJESDAL,PRESSER + (CERN+HEID)
GJESDAL1 74 PL 52B 113 +PRESSER,KAMAE,STEFFEN+ (CERN+HEID)

MESSNER 74 PRL 33 1458 +FRANKLIN,MORSE,NAUENBERG+ (COLO+SLAC+UCSC)
NIEBERGA 74 PL 49B 103 NIEBERGALL,REGLER,STIER + (CERN+ORSA+VIEN)
SLONE 74 SLAC 181-THESIS DAVID NEIL SLONE (SLAC)
WANG 74 PR D9 540 +SMITH,WHATLEY,ZORN,HORNBOSTEL (UMD+BNL)
WILLIAMS 74 PRL 33 240 +LARSEN,LEIPUNER,SAPP,SESSOMS + (BNL+YALE)
WOO 74 LNC 10 38 +BUCHANAN,PEPPER (UCLA)

BALDOCEO 75 NC 25A 688 BALDO-CEOLIN,BOBISUT,CALIMANI+ (PADO+WISC)
BLUMENTH 75 PRL 34 164 BLUMENTHAL,FRANKEL,NAGY + (PENN+CHIC+TEMP)
BUCHANAN 75 PR D11 457 +DRICKEY,PEPPER,RUDNICK + (UCLA+SLAC+JHU)
CARITHER 75 PRL 34 1244 CARITHERS,MODIS,NYGREN,PUN + (COLU+NYU)
SHEN 75 LBL-4275 THESIS GILBERT SHEN (LBL)
FUKUSHIM 76 PRL 36 348 FUKUSHIMA,JENSEN,SURKO,THALER+ (PRIN+MASA)

PAPERS NOT REFERRED TO IN DATA CARDS

ALEXANDE 62 PRL 9 69 G ALEXANDER,S ALMEIDA,F CRAWFORD (LRL)
JOVANOVI 63 BNL CONF 42 JOVANOVIC,FISCHER,BURRIS + (BNL+MARYLAND)
STERN 64 PRL 12 459 STERN,BINFORD,LIND,ANDERSON + (WISC+LRL)
BEHR 65 ARGONNE CONF 59 BEHR,BRISSON,BELLOTTI+ (EPOL,MILA,PADO)
MESTVIRI 65 JINR P 2449 MESTVIRISHVILI,NYAGU,PETROV,RUSAKOV+ (JINR)
TRILLING 65 UCRL 16473 GEORGE H TRILLING (LRL)
UPDATED FROM 1965 ARGONNE CONF., PAGE 115.
GINSBERG 67 PR 162 1570 EDWARD S GINSBERG (U. MASS BOSTON)

RUBBIA 67 PL 24B 531 C.RUBBIA,J.STEINBERGER (CERN+COLU)
ALSO 1 66 PL 20 207 ALFF-STEINBERGER,HEUER,KLEINKNECHT+ (CERN)
ALSO 2 66 PL 21 595 ALFF-STEINBERGER,HEUER,KLEINKNECHT+ (CERN)
ALSO 3 66 PL 23 167 C.RUBBIA,J.STEINBERGER (CERN+COLU)
SCHMIDT 67 NEVIS 160(THESIS) P. SCHMIDT (COLUMBIA)
CRONIN 68 VIENNA CONF P.281 CRONIN,RAPPORTEURS TALK (PRINCETON)
BECHERRA 70 PR D1 1452 T BECHERRAWY (ROCH)
GINSBERG 70 PR D1 229 E S GINSBERG (IIT HAIFA)
HEUSSE 70 LNC 3 449 +AUBERT,PASCAUD,VIALLE (ORSAY)
GINSBERG 73 PR D8 3887 E S GINSBERG, J SMITH (MIT+STON)

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14 ETA(549,JPG=0-+) I=0

FOR C. BALTAY'S REVIEW OF THE ETA MESON, SEE PROC. UNIV. OF PENN. CONF. ON MESON SPECTROSCOPY (W.A.BENJAMIN, N.Y., 1968)

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14 ETA MASS (MEV)

M	53	549.0	1.2	BASTIEN	62	HBC	
M	35	546.0	4.0	PICKUP	62	HBC	
M	91	548.0	1.0	ALFF	62	HBC	
M		549.3	2.9	DELCOURT	63	CNTR	
M	148	549.0	0.7	FOELSCHE	64	HBC	
M	325	552.0	3.0	KRAEMER	64	DBC	
M		548.2	0.65	FOSTER3	65	HBC	7/66
M	250	555.0	2.0	JAMES	66	HBC	6/66
M		. . . .					
M	AVG	548.82	0.56	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)			
M	STUDENT	548.72	0.44	AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT (SEE IDEOGRAM BELOW)			

Stable Particles

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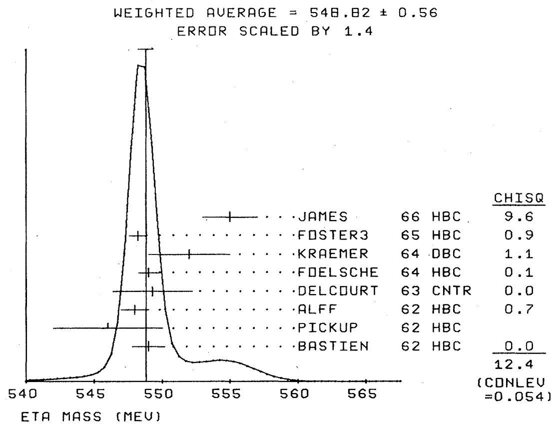
Data Card Listings

For notation, see key at front of Listings.

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                     14  ETA WIDTH

W        ETA WIDTH DETERMINED FROM MASS SPECTRUM (UNITS MEV)
W         91  (10.0)  OR LESS                ALFF       62 HBC
W        148  (10.0)  OR LESS                FOELSCHE   64 HBC
W         31  (12.0)  OR LESS                JAMES      66 HBC                6/66
W              (4.0)  OR LESS                BALTAY     66 DBC                7/66
W               (.9)  OR LESS   CL=.95       JONES      66 CNTR               8/67

W        ETA WIDTH DETERMINED FROM DECAY RATE (UNITS KEV)
W         THIS IS THE PARTIAL DECAY RATE (W1) FOR THE MODE (ETA INTO 2GAMMA)
W         DIVIDED BY THE FITTED BRANCHING FRACTION (P1) FOR THAT MODE.
W              . . . . . . . . .
W   FIT         0.85       0.12    FROM FIT

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                     14  ETA PARTIAL DECAY MODES

                                                            DECAY MASSES
P1       ETA INTO 2GAMMA                                      0+    0
P2       ETA INTO 3PIO                                      134+ 134+ 134
P3       ETA INTO PI+ PI- PIO                               139+ 139+ 134
P4       ETA INTO PI+ PI- GAMMA                             139+ 139+   0
P5       ETA INTO E+ E- PIO (VIOLATES C IN E.M.I.)          134+  .5+  .5
P6       ETA INTO E+ E- PI+ PI-                             139+ 139+  .5+  .5
P7       ETA INTO PIO 2GAMMA                                134+   0+   0
P8       ETA INTO E+ E- GAMMA                                .5+  .5+   0
P9       ETA INTO 2PIO GAMMA (VIOLATES C)                   134+ 134+   0
P10      ETA INTO PI+ PI- PIO GAMMA                         139+ 139+ 134+   0
P11      ETA INTO PI+ PI- 2GAMMA                            139+ 139+   0+   0
P12      ETA INTO MU+ MU-                                   105+ 105
P13      ETA INTO MU+ MU- GAMMA                             105+ 105+   0
P14      ETA INTO MU+ MU- PIO                               105+ 105+ 134
P15      ETA INTO PI+ PI-                                   139+ 139

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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

	P 1	P 2	P 3	P 4	P 7	P 8
P 1	.3799+-.0098					
P 2	-.2691	.2990+-.0106				
P 3	-.3224	-.2353	.2358+-.0056			
P 4	-.2866	-.2095	.8201	.0489+-.0013		
P 7	-.4271	-.5781	-.0939	-.0801	.0314+-.0109	
P 8	-.0434	-.0326	-.0494	-.0501	-.0036	.0050+-.0012

FITTED PARTIAL DECAY MODE RATES

The matrix below is the branching fraction matrix above, transformed into rate space; i.e., $G_i \equiv \Gamma_i = \Gamma_{total} P_i$, in appropriate units. In analogy to the matrix above, the diagonal elements are $G_i \pm \delta G_i$, where $\delta G_i = \sqrt{\langle \delta G_i \delta G_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta G_i \delta G_j \rangle / (\delta G_i \cdot \delta G_j)$. Note that, because of the error in Γ_{total}, the errors and correlations here are not directly derivable from those above.

	G 1	G 2	G 3	G 4	G 7	G 8
G 1	.3240+-.0460					
G 2	.9386	.2550+-.0385				
G 3	.9689	.9513	.2011+-.0294			
G 4	.9646	.9471	1.0097	.0417+-.0061		
G 7	.3661	.3028	.4240	.4226	.0268+-.0104	
G 8	.5178	.5082	.5233	.5199	.2318	.0043+-.0012

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14 ETA DECAY RATES

Note on Conflicting Results for $\eta \to \gamma\gamma$ Decay Rate

The BROWMAN 74 result for $\Gamma_{\gamma\gamma}$ is three standard deviations below the earlier BEMPORAD 67 result. This is because the BEMPORAD 67 analysis finds a negligible strong-production amplitude and attributes all of their observed η photoproduction cross section to Coulomb production. BROWMAN 74, on the other hand, find that the strong-production contribution to the cross section is significant, especially at lower energies, and that the Coulomb contribution is smaller, resulting in a smaller value of $\Gamma_{\gamma\gamma}$.

The η photoproduction data of BROWMAN 74 were taken at incident γ-ray energies of 5.8, 9.0, and 11.45 GeV on beryllium, aluminum, copper, silver, and uranium targets, while the BEMPORAD 67 data were taken at 4.0 and 5.5 GeV on lead, silver, and zinc. The higher energies, higher statistics, better angular resolution, and larger range of atomic weights of the BROWMAN 74 experiment result in a more reliable separation of the Coulomb amplitude from the strong-production amplitude. In addition, the bad approximation mentioned in BROWMAN 74 footnote 4 was present in the theoretical work utilized by BEMPORAD 67 and this may account for some of the discrepancy.

Browman et al. state that the BROWMAN 74 result is compatible with the BEMPORAD 67 data, although the agreement is not as good as that given by the BEMPORAD 67 fit to these data. On the other hand, the BEMPORAD 67 result appears to be incompatible with the 9 GeV data (especially uranium) shown in Fig. 2 of BROWMAN 74.

We quote the BROWMAN 74 result.

```
W1      ETA INTO 2GAMMA (UNITS KEV)                        (G1)
W1  B        (1.00)    (0.22)         BEMPORAD  67 CNTR    PRIMAKOFF EFFECT 11/75*
W1            0.324     0.046         BROWMAN   74 CNTR    PRIMAKOFF EFFECT  7/74*
W1  B   BEMPORAD 67 GIVES W1=1.21+-.26 KEV ASSUMING THAT W1/TOTAL=0.314.    11/75*
W1  B   BEMPORAD PRIVATE COMMUNICATION GIVES MORE GENERAL RESULT AS         11/75*
W1  B   W1*W1/TOTAL=.380+-.083.  WE EVALUATE THIS USING W1/TOTAL=.38+-.01.  11/75*
W1  B   NOT INCLUDED IN AVERAGE BECAUSE THE UNCERTIANTY RESULTING FROM THE   2/76*
W1  B   SEPARATION OF THE COULOMB AND NUCLEAR AMPLITUDES HAS APPARENTLY      2/76*
W1  B   BEEN UNDERESTIMATED.  SEE NOTE ON DISCREPANCY ABOVE.                 2/76*
W1          . . . . . . . . .
W1  FIT       0.324     0.046   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

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                    14  ETA BRANCHING RATIOS

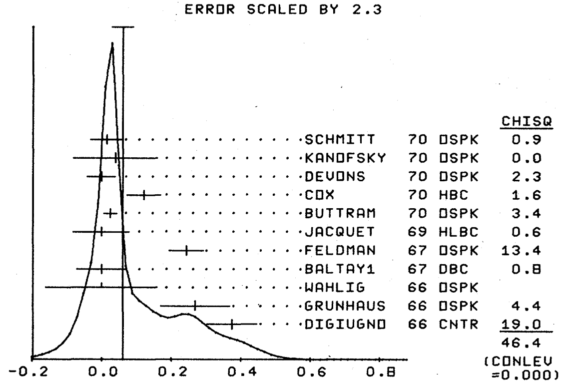
R1      ETA INTO NEUTRALS/CHARGED                              (P1+P2+P7)/(P3+P4+P8)
R1   N   10   (2.5)    (1.0)          PICKUP    62 HBC
R1   N   53   (3.20)   (1.26)         BASTIEN   62 HBC
R1   N        (2.7)    (0.8)          SHAFER    62 HBC
R1             2.6       .9           BUSCHBECK 63 HBC                       7/66
R1   N  280   (4.5)    (1.0)          JAMES     66 HBC                       6/66
R1   N   THESE EXPERIMENTS HAVE NOT BEEN USED IN COMPUTING THE AVERAGES
R1   N   AS THEY WERE UNABLE TO SEPARATE CLEARLY PARTIAL MODES (3) AND (4)
R1   N   FROM EACH OTHER.  THE REPORTED VALUES THUS PROBABLY CONTAIN
R1   N   SOME (UNKNOWN) FRACTION OF MODE (4).
R1             2.64     0.23          BALTAY2   67 DBC                      11/67
R1          . . . . . . . . .
R1   AVG       2.64     0.22   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1   STUDENT   2.64     0.24   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R1   FIT       2.452    0.081 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R2      ETA INTO 2GAMMA/CHARGED                                 (P1)/(P3+P4+P8)
R2             0.99     0.48          CRAWFORD  63 HBC
R2          . . . . . . . . .
R2   FIT       1.311    0.053 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
```

Note on $\eta \to \pi^0\gamma\gamma$

The discrepancies between various measurements of branching ratios involving $\eta \to \pi^0\gamma\gamma$ are displayed in the ideogram below, in which all relevant experiments have been converted to a common ratio, $\pi^0\gamma\gamma$/neutrals. Our branching ratio fit does not include DIGIUGNO 66, FELDMAN 67, or the upper limit measurements. See page 43 of "Review of Particle Properties", Physics Letters 39B, No. 1 (1972) for more discussion.

WEIGHTED AVERAGE = 0.061 ± 0.031
ERROR SCALED BY 2.3



ETA B.R. INTO (PIO 2GAMMA)/NEUTRALS

```
R3      ETA INTO (PIO 2GAMMA)/NEUTRALS                   (P7)/(P1+P2+P7)
R3   S       (0.375)  (0.072)        DIGIUGNO  66 CNTR    ERROR DOUBLED      6/66
R3    THE ERRORS OF DIGIUGNO+ 66 HAVE BEEN INCREASED BY A FACTOR
R3    OF TWO, TO TAKE INTO ACCOUNT POSSIBLE SYSTEMATIC ERRORS, AS
R3    SUGGESTED BY THE AUTHORS.
R3             .27       .10          GRUNHAUS  66 OSPK                      8/67
R3   R       (.028)    (.044)         BUNIATOV  67 OSPK                     11/67
R3   S       (.244)    (.05)          FELDMAN   67 OSPK                      8/67
R3   S   SEE THE NOTE ON ETA DECAY INTO NEUTRALS ABOVE.
R3            .026      .019          BUTTRAM   70 OSPK                     12/70
R3            .122      .052     .044 COX       70 HBC                       6/70
R3           (.07) OR LESS  CL=.90    DEVONS    70 OSPK                     12/70
R3 R    16    .016      .047          SCHMITT   70 OSPK                     12/70
R3 R     SCHMITT 70 IS A REANALYSIS BUNIATOV 67
R3   E       (0.11)    (0.03)         STRUGALSK 71 HLBC                      5/71
R3   E   THIS MEASUREMENT HAS BEEN EXCLUDED BECAUSE THE ERROR APPEARS        2/71
R3   E   TO BE SERIOUSLY UNDERESTIMATED.                                     2/71
R3          . . . . . . . . .
R3   AVG      0.042     0.023   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
R3   STUDENT  0.039     0.019   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R3   FIT      0.044     0.015 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R4      ETA INTO (PI+ PI- GAMMA)/(PI+ PI- PIO)           (P4)/(P3)
R4            0.14      0.08          FOELSCHE  64 HBC
R4   M   24  (0.73)    (0.25)         PAULI     64 DBC
R4   M   THIS EXPERIMENT HAS NOT BEEN INCLUDED IN THE AVERAGES SINCE IT IS
R4   M   NOT CLEAR THAT THEIR CLASS B EVENTS ARE ACTUALLY FROM ETAS.
R4            0.30      0.06          CRAWFORD  66 HBC                       6/66
R4             .10       .10          KRAEMER   64 CBC                       7/66
R4             .196      .041         FOSTER3   65 HBC                       7/66
R4             .25       .035         LITCHFIEL 67 DBC                       8/67
R4            0.28      0.04          BALTAY2   67 DBC                      11/67
R4     7250    .201      .006         GORMLEY   70 ASPK                      6/70
R4      18K   0.209     0.004         THALER    73 ASPK                      6/73
R4          . . . . . . . . .
R4   AVG      0.2074    0.0037  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
R4   STUDENT  0.2074    0.0037  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R4   FIT      0.2075    0.0033 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
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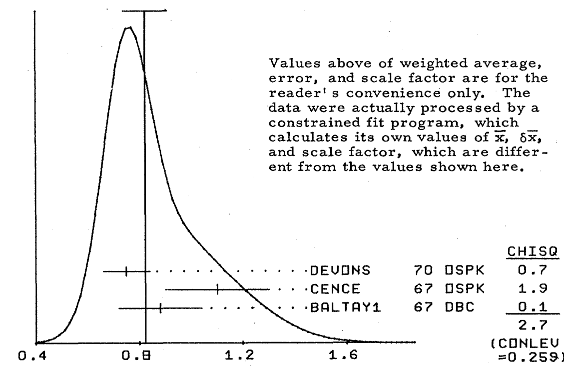
R5      ETA INTO (3PIO) + 2/3(PIO 2GAMMA)/ PI+PI-PIO     (P2+2/3P7)/P3
R5            0.83      0.32          CRAWFORD  63 HBC                       7/66
R5            2.0       1.0           FOELSCHE  64 HBC                       7/66
R5            0.90      0.24          FOSTER1   65 HBC                       7/66
R5          . . . . . . . . .
R5   AVG      0.91      0.19    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R5   STUDENT  0.91      0.20    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R5   FIT      1.357     0.057  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R6      ETA INTO 3PIO/2GAMMA                              (P2)/(P1)
R6           (.90) OR MORE            CHRETIEN  62 PBC
R6            0.88      0.16          BALTAY1   67 DBC                      11/67
R6            1.1       0.2           CENCE     67 OSPK                      1/68
R6            0.75      0.09          DEVONS    70 OSPK                     12/70
R6          . . . . . . . . .
R6   AVG      0.824     0.085   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
R6   STUDENT  0.821     0.085   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R6   FIT      0.787     0.039  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
                        (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 0.824 ± 0.085
ERROR SCALED BY 1.2



ETA INTO (3PIO)/(2GAMMA)

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R7      ETA INTO 2GAMMA/(PI+ PI- PO)                      (P1)/(P3)
R7            1.61      0.39          FOSTER1   65 HBC
R7     401    1.72       .25          BAGLIN    69 HLBC                      7/69
R7          . . . . . . . . .
R7   AVG      1.69      0.21    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R7   STUDENT  1.69      0.23    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R7   FIT      1.611     0.065  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R8      ETA INTO NEUTRAL/(PI+ PI- PIO)                    (P1+P2+P7)/(P3)
R8      50    3.6       0.8           KRAEMER   64 DBC
R8            3.8       1.1           PAULI     64 DBC                       7/66
R8            2.89      0.56          ALFF-STEI 66 HBC                       9/66
R8     244    3.6       0.6           FLATTE2   67 HBC                       1/68
R8      29    3.4       1.1           AGUILAR-B 72 HBC                      11/72
R8 B    70    2.83      0.80          BLOODWORT 72 HBC                      11/72
R8      74    2.54      1.89          KENDALL   74 OSPK                     12/75*
R8 B    ERROR INCREASED FROM PUBLISHED VALUE 0.5 BY BLOODWORTH, PRIV. COMM.  1/73
R8          . . . . . . . . .
R8   AVG      3.26      0.30    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R8   STUDENT  3.26      0.33    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R8   FIT      3.01      0.10   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R9      ETA INTO (E+E-PIO)/(PI+PI-PIO) (UNITS 10**-4)     (P5)/(P3)
R9           110.     OR LESS         PRICE     65 HBC
R9       0    77.     OR LESS         FOSTER2   65 HBC
R9            42.     OR LESS  CL=.90 BAGLIN1   67 HLBC                      8/67
R9       0    16.     OR LESS  CL=.90 BILLING   67 HLBC                     11/67
R9             1.9    OR LESS  CL=.90 JANE1     75 OSPK                     12/75*

R10     ETA INTO (E+E-PI+PI-)/TOTAL (UNITS 10**-2)        (P6)
R10          (0.7)    OR LESS         RITTENBER 65 HBC                       6/66

R11     ETA INTO (E+E-PI+PI-)/(PI+PI-GAMMA)               (P6)/(P4)
R11      1    0.026     0.026         GROSSMAN  66 HBC                       6/66

R12     ETA INTO 2 GAMMA/NEUTRALS                         (P1)/(P1+P2+P7)
R12 S        (0.416)  (0.044)         DIGIUGNO  66 CNTR   ERROR DOUBLED      6/66
R12            .44       .07          GRUNHAUS  66 OSPK                      8/67
R12 S        (.579)   (.052)          FELDMAN   67 OSPK                      8/67
R12 S   SEE THE NOTE ON ETA DECAY INTO NEUTRALS ABOVE.
R12 T        (0.39)   (0.06)          JONES     66 CNTR                      8/67
R12 T   THIS RESULT FROM COMBINING CROSS SECTIONS FROM TWO DIFFERENT EXPTS.
R12            .59      .033          BUNIATOV  67 OSPK                     11/67
R12            .535     .018          BUTTRAM   70 OSPK                     12/70
R12            .486     .036          COX       70 HBC                       6/70
R12           0.57     0.09           STRUGALSK 71 HLBC                      5/71
R12     113   0.60     0.14           KENDALL   74 OSPK                     12/75*
R12         . . . . . . . . .
R12 AVG       0.535    0.018    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
R12 STUDENT   0.535    0.016    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R12 FIT       0.535    0.013   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)
                       (SEE IDEOGRAM BELOW )

R13     ETA INTO 3PIO/NEUTRALS                            (P2)/(P1+P2+P7)
R13 S        (0.209)  (0.054)         DIGIUGNO  66 CNTR   ERROR DOUBLED      6/66
R13 R        (.29)    (.10)           GRUNHAUS  66 OSPK                      8/67
R13 S        (.177)   (.035)          FELDMAN   67 OSPK                      8/67
R13 S   SEE THE NOTE ON ETA DECAY INTO NEUTRALS ABOVE.
R13            .41      .033          BUNIATOV  67 OSPK                     11/67
R13 R   REDUNDANT INFORMATION FROM THIS EXPERIMENT.
R13 R        (.439)   (.024)          BUTTRAM   70 OSPK                     12/70
R13            .392     .042          COX       70 HBC                       6/70
R13           0.32     0.09           STRUGALSK 71 HLBC                      5/71
R13      75   0.40     0.14           KENDALL   74 OSPK                     12/75*
R13         . . . . . . . . .
R13 AVG       0.397    0.025    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R13 STUDENT   0.397    0.027    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R13 FIT       0.421    0.014   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
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Stable Particles

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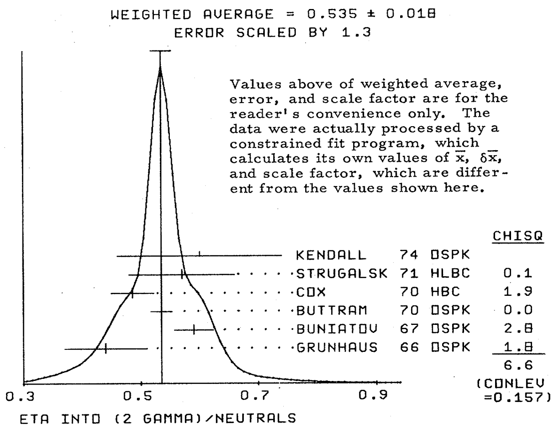
Data Card Listings

For notation, see key at front of Listings.

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R14      ETA INTO PIO (2 GAMMA)/2GAMMA                          (P7)/(P1)
R14          (.5)  OR LESS  CL=.90    WAHLIG     66 SPRK                          7/66
R14          0.0       0.14           BALTAY1    67 DBC                          11/67
R14 P        (0.05)    (0.04)         BONAMY     67 SPRK   PRELIMINARY RESULT   11/67
R14          . . . . . . . . .
R14 FIT      0.083     0.030   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R15      ETA INTO (E+E-PIO)/TOTAL (UNITS 10**-2)                (P5)
R15          (0.7)  OR LESS           RITTENBER  65 HBC                           6/66
R15          (0.084)OR LESS  CL=.90   BAZIN      68 DBC                           6/68

R16      ETA INTO 2GAMMA/(3PIO + PIO 2GAMMA)                    (P1)/(P2+P7)
R16          0.80      .25            BACCI      63 CNTR                          7/66
R16          . . . . . . . . .
R16 FIT      1.150     0.060   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R17      ETA INTO (PI+PI-PIO GAMMA)/(PI+PI-PIO) (UNITS 10**-2)
R17                                                             (P10)/(P3)
R17          (7.0)  OR LESS           FLATTE     67 HBC                           8/67
R17          (0.9)  OR LESS           PRICE      67 HBC                           8/67
R17          (1.6)  OR LESS  CL=.95   BALTAY2    67 DBC                          11/67
R17          (1.7)  OR LESS  CL=.90   ARNOLD     68 HLBC                          9/68
R17  T   0   0.24   OR LESS  CL=.90   THALER     73 ASPK                          6/73
R17  T   0   0.0       0.15           LIMIT ABOVE RESTATED FOR AVERAGING          6/73

R18      ETA INTO (PI+PI- 2GAMMA)/(PI+PI-PIO)                   (P11)/(P3)
R18          (.009)OR LESS            PRICE      67 HBC                           8/67
R18          (.016)OR LESS   CL=.95   BALTAY2    67 DBC                          11/67

R19      ETA INTO 3PIO/(PI+ PI- PIO)                            (P2)/(P3)
R19          1.3       .4             BAGLIN2    67 HLBC                          8/67
R19          1.47      0.20     0.17  BULLOCK    68 HLBC                          9/68
R19    199   1.50      .15      .29   BAGLIN     69 HLBC                          7/69
R19          . . . . . . . . .
R19 AVG      1.46      0.13     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R19 STUDENT  1.46      0.14     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R19 FIT      1.268     0.060   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R20      ETA INTO 2GAMMA/((3PIO)+2/3(PIO 2GAMMA))               (P1)/(P2+2/3P7)
R20          1.10      0.5            MULLER     63 DBC                           7/66
R20          . . . . . . . . .
R20 FIT      1.187     0.058   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R21      ETA INTO NEUTRALS/TOTAL                                (P1+P2+P7)
R21          .79       .08            BUNIATOV   67 OSPK                         11/67
R21    16K   .705      .008           BASILE     71 CNTR MM SPECTROMETER          8/71
R21          . . . . . . . . .
R21 AVG      0.7058    0.0080   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R21 STUDENT  0.7058    0.0086   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R21 FIT      0.7103    0.0068 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R22      ETA INTO (PIO 2GAMMA)/TOTAL                            (P7)
R22          .12   OR LESS  CL=.95    JACQUET    69 HLBC                          6/70
R22          . . . . . . . . .
R22 FIT      0.031     0.011   FROM FIT

R23      ETA INTO MU+MU-/TOTAL (UNITS 10**-5)                   (P12)
R23      0   2.     OR LESS  CL=.95   WEHMANN    68 OSPK                          4/68

R24      ETA INTO MU+MU-PIO/TOTAL (UNITS 10**-4)                (P14)
R24          5.     OR LESS           WEHMANN    68 OSPK                          4/68

R25      ETA INTO MU+MU-/2GAMMA (UNITS 10**-5)                  (P12)/(P1)
R25          5.9       2.2            HYAMS      69 OSPK                          7/69

R26      ETA INTO (PIO 2GAMMA)/(3PIO + PIO 2GAMMA)              (P7)/(P2+P7)
R26  N       0.1       0.3            KANOFSKY   70 OSPK                          2/71
R26  N  WE HAVE CHANGED THE ERROR ON THIS EXPERIMENT FROM +0.3,-0.1               2/71
R26  N  TO THE ABOVE +0.3,-0.3 SINCE IT IS CLEAR FROM FIGURE 7 IN THE             2/71
R26  N  ARTICLE THAT A CENTRAL VALUE OF 0.0 IS ABOUT AS PROBABLE AS THE           2/71
R26  N  QUOTED VALUE OF 0.1.                                                      2/71
R26          . . . . . . . . .
R26 FIT      0.095     0.032   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R27      ETA INTO (PI+ PI-)/TOTAL (UNITS 10**-2)                (P15)             6/73
R27      0   (0.15) OR LESS           THALER     73 ASPK CON. LEV. NOT GIVEN      6/73

R28      ETA INTO (E+E-GAMMA)/(PI+PI-PIO) (UNITS 10**-2)  (P8)/(P3)
R28  J  80   2.1       0.5            JANE2      75 OSPK                          2/76*
R28  J  VALUE CHANGED BY ERRATUM.                                                 2/76*
R28          . . . . . . . . .
R28 FIT      2.11      0.50    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                    14  ETA C-NONCONSERVING DECAY PARAMETERS

     RELATED TEXT SECTION VI C.1

A1      LEFT-RIGHT ASYMMETRY PARAMETER FOR PI+ PI- PIO  (UNITS 10**-2)
A1     1351     7.2       2.8               BALTAY    66 DBC                        8/66
A1     1300     5.8       3.4               CLPWY     66 HBC                        8/66
A1    10665    (0.3)     (1.0)              CNOPS     66 OSPK REPL BY MULLER 69     8/67
A1      705    -6.1       4.0               LARRIBE   66 HBC                        8/67
A1   G36800    (1.5)     (.5)               GORMLEY3  68 ASPK                     . 6/68
A1    10709      .3       1.1               MULLER    69 OSPK                       9/69
A1     1138    -1.4       3.                CARPENTR  70 HBC                        6/70
A1      349     3.2       5.4               DANBURG   70 DBC                        2/71
A1     220K    -0.05      0.22              LAYTER    72 ASPK                       8/72
A1     165K     0.28      0.26              JANE1     74 OSPK                       3/74
A1  G   GORMLEY3 68 ASYMMETRY PROBABLY DUE TO UNMEASURED (E X B) SPK. CH.           3/74
A1  G   EFFECTS.  NEW EXPTS. WITH (E X B) CONTROLS DONT OBSERVE ASYMMETRY.          3/74
A1             . . . . . . . . .
A1  AVG         0.12      0.17     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
A1  STUDENT     0.11      0.19     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

A2      LEFT-RIGHT ASYMMETRY PARAMETER FOR PI+ PI- GAMMA (UNITS 10**-2)
A2       33    -2.       17.                CRAWFORD  66 HBC                       11/66
A2             -4.        8.                LITCHFIEL 67 DBC                        8/67
A2 N   1620     1.5       2.5               MULLER    69 OSPK                       9/69
A2     7257     1.22      1.56              GORMLEY   70 ASPK                       6/70
A2      36K     0.5       0.6               THALER    72 ASPK                       8/72
A2      35K     1.2       0.6               JANE2     74 OSPK                       3/74
A2 N   MULLER 69 IS SENSITIVE ONLY TO UPPER .4 OF GAMMA-RAY SPECTRUM.
A2             . . . . . . . . .
A2  AVG         0.88      0.40     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
A2  STUDENT     0.88      0.45     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

AS      SEXTANT ASYMMETRY PARAMETER FOR PI+ PI- PIO  (UNITS 10**-2)
AS     1300     6.8       3.3               CLPWY     66 HBC                       12/75*
AS      705    -2.4       4.0               LARRIBE   66 HBC                       12/75*
AS      37K     0.5       0.5               GORMLEY3  68 WIRE                      12/75*
AS     220K     0.10      0.22              LAYTER    72 ASPK                      12/75*
AS     165K     0.20      0.25              JANE1     74 OSPK                      12/75*
AS             . . . . . . . . .
AS  AVG         0.19      0.16     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
AS  STUDENT     0.19      0.17     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

AQ      QUADRANT ASYMMETRY PARAMETER FOR PI+ PI- PIO (UNITS 10**-2)
AQ     220K    -0.07      0.22              LAYTER    72 ASPK                      12/75*
AQ     165K    -0.30      0.25              JANE1     74 OSPK                      12/75*
AQ             . . . . . . . . .
AQ  AVG        -0.17      0.17     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
AQ  STUDENT    -0.17      0.18     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

BET     BETA FOR ETA TO PI+ PI- GAMMA. SENSITIVE TO D-WAVE CONTRIBUTION.
BET     DN/DCOS THETA = SIN**2 THETA * (1 + BETA * COS**2 THETA)                   12/75*
BET    7250    -0.060     0.065             GORMLEY   70 WIRE                      12/75*
BET  L          0.12      0.06              THALER    72 ASPK                      12/75*
BET     35K     0.11      0.11              JANE2     74 OSPK                      12/75*
BET  L  AUTHORS DONT BELIEVE THIS TO INDICATE D-WAVE BECAUSE DEPENDENCE OF         12/75*
BET  L  BETA ON GAMMA ENERGY INCONSISTENT WITH THEOR. PREDICTION.                  12/75*
BET  L  COS**2 DEPENDENCE MAY ALSO COME FROM P AND F-WAVE INTERFERENCE.            12/75*
BET            . . . . . . . . .
BET AVG         0.047     0.062    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
BET STUDENT     0.053     0.053    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

                    14 ENERGY DEPENDENCE OF ETA DALITZ PLOT

DP      RELATED TEXT SECTION VI C.2
DP      THE FOLLOWING EXPTS FIT TO ONE OR MORE OF THE COEFFICIENTS
DP      A,B,C,D, OR E FOR ETA TO PI+ PI- PIO
DP      MATRIX ELEMENT**2=1 + A*Y + B*(Y**2) + C*X + D*(X**2) + E*X*Y
DP     1300 SEE TEXT SEC VI C.2             CLPWY     66 HBC                       12/75*
DP      705 SEE TEXT SEC VI C.2             LARRIBE   66 HBC                       12/75*
DP     7170 SEE TEXT SEC VI C.2             CNOPS     68 OSPK                      12/75*
DP      37K SEE TEXT SEC VI C.2             GORMLEY3  68 WIRE                      12/75*
DP      526 SEE TEXT SEC VI C.2             BAGLIN    69 HLBC                      12/75*
DP     1138 SEE TEXT SEC VI C.2             CARPENTR  70 HBC                       12/75*
DP      349 SEE TEXT SEC VI C.2             DANBURG   70 DBC                       12/75*
DP     7250 SEE TEXT SEC VI C.2             GORMLEY   70 WIRE                      12/75*
DP     220K SEE TEXT SEC VI C.2             LAYTER    72 ASPK                      12/75*
DP      81K SEE TEXT SEC VI C.2             LAYTER    73 ASPK                      12/75*

AO      ALPHA PARAMETER FOR ETA TO 3 PIO
AO      MATRIX ELEMENT **2 = 1 + 2*ALPHA*Z (SEE TEXT SEC VI C.3)                   12/75*
AO      192    -0.32      0.37              BAGLIN    70 HLBC                      12/75*

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REFERENCES FOR ETA


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PEVSNER   61 PRL 7 421           PEVSNER,KRAEMER,NUSSBAUM,RICHARDSON + (JHU)

ALFF      62 PRL 9 322           ALFF,BERLEY,COLLEY,BRUGGER + (COLU+RUTGERS)
BASTIEN   62 PRL 8 114           BASTIEN,BERGE,DAHL,FERRO-LUZZI +      (LRL)
CHRETIEN 62 PRL   9  127         CHRETIEN+    (BRAN+BROWN+HARVARD+MIT+PADOVA)
PICKUP    62 PRL 8 329           E PICKUP,ROBINSON,SALANT          (CNRC+BNL)
SHAFER    62 CERN CONF 307       J SHAFER,FERRO-LUZZI,MURRAY +      (UCB+LRL)

BACCI     63 PRL 11 37           BACCI,PENSO,SALVINI +            (ROMA+FRAS)
BUSCHBEC 63 SIENA CONF 1 166     BUSCHBECK-CZAPP,COOPER + (VIENNA,CERN,AMST)
CRAWFORD 63 PRL 10 546           F S CRAWFORD,LLOYD,FOWLER         (LRL+DUKE)
    ALSO 66 PRL 16 907           F S CRAWFORD,L LLOYD,E FOWLER     (LRL+DUKE)
DELCOURT 63 PL 7 215             DELCOURT,LEFRANCOIS,PEREZ Y JORBA+  (ORSAY)
MULLER    63 SIENA CONF 99       MULLER,PAULI +                    (SACL+ROMA)

FOELSCHE 64 PR 134 B 1138        H W FOELSCHE,H L KRAYBILL              (YALE)
KRAEMER   64 PR 136 B 496        KRAEMER,MADANSKY,FIELDS +    (JHU+NWES+WOOD)
PAULI     64 PL 13 351           E PAULI,A MULLER                     (SACLAY)

FOSTER1   65 PR 138 B 652        FOSTER,PETERS,MEER,LOEFFLER + (WISC+PURDUE)
FOSTER2   65 ATHENS              FOSTER,GOOD,MEER                  (WISCONSIN)
FOSTER3   65 THESIS              M.C.FOSTER                        (WISCONSIN)
PRICE     65 PRL  15  123        L.R.PRICE,F.S.CRAWFORD                  (LRL)
RITTENBE 65 PRL 15 556           RITTENBERG,KALBFLEISCH              (LRL+BNL)

ALFF-STE 66 PR 145 1072          ALFF-STEINBERGER,BERLEY+ (COLUMBIA+RUTGERS)
BALTAY    66 PRL 16 1224         +FRANZINI,KIM,KIRSCH+(COLUMBIA+STONY BROOK)
CLPWY     66 PR 149  1044        COLUMBIA,LRL,PURDUE,WISCONSIN,YALE
CNOPS     66 PL 22 546           CNOPS,FINOCCHIARS,LASSALLE,(CERN,ETHZ,SACL)
CRAWFORD 66 PRL  16  333         F.S.CRAWFORD,L.R.PRICE                  (LRL)
DIGIUGNO 66 PRL 16 767           DIGIUGNO,GIORGI,SILVESTRI+ (NAPL,TRST,FRAS)
GROSSMAN 66 PR 146  993          R GROSSMAN,L PRICE,F CRAWFORD           (LRL)
GRUNHAUS 66 THESIS               J.GRUNHAUS                         (COLUMBIA)
JAMES     66 PR 142    896       F E JAMES,H L KRAYBILL             (YALE+BNL)
JONES     66 PL 23  597          JONES,BINNIE,DUANE,HORSEY,MASON,(LOIC,RHEL)
LARRIBE   66 PL 23 600           LARRIBE,LEVEQUE,MULLER,PAULI,+  (SACL+RHEL)
WAHLIG    66 PRL  17  221        WAHLIG,SHIBATA,MANNELLI            (MIT+PISA)
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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

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BAGLIN1  67 PL 24B 637           BAGLIN,BEZAGUET,DEGRANGE,+        (EPOL+UCB)
BAGLIN2  67 BAPS 12 567          BAGLIN,BEZAGUET,DEGRANGE,+        (EPOL+UCB)
BALTAY1  67 PRL 19 1495          BALTAY,FRANZINI,KIM,NEWMAN+      (COLU+BRAN)
BALTAY2  67 PRL 19 1498          BALTAY,FRANZINI,KIM,NEWMAN+      (COLU+STON)
BEMPORAD 67 PL 25B 380           BEMPORAD,BRACCINI,FOA,LUBELSMEY+(PISA,BONN)
    ALSO    PRIVATE COMMUNICATION
BILLING  67 PL 25B 435           BILLING,BULLOCK,ESTEN,GOVAN,+     (LOUC,OXF)
BONAMY   67 HEIDELBERG CONF.     BONAMY,SONDEREGGER                  (SACLAY)
BOWEN    67 PL 24B 206           BOWEN,CNOPS ,FINOCCHIARO,+ (CERN+ETHZ+SACL)
BUNIATOV 67 PL 25B 560           BUNIATOV,ZAVATTINI,DEINET,+     (CERN+KARL)
CENCE    67 PRL 19 1393          CENCE,PETERSON,STENGER,CHIU+   (HAWAII+LRL)
FELDMAN  67 PRL 18 868           FELDMAN,FRATI,GLEESON,HALPERN,+       (PENN)
FLATTE   67 PRL 18 976           S.M.FLATTE                             (LRL)
FLATTE2  67 PR 163 1441          S.M.FLATTE AND C.G.WOHL                (LRL)
LITCHFIE 67 PL 24B 486           LITCHFIELD,RANGAN,SEGAR,SMITH+(RHEL+SACLAY)
PRICE    67 PRL 18 1207          L.R.PRICE,F.S.CRAWFORD                 (LRL)

ARNOLD   68 PL 27B 466           +PATY,BAGLIN,BINGHAM+  (STRB+MADR+EPOL+UCB)
BAZIN    68 PRL 20 895           BAZIN,GOSHAW,ZACHER,+    (PRINCETON,QUEENS)
BULLOCK  68 PL 27B 402           +ESTEN,FLEMING,GOVAN,HENDERSON,OWEN+ (LOUC)
GORMLEY3 68 PRL 21 402           GORMLEY,HYMAN,LEE,NASH,PEOPLES+  (COLU+BNL)
WEHMANN  68 PRL 20 748           WEHMANN,ENGELS,+ (HARV+CASE+SLAC+CORN+MCGI)

BAGLIN   69 PL 29B 445           BAGLIN,BEZAGUET,+        (EPOL,UCB,MADR,STRB)
    ALSO 70 NP B22 66            +BEZAGUET,DEGRANGE,MUSSET +(EPOL,MADR,STRB)
HYAMS    69 PL 29B 128           HYAMS,KOCH,POTTER,VON LINDERN,+ (CERN,MPIM)
JACQUET  69 NC 58 743            JACQUET,NGUYEN-KHAC,HAATUFT+     (EPOL,BERG)
MULLER   69 THESIS               ARMAND MULLER                         (STRB)

BAGLIN   70 NP B22 66            +BEZAGUET,DEGRANGE,MUSSET+ (EPOL+MADR+STRB)
BUTTRAM  70 PRL 25 1358          +KREISLER,MISCHKE                     (PRIN)
CARPENTR 70 PR D1 1303           CARPENTER,BINKLEY,CHAPMAN,COX,DAGAN+ (DUKE)
COX      70 PRL 24 534           COX,FORTNEY,GOLSON                    (DUKE)
DANBURG  70 PR D2 2564           +ABOLINS,DAHL,DAVIES,HOCH,KIRZ,+       (LRL)
DEVONS   70 PR D1 1936           +GRUNHAUS,KOZLOWSKI,NEMETHY +    (COLU,SYRA)
GORMLEY  70 PR D2 501            GORMLEY,HYMAN,LEE,NASH,PEOPLES+  (COLU+BNL)
    ALSO 70 NEVIS 181(THESIS)    MICHAEL GORMLEY                       (COLU)
KANOFSKY 70 NC 68 413            A. KANOFSKY                           (LEHI)
SCHMITT  70 PL 32B 638           +BUNIATOV,ZAVATTINI,DEINET+      (CERN,KARL)

BASILE   71 NC 3A 796            +BOLLINI,DALPIAZ,FRABETTI+ (CERN,BGNA,STRB)
STRUGALS 71 NP B27 429           +CHUVILO,GEMESY,IVANOVSKAYA+          (JINR)
AGUILAR- 72 PR D6 29             AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS   (BNL)
BLOODWOR 72 NP B39 525           BLOODWORTH,JACKSON,PRENTICE,YOON  (TORONTO)
LAYTER   72 PRL 29 316           +APPEL,KOTLEWSKI,LEE,STEIN,THALER     (COLU)
THALER   72 PRL 29 313           +APPEL,KOTLEWSKI,LAYTER,LEE,STEIN     (COLU)
THALER   73 PR D7 2569           +APPEL,KOTLEWSKI,LAYTER,LEE,STEIN     (COLU)
BROWMAN  74 PRL 32 1067          +DEWIRE,GITTELMAN,HANSON,LOH +  (CORN+BING)
JANE1    74 PL 48B 260           +JONES,LIPMAN,OWEN,PENNEY+ (RHEL+LOWC+SUSS)
JANE2    74 PL 48B 265           +JONES,LIPMAN,OWEN,PENNEY+ (RHEL+LOWC+SUSS)
KENDALL  74 NC 21A 387           +LANOU,MASSIMO,SHAPIRO +     (BROW+BARI+MIT)
JANE1    75 PL 59B 99            +GRANNIS,JONES,LIPMAN,OWEN +     (RHEL+LOWC)
JANE2    75 PL 59B 103           +GRANNIS,JONES,LIPMAN,OWEN +     (RHEL+LOWC)
    ALSO 76 PL (TO BE PUBL.)     ERRATUM, M.R.JANE, PRIVATE COMMUNICATION.

         QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN THE DATA CARDS

BASTIEN  62 PRL 8 114            BASTIEN,BERGE,DAHL,FERRO-LUZZI,MILLER+(LRL)
CARMONY  62 PRL 8 117            D CARMONY,A ROSENFELD,VAN DE WALLE    (LRL)
ROSENFEL 62 PRL 8 293            A ROSENFELD,D CARMONY,VAN DE WALLE    (LRL)

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                    16  PROTON(938,J=1/2) I=1/2

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                    16  PROTON MASS (MEV)

M          (938.256)  (0.005)         COHEN      65 RVUE                      7/66
M          (938.2592) (0.0052)        TAYLOR     69 RVUE    USING NEW E/H     7/70
M           938.2796   0.0027         COHEN      73 RVUE                      3/74

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                    16  PROTON MEAN LIFE (UNITS 10**26 YR)

T          (.000001)OR MORE           GOLDHABE   54 TH 232 FISS.MODE INDEPEN
T           (0.002)OR MORE            FLEROV     57 TH 232 FISS.MODE INDEPEN
T   B        (1.5)  OR MORE           BACKENSTO  60 CNTR
T   B       (60.0)  OR MORE           KROPP      65 CNTR
T          (200.0)  OR MORE           GURR       67 CNTR DEP. ON DECAY MODE
T          (1300.0) OR MORE           BERGAMASC  74 CNTR                     12/75*
T    R      20000.0  OR MORE          REINES     74 CNTR                     12/75*
T   B   KROPP AND BACKENSTOSS SENSITIVE TO PARTICULAR DECAY MODES OF PROTON
T    R  REINES 74 LOOKS AT DECAY CHAINS ENDING IN MUON DECAY.               12/75*

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                    16  PROTON MAGNET. MOMENT(E/2MP)

MM         (2.79276) (.00002)         COHEN      65 RVUE
MM         (2.792782)(.000017)        TAYLOR     69 RVUE    USING NEW E/H     7/70
MM          2.7928456 .0000011        COHEN      73 RVUE                      3/74

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                    16  ANTIPROTON MAGNETIC MOMENT (E/2MP)

MM1 O      (-1.8)     (1.2)           BUTTON     62 CNTR
MM1 R      (-2.83)    (0.10)          FOX        72 CNTR                     11/75*
MM1  R      -2.819     0.056          ROBERTS    74 CNTR                      7/75*
MM1 O   OLD EXPERIMENT WITH LARGE ERROR.  NOT AVERAGED.
MM1  R  ROBERTS 74 IS REANALYSIS OF FOX 72 DATA.  REPLACES OLD FOX VALUE.     7/75*

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                    16  PROTON ELECTRIC DIPOLE MOMENT (UNITS 10**-23 E CM)
              NONZERO VALUE IMPLIES VIOLATION OF T AND P IN EM INTERACTION

EDM     1G  700.       900.           HARRISON   69 MBR                      10/69

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REFERENCES FOR PROTON


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GOLDHABE 54 PR 96 1157 FNOTE2 GOLDHABER,F REINES+           (LOS ALAMOS,BNL)
FLEROV   57 SOV PHYS DOK 3 79  FLEROV,KLOCHKOV,SKOBKIN,TERENTEV      (USSR)
BACKENST 60 NC  16  749        BACKENSTOSS,FRAUENFELDER,HYAMS +      (CERN)
BUTTON   62 PR 127 1297        J BUTTON,B MAGLIC                      (LBL)
COHEN    65 RMP 37 537         +DUMOND (N.AMER.AVIATION SCIENCE CENT.,CIT)
KROPP    65 PR 137 B 740       W R KROPP,F REINES   (CASE INST TECHNOLOGY)
GURR     67 PR  158  1321      GURR,KROPP,REINES,MEYER (CASE,JOHANNESBURG)
HARRISON 69 PRL   22  1263     HARRISON,SANDARS,WRIGHT  (CLARENDON OXFORD)
TAYLOR   69 RMP 41 375         +PARKER,LANGENBERG            (PRIN+UCI+PENN)
FOX      72 PRL 29 193         +BARNES,EISENSTEIN+(BNL+CARN+VPI+WILL+WYOM)
COHEN    73 J.PHYS.CHEM.REF.DATA 2, P.663, E.R.COHEN,B.N.TAYLOR
BERGAMAS 74 LNC 11 636         BERGAMASCO,PICCHI                 (TORI+FRAS)
REINES   74 PRL 32 493         +CROUCH                            (UCI+CASE)
ROBERTS  74 PRL 33 1181        +COX,ECKHAUSE+ (WILL+VPI+CARN+WYOM+CIT+BNL)
    ALSO 75 PR D12 1232        ROBERTS,COX +  (WILL+VPI+CARN+WYOM+CIT+BNL)

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                    17  NEUTRON(939,J=1/2) I=1/2

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                    17  NEUTRON MASS (MEV)

M   T      (939.5527) (0.0052)        TAYLOR     69 RVUE    USING NEW E/H     7/70
M   T       939.5731   0.0027         COHEN      73 RVUE                      3/74
M   T   THESE DETERMINATIONS OF NEUTRON MASS NOT INDEPENDENT OF               7/70
M   T   NEUTRON-PROTON MASS DIFFERENCE MEASUREMENTS BELOW.                     7/70

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                    17  (NEUTRON) - (PROTON) MASS DIFFERENCE (MEV)

D   M       (1.29344)(0.00007)        MATTAUCH   65 RVUE                      3/71
D            1.29343  0.00004         COHEN      74 RVUE                      3/74
D   M   WE HAVE CONVERTED MATTAUCH NEUTRON-HYDROGEN MASS DIFFERENCE TO        3/71
D   M   NEUTRON-PROTON MASS DIFFERENCE USING CURRENT VALUE OF ELECTRON MASS   3/71
D   M   AND A HYDROGEN BINDING ENERGY OF 13.6 EV.                             3/71

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                    17  NEUTRON MAGNETIC MOMENT (MAGNETONS,938.2 MEV)

MM        -1.913148 0.000066          COHEN      56 RVUE                      7/66

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                    17  NEUTRON ELECTRIC DIPOLE MOMENT (UNITS 10**-23 E CM)
                TEST OF CP OR T VIOLATION IN THE EM INTERACTION

EDM         (5.)    OR LESS           BAIRD      69 MBR  INCLUDED IN DRESS73 10/69
EDM          0.32     0.75            DRESS      73 MBR  .LT.10**-23 CL=.80   6/73

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                    17  NEUTRON MEAN LIFE (UNITS 10**3 SEC)

        THE MEASUREMENT OF THE NEUTRON MEAN LIFE BY SOSNOVSKII 59 HAS
        BEEN DISCARDED SINCE 1.  IT DISAGREES WITH THE BETTER AND MORE
        RECENT RESULT OF CHRISTENSEN 67.  2.  THE VALUE OF GA/GV DE-
        RIVED FROM THE NEW VALUE OF THE MEAN LIFE AGREES WELL WITH THE
        GA/GV VALUE OBTAINED FROM THE FREE NEUTRON DATA.

T           (1.012)  (0.021)          SOSNOVSKI 59 PILE     SEE NOTE E        7/68
T.          (0.935)  (0.014)          CHRISTENS 67 PILE REPL BY CHRISTENS72   3/68
T            0.918    0.014           CHRISTENS 72 PILE                       6/72
    E   ERROR CHANGED BECAUSE ERROR IN CROSS SECTION FOR NEUTRON ABSORPTION
    E   IN GOLD HAS BEEN REDUCED.

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                    17  NEUTRON BETA DECAY COUPLING CONSTANTS

        RELATED TEXT SECTION VI D.1

AV      GA/GV  (SEE TEXT FOR SIGN CONVENTION)
AV  C       (-1.250)  (0.044)         CONFORTO  67 RVUE  SEE NOTE C BELOW
AV EP       (-1.23)   (0.01)          CHRISTENS 67 CNTR  N DECAY FT VALUE    11/68
AV  P       (-1.22)   (0.08)          GRIGOREV  68 CNTR E-NEU ANG CORREL     10/71
AV  P       (-1.26)   (0.02)          CHRISTENS 70 CNTR PE,NEUT SPIN CORREL  10/71
AV EP       (-1.27)   (0.025)         EROZOLIMS 71 CNTR PE,NEUT SPIN CORREL  10/71
AV EP       (-1.239)  (0.011)         CHRISTENS 72 CNTR    N DEC.+ FT VALUE   1/73
AV  P       (-1.263)  (0.016)         KROPF     73 RVUE    N DECAY ALONE      1/73
AV   P       -1.250    0.009          KROPF     73 RVUE    N DEC.+ FT VALUE   1/73
AV E         -1.250    0.036          DOBROZEMS 75 CNTR E-NEU ANG CORREL.    12/75*
AV  C   CONFORTO 67 COMBINES FREE NEUTRON DATA TO 1967.  REPL. BY KROPF 73.   1/73
AV E    THESE EXPERIMENTS MEASURE THE ABSOLUTE VALUE OF GA/GV ONLY           10/71
AV   P  KROPF 73 VALUE OBTAINED BY FITTING ALL DATA THROUGH 1972.             1/73
AV           . . . . . . . . . .
AV  AVG      -1.2500   0.0087  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
AV  STUDENT  -1.2500   0.0094  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

F       PHASE ANGLE OF GA RELATIVE TO GV  (DEGREES)
F   C      (176.1)     (6.4)          CONFORTO  67 RVUE                      11/68
F   P      (181.3)     (1.3)          EROZOLIMS 70 CNTR   POLAR. NEUTRON     10/69
F    P      181.1       1.3           KROPF     73 RVUE    N DECAY            1/73
F   C   CONFORTO 67 COMBINES FREE NEUTRON DATA TO 1967.  REPL. BY KROPF 73.   1/73
F    P  KROPF 73 VALUE OBTAINED BY FITTING ALL DATA THROUGH 1972.             1/73

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REFERENCES FOR NEUTRON


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COHEN    56 PR 104 283         V W COHEN, CORNGOLD, RAMSEY   (BNL+HARVARD)
SOSNOVSK 59 JETP  9  717       SOSNOVSKII,SPIVAK,PROKOFEV +   (IAE MOSCOW)

MATTAUCH 65 NP 67 1            +THIELE,WAPSTRA     (MAX PLANCK INST.CHEM.)
CHRISTEN 67 PL 26B 11          CHRISTENSEN,NIELSON,BAHNSEN,BROWN+   (RISO)
CONFORTO 67 APAH 22 15         G. CONFORTO                          (CERN)
GRIGOREV 68 SJNP 6 239         +GRISHIN,VLADIMIRSKII,NIKOLAEVSKII + (ITEP)

BAIRD    69 PR  179  1285      +MILLER,DRESS,RAMSEY              (ORNL,HARV)
TAYLOR   69 RMP 41 375         +PARKER,LANGENBERG            (PRIN+UCI+PENN)
CHRISTEN 70 PR C1 1693         CHRISTENSEN,KROHN,RINGO               (ANL)
EROZOLIM 70 SJNP 11 583        EROZOLIMSKI,BONDARENKO,  +    (KURC MOSCOW)
    ALSO    PL 27B 557         EROZOLIMSKY,BONDARENKO  +  (KURC IN MOSCOW)
EROZOLIM 71 JETPL 13 252       EROZOLIMSKII,BONDARENKO +     (KURC MOSCOW)
CHRISTEN 72 PR D5 1628         CHRISTENSEN,NIELSON,BAHNSEN,BROWN+   (RISO)
COHEN    73 J.PHYS.CHEM.REF.DATA 2, P.663, E.R.COHEN,B.N.TAYLOR
DRESS    73 PR D7 3147         DRESS,MILLER,RAMSEY               (ORNL+HARV)
KROPF    73 ZPHY TO BE PUBL.   A KROPF,H PAUL                        (LINZ)
    ALSO 70 NP A154 160        H PAUL                                (VIEN)
COHEN    74 PRIVATE COMM.      E.R.COHEN (ROCKWELL INTERNATL. SCI. CENTER)
DOBROZEM 75 PR D11 510         DOBROZEMSKY,KERSCHBAUM,MORAW,PAUL +  (SEIB)

                               PAPERS NOT REFERRED TO IN DATA CARDS

JACKSON  57 PR 106 517         JACKSON,TREIMAN,WYLD            (PRINCETON)
COHEN    65 RMP 37 537         +DUMOND (N.AMER.AVIATION SCIENCE CENT.,CIT)
BHALLA   66 PL 19  691         C P BHALLA                        (ALABAMA)

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Stable Particles

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Data Card Listings

For notation, see key at front of Listings.

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                    18  LAMBDA(1115,JP=1/2+) I=0
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                    18  LAMBDA MASS (MEV)

M   N   SINCE OUR FINAL VALUES FOR THE SIGMA AND LAMBDA MASSES COME FROM
M   N   DOING AN OVERALL FIT TO ALL MEASURED MASSES AND MASS DIFFERENCES,
M   N   WE HAVE USED THE UNCORRELATED MEASUREMENTS FROM SCHMIDT 65 RATHER
M   N   THAN THE ONES COMING FROM THE OVERALL FIT REPORTED IN THAT PAPER.
M   N   SINCE THERE SEEMS TO BE NO CONVINCING ARGUMENT AS TO WHY ONE SHOULD
M   N   IGNORE DATA USING RANGE MEASUREMENTS, WE HAVE INCLUDED HERE VALUES
M   N   DEPENDING ON PROTON AND PION RANGES.  THE SCHMIDT 65 MASSES HAVE
M   N   BEEN REEVALUATED USING OUR APRIL 1973 PROTON AND CHARGED K AND PI
M   N   MASSES.  P. SCHMIDT, PRIVATE COMMUNICATION, (1974).

M          1115.44      0.12            BHOWMIK   63 RVUE +  SEE NOTE L BELOW
M   L   ABOVE LAMBDA MASS HAS BEEN RAISED 35 KEV TO ACCOUNT FOR 46 KEV
M   L   INCREASE IN PROTON MASS AND 11 KEV DECREASE IN CHARGED PION MASS.
M   S  635(1115.86)    (0.09)           BALTAY    65 HBC    ERROR IS STATIS.   6/66
M      488 1115.65      0.07            SCHMIDT   65 HBC  SEE NOTE N           3/74
M   S 1147(1115.74)    (0.04)           CHIEN     66 HBC       6.9 PBAR P      9/67
M   S  972(1115.69)    (0.05)           CHIEN     66 HBC       6.9 PBAR PANTIL 9/67
M          1115.6       0.4             LONDON    66 HBC                       6/66
M         (1116.0)     (0.2)            BADIER    67 HBC     2.4 PBAR P,LLBAR  8/67
M      195 1115.39      0.12            MAYEUR    67 EMUL                     11/67
M   B 1524(1115.52)    (0.03)           BOHM      70 EMUL                      3/72
M      935 1115.59      0.08            HYMAN     72 HEBC                     11/71
M   B   AVERAGE OF VERY INCONSISTENT DATA. ERROR STATISTICAL ONLY. AUTHORS     3/72
M   B   DETECT SYSTEMATIC EFFECT OF ABOUT .15 MEV, WHICH THEY ATTRIBUTE        3/72
M   B   TO ERROR IN RANGE-ENERGY RELATIONS, IN REGION BETA=0.6-0.7.            3/72
M   B   THIS EFFECT, IF CONFIRMED, WOULD AFFECT VERY LITTLE THE VALUES OF      3/72
M   B   BHOWMICK 63 AND MAYEUR 67.
M   S   ERROR PURELY STATISTICAL.
M           . . . . . . . . . .
M   AVG    1115.566     0.056   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
M   STUDENT1115.568     0.053   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
M   FI     1115.600     0.048  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)  2/76*
                       (SEE IDEOGRAM BELOW )
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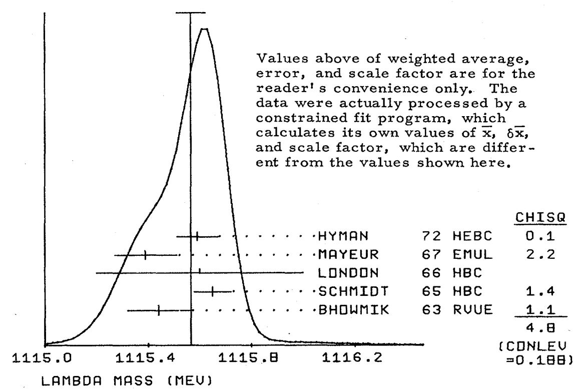

Values above of weighted average, error, and scale factor are for the reader's convenience only. The data were actually processed by a constrained fit program, which calculates its own values of $\bar{x}$, $\delta\bar{x}$, and scale factor, which are different from the values shown here.

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                    18  LAMDA - ANTILAMBDA MASS DIFFERENCE (MEV)
DM            0.05      0.06          CHIEN     66 HBC      6.9 PBAR P        9/67
DM            0.29      0.15          BADIER    67 HBC     2.4 PBAR P         8/67
DM          . . . . . . . . . .
DM  AVG       0.083     0.083   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
DM  STUDENT   0.080     0.063   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    18  LAMBDA MEAN LIFE (UNITS 10**-10)

T      188    2.63      0.21      0.21  BOLDT     58 CC
T      825    2.72      0.16      0.16  CRAWFORD  59 HBC
T      140    2.72      0.29      0.27  BOWEN     60 CC
T      186    2.60      0.28      0.20  CHANG     62 HBC
T      799    2.69      0.11      0.11  HUMPHREY  62 HBC
T     2239    2.36      0.06      0.06  BLOCK     63 HEBC
T      706    2.76      0.20            CHRETIEN  63 HLBC
T      794    2.59      0.09            HUBBARD   64 HBC
T     2260    2.31      0.10            KREISLER  64 OSPK
T     1378    2.59      0.07            SCHWARTZ  64 HBC
T      635    2.51      0.16            BALTAY    65 HBC                      6/66
T     2534    2.6       0.1             HILL      65 OSPK
T      916    2.35      0.09            BURAN     66 HLBC                     6/66
T   S 1147   (2.50)    (0.14)           CHIEN     66 HBC      6.9 PBAR P      9/67
T   S  972   (2.70)    (0.20)           CHIEN     66 HBC      6.9 PBAR P,ANTI 9/67
T     2213    2.452     0.056     0.054 ENGELMANN 66 HBC                      9/66
T      585    2.68      0.13      0.11  AUERBACH  67 OSPK                     8/67
T             2.44      0.15            BADIER    67 HBC     2.4 PBAR P       6/68
T             2.55      0.15            BADIER    67 HBC     2.4 PBAR P,ANTIL 6/68
T     8342    2.535     0.035           GRIMM     68 HBC                      6/68
T     2600    2.47      0.08            HEPP      68 HBC                      8/68
T     1059    2.39      0.10            DEMIDOV   70 HLBC PI-P, 3.86 GEV/C   12/70
T     4572    2.54      0.04            BALTAY    71 HBC     K-P AT REST      6/71
T     6582    2.69      0.05            ALTHOFF2  73 OSPK    PI+N TO K+LAMBDA 2/74
T      36K    2.626     0.020           POULARD   73 HBC     K-P,KMOM .4TO2.3 9/73
T   S   ERROR PURELY STATISTICAL.
T           . . . . . . . . . .
T   AVG       2.578     0.021     0.021 AVERAGE (ERROR INCL. SCALE FACTOR OF 1.6)
T   STUDENT   2.577     0.020     0.020 AVG. USING STUDENT10(H/1.11) -- SEE TEXT
                       (SEE IDEOGRAM BELOW )
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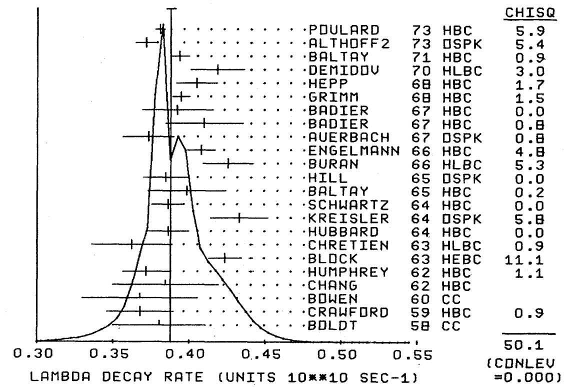


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                18  (LAMBDA - ANTILAMBDA)/AVG., MEAN LIFE DIFFERENCE

DT            0.044     0.085           BADIER    67 HBC     2.4 PBAR P       8/67

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                18  LAMBDA MAGNETIC MOMENT (MAGNETONS,938.26 MEV)

MM           -1.5       0.5             COOL      62 OSPK
MM            0.0       0.6             KERNAN    63 CC
MM     8553  -1.39      0.72            ANDERSON  64 HBC
MM      151  -0.5       0.28            CHARRIERE 65 EMUL
MM       49  -0.67      0.31      0.37  BARKOV    71 EMUL    PRELIM. RESULT   2/72
MM     1300  -0.66      0.07            DAHLJENSE 71 EMUL    MAG FIELD=200KG  6/71
MM     3868  -0.73      0.18            HILL      71 OSPK                    10/71
MM          . . . . . . . . . .
MM  AVG      -0.672     0.061   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
MM  STUDENT  -0.670     0.067   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                18  LAMBDA ELECTRIC DIPOLE MOMENT (UNITS 10**-14 E CM)
          NONZERO VALUE IMPLIES VIOLATION OF T AND P

EDM           5.0    OR LESS  CL=.95    GIBSON    66 EMUL                     2/72
EDM  B        1.0    OR LESS  CL=.95    BARONI    71 EMUL                     2/72
EDM  B  BARONI MEASURES (-5.9+-2.9)*10**-15 E CM                              2/72

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                18  LAMBDA PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      LAMBDA INTO PROTON PI-                               938+ 139
P2      LAMBDA INTO NEUTRON PIO                              939+ 134
P3      LAMBDA INTO PROTON MU- NEUTRINO                      938+ 105+   0
P4      LAMBDA INTO PROTON E- NEUTRINO                       938+  .5+   0
P5      LAMBDA INTO PROTON PI- GAMMA                         938+ 139+   0

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                18  LAMBDA BRANCHING RATIOS

R1      LAMBDA INTO (P PI-)/((P PI-)+(N PIO))               (P1)/(P1+P2)
R1            0.627     0.031           CRAWFORD  59 HBC
R1            0.65      0.05            COLUMBIA  60 HBC
R1   U       (0.685)   (0.017)          ANDERSON  62 HBC
R1      903   0.643     0.016           HUMPHREY  62 HBC
R1 U  6736    0.635     0.007           DOYLE     69 HBC     PI-P TO LAM. KO  2/71
R1    4572    0.646     0.008           BALTAY    71 HBC     K-P AT REST      6/71
R1   U  ANDERSON RESULT NOT PUBLISHED, EVENTS ADDED TO DOYLE SAMPLE.          2/71
R1          . . . . . . . . . .
R1  AVG       0.6399    0.0049  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  STUDENT   0.6398    0.0055  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R1  FIT       0.6419    0.0049 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2      LAMBDA INTO (N PIO)/((P PI-)+(N PIO))               (P2)/(P1+P2)
R2            0.23      0.09            EISLER    57 HLBC
R2            0.43      0.14            CRAWFORD  59 HBC
R2            0.28      0.08            BAGLIN    60 HLBC
R2            0.35      0.05            BROWN     63 HLBC
R2       75   0.291     0.034           CHRETIEN  63 HLBC
R2          . . . . . . . . . .
R2  AVG       0.304     0.025   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2  STUDENT   0.304     0.028   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R2  FIT       0.3581    0.0049 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3      LAMBDA INTO (P E- NEU)/TOTAL (UNITS 10**-3)          (P4)/(P1+P2)
R3  O   15   (2.0)     (0.5)            HUMPHREY  61 RVUE
R3  O    8   (2.9)     (1.5)      (1.2) AUBERT    62 FBC
R3  N  150   (0.82)    (0.12)           ELY       63 FBC     K- AT REST
R3  N  102   (0.78)    (0.12)    (0.13) BAGLIN    64 FBC     K- AT 1.45 GEV/C
R3  O   20   (1.55)    (0.34)           LIND      64 HBC
R3  N  143   (0.80)    (0.08)           MALONEY   69 HBC                     10/69
R3  N   86   (0.78)    (0.09)           CANTER    71 HBC     K-P AT REST      4/71
R3  N  218   (0.88)    (0.10)           LINDQUIST 71 OSPK    PI- P TO KO LAM  2/72
R3  N   THESE VALUES HAVE BEEN CHANGED BY US INTO RATIOS TO PROTON PI-,       3/72
R3  N   BECAUSE THAT IS THE DIRECTLY MEASURED QUANTITY. SEE R5 BELOW          3/72
R3  O   LOW STATISTICS EXPERIMENTS.  NOT AVERAGED                             7/70
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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

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R4      LAMBDA INTO (P MU- NEU)/TOTAL (UNITS 10**-4)      (P3)/(P1+P2)
R4        1    (0.2)   OR MORE              GOOD       62 HBC
R4        1    (1.0)   OR LESS              ALSTON     63 HBC
R4        2    (1.0)   OR LESS              KERNAN     64 FBC
R4       BETWEEN 1.3 AND 6.0                LIND       64 HBC
R4        3     1.3      0.7                LIND       64 RVUE                       7/66
R4        2     1.5      1.2                RONNE      64 FBC
R4        9     2.4      0.8                CANTER1    71 HBC     STOPPED K-P        7/71
R4       14     1.4      0.5                BAGGETT2   72 HBC     STOP K-            8/72
R4             . . . . . . . . .
R4  AVG         1.57     0.35    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R4  STUDENT     1.56     0.38    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R5      LAMBDA INTO (P E- NEU)/(P PI-) (UNITS 10**-3)     (P4)/(P1)
R5      150     1.23     0.20               ELY        63 FBC                        2/72
R5      120     1.17     0.18               BAGLIN     64 FBC                        2/72
R5      143     1.20     0.12               MALONEY    69 HBC                        2/72
R5     1078     1.31     0.06               ALTHOFF1   71 OSPK                       2/72
R5   C   86     1.17     0.13               CANTER     71 HBC     K-P AT REST        3/72
R5   C  218     1.32     0.15               LINDQUIST 71 OSPK     PI-P TO K0 LAM     3/72
R5   C  CALCULATED BY US FROM R3 ASSUMING THE AUTHORS USED (P PI-)/TOT=2/3            3/72
R5             . . . . . . . . .
R5  AVG         1.267    0.044   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R5  STUDENT     1.267    0.050   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R6      LAMBDA INTO (P PI- GAMMA)/(P PI-) (UNITS 10**-3) (P5)/(P1)                   1/73
R6       72     1.32     0.22               BAGGETT3   72 HBC   PI- MOM LT 95 MEV/C  1/73

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18 LAMBDA DECAY PARAMETERS

RELATED TEXT SECTION VI D AND APPENDIX III

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A-      ALPHA LAMBDA- (LAMBDA INTO PI- PROTON)
A-     1156    0.62      0.07               CRONIN     63 CNTR    LAMBDA FROM PI-P   8/67
A-            (0.663)   (0.022)             BERGE      66 RVUE  INCLUDES ABOVE       9/66
A-    10130    0.645     0.017              OVERSETH   67 OSPK    LAMBDA FROM PI-P   8/67
A-  M  2529   (0.747)   (0.086)             MERRILL    68 HBC   REPL BY DAUBER 68    6/68
A-     3520    0.67      0.06               DAUBER     69 HBC   FROM XI DECAY        6/68
A-    10325    0.649     0.023              CLELAND    72 OSPK    LAMBDA FROM PI-P   5/72
A-            . . . . . . . . .
A-  AVG        0.647     0.013   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
A-  STUDENT    0.647     0.014   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

A0      ALPHA0 /ALPHA- FOR LAMBCA (L INTO PI0 N/L INTO PI- P)
A0             1.10      0.27               CORK       60 CNTR
A0 O  4760     1.000     0.068              OLSEN      70 OSPK PI+N TO K+ LAMBDA     5/70
A0            . . . . . . . . .
A0  AVG        1.006     0.066   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
A0  STUDENT    1.006     0.071   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
A0 O    DONE BY COMPARING PROTON DISTR.WITH N DISTR. FROM LAMBDA DECAY.

F-      PHI ANGLE (SIN(PHI)/COS(PHI)=BETA/GAMMA)  (DEGREES)
F-     1156   13.0      17.0                CRONIN     63 OSPK    LAMBDA FROM PI-P 11/67
F-    10130   -8.0       6.0                OVERSETH   67 OSPK    LAMBDA FROM PI-P 11/67
F-     7377  (-9.2)     (5.2)               CLELAND    67 OSPK REPL BY CLELAND 72  5/72
F-    10325   -7.0       4.5                CLELAND    72 OSPK    LAMBDA FROM PI-P  5/72
F-            . . . . . . . . .
F-  AVG       -6.5       3.5     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
F-  STUDENT   -6.6       3.8     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

AV      GA/GV FOR LAMBDA BETA DECAY (SEE TEXT SEC. VI D.1 FOR SIGN CONV.)
AV  C   22  (-1.03)                         LIND       64 HBC                        6/68
AV  C  102    (0.6)  OR MORE                BAGLIN     65 HLBC    NO SIGN GIVEN      1/71
AV  C     BETW 0. AND -1.1                  BARLOW     65 OSPK                       6/68
AV  C  102    (0.7)  OR MORE  CL=.95        ELY        65 HLBC     ABS. VALUE        1/71
AV  C   EXPERIMENTS INCLUDED IN CONFORTO 65, RVUE                                    6/68
AV           -1.14      0.23      0.33  CONFORTO   65 RVUE                          11/67
AV M   148   -0.72      0.14      0.19  MALONEY    69 HBC                           10/69
AV  A 1078  (-0.62)    (0.08)    (0.09) ALTHOFF2   71 OSPK    POLARIZED LAMBDA       7/73
AV M   141   -0.75      0.15      0.18  CANTER     71 HBC                            4/71
AV  L  173  (-0.32)    (0.13)    (0.17) LINDQUIST 71 OSPK   UP-DOWN ASYMMETRY        9/71
AV ML  173  (-0.68)    (0.27)    (0.54) LINDQUIST 71 OSPK   E-NEU CORRELATION        9/71
AV L   173   -0.40      0.13      0.17  LINDQUIST 71 OSPK   E-NEU AND UP-DOWN        9/71
AV M   352   -0.74      0.09      0.12  BAGGETT1   72 HBC     STOP.K-                2/72
AV A   817   -0.63      0.06            ALTHOFF1   73 OSPK    POLARIZED LAMBDA       7/73
AV  A   ALTHOFF1 73 INCLUDES DATA OF ALTHOFF2 71.  USES PROT SPECTRUM AND            7/73
AV  A   THREE SPIN ASYMMETRIES.                                                      7/73
AV M    EXPT MEASURES ONLY THE ABSOLUTE VALUE OF A/V                                 7/73
AV  L   LINDQUIST 71 GETS THREE VALUES.  WE AVERAGE THE ONE THAT USES               10/71
AV  L   ALL DATA.                                                                   10/71
AV            . . . . . . . . .
AV  AVG       -0.658     0.054   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
AV  STUDENT   -0.660     0.051   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                                 (SEE IDEOGRAM BELOW )
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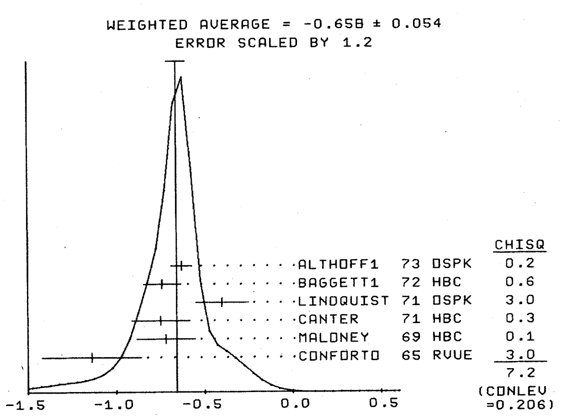


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REFERENCES FOR LAMBDA


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EISLER   57 NC      5 1700       EISLER,PLANO,SAMIOS,SCHWARTZ +    (COLU+BNL)
BOLDT    58 PRL     1  148       E BOLDT,D O CALDWELL,Y PAL              (MIT)
CRAWFORD 59 PRL     2  266       CRAWFORD,CRESTI,DOUGLASS,GOOD +         (LRL)

BAGLIN   60 NC     18 1043       BAGLIN,BLOCH,BRISSON,HENNESSY +        (EPOL)
BOWEN    60 PR    119 2030       BOWEN,HARDY,REYNOLDS,SUN +        (PRINCETON)
CORK     60 PR    120 1000       CORK,KERTH,WENZEL,CRONIN+      (LRL+PRIN+BNL)
COLUMBIA 60 ROCH CONF 726        M SCHWARTZ +                       (COLUMBIA)
HUMPHREY 61 PRL     6  478       HUMPHREY,KIRZ,ROSENFELD,RHEE +     (LRL+SYRA)

ANDERSON 62 CERN CONF-832        ANDERSON,CRAWFORD,GOLDEN,LLOYD +        (LRL)
AUBERT   62 NC     25  479       AUBERT,BRISSON,HENNESSY,SIX +          (EPOL)
CHANG    62 THESIS DUKE          CHUEN CHUEN CHANG                      (DUKE)
COOL     62 PR    127 2223       COOL,HILL,MARSHALL +        (BNL+MIT+NYU+ANL)
GOOD     62 PRL     9  518       M L GOOD,V G LIND                 (WISCONSIN)
HUMPHREY 62 PR    127 1305       W E HUMPHREY,R R ROSS                   (LRL)

ALSTON   63 UCRL 10926           ALSTON,KIRZ,NEUFELD,SOLMITZ,WOHLMUT     (LRL)
BHOWMIK  63 NC     28 1494       B BHOWMIK,D P GOYAL                   (DELHI)
BLOCK    63 PR    130  766       BLOCK,GESSAROLI,RATTI+(NWES+BGNA+SYRA+ORNL)
BROWN    63 PR    130  769       BROWN,KADYK,TRILLING,ROE +         (LRL+MICH)
CHRETIEN 63 PR    131  2208      CHRETIEN,CROUCH+    (BRAN+BROWN+HARVARD+MIT)
CRONIN   63 PR    129 1795       J W CRONIN,O E OVERSETH           (PRINCETON)
ELY      63 PR    131  868       ELY,GIDAL,KALMUS,OSWALD,POWELL +        (LRL)
KERNAN   63 PR    129  870       KERNAN,NOVEY,WARSHAW,WATTENBERG   (ANL+ILL)

ANDERSON 64 PRL    13  167       J A ANDERSON,F S CRAWFORD               (LRL)
BAGLIN   64 NC     35  977       BAGLIN,BINGHAM+  (EPOL+CERN+LOUC+RHEL+BERG)
HUBBARD  64 PR    135 B 183      HUBBARD,BERGE,KALBFLEISCH,SHAFER +      (LRL)
KERNAN   64 PR    133 B 1271     KERNAN,POWELL,SANDLER +            (LRL+LOUC)
KREISLER 64 PR 136 B 1074        M N KREISLER,O OVERSETH,J CRONIN       (PRIN)
LIND     64 PR    135 B 1483     LIND,BINFORD,GOOD,STERN           (WISCONSIN)
RONNE    64 PL     11   357      RONNE+           (CERN+EPOL+LOUC++UNIV.BERGEN)
SCHWARTZ 64 UCRL 11360 THESIS JOSEPH ADAM SCHWARTZ                       (LRL)

BAGLIN   65 NC 35 977            BAGLIN +          (EPOL,CERN,LOUC,RHEL,BERGEN)
BALTAY   65 PR 140 B 1027        BALTAY,SANDWEISS,CULWICK,KOPP +   (YALE+BNL)
BARLOW   65 PL   18  64          J BARLOW,BLAIR,CONFORTO+     (CERN+RHEL+PENN)
CHARRIER 65 PL    15     66      CHARRIERE,GIBSON+       (EPOL+BRIS+CERN+MPIM)
      ALSO 66 NC  46A  205       CHARRIERE,GIBSON +      (EPOL,BRIS,CERN,MPIM)
CONFORTO 65 EC INT HERZEGNOVI G CONFORTO                                (CERN)
ELY      65 PR 137 B1302         ELY,GIDAL,KALMUS,POWELL +          (LRL,LOUC)
HILL     65 PRL 15 85            HILL,LI,JENKINS,KYCIA,RUDERMAN      (MIT,BNL)
SCHMIDT  65 PR 140 B 1328        P SCHMIDT                          (COLUMBIA)

BERGE    66  BERKELEY 46         BERGE,CABIBBO              ((RVUE) LRL,CERN)
BURAN    66 PL 20 318            BURAN,EIVINDSON,SKJEGGESTAD,TOFTE +  (OSLO)
CHIEN    66 PR   152  1171       +LACH,SANDWEISS,TAFT,YEH,OREN +   (YALE+BNL)
ENGELMAN 66 NC 45A  1038         ENGELMANN,FILTHUTH,ALEXANDER+    (HEID,REHO)
GIBSON   66 NC 45A 882           W M GIBSON,K GREEN                     (BRIS)
LONDON   66 PR 143 1034          LONDON,RAU,GOLDBERG,LICHTMAN+     (BNL, SYRA)

AUERBACH 67 NC  47A  19          AUERBACH,BOWEN,DOBBS,LANDE,MANN+       (PENN)
BADIER   67 PL 25B 152           +BONNET,BRIANDET,SADOULET              (EPOL)
CLELAND  67 PL 26B 45            CLELAND,BIENLEIN,CONFORTO+ (CERN+GEVA+LUND)
MAYEUR   67 U.LIBR.BRUX.BUL32 C.MAYEUR,E.TOMPA,J.WICKENS          (BELG,LOUC)
OVERSETH 67 PRL  19  391         O E OVERSETH, R F ROTH            (MICH+PRIN)
GRIMM    68 NC 54A 187           H.-J.GRIMM                       (HEIDELBERG)
HEPP     68 ZPHYS 214 71         V.HEPP,H. SCHLEICH               (HEIDELBERG)
MERRILL  68 PR 167 1202          MERRILL,SHAFER                          (LRL)

DAUBER   69 PR  179 1262         +BERGE,HUBBARD,MERRILL,MILLER           (LRL)
DOYLE    69 UCRL 18139-THESIS J.C. DOYLE                                 (LRL)
MALONEY  69 PRL 23 425           MALONEY,SECHI-ZORN           (UNIV MARYLAND)
BOHM     70 NC 70A 384           + KRECKER + (BERL+BRUX+DUUC+LOUC+LOWC+WARS)
DEMIDOV  70 SJNP 10 681          +KIRILLOV-UGRYUMOV,PONOSOV,PROTASOV+ (ITEP)
OLSEN    70 PRL 24 843           +PONDROM,HANDLER,LIMON,SMITH +   (WISC,MICH)

ALTHOFF1 71 PL 37B 531           +BROWN,FREYTAG,HEARD,HEINTZE +   (CERN,HEID)
ALTHOFF2 71 PL 37B 535           +BROWN,FREYTAG,HEARD,HEINTZE +   (CERN,HEID)
BALTAY   71 PR D4 670            +BRIDGEWATER,COOPER,HABIBI+       (COLU+BING)
BARKOV   71 JETPL 14 60          +GUREVICH,MAKARINA,MARTEMYANOV+        (ITEP)
BARONI   71 LNC 2 1256           G BARONI,S PETRERA,G ROMANO            (ROMA)
CANTER   71 PRL 26 868           +COLE,LEE-FRANZINI,LOVELESS +    (STON+COLU)

CANTER1  71 PRL 27 59            +COLE,LEE-FRANZINI,LOVELESS+     (STON+COLU)
DAHLJENS 71 NC 3A 1              DAHL-JENSEN +     (CERN+ANKA+LAUS+MPIM+ROMA)
HILL     71 PR D4 1979           +LI,JENKINS,KYCIA,RUDERMAN          (MIT,BNL)
    ALSO 65 PRL 15 85            HILL,LI,JENKINS,KYCIA,RUDERMAN      (MIT,BNL)
LINDQUIS 71 PRL 27 612           LINDQUIST,SUMNER+           (EFI,WUSL,OSU,ANL)

BAGGETT1 72 ZPHY 249 279         +BAGGETT,EISELE,FILTHUTH,FREHSE+       (HEID)
BAGGETT2 72 ZPHY 252 362         +BAGGETT,EISELE,FILTHUTH,FREHSE+       (HEID)
BAGGETT3 72 PL 42B 379           +BAGGETT,EISELE,FILTHUTH,FREHSE,HEPP+(HEID)
CLELAND  72 NP B40 221           +CONFORTO,EATON,GERBER+     (CERN+GEVA+LUND)
HYMAN    72 PR D5 1063           +BUNNELL,DERRICK,FIELDS,KATZ+     (ANL+CARN)

ALTHOFF1 73 PL 43B 237           +BROWN,FREYTAG,HEARD,HEINTZE+    (CERN+HEID)
ALTHOFF2 73 NP B66 29            +BROWN,FREYTAG,HEARD,HEINTZE+    (CERN+HEID)
POULARD  73 PL 46B 135           +GIVERNAUD,BORG                        (SACL)

                                 PAPERS NOT REFERRED TO IN DATA CARDS

ARMENTER 62 CERN CONF 236        ARMENTEROS+ (CERN+EPOL+LOIC+BIRM+CEN-SACLAY)
BALTAY   62 CERN CONF 233        BALTAY,FOWLER,SANDWEISS,CULWICK+ (YALE+BNL)
BERGE    63 THESIS (BERKELEY) J PETER BERGE                              (LRL)
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19 SIGMA+(1189,JP=1/2+) I=1

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19 SIGMA+ MASS (MEV)

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M   N SEE NOTE PRECEDING LAMBDA MASS LISTINGS

M      144 1189.38      0.15            BARKAS     63 EMUL +  SEE NOTE S BELOW
M       58 1189.48      0.22            BHOWMIK    64 EMUL +  SEE NOTE S BELOW
M   S  ABOVE SIGMA+ MASSES HAVE BEEN RAISED 30  KEV TO ACCOUNT FOR 46 KEV
M   S  INCREASE IN PROTON MASS AND 21 KEV DECREASE IN PION MASS
M     4205 1189.61      0.08            SCHMIDT    65 HBC  SEE NOTE N             3/74
M          1189.16      0.12            HYMAN      67 HEBC                        6/68
M    B 607 1189.33      0.04            BOHM       72 EMUL                       12/73
M    B  BOHM 72 UPDATED WITH PDG APR. 73 K-, PI- AND PI0 MASSES.                 12/73
M            . . . . . . . . .
M   AVG    1189.371     0.060   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.8)
M   STUDENT1189.354     0.041   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
M   FIT    1189.366     0.057  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.8)  2/76*
                               (SEE IDEOGRAM BELOW )
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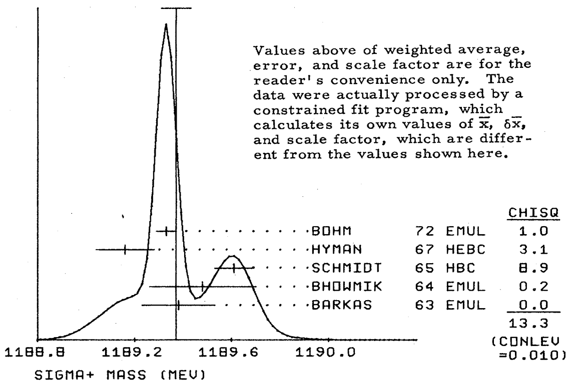
Stable Particles

Σ^+

Data Card Listings

For notation, see key at front of Listings.

WEIGHTED AVERAGE = 1189.371 ± 0.060
ERROR SCALED BY 1.8



Values above of weighted average, error, and scale factor are for the reader's convenience only. The data were actually processed by a constrained fit program, which calculates its own values of $\bar{x}$, $\delta\bar{x}$, and scale factor, which are different from the values shown here.

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                 19  SIGMA+ MEAN LIFE (UNITS 10**-10)

T                                         GLASER     58 RVUE
T       127     0.98     0.16     0.12   PUSCHEL    60 EMUL
T        41     0.82     0.34     0.20   EVANS      60 EMUL
T       117     0.85     0.14     0.11   FREDEN     60 EMUL
T        54     0.80     0.10     0.067  KAPLON     60 EMUL
T        23     0.76     0.22     0.14   CHIESA     61 EMUL
T        49     0.75     0.13     0.09   BERTHELOT  61 HLBC
T       140     0.82     0.10     0.08   BARKAS     61 EMUL
T       192     0.749    0.056    0.052  GRARD      62 HBC
T       456     0.765    0.04     0.04   HUMPHREY   62 HBC
T       203     0.84     0.12     0.08   BHOWMIK    64 EMUL
T       181     0.84     0.09            BALTAY     65 HBC                       6/66
T       900     0.76     0.03            CARAYAN    65 HBC                       6/66
T  C   1300     0.83     0.032           CHANG      66 HBC                       6/66
T   S   125    (0.86)   (0.15)           CHIEN      66 HBC  +   6.9 PBAR P       9/67
T   S   117    (1.10)   (0.24)           CHIEN      66 HBC  -   6.9 PBAR P,ANTI  9/67
T       381     0.80     0.07            COOK       66 OSPK                      7/66
T     10664     0.803    0.008           BARLOUTAU  69 HBC    K-P .4-1.2 GEV/C 11/69
T       20K     0.795    0.010           EISELE     70 HBC    K-P AT REST       2/71
T       526     0.83     0.04            BAKKER     71 DBC  - K-N TO SIG+ 2PI- 10/71
T  C    CHANG ERROR 0.018 RAISED BY US.  SEE 1970 EDITION, RMP 42,123(1970)   1/73
T   S   ERROR PURELY STATISTICAL
T              . . . . . . . . .
T   AVG         0.8004   0.0058   0.0057 AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)
T   STUDENT     0.8004   0.0064   0.0063 AVG. USING STUDENT10(H/1.11) -- SEE TEXT

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                 19  SIGMA+ MAGNETIC MOMENT (MAGNETONS,938.26 MEV)

MM      381     1.5      1.1             COOK       66 OSPK                      7/66
MM       52     3.5      1.5             KOTELCHUC  67 EMUL   K-P AT 1.15BEV/C  8/67
MM       51     3.0      1.2             SULLIVAN   67 EMUL   PHOTOPRODUCTION   8/67
MM       69     3.5      1.2             COMBE      68 EMUL                    10/68
MM    29333     2.1      1.0             MAST       68 HBC    K-P AT .4 GEV/C   6/68
MM      955     2.67     0.97            ALLEY      71 OSPK   1.28 GEV/C PI+P  10/70
MM     2651     2.7      0.9             SAHA       73 HLBC   K-P.25TO.55GEV/C  6/73
MM             . . . . . . . . .
MM  AVG         2.62     0.41    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
MM  STUDENT     2.62     0.45    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                 19  SIGMA+ PARTIAL DECAY MODES

                                                             DECAY MASSES
P1      SIGMA+ INTO PROTON PIO                              938+ 134
P2      SIGMA+ INTO NEUTRON PI+                             939+ 139
P3      SIGMA+ INTO NEUTRON PI+ GAMMA                       939+ 139+   0
P4      SIGMA+ INTO LAMBDA E+ NEU                          1115+  .5+   0
P5      SIGMA+ INTO PROTON GAMMA                            938+   0
P6      SIGMA+ INTO NEUTRON MU+ NEUTRINO                    939+ 105+   0
P7      SIGMA+ INTO NEUTRON E+ NEUTRINO                     939+  .5+   0
P8      SIGMA+ INTO PROTON E+ E-                            938+  .5+  .5

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                 19  SIGMA+ BRANCHING RATIOS

R1      SIGMA+ INTO (NEUTRON PI+)/(NUCLEON PI)                   (P2)/(P1+P2)
R1      308     0.490    0.024           HUMPHREY   62 HBC
R1      534     0.46     0.02            CHANG      66 HBC                       6/66
R1     1331     0.488    0.010           BARLOUTAU  69 HBC    K-P .4-1.2 GEV/C 11/69
R1      537     0.484    0.015           TOVEE      71 EMUL                     12/71
R1             . . . . . . . . .
R1  AVG         0.4835   0.0073   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  STUDENT     0.4838   0.0081   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R2      SIGMA+ INTO (NEUT PI+ GAM)/(PI+N) (UNITS 10**-3) (P3)/P2)
R2             (1.8)     ABOUT           BAZIN2     65 HBC    PI+ LT 116 MEV/C  8/67
R2       29     0.27     0.05            ANG        69 HBC    PI+ LT 110 MEV/C 11/68
R2      180     0.93     0.10            EBENHOH    73 HBC    PI+ LT 150 MEV/C  3/74

R3      SIGMA+ INTO (LAMBDA E+ NEU)/TOTAL (UNITS 10**-5) (P4)
R3  W     4    (3.3)    (1.7)            WILLIS     64 HBC    STOP. K-          9/66
R3  W                   EVENTS FROM THIS EXPERIMENT,INCLUDED IN EISELE1 69    11/69
R3        6     2.0      0.8             BARASH     67 HBC    STOP K-           8/67
R3        5     1.6      0.7             BALTAY     69 HBC    STOP K-          11/69
R3       10     2.9      1.0             EISELE1    69 HBC    STOP K-          10/69
R3             . . . . . . . . .
R3  AVG         2.02     0.47     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3  STUDENT     2.01     0.52     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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R4      SIGMA+ INTO (P GAMMA)/(P PIO) (UNITS 10**-2)     (P5)/(P1)
R4        1    (0.68) OR LESS            CARRARA    64 HBC
R4       24     0.37     0.08            BAZIN      65 HBC
R4        4    (0.17)                    QUARENI    65 EMUL                      6/66
R4       45     0.21     0.03            ANG        69 HBC     STOP K-         10/69
R4       31     0.276    0.051           GERSHWIN   69 HBC                     10/69
R4             . . . . . . . . .
R4  AVG         0.240    0.035    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
R4  STUDENT     0.239    0.030    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                                  (SEE IDEOGRAM BELOW )
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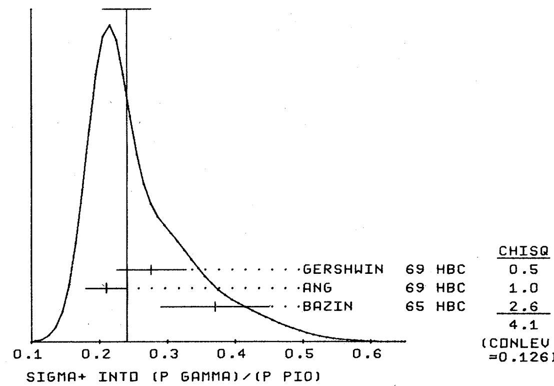
WEIGHTED AVERAGE = 0.240 ± 0.035
ERROR SCALED BY 1.4

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R5      SIGMA+ INTO (N E+ NEU)/(N PI+) (UNITS 10**-5)      (P7)/(P2)
R5 EO    0    (16220)EFFECTIVE DENOM.  COURANT   64 HBC     SEE NOTE E      11/67
R5 EO    0     (2720)EFFECTIVE DENOM.  MURPHY    64 HBC     SEE NOTE E      11/67
R5 EO    1     (9690)EFFECTIVE DENOM.  NAUENBERG 64 HBC     SEE NOTE E       6/68
R5  O    0    (32406)EFFECTIVE DENOM.  BIERMAN   68 HBC                      6/68
R5 UA    0    (80400)EFFECTIVE DENOM.  EISELE2   69 HBC  +  STOP K-          6/68
R5 UO    1    (30000)EFFECTIVE DENOM.  NORTON    69 HBC                     11/69
R5  O   OLDER LOWER STATISTICS EXPTS. NOT INCLUDED IN AVERAGE.              2/76*
R5 U     0    105000 EFFECTIVE DENOM.  SECHIZORN 73 HBC     STOP K-         2/76*
R5 U A   0    111000 EFFECTIVE DENOM.  EBENHOH   74 HBC     STOP K-         1/76*
R5 U                 EFFECTIVE DENOM.  CALCULATED BY US
R5 E                 EFFECTIVE DENOM.  TAKEN FROM EISELE 67                11/67
R5    A  EISELE2 69 REPLACED BY BY EBENHOH 74.                              1/76*
R5         . . . . . . . . .
R5           1.1   OR LESS  CL=.90   OUR AVERAGE (2.3 EVTS)/(EFF.DNOM.SUM)  2/76*
R5       NUMBER OF EVENTS INCREASED TO 2.3 FOR 90PC CONFIDENCE LEVEL        2/76*

R6      SIGMA+ INTO (N MU+ NEU)/(PI+N) (UNITS 10**-5)      (P6)/(P2)
R6       1      (120)ANALYSED EVENTS   GALTIERI  62 EMUL    NO RATIO QUOTED 11/67
R6 E     0     10150 EFFECTIVE DENOM.  COURANT   64 HBC     SEE NOTE E      11/67
R6 E     0      1710 EFFECTIVE DENCM.  NAUENBERG 64 HBC     SEE NOTE E      11/67
R6 U     2     62000 EFFECTIVE DENOM.  EISELE2   69 HBC                      6/68
R6       0     33800 EFFECTIVE DENOM.  BAGGETT   69 HBC                     11/68
R6 E                 EFFECTIVE DENOM.  TAKEN FROM EISELE 67                11/67
R6 U                 EFFECTIVE DENOM.  CALCULATED BY US
R6         . . . . . . . . .
R6           6.2   OR LESS  CL=.90   OUR AVERAGE (6.7 EVTS)/(EFF.DNOM.SUM)  2/76*
R6       NUMBER OF EVENTS INCREASED TO 6.7 FOR 90PC CONFIDENCE LEVEL        2/76*

R7      (SIGMA+ INTO LEPTONS)/(SIGMA- INTO LEPTONS)
R7       0     0.034 OR LESS            BAGGETT   67 HBC                      6/68
R7       1     0.08  OR LESS            NORTON    69 HBC                     10/69
R7         . . . . . . . . .
R7            0.043 OR LESS  CL=.90   OUR AVERAGE  USING R5 AND R6          2/76*

R8      SIGMA+ INTO (PROTON E+ E-)/TOTAL (UNITS 10**-6)  (P8)
R8            7.0   OR LESS             ANG       69 HBC     STOP K-        10/69
R8    A   ANG 69 FOUND 3 E+E- EVENTS IN AGREEMENT WITH GAMMA CONVERSION OF
R8    A   PROTON GAMMA DECAY -LIMIT GIVEN HERE IS FOR NEUTRAL CURRENT

R9      (SIGMA+ INTO N MU+ NEU)/(SIGMA- INTO N MU- NEU)
R9       2  0.06      0.045    0.03    EISELE2   69 HBC  +-   STOP K-       10/69
R9         . . . . . . . . .
R9            0.12  OR LESS  CL=.90   OUR AVERAGE  USING R6                 2/71

R10     (SIGMA+ INTO N E+ NEU)/(SIGMA- INTO N E- NEU)
R10 E    0    (0.03) OR LESS  CL=.90   EISELE2   69 HBC  +- STOP K-         10/69
R10 O    0    (0.12) OR LESS  CL=.95   COLE      71 HBC     STOP K-         10/71
R10 O   LOWER STATISTICS EXPERIMENT NOT INCLUDED IN AVERAGE                 2/76*
R10      0     0.018 OR LESS  CL=.90   SECHIZORN 73 HBC     STOP K-,POISSON  8/73
R10  E   0     0.019 OR LESS  CL=.90   EBENHOH   74 HBC  +- STOP K-        12/75*
R10  E  EISELE2 69 REPLACED BY EBENHOH 74.                                 12/75*
R10        . . . . . . . . .
R10           0.009 OR LESS  CL=.90   OUR AVERAGE  USING R5                 2/76*

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                 19  SIGMA+ DECAY PARAMETERS

        RELATED TEXT SECTION VI D AND APPENDIX III

A+0     ALPHA+/ALPHAO FOR SIGMA+ (SIG+ TO PI+ N)/(SIG+ TO PIO P)
A+0            +0.04      0.11             CORK      60 CNTR    SIG+ FROM PI+P
A+0           (+0.20)    (0.24)            TRIPP     62 HBC  +  REPLAC.BY BANGER
A+0 O 3500    (-.014)    (0.052)           BANGERTER 66 HBC  +  SIG+ FROM K-P    9/66
A+0 O 2600    (-.047)    (.07)             BERLEY    66 HBC  +  SIG+ FROM K-P    9/66
A+0     20K  (-0.104)    (0.028)           REUCROFT  76 HBC     PRELIMINARY      2/76*
A+0 O          OLD RESULTS,HAVE BEEN REPLACED . SEE BELOW -

A+      ALPHA SIGMA++(SIG+ TO PI+ N)
A+    35000    0.069     0.017             BANGERTER 69 HBC     K-P AT 400 MEV/C 11/69
A+     4101    0.037     0.049             BERLEY    70 HBC                     12/70
A+         . . . . . . . . . .
A+  AVG        0.066     0.016    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
A+  STUDENT    0.066     0.017    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

Σ^+, Σ^-

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AO      ALPHA SIGMAO (SIG+ INTO PIO PROTON)
AO          -0.80      0.16             BEALL       62 CNTR
AO         (-0.90)    (0.25)            TRIPP       62 HBC     REPLAC. BY BANGE
AO  O 5200 (-0.986)   (0.072)           BANGERTER 66 HBC     K-P TO SIG+ PI-    7/66
AO   32000  -0.999     0.022            BANGERTER 69 HBC                        10/69
AO H  1335  -0.98      0.05      0.02   HARRIS      70 OSPK   PI+P TO SIG+ K+    5/70
AO     16K  -0.940     0.045            BELLAMY     72 ASPK   PI+P TO SIG+ K+   11/72
AO L  1259  -0.945     0.055     0.042  LIPMAN      73 OSPK   PI+P TO SIG +      7/73
AO L    DECAY PROTONS SCATTERED OFF ALUMINUM.                                    7/73
AO H    DECAY PROTCNS SCATTERED OFF CARBON.
AO
AO            . . . . . . . . .
AO  AVG     -0.979     0.016    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
AO  STUDENT -0.979     0.018    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

F+      PHI+ ANGLE (SIG+ INTO N PI)   SIN(PHI)/COS(PHI)=BETA/GAMMA  (DEGREE)
F+  O  370 (180.)     (30.)            BERLEY      66 HBC   + NEUTRON RESCATT.  9/66
F+     560  143.       29.             BANGERT1    69 HBC                       10/69
F+    C1054  184.      24.             BERLEY      70 HBC     K-P AT 400 MEV/C 11/69
F+    C  CHANGED FROM 176 TO 184 TO AGREE WITH SIGN CONVENTION.
F+
F+            . . . . . . . . .
F+  AVG      167.3     20.1     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
F+  STUDENT 167.5      21.2     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

AG      ALPHA SIGMAG (SIG+ INTO PROTON GAMMA)
AG      61   -1.03     0.52     0.42  GERSHWIN  69 HBC     K-P TO SIG PI      11/69

FO      PHIO ANGLE (SIG+ INTO PIO PROTON) SIN(PHI)/COS(PHI)=BETA/GAMMA (DEG)
FO H          22.0      90.0            HARRIS      70 OSPK PI+P TO SIG+ K+     5/70
FO L  1259    38.1      35.7     37.1   LIPMAN      73 OSPK    PI+P TO SIG+K+   7/73
FO L    DECAY PROTON SCATTERED OFF ALUMINUM.                                    7/73
FO H    DECAY PROTONS SCATTERED OFF CARBON.
FO
FO            . . . . . . . . .
FO  AVG       35.8      33.7     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
FO  STUDENT   35.8      36.3     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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REFERENCES FOR SIGMA+


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CORK      60 PR 120 1000         CORK,KERTH,WENZEL,CRONIN,COOL(LRL+PRIN+BNL)
EVANS     60 NC 15 873           BRIST+BRUSS+IAS-U.COL-DUBLIN+LON+MILAN+PAD
FREDEN    60 NC 16 611           S FREDEN,H KORNBLUM,R WHITE            (LRL)
KAPLON    60 ANP 9 139           M KAPLON,A MELISSINOS,YAMANOUCHI      (ROCH)
PUSCHEL   60 NP 20 254           W PUSCHEL                (MAX PLANCK INST)

BARKAS    61 PR 124 1209         BARKAS,DYER,MASON,NICHOLS,SMITH        (LRL)
BERTHELO  61 NC 21 693           BERTHELOT,DAUDIN,GOUSSU +    (SACLAY+ORSAY)
CHIESA    61 NC 19 1171          CHIESA,QUASSIATI,RINAUDO       (INFN-TURIN)

BEALL     62 PRL 8 75            BEALL,CORK,KEEFE,MURPHY,WENZEL         (LRL)
GRARD     62 PR 127 607          F GRARD,G A SMITH                      (LRL)
GALTIERI  62 PRL 9 26            GALTIERI,BARKAS,HECKMAN,PATRICK,SMITH (LRL)
HUMPHREY  62 PR 127 1305         W E HUMPHREY,R R ROSS                  (LRL)
TRIPP     62 PRL 9 66            R D TRIPP,M B WATSON,M FERRO-LUZZI     (LRL)

BARKAS    63 PRL 11 26           W H BARKAS,J N DYER,H H HECKMANN       (LRL)
    ALSO  61 UCRL 9450           JOHN DYER (THESIS, BERKELEY)           (LRL)

BHOWMIK   64 NP 53 22            B BHOWMIK,P JAIN,P MATHUR,LAKSHMI   (DELHI)
CARRARA   64 PL 12 72            CARRARA,CRESTI,GRIGOLETTO,PERUZZO+ (PADOVA)
COURANT   64 PR 136 B 1791       COURANT,FILTHUTH+    (CERN+HEID+UMD+NRL+BNL)
MURPHY    64 PR 134 B 188        C THORNTON MURPHY                 (WISCONSIN)
NAUENBER  64 PRL 12 679          NAUENBERG,MARATECK,+        (COLU+RUTG+PRIN)
WILLIS    64 PRL 13 291          WILLIS,COURANT,ENGELMAN+(BNL,CERN,HEID,UMD)

BALTAY    65 PR 140 B 1027       BALTAY,SANDWEISS,CULWICK,KOPP +  (YALE+BNL)
BAZIN     65 PRL 14 154          BAZIN,BLUMENFELD,NAUENBERG +     (PRIN+COLU)
BAZIN2    65 PR 140  B1358       BAZIN,PLANO,SCHMIDT+         (PRIN,RUTG,COLU)
CARAYAN   65 PR 138 B 433        CARAYANNOPOULOS,TAUTFEST,WILLMANN  (PURDUE)
QUARENI   65 NC 40 A 928         QUARENI,CARTACCI +    (BGNA,FIRZ,GENO,PARMA)
SCHMIDT   65 PR 140 B 1328       P SCHMIDT                         (COLUMBIA)

BANGERTE  66 PRL  17  495        BANGERTER,GALTIERI,BERGE,MURRAY+       (LRL)
BERLEY    66 PRL 17 1071         +HERZBACH,KOFLER,YAMAMOTO + (BNL+MASA+YALE)
CHANG     66 PR  151  1081       CHUNG YUN CHANG                   (COLUMBIA)
    ALSO  65 NEVIS 145  THESIS   CHUNG YUN CHANG                   (COLUMBIA)
CHIEN     66 PR  152  1171       +LACH,SANDWEISS,TAFT,YEH,OREN +  (YALE+BNL)
COOK      66 PRL  17  223        V COOK,EWART,MASEK,ORR,PLATNER (WASHINGTON)

BAGGETT   67 PRL 19 1458         BAGGETT,DAY,GLASSER,KEHOE,KNOP+   (MARYLAND)
    ALSO  68 VIENNA ABS. 374     BAGGETT,KEHOE                     (MARYLAND)
    ALSO  68 PRIVATE COMM.       N. BAGGETT                        (MARYLAND)

BARASH    67 PRL 19  181         BARASH,DAY,GLASSER,KEHOE,KNOP +   (MARYLAND)
EISELE    67 ZPHYS 205 409       +ENGELMANN,FILTHUTH,FOLISH,HEPP+      (HEID)
HYMAN     67 PL 25 B 376         +LOKEN,PEWITT,MCKENZIE,+    (ANL+CARN+NWES)
KOTELCHU  67 PRL 18 1166         KOTELCHUCK,GOZA,SULLIVAN,ROSS  (VANDERBILT)
SULLIVAN  67 PRL 18 1163         SULLIVAN,MCINTURFF,KOTELCHUCH  (VANDERBILT)
    ALSO  64 PRL 13 246          A D MCINTURFF,C E ROOS         (VANDERBILT)

BIERMAN   68 PRL 20 1459         BIERMAN,KOUNOSU,NAUENBERG +      (PRINCETON)
COMBE     68 NC 57A 54           CERN-BRISTOL-LAUSANNE-MUNICH-ROME-COLLABOR
MAST      68 PRL 20 1312         MAST,GERSHWIN,ALSTON-GARNJOST +        (LRL)

ANG       69 ZPHYS 228 151       +EBENHOH,EISELE,ENGELMANN,FILTHUTH+   (HEID)
BAGGETT   69 MDDP-TR-973         N V BAGGETT (THESIS)                   (UMD)
BALTAY    69 PRL 22 615          BALTAY,FRANZINI,NEWMAN,NORTON+  (COLU,STON)
BANGERTE  69 UCRL-19244          ROGER ODELL BANGERTER (THESIS)         (LRL)
BANGERT1  69 PR 187 1821         BANGERTER,GARNJOST,GALTIERI,GERSHWIN+ (LRL)
BARLOUTA  69 NP B14 153          BARLOUTAUD,BELLEFON,GRANET+(SACL+CERN+HEID)
EISELE1   69 ZPHYS 221 1         +ENGELMANN,FILTHUTH,FOHLISCH,HEPP+    (HEID)
EISELE2   69 ZPHYS 221 401       +ENGELMANN,FILTHUTH,FOHLISCH,HEPP+    (HEID)
GERSHWIN  69 PR 188 2077         +ALSTON-GARNJOST,BANGERTER +           (LRL)
    ALSO     UCRL 19246 THESIS   LAWRENCE K GERSHWIN                    (LRL)
NORTON    69 NEVIS 175 (THESIS)  HERBERT NORTON                    (COLUMBIA)

BERLEY    70 PR D1 2015          +YAMIN,HERTZBACH,KOFLER +   (BNL,MASA,YALE)
EISELE    70 ZPHY 238 372        +FILTHUTH,HEPP,PRESSER,ZECH    (HEIDELBERG)
HARRIS    70 PRL 24 165          +OVERSETH,PONDROM,DETTMANN       (MICH,WISC)

ALLEY     71 PR  D3  75          +BENBROOK,COOK,GLASS,GREEN,HAGUE +    (WASH)
BAKKER    71 LNC 1 37            +,SABRE COLLAB.  (ZEEM+SACL+BGNA+REHO+EPOL)
COLE      71 PR D4 631           +LEE-FRANZINI,LOVELESS,BALTAY+  (STON,COLU)
TOVEE     71 NP B33 493          LOUC,BELGRADE,BERL,BRUX,DUBLIN,WARS COLLAB
BELLAMY   72 PL 39B 299          +ANDERSON,CRAWFORD,OSMON+  (LOWC+RHEL+SUSS)
BOHM      72 NP B48 1            BERLIN+BELGRADE+BRUX+DUBLIN+LOUC+WARSAW
    ALSO  73 IIHE-73.2 NOV       BRUSSELS BULLETIN, SAME COLLABORATION

EBENHOH   73 ZPHY 264 413        +ELSELE,FILTHUTH,HEPP,LEITNER,THOUW+ (HEID)
LIPMAN    73 PL 43B 89           +UTO,WALKER,MONTGOMERY+    (RHEL+SUSS+LOWC)
SAHA      73 PR D7 3295          +FETKOVICH,HEINTZELMAN,MELTZER +      (CARN)
SECHIZOR  73 PR D8 12            B.SECHI-ZORN,G.SNOW                    (UMD)
EBENHOH   74 ZPHY 266 367        +EISELE,ENGELMANN,FILTHUTH,HEPP +     (HEID)
REUCROFT  76 PREPRINT            +ROOS,WATERS,WEBSTER,HANSL+      (VAND,MPIM)
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PAPERS NOT REFERRED TO IN DATA CARDS


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GLASER    58 CERN CONF 270       GLASER,GOOD,MORRISON            (MICH+LFL)
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QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN THE DATA CARDS


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TRIPP     62 PRL 8 175           R TRIPP,M WATSON,M FERRO-LUZZI        (LRL) P
ALFF      63 SIENA CONF 1 205    ALFF,NAUENBERG,KIRSCH,+       (COLU+RUTG+BNL)
    ALSO  65 PR 137 B 1105       ALFF,GELFAND,BRUGGER,BERLEY+(COLU+RUTG+BNL)
COURANT   63 SIENA CONF 1 73     COURANT,FILTHUTH,BURNSTEIN,DAY+ (CERN+UMD)
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           20   SIGMA-(1198,JP=1/2+) I=1
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           20   SIGMA- MASS (MEV)

M    N    SEE NOTE PRECEDING LAMBDA MASS LISTINGS

M     3000 1197.43      0.08               SCHMIDT    65 HBC   SEE NOTE N       3/74
M
M             . . . . . . . . .
M    FIT    1197.35     0.06    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*
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           20   (SIGMA-) - (SIGMA+) MASS DIFFERENCE (MEV)

D       87     8.25     0.40               BARKAS     63 EMUL  -
D     2500     8.25     0.25               DOSCH      65 HBC
D       86     7.91     0.23               BOHM       72 EMUL                   1/73
D
D             . . . . . . . . .
D    AVG       8.09     0.16    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D    STUDENT   8.10     0.18    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
D    FIT       7.98     0.38    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)  2/76*
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           20   (SIGMA-) - (LAMBDA) MASS DIFFERENCE (MEV)

DL   N    SEE NOTE PRECEDING LAMBDA MASS LISTINGS.

DL            81.70     0.19               BURNSTEIN 64 HBC                     9/66
DL      85    81.80     0.13               SCHMIDT    65 HBC   SEE NOTE N       3/74
DL    2279    81.64     0.09               HEPP       68 HBC                    8/68
DL
DL            . . . . . . . . .
DL   AVG      81.693    0.069   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
DL   STUDENT  81.692    0.077   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
DL   FIT      81.750    0.054   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*
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           20   SIGMA- MEAN LIFE (UNITS 10**-10)

T              1.67     0.40     0.28  BROWN      58 HLBC
T              1.89     0.33     0.25  EISLER     58 HLBC
T        45    1.35     0.32     0.17  CHIESA     61 EMUL
T        41    1.75     0.39     0.30  BARKAS     61 EMUL
T      1208    1.58     0.06     0.06  HUMPHREY   62 HBC      STOP. K-
T   C  3267    1.666    0.075          CHANG      66 HBC      STOP. K-           6/66
T   S    61   (2.08)   (0.22)          CHIEN      66 HBC   -   6.9 PBAR P        9/67
T   S    64   (1.46)   (0.31)          CHIEN      66 HBC   +   6.9 PBAR P,ANTI   9/67
T       506    1.38     0.07           WHITESIDE 68 HBC      STOP. K-            6/68
T     10253    1.472    0.016          BARLOUTAU 69 HBC      K-P .4-1.2 GEV/C  11/69
T       .1M    1.485    0.022          EISELE     70 HBC      K-P AT REST        2/71
T      1383    1.42     0.05           BAKKER     71 DBC    - K-N TO SIG- 2PI   10/71
T              1.41     0.09     0.08  TOVEE      71 EMUL                       12/71
T      2400    1.463    0.039          ROBERTSON 72 HBC      K-P .25 GEV/C       3/74
T   C    CHANG ERROR 0.018 RAISED BY US.  SEE 1970 EDITION, RMP 42,123(1970)     1/73
T   S    ERROR PURELY STATISTICAL.
T
T             . . . . . . . . .
T   AVG        1.482    0.017    0.017  AVERAGE (ERROR INCL. SCALE FACTOR OF 1.5)
T   STUDENT    1.479    0.013    0.013  AVG. USING STUDENT10(H/1.11) -- SEE TEXT
                        (SEE IDEOGRAM BELOW )
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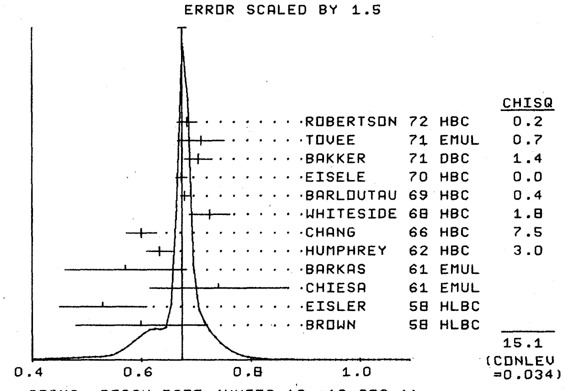
WEIGHTED AVERAGE = 0.6746 ± 0.0076
ERROR SCALED BY 1.5

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           20   SIGMA- MAGNETIC MOMENT (MAGNETONS,938.26 MEV)

MM   R,     BTWN -1.6 AND +0.8          FOX        73 CNTR    SIG-ATOM FINE ST  3/74
MM    R        -1.48       0.37         ROBERTS    74 CNTR    SIG-ATOM FINE ST 12/75*
MM    R   ROBERTS 74 INCLUDES DATA FROM FOX 73.                                12/75*
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Stable Particles
Σ^-, Σ^0

Data Card Listings
For notation, see key at front of Listings.

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               20  SIGMA- PARTIAL DECAY MODES

                                                        DECAY MASSES
P1      SIGMA- INTO NEUTRON PI-                          939+ 139
P2      SIGMA- INTO NEUTRON PI- GAMMA                    939+ 139+    0
P3      SIGMA- INTO NEUTRON MU- NEUTRINO                 939+ 105+    0
P4      SIGMA- INTO NEUTRON E- NEUTRINO                  939+  .5+    0
P5      SIGMA- INTO LAMBDA E- NEUTRINO                  1115+  .5+    0
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               20  SIGMA- BRANCHING RATIOS

R1      SIGMA- INTO (N MU- NEU)/(N PI-) (UNITS 10**-3)     (P3)/(P1)
R1        22     0.66      0.15          COURANT    64 HBC
R1        11     0.56      0.20          BAZIN      65 HBC      FROM STOP. K-      6/66
R1        56     0.43      0.09          BAGGETT    69 HBC      STOP. K-          10/69
R1        72     0.43      0.06          ANG 1      69 HBC      STOP K-           10/69
R1        13     0.38      0.11          COLE       71 HBC      STOP K-           10/71
R1            . . . . . . . . .
R1   AVG         0.447     0.043   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1   STUDENT     0.445     0.047   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R2      SIGMA- INTO (N E- NEU)/(N PI-) (UNITS 10**-3)      (P4)/(P1)
R2         9     1.0       0.4       0.3 MURPHY     64 HLBC
R2        16     1.37      0.34          NAUENBERG  64 HBC
R2        16     1.15      0.4           MILLER     64 FBC
R2        31     1.4       0.3           COURANT    64 HBC
R2       180     1.11      0.09          BIERMAN    68 HBC                          6/68
R2   A   331    (1.02)    (0.08)         ANG 1      69 HBC    - STOP K-           10/69
R2        57     0.97      0.15          COLE       71 HBC      STOP K-           10/71
R2       455     1.05      0.07          SECHIZORN  73 HBC      STOP K-            8/73
R2   A   601     1.09      0.06          EBENHOH    74 HBC      STOP K-            1/76*
R2   A   ANG 1 69 REPLACED BY EBENHOH 74.                                         1/76*
R2            . . . . . . . . .
R2   AVG         1.082     0.038   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2   STUDENT     1.082     0.041   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R3      SIGMA- INTO (LAMBDA E- NEU)/(N PI-) (UNITS 10**-4)
R3                                                         (P5)/(P1)
R3        11     0.75      0.28          COURANT    64 HBC      STOP. K-
R3        35     0.64      0.12          BARASH     67 HBC      STOP K-            8/67
R3        31     0.69      0.12          EISELE1    69 HBC      STOP K-           10/69
R3        31     0.52      0.09          BALTAY     69 HBC      STOP K-            4/69
R3            . . . . . . . . .
R3   AVG         0.604     0.060   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3   STUDENT     0.605     0.069   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R4      SIGMA- INTO (N PI- GAMMA)/(N PI-) (UNITS 10**-3)  (P2)/(P1)
R4             (1.1)APPROXIM.                BAZIN      65 HBC      PI- LT 166 MEV/C  8/67
R4        23     0.10       .02              ANG 2      69 HBC      PI- LT 110 MEV/C 10/69
R4       292     0.46      0.06              EBENHOH    73 HBC      PI+ LT 150 MEV/C  3/74
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               20  SIGMA- DECAY PARAMETERS

          RELATED TEXT SECTION VI D AND APPENDIX III

A-      ALPHA SIGMA-
A-            (-0.16)   (0.21)           TRIPP      62 HBC      REPL.BY BANGERTE
A-   O 6500  (-0.010)   (0.043)          BANGERTER 66 HBC       K-P TO SIG- PI+    7/66
A-   O 6068  (-0.104)   (0.04)           BERLEY     67 HBC      K-P TO SIG- PI+   11/67
A-     51000   -0.071    0.012           BANGERTER 69 HBC                         10/69
A-   B 5978  (-0.134)   (0.034)          BERLEY     70 HBC      K-P AT 400 MEV/C  2/71
A-     63000   -0.067    0.011           BOGERT     70 HBC      K-P AT 400 MEV/C 12/70
A-   O  OLD RESULTS.  HAVE BEEN REPLACED.
A-   B  BERLEY 70 REPLACED BY BOGERT 70                                           2/71
A-            . . . . . . . . .
A-   AVG        -0.0688    0.0081  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
A-   STUDENT    -0.0688    0.0087  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

F-      PHI ANGLE (SIN(PHI)/COS(PHI)=BETA/GAMMA)   (DEGREES)
F-   O 1006  (+22.)     (30.)            BERLEY     67 HBC      K-P TO SIG- PI+   11/67
F-     1385   14.        19.             BANGERT1   69 HBC                        10/69
F-    C1092  + 5.        23.             BERLEY     70 HBC      NEUTRON RESCATT.  11/69
F-   C  CHANGED FROM -5 TO +5 TO AGREE WITH SIGN CONVENTION
F-            . . . . . . . . .
F-   AVG        10.3      14.6     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
F-   STUDENT    10.4      15.8     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

AV      GV/GA FOR SIGMA TO LAMBDA BETA DECAY (TEXT SEC VI D.1 FOR SIGN CONV)
AV         PREDICTED TO BE ZERO BY CONSERVED VECTOR CURRENT THEORY
AV   FB  45   (0.31)    (0.30)           BARASH     67 HBC                        11/67
AV   FS  51   (0.7)     (0.4)            BALTAY     69 HBC      USING SIG+-        4/69
AV   FS  81  (+0.22)    (0.28)           EISELE1    69 HBC                        10/68
AV F S 186     0.37      0.20            FRANZINI   72 HBC      USING SIG+-        1/73
AV    T  55   -0.17      0.35            TANENBAUM  75 SPEC                       12/75*
AV    B  BARASH 67 MEASURED ABSOLUTE VALUE.
AV    S  SIGN CHANGED TO AGREE WITH OUR CONVENTION.
AV F     FRANZINI 72 INCLUDES EVENTS OF BARASH 67, EISELE1 69, BALTAY 69.          1/73
AV    T  WE QUOTE TANENBAUM 75 WHICH ASSUMES CVC WK MAG TERM.                      1/76*
AV            . . . . . . . . .
AV   AVG         0.24      0.23    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
AV   STUDENT     0.24      0.20    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

AV1     GA/GV FOR SIGMA TO NEUTRON BETA DECAY(TEXT SEC VI D.1 FOR SIGN CONV)
AV1       57   (0.05)   (0.23)   (0.32) GERSHWIN   68 HBC  REPLACED BY GER.69     6/68
AV1  C    49    0.23     0.16           COLLERAIN  69 HBC  NEUTRON SCATTER.      10/69
AV1  C    33    0.37     0.26     0.19  EISELE2    69 HBC  NEUTRON SCATTER.     .10/69
AV1       61   +0.19     0.20     0.17  GERSHWIN   69 HBC  POLARIZED SIGMAS      10/69
AV1       63   -0.33     0.30     0.85  BOGERT     70 HBC  K-P AT 400 MEV/C      10/70
AV1  S         -0.20     0.28           EBENHOH    70 HBC      E- SPECTRUM        3/72
AV1  C    36    0.29     0.28     0.29  BALTAY     72 HBC      NEUTRON SCATTER    6/72
AV1       43   -0.4      0.52     1.5   ELLIS      72 ASPK     POLARIZED SIGMAS  10/71
AV1 E          (+0.10)  (0.11)          ELLIS      72 RVUE     SUM LIKEL.(+SOL)  10/71
AV1 E          (-0.27)  (0.13)   (0.17) ELLIS      72 RVUE     SUM LIKEL.(-SOL)  10/71
AV1  C3507      0.435    0.035          TANENBAU   74 ASPK                       10/74*
AV1  C  COLLERAINE,EISELE,BALTAY,TANENBAUM MEASURE ABSOLUTE VALUE OF GA/GV.   11/75*
AV1     GERSHWIN 69, BOGERT 70, EBENHOH 70, AND ELLIS 72 MEASURE THE SIGN.
AV1     BUT NEITHER HAS A DEFINITE SIGN DETERMINATION. SINCE THE SIGN IS
AV1     UNDETERMINED THE AVERAGE OF THE SIX VALUES IS MEANINGLESS.
AV1 E   ELLIS 72 HAS COMBINED THE MAXIMUM LIKELIHOODS OF COLLERAINE 69,          3/72
AV1 E   EISELE2 69, GERSHWIN 69, ELLIS 72, AND GETS TWO POSSIBLE VALUES.         3/72
AV1  S  SIGN CHANGED TO AGREE WITH OUR CONVE. INCLUDES BIERMAN 68 EVENTS.        3/72

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REFERENCES FOR SIGMA-


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BROWN     58 CERN CONF 270      BROWN,GLASER,GRAVES,PERL,CRONIN +      (MICH)
EISLER    58 NC SERIO 10 150    EISLER,BASSI,CONVERSI+ (COLU,BNL,BGNA,PISA)
BARKAS    61 PR 124 1209        BARKAS,DYER,MASON,NICKOLS,SMITH         (LRL)
CHIESA    61 NC 19 1171         A M CHIESA,B QUASSIATI,G RINAUDO      (TURIN)
HUMPHREY  62 PR 127 1305        W E HUMPHREY,R R ROSS                   (LRL)
TRIPP     62 PRL 9 66           R D TRIPP,M WATSON,M FERRO-LUZZI        (LRL)

BARKAS    63 PRL 11 26          W H BARKAS,J N DYER,H H HECKMAN         (LRL)
BURNSTEI  64 PRL 13 66          BURNSTEIN,DAY,KEHOE,SECHI ZORN,SNOW     (UMD)
COURANT   64 PR 136 B 1791      COURANT,FILTHUTH+   (CERN+HEID+UMD+NRL+BNL)
MILLER    64 PL 11 262          MILLER,STANNARD,BEZAGUET+  (LOUC,EPOL+BERG)
MURPHY    64 PR 134 B 188       C THORNTON MURPHY                 (WISCONSIN)
NAUENBER  64 PRL 12 679         NAUENBERG,SCHMIDT,MARATECK+(COLU+RUTG+PRIN)

BAZIN     65 PR 140 B 1358      BAZIN,PLANO,SCHMIDT +        (PRIN+RUTG+COLU)
DOSCH     65 PL 14 239          DOSCH,ENGELMANN,FILTHUTH,HEPP,KLUGE+ (HEID)
    ALSO  66 PR  151  1081      CHUNG YUN CHANG                    (COLUMBIA)
SCHMIDT   65 PR 140 B 1328      P SCHMIDT                          (COLUMBIA)
BANGERTE  66 PRL  17  495       BANGERTER,GALTIERI,BERGE,MURRAY+        (LRL)
CHANG     66 PR  151 1081       CHUNG YUN CHANG                    (COLUMBIA)
CHIEN     66 PR  152  1171      +LACH,SANDWEISS,TAFT,YEH,OREN +    (YALE+BNL)

BARASH    67 PRL 19  181        BARASH,DAY,GLASSER,KEHOE,KNOP +  (MARYLAND)
BERLEY    67 PRL  19  979       BERLEY,HERTZBACH,KOFLER +    (BNL,MASA,YALE)
BIERMAN   68 PRL 20 1459        BIERMAN,KOUNOSU,NAUENBERG +      (PRINCETON)
GERSHWIN  68 PRL 20 1270        GERSHWIN,ALSTON-GARNJOST,BANGERTER+     (LRL)
HEPP      68 ZPHY          214 71 V.HEPP,H. SCHLEICH             (HEIDELBERG)
WHITESID  68 NC  54A  537       H. WHITESIDE,J. GOLLUB              (OBERLIN)

ANG 1     69 ZPHY 223 103       ANG,EISELE,ENGELMANN,FILTHUTH +        (HEID)
ANG 2     69 ZPHY 228 151       +EBENHOR,EISELE,ENGELMANN,FILTHUTH+    (HEID)
BAGGETT   69 PRL 23 249         BAGGETT,KEHOE,SNOW           (UNIV MARYLAND)
BALTAY    69 PRL 22 615         BALTAY,FRANZINI,NEWMAN,NORTON+   (COLU,STON)
BANGERTE  69 UCRL-19244         ROGER ODELL BANGERTER (THESIS)          (LRL)
BANGERT1  69 PR 187 1821        BANGERTER,GARNJOST,GALTIERI,GERSHWIN+ (LRL)

BARLOUTA  69 NP B14 153         BARLOUTAUD,BELLEFON,GRANET+(SACL+CERN+HEID)
COLLERAI  69 PRL 23 198         COLLERAINE,DAY,GLASSER,KNOP+(UNIV MARYLAND)
EISELE1   69 ZPHY 221 1         +ENGELMANN,FILTHUTH,FOHLISCH,HEPP+     (HEID)
EISELE2   69 ZPHY 223 487       EISELE,ENGELMANN,FILTHUTH,FOHLISCH+    (HEID)
GERSHWIN  69 UCRL-19246         LAWRENCE KENNETH GERSHWIN (THESIS)      (LRL)

BERLEY    70 PR D1 2015         +YAMIN,HERTZBACH,KOFLER +    (BNL,MASA,YALE)
BOGERT    70 PR D2 6            +LUCAS,TAFT,WILLIS,BERLEY + (BNL,MASA,YALE)
EBENHOH   70 KIEV CONF          +EISELE,ENGELMANN,FILTHUTH,FOHLISCH+ (HEID)
EISELE    70 ZPHY 238 372       +FILTHUTH,HEPP,PRESSER,ZECH      (HEIDELBERG)

BAKKER    71 LNC 1 37           +,SABRE COLLAB.  (ZEEM+SACL+BGNA+REHO+EPOL)
COLE      71 PR D4 631          +LEE-FRANZINI,LOVELESS,BALTAY+   (STON,COLU)
    ALSO  69 NEVIS-175 THESIS   HERBERT NORTON                     (COLUMBIA)
TOVEE     71 NP B33 493         LOUC,BELGRADE,BERL,BRUX,DUBLIN,WARS COLLAB
BALTAY    72 PR D5 1569         +FEINMAN,FRANZINI,NEWMAN,YEH+    (COLU+STON)
BOHM      72 NP B48 1           BERLIN+BELGRADE+BRUX+DUBLIN+LOUC+WARSAW
ELLIS     72 NP B39 77          OXF+AERE+RHEL+LOOM+LYON+NWES+ITEP COLLABOR
FRANZINI  72 PR D6 2417         COLUMBIA+HEIDELBERG+MARYLAND+STONY BROOK
ROBERTSO  72 THESIS             R.M.ROBERTSON                           (IIT)
EBENHOH   73 ZPHY 264 413       +EISELE,FILTHUTH,HEPP,LEITNER,THOUW+ (HEID)
FOX       73 PRL 31 1084        +LAM,BARNES,EISENSTEIN+ (BNL+VPI+WILL+WYOM)
SECHIZOR  73 PR D8 12           B.SECHI-ZORN,G.SNOW                     (UMD)
EBENHOH   74 ZPHY 266 367       +EISELE,ENGELMANN,FILTHUTH,HEPP +      (HEID)
ROBERTS   74 PRL 32 1265        WILL+VPI+CARN+WYOM+CIT COLLABORATION
    ALSO  74 PRL 33 122         ERRATUM TO ROBERTS 74
    ALSO  75 PR D12 1232        ROBERTS,COX +  (WILL+VPI+CARN+WYOM+CIT+BNL)
TANENBAU  74 PRL 33 175         TANENBAUM,HUNGERBUEHLER +    (YALE+FNAL+BNL)
    ALSO  75 TANENBAUM
TANENBAU  75 PR D12 1871        TANENBAUM,HUNGERBUEHLER +    (YALE+FNAL+BNL)

                                PAPERS NOT REFERRED TO IN DATA CARDS

BROWN     57 PR 108 1036        J BROWN, D GLASER, M PERL         (MICH+BNL)
NIETO     68 RMP 40 140         M NIETO                                (STON)
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Σ^0

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                  21  SIGMA0(1193,JP=1/2+) I=1

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                  21  (SIGMA-) - (SIGMA0) MASS DIFFERENCE (MEV)
D1   N    SEE NOTE PRECEDING LAMBDA MASS LISTINGS.

D1         18     4.75      0.1                BURNSTEIN 64 HBC
D1         37     4.87      0.12               DOSCH     65 HBC
D1         12     5.01      0.12               SCHMIDT   65 HBC   SEE NOTE N       3/74
D1               . . . . . . . .
D1   AVG          4.860     0.076   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
D1   STUDENT      4.860     0.077   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
D1   FIT          4.882     0.063   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*
                                    (SEE IDEOGRAM BELOW )
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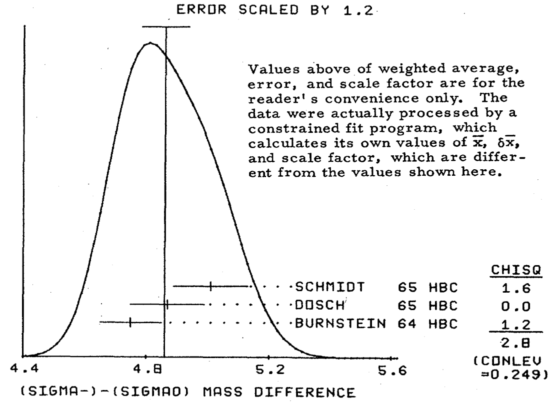
WEIGHTED AVERAGE = 4.860 ± 0.076
ERROR SCALED BY 1.2

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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

Σ^0, Ξ^-

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                   21  (SIGMAO) - (LAMBDA) MASS DIFFERENCE (MEV)

DL   N   SEE NOTE PRECEDING LAMBDA MASS LISTINGS.

DL      208   76.63     0.28            SCHMIDT   65 HBC  SEE NOTE N         6/68
DL      109   76.23     0.55            COLAS     75 HLBC    LAMBDA-GAMMA DEC 12/75*
DL            . . . . . . . . .
DL   AVG      76.55     0.25    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
DL   STUDENT  76.55     0.27    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
DL   FIT      76.87     0.08   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*

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                   21  SIGMAO MEAN LIFE (UNITS 10**-14)

T            (1.0)  OR LESS             DAVIS     62 EMUL

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                   21  SIGMAO PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      SIGMAO INTO LAMBDA GAMMA                             1115+   0
P2      SIGMAO INTO LAMBDA E+ E-                             1115+  .5+  .5
P3      SIGMAO INTO LAMBDA GAMMA GAMMA                       1115+   0+   0

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                   21  SIGMAO BRANCHING RATIOS

R1      SIGMAO INTO(LAMBDA E+ E-)/TOTAL                    (P2)/(P1+P2)
R1           (0.00545)   THEORET. CAL. FEINBERG  58          QUANTUM ELECT.    9/66

R2      SIGMAO INTO (LAMBDA GAMMA GAMMA)/(LAMBDA GAMMA)  (P3)/(P1)            12/75*
R2               0.03  OR LESS  CL=.90    COLAS     75 HLBC                   12/75*

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                              REFERENCES FOR SIGMAO

FEINBERG 58 PR 109 1019      G.FEINBERG                              (BNL)
DAVIS    62 PR 127 605       D DAVIS,R SETTI,M RAYMOND,G TOMASIN     (EFI)
BURNSTEI 64 PRL 13 66        BURNSTEIN,DAY,KEHOE,SECHI ZORN,SNOW     (UMD)
DOSCH    65 PL 14 239        DOSCH,ENGELMANN,FILTHUTH,HEPP,KLUGE+ (HEID)
SCHMIDT  65 PR 140 B 1328    P SCHMIDT                           (COLUMBIA)
COLAS    75 NP B91 253       +FARWELL,FERRER,SIX                     (ORSA)

                              PAPERS NOT REFERRED TO IN DATA CARDS.

COURANT  63 PRL 10 409       COURANT,FILTHUTH,FRANZINI+    (CERN+UMD+NRL)

        QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN THE DATA CARDS

ALFF     65 PR 137 B1105     ALFF,GELFAND,NAUENBERG+ (COLUMBIA+RUTG+BNL)P

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                   22  XI-(1321,JP=1/2 ) I=1/2

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                   22  XI- MASS (MEV)

M   H   11(1317.0)    (2.2)             WANG      61 HLBC
M   H   18(1317.9)    (1.9)             FOWLER    61 HLBC
M   H   (OLD DATA AND LOW STATISTICS DROPPED ON SUGGESTION OF J R HUBBARD)
M      517 1321.4     0.4               JAUNEAU   63 FBC
M       62 1321.1     0.65              SCHNEIDER 63 HBC
M      241 1321.1     0.3               BADIER1   64 HBC
M       ALL MASSES ABOVE WERE RAISED 0.09 MEV BECAUSE LAMBDA MASS RAISED
M      149 1321.3     0.4               PJERROU   65 HBC                      11/67
M        6 1321.67    0.52              CHIEN     66 HBC   -  6.9 PBAR P       9/67
M      299 1321.4     1.1               LONDON    66 HBC                       6/66
M  G   195 1321.87    0.51              GOLDWASSE 70 HBC     5.5 K-P           8/70
M   G   USES LAMBDA MASS OF 1115.58-M(XI) IS 1322.18 IF M(LAMBDA)=1115.84      8/70
M      268 1321.12    0.41              WILQUET   72 HLBC                      1/73
M           . . . . . . . . .
M   AVG     1321.31   0.16     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT1321.31    0.17     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
M   FIT     1321.29   0.14    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*
        THE FIT ASSUMES XI AND ANTI-XI MASSES EQUAL.

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                   22  ANTI-XI+ MASS (MEV)

M1        1(1322.0)   (1.3)             BROWN     62 HBC     ANTI-XI-          7/66
M1        5 1320.69    0.93             CHIEN     66 HBC  +   6.9 PBAR P,ANTI  9/67
M1  S    12(1321.7)   (0.6)             SHEN      67 HBC     ANTI-XI-         10/67
M1       34 1321.2     0.4              STONE     70 HBC                      10/70
M1       35 1321.6     0.8              VOTRUBA   72 HBC     10 GEV/C K+ P    11/72
M1  S   THE ERROR IS STATISTICAL ONLY
M1          . . . . . . . . .
M1  AVG     1321.20    0.33    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M1  STUDENT1321.20     0.36    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
M1  FIT     1321.29    0.14   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*
        THE FIT ASSUMES XI AND ANTI-XI MASSES EQUAL.

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                   22  (XI-) - (ANTI-XI+) MASS DIFFERENCE (MEV)

DM             1.0      1.1             CHIEN     66 HBC      6.9 PBAR P       9/67

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                   22  XI- MAGNETIC MOMENT (MAGNETONS,938.26 MEV)

MM    2724   -0.1       2.1             BINGHAM   70 OSPK  - 1.8 GEV/C K-P     2/71
MM    2436   -2.1       0.8             COOL      74 OSPK -  1.8 GEV/C K-P    10/74*
MM          . . . . . . . . .
MM  AVG      -1.85      0.75   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
MM  STUDENT  -1.86      0.82   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                   22  XI- MEAN LIFE (UNITS 10**-10)

T   H   11    (3.5)     (3.4)    (1.23) WANG      61 HLBC
T   H   18    (1.28)    (0.41)   (0.25) FOWLER    61 HLBC
T   H   (OLD DATA AND LOW STATISTICS DROPPED ON SUGGESTION OF J R HUBBARD)
T      517     1.86      0.15     0.14  JAUNEAU   63 FBC
T       62     1.55      0.31     0.31  SCHNEIDER 63 HBC
T      356    (1.77)    (0.12)          CARMONY   64 HBC   REP BY PJERROU 65
T      794     1.69      0.07           HUBBARD   64 HBC
T      246     1.70      0.12           PJERROU   65 HBC                      11/67
T   S    6    (1.37)    (0.51)          CHIEN     66 HBC   -  6.9 PBAR P       9/67
T      299     1.80      0.16           LONDON    66 HBC                       6/66
T   S         (1.67)    (0.07)          BURGUN    68 HBC    K-P AT 1.3-1.8     2/71
T     2610     1.61      0.04           DAUBER    69 HBC                       6/68
T      680     1.73      0.08     0.07  MAYEUR    72 HLBC   2.1 GEV/C K-       1/73
T     4303     1.63      0.03           BALTAY    74 HBC    1.75 GEV/C K-      3/74
T   S 2436    (1.637)   (0.050)         COOL      74 OSPK - 1.8 GEV/C K-P     10/74*
T   S   THE ERROR IS STATISTICAL ONLY
T           . . . . . . . . .
T   AVG        1.652     0.023    0.022  AVERAGE (ERROR INCL. SCALE FACTOR OF 1.1)  *
T   STUDENT    1.651     0.025    0.024  AVG. USING STUDENT10(H/1.11) -- SEE TEXT

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                   22  ANTI-XI+ MEAN LIFE (UNITS 10**-10)

T1  S    5    (1.51)    (0.55)          CHIEN     66 HBC  +   6.9 PBAR P,ANTI  9/67
T1  S   12    (1.9)     (0.7)    (0.5)  SHEN      67 HBC    ANTI-XI-          10/67
T1      34     1.6       0.3            STONE     70 HBC                      10/70
T1  S   35    (1.55)    (0.35)   (0.20) VOTRUBA   72 HBC    10 GEV/C K+ P     11/72
T1  S   THE ERROR IS STATISTICAL ONLY

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                   22  XI- PARTIAL DECAY MODES

                                                             DECAY MASSES
P1      XI- INTO LAMBDA PI-                                 1115+ 139
P2      XI- INTO LAMBDA E- NEUTRINO                         1115+  .5+   0
P3      XI- INTO NEUTRON PI-                                 939+ 139
P4      XI- INTO LAMBDA MU- NEUTRINO                        1115+ 105+   0
P5      XI- INTO SIGMAO E- NEUTRINO                         1192+  .5+   0
P6      XI- INTO SIGMAO MU- NEUTRINO                        1192+ 105+   0
P7      XI- INTO NEUTRON E- NEUTRINO                         939+  .5+   0
P8      XI- INTO NEUTRON MU- NEUTRINO                        939+ 105+   0
P9      XI- INTO SIGMA- GAMMA                               1197+   0
P10     XI- INTO PROTON PI- PI-                              938+ 139+ 139
P11     XI- INTO PROTON PI- E- NEUTRINO                      938+ 139+  .5+   0
P12     XI- INTO PROTON PI- MU- NEUTRINO                     938+ 139+ 105+   0
P13     XI- INTO XIO E- NEUTRINO                            1314+  .5+   0

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                   22  XI- BRANCHING RATIOS

R1      XI- INTO (LAMBDA E- NEU)/(LAMBDA PI-) (UNITS 10**-3)
R1                                                   (P2)/(P1)
R1       1        155 EFFECTIVE DENOM.  CARMONY   63 HBC                      11/67
R1       0        260 EFFECTIVE DENOM.  JAUNEAU   63 HBC                      11/67
R1       0        220 EFFECTIVE DENOM.  BERGE     66 HBC                      11/67
R1       1        155 EFFECTIVE DENOM.  LONDON    66 HBC                      11/67
R1       0        717 EFFECTIVE DENOM.  TRIPPE    67 HBC                      11/67
R1       2       1976 EFFECTIVE DENOM.  HUBBARD   68 HBC                       6/68
R1  H    4   (1.15)     (0.90)   (0.55) HUBBARD   68 RVUE                      6/68
R1  H   HUBBARD 68 (RVUE) INCLUDES ALL ABOVE EVENTS                            6/68
R1       1       4150 EFFECTIVE DENOM.  YEH       74 HBC                       7/75*
R1          . . . . . . . . .
R1  AVG        0.7       0.3      OUR AVERAGE USING ALL THE ABOVE              2/76*

R2      XI- INTO (NEUTRON PI-)/(LAMBDA PI-) (UNITS 10**-3)
R2                                                   (P3)/(P1)
R2            5.0    OR LESS            FERRO-LUZ 63 HBC                       6/68
R2            1.1    OR LESS            DAUBER    69 HBC                       6/68
R2       0    3.0    OR LESS  CL=.90    YEH       74 HBC       760 EFF.DENOM.  7/75*

R3      XI- INTO (LAMBDA MU- NEUTRINO)/TOTAL (UNITS 10**-3)
R3                                                   (P4)
R3           12.0    OR LESS            BERGE     66 HBC                       6/68
R3            1.3    OR LESS            DAUBER    69 HBC                       6/68
R3       1    0.35     0.35             YEH       74 HBC      2859 EFF.DENOM.  7/75*

R4      XI- INTO (SIGMAO E- NEUTRINO)/TOTAL (UNITS 10**-3)
R4                                                   (P5)
R4            3.0    OR LESS            BERGE     66 HBC                       6/68
R4            0.5    OR LESS            DAUBER    69 HBC                       6/68
R4       0    0.53   OR LESS  CL=.90    YEH       74 HBC      4363 EFF.DENOM.  7/75*

R5      XI- INTO (SIGO MU- NEU)/(LAM PI-) (UNITS 10**-3) (P6)/(P1)
R5            5.0    OR LESS            BERGE     66 HBC                       7/66
R5       0    0.76   OR LESS  CL=.90    YEH       74 HBC      3026 EFF.DENOM.  7/75*

R6      XI- INTO (N E- NEU)/(LAMBDA PI-) (UNITS 10**-3)  (P7)/(P1)
R6           10.0    OR LESS  CL=.90    BINGHAM   65 RVUE                      9/66
R6       0    3.2    OR LESS  CL=.90    YEH       74 HBC       715 EFF.DENOM.  7/75*

R7      XI- INTO (SIGMAO E- NEU + LAMBDA E- NEU)/TOTAL (10**-3)
R7                                                   (P2+P5)
R7       17    0.68     0.22            DUCLOS    71 OSPK    SEE NOTE D       10/71
R7  D   THIS EXPERIMENT CANNOT DISTINGUISH SIGMAO FROM LAMBDA. THE CABIBBO
R7  D   THEORY PREDICTS SIGMAO RATE ABOUT A FACTOR 6 SMALLER THAN THE
R7  D   LAMBDA.  TO GET A VALUE FOR THE TABLE R7 HAS BEEN AVERAGED WITH R1.

R8      XI- INTO (N MU- NEU)/(LAMBDA PI-) (UNITS 10**-3) (P8)/(P1)
R8       0   15.3    OR LESS  CL=.90    YEH       74 HBC       150 EFF.DENOM. 11/75*

R9      XI- INTO (SIGMA- GAMMA)/(LAM PI-) (UNITS 10**-4) (P9)/(P1)
R9       0   11.5    OR LESS  CL=.90    YEH       74 HBC      2000 EFF.DENOM. 11/75*

R10     XI- INTO (P PI- PI-)/(LAMBDA PI-) (UNITS 10**-4) (P10)/(P1)
R10      0    3.7    OR LESS  CL=.90    YEH       74 HBC      6200 EFF.DENCM. 11/75*

R11     XI- INTO (P PI- E- NEU)/(LAM PI-) (UNITS 10**-4) (P11)/(P1)
R11      0    3.7    OR LESS  CL=.90    YEH       74 HBC      6200 EFF.DENCM. 11/75*

R12     XI- INTO (P PI- MU- NEU)/(LAM PI-) (UNITS 10**-4) (P12)/(P1)
R12      0    3.7    OR LESS  CL=.90    YEH       74 HBC      6200 EFF.DENCM. 11/75*

R13     XI- INTO (XIO E- NEU)/(LAM PI-) (UNITS 10**-3)   (P13)/(P1)
R13      0    2.3    OR LESS  CL=.90    YEH       74 HBC      1000 EFF.DENOM. 11/75*

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Stable Particles

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Data Card Listings

For notation, see key at front of Listings.

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                       22  XI- DECAY PARAMETERS

          RELATED TEXT SECTION VI D AND APPENDIX III

A        ALPHA XI-
A   O          (-0.44)    (0.12)          JAUNEAU    63 FBC      SEE NOTE D BELOW  6/68
A   O     62   (-0.73)    (0.23)          SCHNEIDER 63 HBC       SEE NOTE D BELOW  6/68
A        240    -0.5       0.38           BADIER1    64 HBC      SEE NOTE D BELOW  6/68
A        356    -0.62      0.13           CARMONY    64 HBC      SEE NOTE D BELOW  6/68
A       1004    -0.365     0.068          BERGE      66 HBC      SEE NOTE D BELOW  6/68
A  L     364    -0.47      0.13           LONDON     66 HBC      SEE NOTE D BELOW  6/68
A              (-0.391)   (0.032)         BERGE 2    66 RVUE  INCLUDES ALL ABOVE  9/66
A   M   2529   (-0.375)   (0.051)         MERRILL    68 HBC                        6/68
A       2781    -0.391     0.045          DAUBER     69 HBC      SEE NOTE A BELOW
A       2724    -0.383     0.065          BINGHAM    70 OSPK                      10/70
A        820    -0.42      0.11           MAYEUR     72 HLBC     2.1 GEV/C K-      1/73
A       4303    -0.376     0.038          BALTAY     74 HBC      1.75 GEV/C K-     3/74
A       2436    -0.39      0.05           COOL       74 OSPK -   1.8 GEV/C K-P    10/74*
A   A    USED ALPHA LAMBDA = 0.647 +- 0.020.
A   D    ERRORS MULTIPLIED BY 1.1 DUE TO APPROXIMATIONS USED FOR XI
A   D    POLARIZATION. (SEE DAUBER 69 FOR DETAILED DISCUSSION)                     6/68
A  L     LONDON 66 USES ALPHA-LAMBDA = 0.62
A   M    DATA OF MERRILL 68 INCLUDED IN DAUBER 68.
A   O    OLD DATA NOT INCLUDED IN AVERAGE.
A              . . . . . . . . .
A   AVG         -0.392     0.021   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
A   STUDENT     -0.391     0.023   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

F        PHI ANGLE (SIN(PHI)/COS(PHI)=BETA/GAMMA) (DEGREES)
F   O          (-16.0)    (45.0)          JAUNEAU    63 FBC      SEE NOTE D BELOW  6/68
F   O     62   (45.0)     (36.0)          SCHNEIDER 63 HBC       SEE NOTE D BELOW  6/68
F        356    54.0       30.0           CARMONY    64 HBC      SEE NOTE D BELOW  6/68
F       1004     0.        12.            BERGE      66 HBC      SEE NOTE D BELOW  6/68
F  L     364     0.0       20.4           LONDON     66 HBC      SEE NOTE D BELOW  6/68
F   M   2529    (9.8)     (11.6)          MERRILL    68 HBC                        6/68
F       2781   -14.        11.            DAUBER     69 HBC      SEE NOTE A BELOW
F       2724   -26.0       30.0           BINGHAM    70 OSPK                      10/70
F       4303    11.0        9.0           BALTAY     74 HBC      1.75 GEV/C K-     3/74
F       2436     5.0       16.0           COOL       74 OSPK -   1.8 GEV/C K-P    10/74*
F   A    USED ALPHA LAMBDA = 0.647 +- 0.020.
F   D    ERRORS MULTIPLIED BY 1.2 DUE TO APPROXIMATIONS USED FOR XI
F   D    POLARIZATION. (SEE DAUBER 68 FOR DETAILED DISCUSSION)
F  L     LONDON 66 USES ALPHA-LAMBDA = 0.62
F   M    DATA OF MERRILL 68 INCLUDED IN DAUBER 68.
F   O    OLD DATA NOT INCLUDED IN AVERAGE.
F              . . . . . . . . .
F   AVG          2.0       5.7     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
F   STUDENT      2.0       6.2     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                         (SEE IDEOGRAM BELOW )
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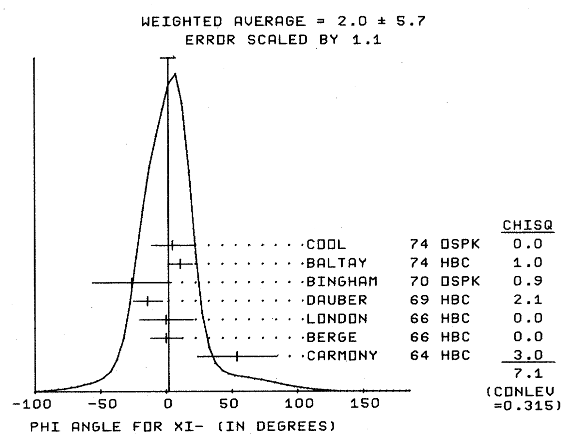


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REFERENCES FOR XI-


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FOWLER   61 PRL 6 134           FOWLER,BIRGE,EBERHARD,ELY,GOOD,POWELL+(LRL)
WANG     61 JETP 13 512         K WANG,T WANG,VIRYASOV,TING,SOLOVEV+ (JINR)
BROWN    62 PRL 8 255           BROWN,CULWICK,FOWLER,GAILLOUD +  (BNL+YALE)

CARMONY  63 PRL  10  381        CARMONY,PJERROU                      (UCLA)
FERRO-LU 63 PR 130 1568         FERRO-LUZZI,ALSTON,ROSENFELD,WOJCICKI (LRL)
JAUNEAU  63 SIENA CONF 4        JAUNEAU+         (EPOL+CERN+LOUC+RHEL+BERGEN)
   ALSO  63 PL  5  261          JAUNEAU,+        (EPOL,CERN,LOUC,RHEL,BERGEN)
SCHNEIDE 63 PL 4 360            H SCHNEIDER                          (CERN)

CARMONY  64 PRL 12 482          CARMONY,PJERROU,SCHLEIN,SLATER,STORK+(UCLA) J
BADIER1  64 DUBNA CONF I 593    BADIER,DEMOULIN,BARLOUTAUD+(EPOL,SACL,ZEEM)
HUBBARD  64 PR 135 B 183        HUBBARD,BERGE,KALBFLEISCH,SHAFER +    (LRL)
BINGHAM  65 PRSL  285  202      H H BINGHAM                          (CERN)
PJERROU  65 PRL 14 275          + SCHLEIN,SLATER,SMITH,STORK,TICHO   (UCLA)
PJERROU  65 THESIS              G M PJERROU                          (UCLA)

BERGE    66 PR  147  945        BERGE,EBERHARD,HUBBARD,MERRILL +      (LRL)
BERGE 2  66 BERKELEY CONF 46    BERGE,CABIBBO               (LRL,CERN(RVUE))
LONDON   66 PR 143 1034         LONDON,RAU,GOLDBERG,LICHTMAN+(BNL+SYRACUSE)
CHIEN    66 PR  152  1171       +LACH,SANDWEISS,TAFT,YEH,OREN +  (YALE+BNL)
SHEN     67 PL 25 B 443         B.C.SHEN,A.FIRESTONE,G.GOLDHABER  (UCB+LRL)
TRIPPE   67 PRIV. COMM.         T. TRIPPE                            (UCLA)

BURGUN   68 NP B8 447           +MEYER,PAULI,TALLINI, +    (SACL+CDEF+RHEL)
HUBBARD  68 PRL 20 465          HUBBARD,BERGE,DAUBER                  (LRL)
MERRILL  68 PR 167 1202         MERRILL,SHAFER                        (LRL)J

DAUBER   69 PR  179 1272        +BERGE,HUBBARD,MERRILL,MILLER         (LRL)J
BINGHAM  70 PR D1 3010          +COOK,HUMPHREY,SANDER,WILLIAMS+ (UCSD,WASH)
GOLDWASS 70 PR D1 1960          GOLDWASSER, SCHULTZ                   (ILL)
STONE    70 PL 32B 515          +BERLINGHIERI,BROMBERG,COHEN,FERBEL +(ROCH)
DUCLOS   71 NP B32 493          +FREYTAG,HEINTZE,HEINZELMAN,JONES+    (CERN)
MAYEUR   72 NP B47 333          +VAN BINST,WILQUET+    (BRUX+CERN+TUFT+LOUC)
VOTRUBA  72 NP B45 77           VOTRUBA,SAFDER,RATCLIFFE         (BIRM+EDIN)
WILQUET  72 PL 42B 372          +FLIAGINE,GUY,KNIGHT+ (BRUX+CERN+TUFT+LOUC)
BALTAY   74 PR D9 49            +BRIDGEWATER,COOPER,GERSHWIN+  (COLU+BING)J
COOL     74 PR D10 792          +GIACOMELLI,JENKINS,KYCIA,LEONTIC,LI+ (BNL)
   ALSO  72 PRL 29 1630         COOL,GIACOMELLI,JENKINS,KYCIA,LEONTIC+(BNL)
YEH      74 PR D10 3545         +GAIGALAS,SMITH,ZENDLE,BALTAY + (BING+COLU)
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                      23  XIO(1314,JP=1/2 ) I=1/2

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                      23  XIO MASS (MEV)

M        1 1313.4      1.8            PALMER    68 HBC                       3/68
M       49 1315.2      0.92           WILQUET   72 HLBC                      1/73
M          . . . . . . . . . .
M    AVG    1314.83    0.82     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M    STUDENT1314.84    0.91     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
M    FIT    1314.90    0.55   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*

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                      23  (XI-) - (XIO) MASS DIFFERENCE (MEV)

D        23    6.8     1.6            JAUNEAU   63 FBC
D        45   (6.1)   (1.6)           CARMONY   64 HBC    REP BY PJERROU 65
D        88    6.1     0.9            PJERROU   65 HBC                      11/67
D        29    6.9     2.2            LONDON    66 HBC                       6/66
D          . . . . . . . . . .
D    AVG       6.34    0.74     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D    STUDENT   6.34    0.80     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
D    FIT       6.40    0.55   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/76*

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                      23  XIO MEAN LIFE (UNITS 10**-10)

T        24    3.9     1.4     0.80  JAUNEAU   63 FBC
T        45   (3.5)   (1.0)   (0.8)  CARMONY   64 HBC    REP BY PJERROU 65
T       101    2.5     0.4     0.3   HUBBARD   64 HBC
T        80    3.0     0.5           PJERROU   65 HBC                       11/67
T       340    3.07    0.22    0.20  DAUBER    69 HBC                        6/68
T    B  469   (2.85)  (0.20)  (0.18) BRIDGEWAT 72 HBC     1.75 GEV/C K-P     1/73
T   M   157    2.90    0.32    0.27  MAYEUR    72 HLBC    2.1 GEV/C K-       1/74
T   B   652    2.88    0.21    0.19  BALTAY    74 HBC     1.75 GEV/C K-      3/74
T   M    MAYEUR 72 VALUE MODIFIED BY ERRATUM.                                1/74
T   B    BALTAY 74 INCLUDES BRIDGEWATER 72.                                  3/74
T         . . . . . . . . .
T    AVG       2.96    0.12    0.11   AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)
T    STUDENT   2.96    0.14    0.13   AVG. USING STUDENT10(H/1.11) -- SEE TEXT

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                      23  XIO PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      XIO INTO LAMBDA PIO                             1115+ 134
P2      XIO INTO PROTON PI-                              938+ 139
P3      XIO INTO PROTON E- NEU                           938+  .5+   0
P4      XIO INTO SIGMA+ E- NEU                          1189+  .5+   0
P5      XIO INTO SIGMA- E+ NEU                          1197+  .5+   0
P6      XIO INTO SIGMA+ MU- NEUTRINO                    1189+ 105+   0
P7      XIO INTO SIGMA- MU+ NEUTRINO                    1197+ 105+   0
P8      XIO INTO PROTON MU- NEUTRINO                     938+ 105+   0
P9      XIO INTO LAMBDA GAMMA                           1115+   0
P10     XIO INTO SIGMAO GAMMA                           1192+   0

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                      23  XIO BRANCHING RATIOS

R1      XIO INTO (PROTON PI-)/(LAMBDA PIO)  (UNITS 10**-5) (P2)/(P1)
R1          2700.    OR LESS             TICHO     63 HBC                       6/68
R1           500.    OR LESS             HUBBARD   66 HBC                       6/68
R1            90.    OR LESS             DAUBER    69 HBC                       6/68
R1       0   180.    OR LESS   CL=.90    YEH       74 HBC     1300 EFF.DENOM.  11/75*
R1             3.6   OR LESS   CL=.90    GEWENIGER 75 SPEC                     11/75*

R2      XIO INTO (PROTON E- NEU)/(LAMBDA PIO) (UNITS 10**-3)
R2                                                   (P3)/(P1)
R2            27.0   OR LESS             TICHO     63 HBC                       6/68
R2             6.0   OR LESS             HUBBARD   66 HBC                       6/68
R2             1.3   OR LESS             DAUBER    69 HBC                       6/68
R2       0     3.4   OR LESS   CL=.90    YEH       74 HBC      670 EFF.DENOM.  11/75*

R3      XIO INTO (SIGMA+ E- NEU)/(LAMBDA PIO) (UNITS 10**-3)
R3                                                   (P4)/(P1)
R3            13.0   OR LESS             TICHO     63 HBC                       6/68
R3             7.0   OR LESS             HUBBARD   66 HBC                       6/68
R3             1.5   OR LESS             DAUBER    69 HBC                       6/68
R3       0     1.1   OR LESS   CL=.90    YEH       74 HBC     2100 EFF.DENCM.  11/75*

R4      XIO INTO (SIGMA- E+ NEU)/(LAMBDA PIO) (UNITS 10**-3)
R4                                                   (P5)/(P1)
R4             6.0   OR LESS             HUBBARD   66 HBC                       6/68
R4             1.5   OR LESS             DAUBER    69 HBC                       6/68
R4       0     0.9   OR LESS   CL=.90    YEH       74 HBC     2500 EFF.DENCM.  11/75*

R5      XIO INTO (SIGMA+ MU- NEU)/TOTAL (UNITS 10**-3)   (P6)
R5             7.0   OR LESS             HUBBARD   66 HBC                       6/68
R5             1.5   OR LESS             DAUBER    69 HBC                       6/68
R5       0     1.1   OR LESS   CL=.90    YEH       74 HBC     2100 EFF.DENOM.  11/75*

R6      XIO INTO (SIGMA- MU+ NEU)/TOTAL (UNITS 10**-3)   (P7)
R6             6.0   OR LESS             HUBBARD   66 HBC                       6/68
R6             1.5   OR LESS             DAUBER    69 HBC                       6/68
R6       0     0.9   OR LESS   CL=.90    YEH       74 HBC     2500 EFF.DENOM.  11/75*

R7      XIO INTO (PROTON MU- NEU)/TOTAL (UNITS 10**-3)   (P8)
R7             6.0   OR LESS             HUBBARD   66 HBC                       6/68
R7             1.3   OR LESS             DAUBER    69 HBC                       6/68
R7       0     3.5   OR LESS   CL=.90    YEH       74 HBC      664 EFF.DENOM.  11/75*

R8      XIO INTO (LAMBDA GAMMA)/(LAM PIO) (UNITS 10**-3) (P9)/(P1)
R8       1     5.        5.              YEH       74 HBC      200 EFF.DENOM.  11/75*

R9      XIO INTO (SIGMAO GAMMA)/(LAM PIO) (UNITS 10**-2) (P10)/(P1)
R9      0-1    6.5   OR LESS   CL=.90    YEH       74 HBC       60 EFF.DENOM.  11/75*

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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

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              23  XIO DECAY PARAMETER

         RELATED TEXT SECTION VI D AND APPENDIX III

A       ALPHA XI 0
A               -0.09      0.46             PJERROU   65 HBC     SEE NOTE D BELOW  6/68
A       146     -0.13      0.17             BERGE     66 HBC     SEE NOTE D BELOW  6/68
A  L     46     -0.2       0.4              LONDON    66 HBC     SEE NOTE D BELOW  6/68
A   M   490    (-0.33)    (0.11)            MERRILL   66 HBC     SEE NOTE D BELOW  6/68
A  A    739     -0.43      0.09             DAUBER    69         SEE NOTE A BELOW
A   B   440    (-0.52)    (0.09)            BRIDGEWAT 72 HBC     1.75 GEV/C K-P    1/73
A       130     -0.84      0.27             MAYEUR    72 HLBC    2.1 GEV/C K-      1/73
A  B    652     -0.54      0.10             BALTAY    74 HBC     1.75 GEV/C K-     3/74
A   A    USED ALPHA LAMBDA = 0.647 +- 0.020.
A   D    ERRORS MULTIPLIED BY 1.1 DUE TO APPROXIMATIONS USED FOR XI
A   D    POLARIZATION. (SEE DAUBER 69 FOR DETAILED DISCUSSION)
A  L     LONDON 66 USES ALPHA-LAMBDA = 0.62
A   M    MERRILL 66 REPLACED BY DAUBER 69
A   B    BRIDGEWATER 72 ERROR PURELY STATISTICAL.                                  1/73
A  B     BALTAY 74 INCLUDES BRIDGEWATER 72.                                        3/74
A             . . . . . . . . . .
A   AVG        -0.441      0.078   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
A   STUDENT    -0.445      0.069   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                           (SEE IDEOGRAM BELOW )
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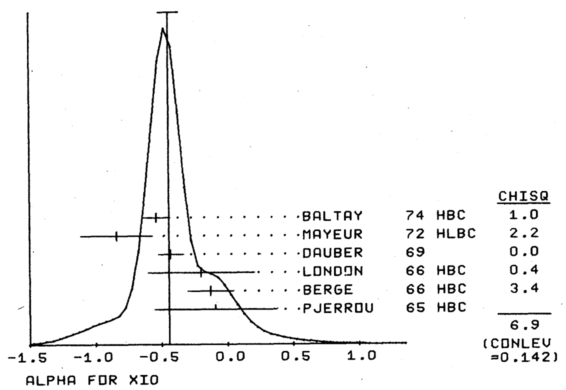
WEIGHTED AVERAGE = -0.441 ± 0.078
ERROR SCALED BY 1.3

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F       PHI ANGLE  (SIN(PHI)/COS(PHI)=BETA/GAMMA)  (DEGREES)
F       146    -8.        30.               BERGE     66 HBC    SEE NOTE D BELOW  6/68
F   M   490 (107.0)      (46.0)             MERRILL   66 HBC    SEE NOTE D BELOW  6/68
F  A    739    38.        19.               DAUBER    69 HBC    SEE NOTE A BELOW
F   B   440   (11.2)     (14.4)             BRIDGEWAT 72 HBC    1.75 GEV/C K-P    1/73
F  B    652    16.0       17.0              BALTAY    74 HBC    1.75 GEV/C K-     3/74
F   A    USED ALPHA LAMBDA = 0.647 +- 0.020.
F   D    ERRORS MULTIPLIED BY 1.2 DUE TO APPROXIMATIONS USED FOR XI
F   D    POLARIZATION. (SEE DAUBER 69 FOR DETAILED DISCUSSION)
F   M    MERRILL 66 REPLACED BY DAUBER 69
F   B    BRIDGEWATER 72 ERROR PURELY STATISTICAL.                                 1/73
F  B     BALTAY 74 INCLUDES BRIDGEWATER 72.                                       3/74
F             . . . . . . . . . .
F   AVG        20.7       11.7     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
F   STUDENT    20.6       13.2     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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REFERENCES FOR XIO


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ALVAREZ  59 PRL 2 215           ALVAREZ,EBERHARD,GOOD,GRAZIANO,TICHO+ (LPL)
JAUNEAU  63 SIENA CONF 1 1      JAUNEAU+        (EPOL+CERN+LOUC+RHEL+BERGEN)
   ALSO  63 PL 4 49             JAUNEAU+        (EPOL+CERN+LOUC+RHEL+BERGEN)
TICHO    63 BNL CONF 410        HAROLD K TICHO                        (UCLA)

CARMONY  64 PRL 12 482          CARMONY,PJERROU,SCHLEIN,SLATER,STORK+(UCLA)
HUBBARD  64 PR 135 B 183        HUBBARD,BERGE,KALBFLEISCH,SHAFER +     (LRL)
PJERROU  65 PRL 14 275          + SCHLEIN,SLATER,SMITH,STORK,TICHO    (UCLA)
PJERROU  65 THESIS              G M PJERROU                           (UCLA)

BERGE    66 PR  147  945        BERGE,EBERHARD,HUBBARD,MERRILL +       (LRL)
HUBBARD  66 UCRL 11510          J RICHARD HUBBARD (THESIS,BERKELEY)    (LRL)
LONDON   66 PR 143 1034         LONDON,RAU,GOLDBERG,LICHTMAN+(BNL+SYRACUSE)
MERRILL  66  BERKELEY CONF      MERRILL,SHAFER,BERGE                   (LRL)
   ALSO  66 UCRL 16455          DEANE MERRILL (THESIS, BERKELEY)       (LRL)

PALMER   68 PL 26B  323         PALMER,RADOJICIC,RAU,RICHARDSON+ (BNL,SYRA)
DAUBER   69 PR  179 1262        +BERGE,HUBBARD,MERRILL,MILLER          (LRL)

BRIDGEWA 72 NEVIS 195(THESIS) ALBERT BRIDGEWATER                 (COLUMBIA)
MAYEUR   72 NP B47 333          +VAN BINST,WILQUET+    (BRUX+CERN+TUFT+LOUC)
   ALSO  73 NP B53 268          ERRATUM TO MAYEUR 72
WILQUET  72 PL 42B 372          +FLIAGINE,GUY,KNIGHT+ (BRUX+CERN+TUFT+LOUC)
BALTAY   74 PR D9 49            +BRIDGEWATER,COOPER,GERSHWIN+    (COLU+BING)J
YEH      74 PR D10 3545         +GAIGALAS,SMITH,ZENDLE,BALTAY + (BING+COLU)
GEWENIGE 75 PL 57B 193          GEWENIGER,GJESDAL,PRESSER +      (CERN+HEID)
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             24  OMEGA-(1675,JP=3/2+) I=0
          QUANTUM NUMBERS ASSIGNED FROM SU3

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             24  OMEGA- MASS (MEV)

M   E    1(1615.)                        EISENBERG 54 EMUL                         9/73
M    F   1 1672.1      1.                FRY1      55 EMUL                         9/73
M    F   1 1670.6     (1.)               FRY2      55 EMUL                         9/73
M        1 1673.0      8.0               ABRAMS    64 HBC     INTO XI- PIO
M        3 1673.3      1.0               PALMER    68 HBC     K-P 4.6,5. GEV/C 11/69
M        3 1671.8      0.8               SCHULTZ   68 HBC     K-P 5.5 GEV/C    11/69
M        5 1674.2      1.6               SCOTTER   68 HBC     K-P 6.  GEV/C    11/69
M   B    6(1671.9)    (1.2)              SPETH     69 HBC     K-P 10. GEV/C    11/69
M    B  13 1671.43     0.78              ABCLV     73 HBC     K-P 10. GEV/C    12/73
M   E   EISENBERG 54 MASS CALCULATED FOR DECAY IN FLIGHT. ALVAREZ 73 HAS        9/73
M   E   SHOWN THAT THE OMEGA INTERACTED WITH AG NUCLEUS TO GIVE K- XI AG.       9/73
M    F  BOTH FRY EVENTS IDENTIFIED AS OMEGA- BY ALVAREZ 73.                     9/73
M    F  FRY MASSES ASSUME DECAY TO LAMBDA K- AT REST.  DECAY FROM ATOMIC        3/74
M    F  ORBIT COULD DOPPLER SHIFT THE K- ENERGY AND RESULTING OMEGA- MASS       3/74
M    F  BY SEVERAL MEV FOR FRY 2.  THIS SHIFT IS NEGLIGIBLE FOR FRY 1           3/74
M    F  BECAUSE THE OMEGA DECAY IS APPROXIMATELY PERPENDICULAR TO ITS           3/74
M    F  ORBITAL VELOCITY, AS IS KNOWN BECAUSE THE LAMBDA STRIKES THE            3/74
M    F  NUCLEUS (L.ALVAREZ, PRIVATE COMM. 1973).  WE HAVE CALCULATED THE        3/74
M    F  ERROR ASSUMING THAT ORBITAL N IS 4 OR LARGER.                           3/74
M    B  ABCLV VALUE INCLUDES THE SPETH 69 EVENTS.                              12/73
M          . . . . . . . . . .
M   AVG     1672.18     0.42    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT1672.16      0.48    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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             24  ANTI-OMEGA+ MASS (MEV)

MB       1 1673.1      1.0               FIRESTONE 71 HBC     12 GEV/C K+D      3/71

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             24  OMEGA- MEAN LIFE (UNITS 10**-10 SEC)

T   A    1   (1.63)                      ABRAMS    64 HBC                        7/66
T   A    1   (0.7)                       BARNES 1  64 HBC                        7/66
T   A    1   (1.4)                       BARNES 2  64 HBC                        7/66
T   A    1   (1.85)                      COLLEY    65 HBC                        7/66
T   A    1   (1.5)                       RICHARDSO 65 HBC                        7/66
T   A    1   (0.93)                      ABCLV COL 68 HBC                       11/67
T   A    1   (2.6)                       ABCLV COL 68 HBC                       11/67
T   A    1   (1.6)                       ABCLV COL 68 HBC                       11/67
T   A    1   (0.21)                      ABCLV COL 68 HBC                       11/67
T   A    1   (1.20)                      SCHULTZ   68 HBC                       11/67
T   A    1   (0.06)                      SCHULTZ   68 HBC                       11/67
T   A    1   (0.63)                      SCHULTZ   68 HBC                       11/67
T   A    1   (0.25)                      SCOTTER   68 HBC                        6/68
T   A    1   (0.30)                      SCOTTER   68 HBC                        6/68
T   A    1   (0.71)                      SCOTTER   68 HBC                        6/68
T   A    1   (0.08)                      SCOTTER   68 HBC                        6/68
T   A    1   (1.04)                      SCOTTER   68 HBC                        6/68
T   A    1   (2.38)                      SCOTTER   68 HBC                        6/68
T   A   ALLISON INCLUDES ALL ABOVE + 3 MORE BNL EVENTS, UNPUBLISHED.              6/68
T       21     1.31      0.37     0.24   ALLISON   68 RVUE                       6/68
T       16     1.39      0.45     0.31   ABCLV     73 HBC     K-P 10. GEV/C     12/73
T          . . . . . . . . . .
T   AVG        1.34      0.28     0.20    AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)
T   STUDENT    1.34      0.30     0.21    AVG. USING STUDENT10(H/1.11) -- SEE TEXT

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             24  OMEGA- PARTIAL DECAY MODES

                                                             DECAY MASSES
P1      OMEGA- INTO LAMBDA K-                               1115+ 493
P2      OMEGA- INTO XIO PI-                                 1314+ 139
P3      OMEGA- INTO XI- PIO                                 1321+ 134

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             24  OMEGA- BRANCHING RATIOS

R1      OMEGA- INTO LAMBDA K-                               (P1)
R1   F    1    EVENT                     FRY1      55 EMUL                      11/73
R1   F    1    EVENT                     FRY2      55 EMUL                      11/73
R1   F  BOTH FRY EVENTS IDENTIFIED BY ALVAREZ 73.                               11/73
R1        2    EVENTS                    PALMER    68 HBC                       11/69
R1        3    EVENTS                    SCHULTZ   68 HBC                       11/69
R1        5    EVENTS 1 XI PI DECAY AMB.SCOTTER    68 HBC                       11/69
R1       13    EVENTS +2 AMBIG. WITH XI-ABCLV      73 HBC     K-P 10. GEV/C     12/73

R2      OMEGA- INTO XIO PI-                                 (P2)
R2        5    EVENTS                    PALMER    68 HBC                       11/69
R2        3    EVENTS                    SCOTTER   68 HBC                       11/69
R2        3    EVENTS +1 AMBIG.WITH SIG-ABCLV      73 HBC     K-P 10. GEV/C     12/73

R3      OMEGA- INTO XI- PIO                                 (P3)
R3        1    EVENT                     ABRAMS    64 HBC                       11/69
R3        1    EVENT                     PALMER    68 HBC                       11/69
R3        1    EVENT                     SCOTTER   68 HBC                       11/69
R3        1    EVENT                     ABCLV     73 HBC     K-P 10. GEV/C     12/73

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             24  OMEGA- DECAY PARAMETERS

        RELATED SECTION VI D IN TEXT

AL      ALPHA FOR OMEGA- TO K- LAMBDA
AL       15    -0.66      0.36     0.30  KOCHER    74                           10/74*

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REFERENCES FOR OMEGA-


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EISENBER 54 PR 96 541           Y EISENBERG                       (CORNELL)
FRY1     55 PR 97 1189          FRY,SCHNEPS,SWAMI                    (WISC)
FRY2     55 NC 2 346            FRY,SCHNEPS,SWAMI                    (WISC)
ABRAMS   64 PRL 13 670          + BURNSTEIN,GLASSER +             (UMD+NPL)
BARNES 1 64 PRL  12  204        V E BARNES,CONNOLLY,CRENNELL,CULWICK+ (BNL)
BARNES 2 64 PL 12 134           V E BARNES,CONNOLLY,CRENNELL,CULWICK+ (BNL)
COLLEY   65 PL 19 152           COLLEY,DODD +(BIRM+GLAS+LOIC+MPIM+OXF+RHEL)
RICHARDS 65 BAPS 10 115         RICHARDSON,BARNES,CRENNEL+    (BNL+SYRACUSE)
SAMIOS   65 ARGONNE CONF 189    N P SAMIOS                        ((RVUE) BNL)
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Stable Particles

Ω⁻, PARTICLE SEARCHES


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ABCLV CO 68 NUC PHYS B4 326   AACHEN+BERLIN+CERN+LONDON IMP.COLL.+VIENNA
ALLISON  68 PRIV. COMM.       JOHN ALLISON                     (LANCASTER)
PALMER   68 PL 26B 323        PALMER,RADOJICIC,RAU,RICHARDSON+ (BNL,SYRA)
SCHULTZ  68 PR  168  1509     SCHULTZ+    (ILL,ARGONNE,NORTHWESTERN,WISC)
SCOTTER  68 PL 26B 474        SCOTTER+     (BIRM,GLASGOW,LOIC,MUNICH,OXF)
SPETH    69 PL  29B 252       SPETH+       (AACHEN,BERLIN,CERN,LOIC,VIEN)
FIRESTON 71 PRL 26 410        +GOLDHABER,LISSAUER,SHELDON,TRILLING  (LRL)
ABCLV    73 NP B61 102        AACHEN+BERLIN+CERN+LONDON+VIENNA COLLABOR.
ALVAREZ  73 PR D8 702         LUIS W. ALVAREZ                       (LBL)
KOCHER   74 PL 51B 193        KOCHER,WERNHARD                  (INNS+VIEN)

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PARTICLE SEARCHES

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Heavy Leptons

Two types of searches for heavy leptons have been made. The first type uses the fact that we can calculate the transition rate for the decay of a heavy lepton to states involving other leptons, with or without pions. Production mechanisms are also considered to be well known, proceeding via the electromagnetic interaction. BERNARDINI 73 and BARISH 73 are of this type. The second method (BUSHNIN 73) is to look for charged, weakly interacting, long-lived particles.

Several experiments have observed events which could arise from the decay of a heavy lepton. PERL 75 in a SLAC-LBL experiment have observed 64 events of the form

$$e^+ + e^- \to e^\pm + \mu^\mp + \geqslant 2 \text{ undetected particles}$$

at or above 4 GeV c.m. energy. Such events have no conventional explanation, but could arise from the production and decay of heavy lepton pairs or charmed boson pairs.

Dimuon events such as those of the Harvard, Pennsylvania, Wisconsin, Fermilab experiment (see BENVENUTI1-5 75 entries in the charmed hadron searches section) could involve heavy lepton production and decay. However, the characteristics of their events do not favor the heavy lepton interpretation.

The Kolar Gold Mines cosmic ray experiment (KRISHNASWAMY 75) reported 5 events which typically have three observed tracks emerging from a common origin about 70 cm from the rock walls of the mine. The authors suggest that these may be massive, long-lived particles, possibly heavy leptons produced by neutrino interactions in the rock walls. Another hypothesis (see DE RUJULA 75) which was put forth to account for their apparent copious production but slow decay is that the observed particle is a very long-lived neutral heavy lepton which is a decay product of a charged heavy lepton, itself pair-produced by cosmic rays in the upper atmosphere.

An FNAL neutrino experiment (BENVENUTI 75) roughly simulated the Kolar Gold Mines experiment for the most likely case that the new particle is neutral. Their result appears to contradict (at least fails to confirm) the KRISHNASWAMY 75 result.

Intermediate Bosons ($W^{\pm}_{0}$ and Φ^0)

Experimentally, W bosons could be produced by hadrons, muons, or neutrinos. They can decay into leptons or into hadrons. At present, there is no positive evidence for the existence of W bosons, although there have been several searches. We list upper limits on the mass and on production cross section.

All gauge theories postulate, in addition to the vector boson W, at least one scalar boson (Higgs' scalar), Φ^0. The couplings of the Higgs' scalar are model-dependent, and limits on its mass depend on M_W. We list these limits and add in comment cards the assumptions made.

Quarks

Three main techniques have been used in the experimental search for quarks: accelerators, cosmic rays, and searches in stable matter. The most recent limits using each of these techniques are given in the Data Card Listings. Accelerator experiments generally measure quark production cross sections (we quote these in Section C) and differential cross sections (D). Cosmic ray experiments measure quark flux (F), and searches in stable matter measure quark concentration (RHO). Some of the accelerator and cosmic ray experiments have looked for fractionally charged particles, and some have looked for high-mass, low-velocity particles. We give the fractional charge, mass ranges, velocity ranges, and other information in the notes on the right-hand side of the card and below the data cards.

Magnetic Monopoles

Searches have been made for magnetic monopoles using accelerators, cosmic rays, and searches in matter.

In accelerator searches strong magnetic fields

Data Card Listings

For notation, see key at front of Listings.

Stable Particles

PARTICLE SEARCHES

are used to extract magnetic monopoles trapped in beam dumps. Cross-section limits are calculated using the reaction $pp \to pp\,MM$.

Searches in matter have been made on sediments at the bottom of the Atlantic Ocean (FLEISCHER 69) and at the bottom of the Pacific Ocean (KOLM 71). Both experiments used high magnetic fields in attempting to extract monopoles from the matter. ROSS 73 searched a lunar rock sample using an electromagnetic detector which measures a current change induced in a superconducting circuit when traversed by a magnetically charged object.

PRICE 75, a cosmic ray experiment, reported the observation of a magnetic monopole track in a stack of Lexan sheets and emulsion. They report its mass as $m > 200\ m_p$ and strength $g = 137e$. However, a more conventional interpretation of this event exists. According to ALVAREZ 75, the data can be well fit by the assumption of a fragmenting heavy nucleus. See also EBERHARD 75 for a discussion of the conflict with other experiments.

Charmed Hadrons

The interpretation that the J/ψ and ψ mesons (see the New Heavy Mesons section of the Meson Data Card Listings) are charm-anticharm bound states has encouraged experimenters to search directly for charmed hadrons. Several experiments have obtained results which strongly support the charm hypothesis.

BENVENUTI 75 (see Charmed Particle references) in a Harvard, Pennsylvania, Wisconsin, Fermilab experiment have observed 70 events of the form

$$\nu(\text{or } \bar{\nu}) + N \to \mu^- + \mu^+ + \text{anything}\ .$$

The authors state that these events involve the production and decay of one or more new particles. The observed properties of these events indicate that the new particle could be a charmed hadron but it is not likely to be a heavy lepton or intermediate vector boson.

The 64 events of the form

$$e^+ + e^- \to e^\pm + \mu^\mp + \geq 2 \text{ undetected particles}$$

reported by PERL 75 (see note on Heavy Leptons above) could arise from the pair production of charmed bosons or heavy leptons.

Two heavy liquid bubble chamber neutrino experiments have found events of the form

$$\nu + N \to \mu^- + e^+ + V^0 + \text{anything}$$

where the V^0 is a K^0 or Λ. The appearance of a strange particle with an e^+ is an expected signature of a charmed hadron.[1] The CERN Gargamelle experiment (DEDEN 75 and BLIETSCHAU 75) sees two events in which the V^0 could be K^0 or Λ. An additional four $\mu^- e^+$ events without a V^0 were observed. The FNAL 15' chamber experiment (VON KROGH 76) sees four $\mu^- e^+ K^0$ events and no $\mu^- e^+$ events without a K^0. This is a preliminary result. Their full exposure may yield as many as 50 such events.

A BNL neutrino experiment (CAZZOLI 75) observes a three-constraint event

$$\nu + p \to \mu^- + \Lambda + 3\pi^+ + \pi^-$$

which they interpret either as a large violation of the $\Delta S = \Delta Q$ rule or as a charmed baryon decaying to $\Lambda + 3\pi^+ + \pi^-$.

See the review of Gaillard et al.[1] for a discussion of charmed particle phenomenology with an eye toward searches for these states.

Other Stable Particle Searches

Searches for stable particles (i.e., particles immune to decay via the strong interaction) which do not fit clearly into the above categories are collected here. They are described in the data cards.

Reference

1. M. K. Gaillard, B. J. Lee, and J. L. Rosner, Rev. Mod. Phys. 47, 277 (1975).

HEAVY LEPTON SEARCHES

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M       HEAVY LEPTON MASS LIMITS (GEV)
M   B   0     0.6    OR MORE              BACCI     73 ELEC    E+E- TO E+E-GAM    1/76*
M   B   0     2.2    OR MORE              BACCI     73 ELEC    E+E- TO E+E-GAM    1/76*
M   C   0     2.0    OR MORE   CL=.90     BARISH    73 ASPK + 50,145GEV NEU,NAL   2/74
M   D   0     1.4    OR MORE   CL=.95     BERNARDIN 73 ASPK    E+E-, FRASCATI     2/74
M   D   0     1.0    OR MORE   CL=.95     BERNARDIN 73 ASPK    E+E-, FRASCATI     2/74
M   N  NONE BETWEEN 0.55 AND 4.5          BUSHNIN   73 CNTR    70GEV P,SERPUKOV   2/74
M   E   0     2.4    OR MORE   CL=.90     EICHTEN   73 HLBC +  1-10 GEV NEU       3/74
M   A         1.8    OR MORE   CL=.90     ASRATYAN  74 HLBC +- CERN NEU EXPT     11/75*
M   C         8.4    OR MORE   CL=.90     BARISH    74 SPEC +  50,135GEV NEU      7/74*
M   O   0     1.15   OR MORE   CL=.95     ORITO     74 ASPK +- E+E- FRASCATI     11/75*
M   P  64 BTWN 1.6 AND 2.0                PERL      75 SPEC                       1/76*
M   B  BACCI 73 LOOKS FOR E GAMMA DECAY MODE OF HEAVY ELECTRON. MASS LIMIT  1/76*
M   B  DEPENDS ON COUPLING CONSTANT LAMBDA FOR THIS DECAY.  FIRST VALUE     1/76*
M   B  ABOVE IS FOR LAMBCA**2 LT 9*10**-5, 2ND IS FOR LAMBDA**2 LT 10**-3.  1/76*
M   C  BARISH LOOKED FOR DECAY TO (MU+ 2NEUTRINOS).  ASSUMES BR.FRAC.=.3   11/75*
M   D  BERNARDINI 73 FIRST VALUE ASSUMES UNIVERSAL COUPLING TO ORDINARY     2/74
M   D  LEPTONS.  SECOND VALUE ALSO ASSUMES COUPLING TO HADRONS.             2/74
M   N  BUSHNIN 73 MASSES ASSUME MEAN LIFE ABOVE 7E-10 AND 3E-8 RESPECTVLY.  2/74
M   N  CALCULATED FROM CROSS SEC(C BELOW) AND 30 GEV MUON PAIR PROD. DATA.  2/74
M   E  EICHTEN 73 LIMIT IS FOR GEORGI-GLASHOW TYPE HVY.LEP. M+ PRODUCED IN  2/76*
M   E  NEU NUCL --> M+ HADRONS ASSUMING 15 PERCENT DECAY TO E+ NEU NEU.     2/76*
M   A  ASRATYAN 74 LIMIT IS FOR HEAVY LEPTON L+ PRODUCED IN THE REACTION    2/76*
M   A  ANTINEU NUCL --> L+ HADRONS.                                         2/76*
M   O  ORITO 74 LOOKED FOR H+H- PAIRS GIVING MU-E PAIRS. MASS LIMIT REFERS  3/74
M   O  TO HEAVY ELECTRON, HEAVY MUON OR HEAVY LEPTON WITH OWN L NUMBER.     3/74
M   O  COUPLING TO HADRON ASSUMED FROM THEORETICAL MODELS.                  3/74
M   P  PERL 75 EVENTS ARE E+ E- TO E+- MU-+ AND TWO OR MORE MISSING         1/76*
M   P  PARTICLES,DONE AT SLAC (SPEAR). AUTHORS CLAIM NO CONVENTIONAL        1/76*
M   P  EXPLANATION FOR THESE EVENTS.  TOTAL CM ENERGY 3-7.5 GEV.            1/76*
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Stable Particles

PARTICLE SEARCHES

Data Card Listings

For notation, see key at front of Listings.

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CE      HEAVY LEPTCN PRODUCTION CROSS SECTION (E+ E-) (UNITS 10**-35 CM**2)
CE   P  64    1.9      0.5            PERL      75 SPEC      M=1.6-2.0 GEV    2/76*
CE   P  PERL 75 IS SLAC(SPEAR) EXPT .  EVENTS ARE E+E- TO E+-MU-+ AND 2 OR   2/76*
CE   P  MORE MISSING PARTICLES.  CS IS FOR ECM=4.8 GEV AND THETA=50-130DEG.  2/76*
CE   P  CROSS SECTION RISES FROM 5X10**-36 AT E=4 TO ABOVE MAX. THEN DROPS   2/76*
CE   P  TO 6E-36  AT E=7.5.   AUTHORS SAY THESE EVENTS HAVE NO CONVENTIONAL  2/76*
CE   P  EXPLANATION.  SUGGEST HEAVY LEPTON OR CHARMED HADRON, M=1.6-2.0GEV.  2/76*

C       HEAVY LEPTON PRODUCTION DIFFERENTIAL CROSS SECTION (CM**2/SR-GEV)
C     G   0  1.6E-37 OR LESS  CL=.90   GOLOVKIN  72 CNTR  70GEV P, SERPUKHOV  1/76*
C  B      0  4. E-38 OR LESS  CL=.90   BUSHNIN   73 CNTR  70GEV P, SERPUKHOV  2/74
C     G  MASS RANGE 1 TO 4.5 GEV,THETA=0,P=25 GEV/C.                          1/76*
C  B     BUSHNIN 73 HEAVY LEPTON PATH TRAVERSES 400 GM/CM**2 ABSORBER.        2/74
C  B     DIFFERENTIAL CROSS-SECTION MEASURED AT P=30 GEV/C THETA= 2 MRAD.     3/74

IC      INVARIANT HEAVY LEPTON PRODUCTICN CROSS SECTION (CM**2/GEV**2)
IC   S   0  5.4E-39 OR LESS  CL=.90   CRONIN     74 SPEC -  M=1-6.8 GEV      1/76*
IC   B   0  6.4E-35 OR LESS  CL=.90   BINTINGER 75 SPEC +- M=1-5 GEV         2/76*
IC   S  CRONIN 74 IS AN FNAL 300 GEV P CU EXPT.  LOOKED FOR LONG LIVED       2/76*
IC   S  PENETRATING PARTICLES.  ABOVE LIMIT ASSUMES STABLE.  MULTIPLY IT BY  2/76*
IC   S  EXP(1.22E-8*M/TAU) FOR MASS M(GEV) AND LIFETIME TAU(SEC).            2/76*
IC   B  BINTINGER 75 IS A 30-300 GEV P C EXPT.  LOOKED FOR LONG LIVED        2/76*
IC   B  PENETRATING PARTICLES.  ABOVE LIMIT ASSUMES STABLE.  MULTIPLY IT BY  2/76*
IC   B  EXP(3.5E-8*M/TAU/P) FOR MASS M(GEV), LIFETIME TAU(SEC), MOM.P(GEV).  2/76*

CN      HEAVY LEPTON PRODUCTION CROSS SECTION (NEUTRINO NUCLEON) (CM**2)
CN   K   5  1. E-37 OR MORE           KRISHNASW 75 CNTR +0-  M=2-5 GEV       2/76*
CN   B   0                            BENVENUTI 75 SPEC  0                   2/76*
CN   K  KRISHNASWAMY 75 IS KOLAR GOLD MINE COSMIC RAY EXPT.  TYPICAL EVENT   2/76*
CN   K  HAS VERTEX IN AIR 70 CM FROM WALL WITH THREE OBSERVED CHARGED        2/76*
CN   K  TRACKS.  AUTHORS SUGGEST NEU+ROCK GIVES NEW PARTICLE WITH MEAN LIFE  2/76*
CN   K  10E-9 SEC OR LONGER.  DE RUJULA 75 GIVES ANOTHER INTERPRETATION.     2/76*
CN   B  BENVENUTI 75 IS AN FNAL NEUTRINO EXPERIMENT WHICH ROUGHLY SIMULATES  2/76*
CN   B  THE KRISHNASWAMY 75 EXPT. BUT APPARENTLY CONTRADICTS IT, FINDING     2/76*
CN   B  NO EVENTS.                                                           2/76*

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REFERENCES FOR HEAVY LEPTON SEARCHES


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GOLOVKIN 72 PL 42B 136        +GRACHEV,KHODYREV,KUBAROVSKY+          (SERP)
BACCI    73 PL 44B 530        +PARISI,PENSO,SALVINI,STELLA+     (ROMA+FRAS)
BARISH   73 PRL 31 410        +BARTLETT,BUCHHOLZ,HUMPHREY+       (CIT+FNAL)
BERNARDI 73 NC 17A 383        +BOLLINI,BRUNINI+             (CERN+BGNA+FRAS)
   ALSO 70 LNC 4 1156         ALLES-BORELLI,BERNARDINI,BOLLINI+      (CERN)
BUSHNIN  73 NP B58 476        +DUNAYTZEV,GOLOVKIN,KUBAROVSKY +       (SERP)
   ALSO 72 PL 42B 136         GOLOVKIN,GRACHEV,SHODYREV +            (SERP)
EICHTEN  73 PL 46B 281        +DEDEN+(AACH+BELG+CERN+EPOL+MILA+LALO+LOUC)
ASRATYAN 74 PL 49B 488        +GERSHTEIN,KAFTANOV,KUBANTZEV,LAPIN+ (SERP)
BARISH   74 PRL 32 1387       +BARTLETT,BUCHHOLZ,MERRITT +       (CIT+FNAL)
CRONIN   74 PR D10 3093       +FRISCH,SHOCHET,BOYMOND,MERMOD + (EFI+PRIN)
ORITO    74 PL 48B 165        +VISENTIN,CERADINI,CONVERSI +     (FRAS+ROMA)
BENVENUT 75 PRL 35 1486       BENVENUTI,CLINE,FORD+ (HARV+PENN+WISC+FNAL)
BINTINGE 75 PRL 34 982        BINTINGER,CURRY+       (EFI+HARV+PENN+WISC)
KRISHNAS 75 PL 57B 105        KRISHNASWAMY,MENON+           (BOMBAY+OSAKA)
   ALSO 75 PRL 35 628         DE RUJULA,GEORGI,GLASHOW               (HARV)
PERL     75 PRL 35 1489       +ABRAMS,BOYARSKI,BREIDENBACH +    (LBL+SLAC)
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INTERMEDIATE BOSON SEARCHES

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M       W BOSON MASS LIMITS (GEV)
M    B   0     1.7    OR MORE  CL=.99   BERNARDIN 65 HYBR +  NEU N, CERN       2/74
M    B   0     2.0    OR MORE  CL=.90   BURNS     65 OSPK +  NEU N, BNL        2/74
M    C   0     3.8    OR MORE  CL=.90   BARISH    73 ASPK +  W+ TO LEP+NEU=.2  2/74
M    C   0     4.5    OR MORE  CL=.90   BARISH    73 ASPK +  W+ TO LEP+NEU=.5  2/74
M    C   0     4.7    OR MORE  CL=.90   BARISH    73 ASPK +  W+ TO LEP+NEU=.8  2/74
M    E   0     5.0    OR MORE  CL=.95   BERGESON  73 ELEC                      1/76*
M    B  LOOKED FOR (NEU N) TO (W+ MU- N), W+ TO (MU+ NEU, E+ NEU, OR HDRNS)    2/74
M    C  BARISH 73 LOOKED FOR (NEU N) TO (W+ MU- N), W+ TO (MU+ NEU) AT NAL.    2/74
M    C  RESULT GIVEN FOR THREE ASSUMED BR.FRACS. W+ TO (LEPTON NEU)/ALL.       2/74
M    E  BERGESON 73 LOOKED AT ENERGY DISTR OF NEU-INDUCED MUON FLUX UNDER-     1/76*
M    E  GROUND. SCALE INVARIANCE OF THE INELASTIC STRUCT FN ASSUMED.           1/76*

C       W BOSON PRODUCTION CROSS SECTION (10**-36 CM**2)
C    A   0     6.0    OR LESS           ANKENBRAN 71 CNTR +- W TO(MU NEU)=1.0  2/74
C    A  ANKENBRANDT 71 LOOKED FOR (P N)TO(W HADRONS), W TO (MU NEU) AT BNL.    2/74
C    A  THIS ASSUMES BR OF W TO MU NEU IS 1.  IN GENERAL THIS VALUE IS         2/74
C    A  6.0/BR, WHERE BR=(W TO MU NEU)/(W TO ALL).                             2/74

S       SCALAR BOSON MASS LIMITS (GEV)
S    C   0    10.0    OR MORE  CL=.90   CONVERSI  73 ASPK  0 E+E- FRASCATI     3/74
S    C  CONVERSI 73 LOOKED FOR QED VIOLATION IN E+E- SCATTERING AT 2.8 GEV     3/74
S    C  AND ASSUMED W BOSON MASS=10 GEV.  FOR MW=15 GEV, MS LIMIT= 6.5 GEV     3/74

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REFERENCES FOR INTERMEDIATE BOSON SEARCHES


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BERNARDI 65 NC 38 608         +BIENLEIN,BOHM,DARDEL,FAISSNER+        (CERN)
BURNS    65 PRL 15 42         +GOULIANOS,HYMAN,LEDERMAN,LEE +   (COLU+BNL)
ANKENBRA 71 PR D3 2582        ANKENBRANDT,LARSEN,LEIPUNER+      (BNL+YALE)
BARISH   73 PRL 31 180        +BARTLETT,BUCHHOLZ,HUMPHREY+      (CIT+FNAL)
BERGESON 73 PRL 31 66         +CASSIDAY,HENDRICKS                    (UTAH)
CONVERSI 73 PL 46B 269        +D'ANGELO,GATTO,PACLUZI                (RCMA)
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QUARK SEARCHES

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C      QUARK PRODUCTION CROSS SECT. FROM ACCELERATOR EXPTS  (CM**2)
C    Y  0  3.2E-39 OR LESS  CL=.90   ALLABY    69 CNTR Q= -1/3   M=2GEV       1/76*
C    Y  0  5.5E-38 OR LESS  CL=.90   ALLABY    69 CNTR Q= -2/3   M=2GEV       1/76*
C    Y  0  1.8E-35 OR LESS  CL=.90   ALLABY    69 CNTR Q= +1/3   M=2GEV       1/76*
C    Y  0  1.0E-35 OR LESS  CL=.90   ALLABY    69 CNTR Q= +2/3   M=2GEV       1/76*
C    A  0  4. E-37 OR LESS  CL=.90   ANTIPOV1  69 CNTR Q= -2/3   M=0-5GEV     2/74
C    A  0  3. E-39 OR LESS  CL=.90   ANTIPOV2  69 CNTR Q= -1/3   M=4.5-5GEV   1/76*
C    A  0  3. E-37 OR LESS  CL=.90   ANTIPOV2  69 CNTR Q= -2/3   M=2-5GEV     1/76*
C    V  0  1. E-36 OR LESS  CL=.90   ANTIPOV   71 CNTR Q= -4/3   M=4GEV       1/76*
C    B  0  3. E-34 OR LESS           BOTT-BODE 72 CNTR Q=+-1/3   M=0-22GEV    2/74
C    B  0  6. E-34 OR LESS           BOTT-BODE 72 CNTR Q=+-2/3   M=0-13GEV    2/74
C    P  0  1. E-32 OR LESS  CL=.90   ALPER     73 SPEC Q=  2/3   M=4-24 GEV   1/76*
C    P  0  1. E-32 OR LESS  CL=.90   ALPER     73 SPEC Q=  4/3   M=4-24 GEV   1/76*
C    L  0  1. E-35 OR LESS           LEIPUNER  73 CNTR Q=  1/3   M=0-12GEV    2/74
C    L  0  1. E-35 OR LESS           LEIPUNER  73 CNTR Q=  2/3   M=0-12GEV    2/74
C    L  0  5. E-31 OR LESS           LEIPUNER  73 CNTR Q=  4/3   M=0-12GEV    2/74
C    Y  ALLABY 69 IS A CERN 27 GEV P+BE EXPT.  STUDYS MASSES 0-2.7GEV         1/76*
C    Y  ASSUMING NN=NNQQ.  CROSS SECTIONS ASSUME ISOTROPIC PROD. IN CM.       1/76*
C    Y  CROSS SECTIONS AT 2GEV ARE GIVEN HERE.  SEE FIG.9 FOR MASS DEPEN.     1/76*
C    A  ANTIPOV1 69 IS A SERPUKHOV 70 GEV P EXPT.  MASS LIMIT FROM NN=NNQQ.   2/74
C    A  ANTIPOV1 69 AND ANTIPOV2 69 ARE SERPUKHOV 70GEV P EXPTS.  ANTIPOV2    1/76*
C    A  GIVES RESULTS FOR M=2-5GEV ASSUMING NN-->NNQQ, HADRONIC OR LEPTONIC   1/76*
C    A  QUARKS.  WE QUOTE TYPICAL VALUES.                                     1/76*
C    V  ANTIPOV 71 IS A SERPUKHOV 70 GEV P+AL EXPT.  STUDIES DIQUARK MASSES   1/76*
C    V  1.9-4.4GEV.  WE SHOW 4GEV VALUE.  SEE THEIR FIG.2 FOR MASS DEPEN.     1/76*
C    B  BOTT-BODENHAUSEN 72 IS A CERN ISR 26+26 GEV P+P EXPERIMENT.           2/74
C    P  ALPER 73 IS CERN ISR 26+26 GEV P+P EXPT. ASSUMES ISOTROPIC C.M.       1/76*
C    P  PRODUCTION.  SENSITIVE TO ANY Q>2/3.                                  1/76*
C    L  LEIPUNER 73 IS AN NAL 300 GEV P EXPERIMENT.                           2/74

D       QUARK PROD. DIFFERENTIAL CROSS SEC, ACCELERATOR EXPTS(CM**2/SR-GEV)   2/74
D    D  0  1.5E-36 OR LESS           DORFAN    65 CNTR BE TARG  M=3-7GEV      2/74
D    D  0  3. E-36 OR LESS           DORFAN    65 CNTR FE TARG  M=3-7GEV      2/74
D    Y  0  7.2E-39 OR LESS  CL=.90   ALLABY    69 CNTR Q=-1/3  THETA= 0 MR    1/76*
D    Y  0  5.2E-38 OR LESS  CL=.90   ALLABY    69 CNTR Q=-2/3  THETA=6.5MR    1/76*
D    Y  0  2.6E-35 OR LESS  CL=.90   ALLABY    69 CNTR Q=+1/3  THETA=44 MR    1/76*
D    Y  0  1.3E-35 OR LESS  CL=.90   ALLABY    69 CNTR Q=+2/3  THETA=44 MR    1/76*
D    A  0  7. E-38 OR LESS  CL=.90   ANTIPOV2  69 CNTR Q= -1/3  M=0-5GEV      1/76*
D    A  0  4. E-38 OR LESS  CL=.90   ANTIPOV2  69 CNTR Q= -2/3  M=0-2.5GEV    1/76*
D    V  0  1.6E-36 OR LESS  CL=.90   ANTIPOV   71 CNTR Q=-4/3  THETA=47 MR    1/76*
D    V  0  3.8E-36 OR LESS  CL=.90   ANTIPOV   71 CNTR Q=-4/3  THETA=47 MR    1/76*
D    J  0  5. E-34 OR LESS  CL=.90   JOVANOVIC 75 CNTR Q=1/3, M=7-15 GEV      2/76*
D    J  0  2. E-34 OR LESS  CL=.90   JOVANOVIC 75 CNTR Q=1/3, M=15-26 GEV    11/75*
D    J  0  1.3E-34 OR LESS  CL=.90   JOVANOVIC 75 CNTR Q=2/3, M=10-26 GEV    11/75*
D    J  0  8. E-35 OR LESS  CL=.90   JOVANOVIC 75 CNTR Q=4/3, M=10-26 GEV    11/75*
D    D  DORFAN 65 IS A 30 GEV/C P EXPERIMENT AT BNL.                          2/74
D    Y  SEE FOOTNOTE Y IN SUBSECTION C ABOVE.                                 2/76*
D    A  SEE FOOTNOTE A IN SUBSECTION C ABOVE.                                 2/76*
D    V  FIRST ANTIPOV 71 VALUE IS FOR M=1.9-2.3,2.7-4.4GEV, SECOND IS FOR     1/76*
D    V  M=2.3-2.7GEV.  SEE ALSO NOTE V IN SECTION C ABOVE.                    1/76*
D    J  JOVANOVICH 75 FIG.4 COVERS RANGES Q=1/3 TO 2 AND M=3 TO 26 GEV.      11/75*
D    J  THIS IS A CERN ISR 26+26, 22+22 GEV P+P EXPERIMENT.                   2/76*

F      QUARK FLUX FROM COSMIC RAY EXPERIMENTS  (NUMBER/CM**2-SR-SEC)          2/74
F    C  0  3. E-10 OR LESS           BJORNBOE  68 CNTR M=5GEV OR MORE         2/74
F       0  2.2E-8  OR LESS           FRANZINI  68 CNTR V=.5-.9C  M=2GEV UP    2/74
F       0  2.4E-8  OR LESS  CL=.95   KASHA     68 OSPK V=.5-.75C M=5-15GEV    2/74
F       0  5. E-11 OR LESS  CL=.90   FUKUSHIMA 69 CNTR Q=1/3  SEA LEVEL       2/74
F       0  7.5E-10 OR LESS  CL=.90   FUKUSHIMA 69 CNTR Q=2/3  SEA LEVEL       2/74
F    M  1  EVENT CLAIMED             MCCUSKER  69 CC   Q=2/3                  2/74
F    B  0  1. E-10 OR LESS  CL=.90   BOHM      72 CNTR Q=1/3                  2/74
F    B  0  1. E-10 OR LESS  CL=.90   BOHM      72 CNTR Q=2/3                  2/74
F    H  0  1.7E-8  OR LESS  CL=.90   HICKS     73 CNTR Q=  1/3                1/76*
F    H  0  1.7E-8  OR LESS  CL=.90   HICKS     73 CNTR Q=  2/3                1/76*
F    C  BJORNBOE 68 LOOKED FOR DELAYED PARTICLES AFTER AIR SHOWERS.           2/74
F    M  MC CUSKER 69 CLAIMS 1 CANDIDATE.   LATER SIMILAR EXPTS. SEE NONE.     2/74
F    B  BOHM 72 IS FLUX IN 10**14 TO 10**15 EV AIR SHOWERS                    2/74
F    H  HICKS 73 LOOKED AT LARGE ZENITH ANGLES, THUS USING THE ATMOSPHERE     1/76*
F    H  AS AN EXTENDED FILTER FOR HADRONIC QUARKS. THEIR SEARCH PUTS AN       1/76*
F    H  UPPER LIMIT ON LEPTONIC QUARK FLUX IN COSMIC RAYS.                    1/76*

RHO    QUARK CONCENTRATION IN MATTER (QUARKS PER NUCLEON)
RHO     0    3 E-29 OR LESS          CHUPKA    66 CNTR    SEAWATER            2/74
RHO     0    1 E-16 OR LESS          GALLINARO 66 CNTR    GRAPHITE            2/74
RHO     0    4 E-19 OR LESS          STOVER    67 CNTR    IRON                2/74
RHO     0    1 E-20 OR LESS          RANK      68 CNTR    OIL                 2/74
RHO     0    1 E-24 OR LESS          COOK      69 CNTR    SEAWATER            2/74
RHO     0    1 E-23 OR LESS          COOK      69 CNTR    ROCK SAMPLES        2/74

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REFERENCES FOR QUARK SEARCHES


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DORFAN   65 PRL 14 999        +EADES,LEDERMAN,LEE,TING                    (COLU)
CHUPKA   66 PRL 17 60         +SCHIFFER,STEVENS                            (ANL)
GALLINAR 66 PL 23 609         GALLINARO,MORPURGO                          (GENO)
STOVER   67 PR 164 1599       + MORAN,TRISCHKA                            (SYRA)
BJORNBOE 68 NC B53 241        +DAMGARD,HANSEN,CHATTERJEE+            (BOHR+BERN)
FRANZINI 68 PRL 21 1013       FRANZINI,SHULMAN                            (COLU)
KASHA    68 PR 172 1297       +STEFANSKI                              (BNL+YALE)
RANK     68 PR 176 1635       D.M.RANK                                    (MICH)
ALLABY   69 NC 64A 75         +BIANCHINI,DIDDENS,DOBINSON,HARTUNG+ (CERN)
ANTIPOV1 69 PL 29B 245        +KARPOV,KHROMOV,LANDSBERG,LAPSHIN+    (SERP)
ANTIPOV2 69 PL 30B 576        +BOLOTOV,DEVISHEV,DEVISHEVA,ISAKOV+   (SERP)
COOK     69 PR 188 2092       +DEPASQUALI,FRAUENFELDER,PEACOCK +     (ILL)
FUKUSHIM 69 PR 178 2058       FUKUSHIMA,KIFUNE,KONDO,KOSHIBA+       (TOKY)
MCCUSKER 69 PRL 23 658        MCCUSKER,CAIRNS                     (SYDNEY)
ANTIPOV  71 NP B27 374        +KACHANOV,KUTJIN,LANDSBERG,LEBEDEV + (SERP)
BOHM     72 PRL 28 326        +DIEMONT,FAISSNER,FASOLD,KRISOR+      (AACH)
BOTT-BOD 72 PL 40B 693        +CALDWELL,FABJAN,GRUHN,PEAK+     (CERN+MPIM)
ALPER    73 PL 46B 265        BRITISH-SCANDINAVIAN COLLABORATION
HICKS    73 NC 14A 65         +FLINT,STANDIL                        (MANI)
LEIPUNER 73 PRL 31 1226       +LARSEN,SESSOMS,SMITH,WILLIAMS+  (BNL+YALE)
JOVANOVI 75 PL 56B 105        JOVANOVICH+ (MANI+AACH+CERN+GENO+HARV+TORI)
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PAPERS NOT REFERRED TO IN DATA CARDS

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ZAITSEV  72 SJNP 15 656       +LANDSBERG  -REVIEW PAPER-            (SERP)
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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

PARTICLE SEARCHES

MAGNETIC MONOPOLE SEARCHES

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C        MONOPOLE PROD. CROSS SECTION - ACCELERATOR EXP.      (CM**2)/NUCLEON
C    A    0    1 E-40 OR LESS  CL=.95   AMALDI    63 EMUL    M=0 TO 3 GEV      12/75*
C    A    0    5 E-41 OR LESS  CL=.95   AMALDI    63 EMUL    M=0 TO 3.4 GEV    12/75*
C    P    0    2 E-40 OR LESS           PURCELL   63 CNTR    M=0 TO 3 GEV      12/75*
C    G    0    4 E-43 OR LESS  CL=.95   GUREVICH  72 EMUL    M=0-5 GEV          3/74
C    C    0    6 E-42 OR LESS  CL=.95   CARRIGAN  73 CNTR Q=1/6-24 DIRAC CHAR   3/74
C    M    0    5 E-42 OR LESS  CL=.95   CARRIGAN  74 CNTR    Q=1/30 TO 24      12/75*
C    N    0    1 E-39 OR LESS  CL=.95   CARRIGAN  75 HLBC    NEU ENERGY=1.0     1/76*
C    N    0    4 E-38 OR LESS  CL=.95   CARRIGAN  75 HLBC    NEU ENERGY=5.0     1/76*
C    N    0    1 E-37 OR LESS  CL=.95   CARRIGAN  75 HLBC    NEU ENERGY=8.0     1/76*
C    E    0    5 E-44 OR LESS  CL=.95   EBERHARD  75 CNTR    M=0 TO 12 GEV     11/75*
C    I    0    2 E-36 OR LESS  CL=.95   GIACOMELL 75 EMUL    M=0 TO 20 GEV      2/76*
C    A   AMALDI 63 USES 28 GEV PROT BEAM AT CERN PS. FIRST RESULT IS FOR       12/75*
C    A   PROTON TARGET, SECOND IS FOR NUCLEON TARGET INSIDE NUCLEUS.           12/75*
C    P   PURCELL 63 LOOKS FOR MONOPOLES PRODUCED BY 30 GEV PROT AT THE AGS.    12/75*
C    G   GUREVICH 72 IS A SERPUKHOV 70 GEV/C P EXP. MASS LIMIT FROM PP=PPMM     3/74
C    C   CARRIGAN 73 IS NAL 300 GEV P EXP. MASS LIMIT 0-12 GEV FROM PP=PPMM     3/74
C    M   CARRIGAN 74 IS NAL 400 GEV EXP.  MASS LIMIT 0-13.7 GEV/MONOPOLE.      12/75*
C    N   CARRIGAN 75 REEXAMINES OLD CERN NEUTRINO EXPTS IN HLBC. NEU ENERGY     1/76*
C    N   GIVEN AT RIGHT REPRESENTS NEUTRINO THRESHOLD ENERGY.                   1/76*
C    N   THESE VALUES ARE IN UNITS CM**2/NUCLEUS.                               1/76*
C    E   EBERHARD 75 USED NAL TARGETS - 300 GEV AND 400 GEV P ON ALUMINUM.      2/76*
C    E   Q=1-7 DIRAC CHGS.  USED SAME TYPE OF DETECTOR AS ROSS 73.              2/76*
C    I   GIACOMELLI 75 IS CERN ISR EXP., M=0-30 GEV, Q=0.4-2.5 DIRAC CHGS.      2/76*

CS       MONOPOLE PROD. CROSS SECTION - SEARCH IN MATTER      (CM**2)/NUCLEON
CS   G    0    5 E-38 OR LESS           GOTO      63 EMUL    M=1 GEV           12/75*
CS   G    0    5 E-36 OR LESS           GOTO      63 EMUL    M=10 GEV          12/75*
CS   G    0    5 E-33 OR LESS           GOTO      63 EMUL    M=100 GEV         12/75*
CS        0    3 E-40 OR LESS  CL=.95   PETUKHOV  63 CNTR    METEORITE         12/75*
CS   C    0    1 E-38 OR LESS  CL=.90   CARITHERS 66 ELEC    M=2 GEV           12/75*
CS   C    0    7 E-37 OR LESS  CL=.90   CARITHERS 66 ELEC    M=10 GEV          12/75*
CS   C    0    1 E-35 OR LESS  CL=.90   CARITHERS 66 ELEC    M=25 GEV          12/75*
CS   F    0    5 E-43 OR LESS  CL=.90   FLEISCH1  69 CNTR    M=1 GEV            2/76*
CS   F    0    2 E-40 OR LESS  CL=.90   FLEISCH1  69 CNTR    M=10 GEV           2/76*
CS   F    0    3 E-37 OR LESS  CL=.90   FLEISCH1  69 CNTR    M=100 GEV          2/76*
CS   F    0    5 E-34 OR LESS  CL=.90   FLEISCH1  69 CNTR    M=1000 GEV         2/76*
CS   F    0    1 E-29 OR LESS  CL=.90   FLEISCH1  69 CNTR    M=10000 GEV        2/76*
CS   K    0    1 E-42 OR LESS  CL=.95   KOLM      71 CNTR    M=1.5 GEV          3/74
CS   K    0    1 E-42 OR LESS  CL=.95   KOLM      71 CNTR    M=10 GEV           3/74
CS   K    0    1 E-37 OR LESS  CL=.95   KOLM      71 CNTR    M=100 GEV          3/74
CS   K    0    1 E-34 OR LESS  CL=.95   KOLM      71 CNTR    M=1000 GEV         3/74
CS   K    0    1 E-31 OR LESS  CL=.95   KOLM      71 CNTR    M=1500 GEV         3/74
CS   R    0    1 E-43 OR LESS  CL=.95   ROSS      73 ELEC    M=2 GEV            3/74
CS   R    0    5 E-41 OR LESS  CL=.95   ROSS      73 ELEC    M=10 GEV           3/74
CS   R    0    5 E-38 OR LESS  CL=.95   ROSS      73 ELEC    M=100 GEV          3/74
CS   G   GOTO 63 EXAMINES MAGNETITE ROCK IN THE ADIRONDACK MOUNTAINS.          12/75*
CS   C   CARITHERS 66 LIMITS ABOVE ARE FOR NUCLEON-NUCLEON INTERACTIONS.       12/75*
CS   C   LIMITS FOR PHOTONUCLEON PRODUCTION ARE 10**3 TIMES LARGER.            12/75*
CS   F   FLEISCHER 69 LOOKED FOR MONOPOLES IN SEDIMENTS AT BOTTOM OF OCEAN      3/74
CS   F   DEPOSITED DURING THE LAST 16 MILLION YEARS. Q=60 DIRAC CHAR.OR LESS    3/74
CS   K   KOLM 71 TRIED TO DETECT MONOP. IN DEEP SEAWATER Q=.2-27 DIRAC CHAR.    2/76*
CS   R   ROSS 73 TRIED TO DETECT MONOP. IN LUNAR DUST     Q=.4-36 DIRAC CHAR    2/76*
CS   R   OR LARGER CHARGES EXCEPT FOR G= N*36*GO, WITH N INTEGER.  THEY ALSO    3/74
CS   R   REPORT LIMIT OF DENSITY IN LUNAR MATERIAL AS 1.7*10**-4 MONOP./GM.     2/76*

F        MONOPOLE FLUX IN COSMIC RAYS (NUMBER/CM**2-SEC-SR)
F         0    1 E-13 OR LESS           GOTO      63 EMUL    KE TO 10**4 GEV   12/75*
F         0    5 E-15 OR LESS  CL=.90   CARITHERS 66 ELEC                      12/75*
F    F    0    3 E-19 OR LESS  CL=.90   FLEISCH2  69 SCAN    KE TO 10**10 GEV  12/75*
F         0    2 E-18 OR LESS           KOLM      71 CNTR    KE TO 10**5 GEV   12/75*
F    R    0    5 E-19 OR LESS  CL=.95   ROSS      73 ELEC    KE TO 10**4 GEV   12/75*
F   P     1    1 E-13                   PRICE     75 EMUL    M GT 200 GEV      12/75*
F    F   FLEISCHER 2 69 LOOKED FOR MONOPOLE TRACKS LEFT IN OBSIDIAN AND MICA   12/75*
F    F   OVER GEOLOGICAL TIMES.                                                12/75*
F    R   ROSS 73 INCLUDES DATA OF EBERHARD 71 PAPER.                           12/75*
F    P   SEE ALVAREZ 75 FOR ALTERNATIVE EXPLANATION OF PRICE 75 EVENT.         12/75*
F    P   SEE EBERHARD 75 FOR DISCUSSION OF CONFLICT WITH OTHER EXPERIMENTS.    12/75*
F    P   NOT CONSIDERED CONVINCING EVIDENCE FOR THE EXISTENCE OF MONOPOLES.    12/75*

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REFERENCES FOR MAGNETIC MONOPOLE SEARCHES


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AMALDI    63 NC 28 773          +BARONI,MANFREDINI,BRADNER+(ROMA+UCSD+CERN)
GOTO      63 PR 132 387         +KOLM,FORD                   (TOKY+MIT+BRAN)
PETUKHOV  63 NP 49 87           +YAKIMENKO                           (LEBD)
PURCELL   63 PR 129 2326        +COLLINS,FUJII,HORNBOSTEL,TURKOT (HARV+BNL)
CARITHER  66 PR 149 1070        CARITHERS,STEFANSKI,ADAIR            (YALE)
FLEISCH1  69 PR 184 1393        FLEISCHER,HART,JACOBS+    (GESC+UNCS+GSCO)
   ALSO   70 JAP 41 958         FLEISCHER,HART,JACOBS,PRICE,SCHWARTZ+(GESC)
FLEISCH2  69 PR 184 1398        FLEISCHER,PRICE,WOODS                (GESC)
   ALSO   70 JAP 41 958         FLEISCHER,HART,JACOBS,PRICE,SCHWARTZ+(GESC)
KOLM      71 PR D4 1285         +VILLA,ODIAN                     (MIT+SLAC)
GUREVICH  72 PL 38B 549         +KHAKIMOV,MARTEMIANOV+     (KIAE+NOVO+SERP)
   ALSO   70 PL 31B 394         GUREVICH,KHAKIMOV +        (KIAE+NOVO+SERP)
   ALSO   72 JETP 34 917        BARKOV, GUREVICH,          (KIAE+NOVO+SERP)
CARRIGAN  73 PR D8 3717         +NEZRICK,STRAUSS                     (FNAL)
ROSS      73 PR D8 698          +EBERHARD,ALVAREZ,WATT           (LBL+SLAC)
   ALSO   71 PR D4 3260         EBERHARD,ROSS,ALVAREZ,WATT       (UCB+SLAC)
CARRIGAN  74 PR D10 3867        +NEZRICK,STRAUSS                     (FNAL)
CARRIGAN  75 NP B91 279         +NEZRICK                             (FNAL)
   ALSO   71 PR D3 56           CARRIGAN,NEZRICK                     (FNAL)
EBERHARD  75 PR D11 3099        +ROSS,TAYLOR,ALVAREZ,OBERLACK    (LBL+MPIM)
GIACOMEL  75 NC 28A 21          GIACOMELLI,ROSSI+     (BGNA+CERN+SACL+ROMA)
PRICE     75 PRL 35 487         +SHIRK,OSBORNE,PINSKY         (UCB+HOUSTON)
   ALSO   75 LBL-4260           LUIS ALVAREZ                          (LBL)
   ALSO   75 LBL-4289           PHILIPPE EBERHARD                     (LBL)
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CHARMED HADRON SEARCHES

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CE       CHARMED HADRON PRODUCTION CROSS SECTION(E+ E-) (UNITS 10**-35 CM**2)
CE   B    0   18.     OR LESS  CL=.90   BOYARSKI  75 SPEC K- PI+, K+ PI-        2/76*
CE   B    0   40.     OR LESS  CL=.90   BOYARSKI  75 SPEC KOS PI+ PI-           2/76*
CE   B    0   13.     OR LESS  CL=.90   BOYARSKI  75 SPEC PI+ PI-               2/76*
CE   B    0   12.     OR LESS  CL=.90   BOYARSKI  75 SPEC K+ K-                 2/76*
CE   B    0   49.     OR LESS  CL=.90   BOYARSKI  75 SPEC K-PI+PI+, K+PI-PI-    2/76*
CE   B    0   27.     OR LESS  CL=.90   BOYARSKI  75 SPEC KOS PI+, KOS PI-      2/76*
CE   B    0   33.     OR LESS  CL=.90   BOYARSKI  75 SPEC KOS K+, KOS K-        2/76*
CE   B    0   38.     OR LESS  CL=.90   BOYARSKI  75 SPEC PI+PI-PI+,PI+PI-PI-   2/76*
CE   B    0   90.     OR LESS  CL=.90   BOYARSKI  75 SPEC K+PI-,KOPI+PI- + CC   2/76*
CE   B    0   16.     OR LESS  CL=.90   BOYARSKI  75 SPEC K+ K-, PI+ PI-        2/76*
CE   B    0   51.     OR LESS  CL=.90   BOYARSKI  75 SPEC K+PI-PI-,KOPI+ + CC   2/76*
CE   B    0   76.     OR LESS  CL=.90   BOYARSKI  75 SPEC KOK+,PI+PI+PI- + CC   2/76*
CE   P   64    1.9       0.5            PERL      75 SPEC    E(OR MU) NEUTRI.   2/76*
CE   B   BOYARSKI 75 IS SLAC(SPEAR) EXPT.  LOOKED FOR E+E- --> D ANYTHING       2/76*
CE   B   AT ECM=4.8 GEV WHERE CHARMED MESON D DECAYED VIA CHANNELS SHOWN.       2/76*
CE   B   ABOVE VALUES ARE FOR D MASS=1.85-2.40 GEV.  SIMILAR LIMITS ARE         2/76*
CE   B   GIVEN FOR MASS=1.50-1.85, 2.40-4.00 GEV IN THEIR TABLE 1.              2/76*
CE   P   PERL 75 IS SLAC(SPEAR) EXPT .  EVENTS ARE E+E- TO E+-MU-+ AND 2 OR     2/76*
CE   P   MORE MISSING PARTICLES.  CS IS FOR ECM=4.8 GEV AND THETA=50-130DEG.    2/76*
CE   P   CROSS SECTION RISES FROM 5X10**-36 AT E=4 TO ABOVE MAX. THEN DROPS     2/76*
CE   P   TO 6E-36  AT E=7.5.   AUTHORS SAY THESE EVENTS HAVE NO CONVENTIONAL    2/76*
CE   P   EXPLANATION.  SUGGEST HEAVY LEPTON OR CHARMED HADRON, M=1.6-2.0GEV.    2/76*

CPI      CHARMED HADRON PRODUCTION CROSS SECTION (PI NUCLEON)    (CM**2)        2/76*
CPI  H    0  4. E-30 OR LESS  CL=.95   HAGOPIAN  76 DBC  SHORT LIVED 2-5GEV     2/76*
CPI  H    1  7. E-31 OR LESS  CL=.95   HAGOPIAN  76 DBC  LONG LIVED 1.9-2GEV    2/76*
CPI  H    0  3. E-31 OR LESS  CL=.95   HAGOPIAN  76 DBC  LONG LIVED1-1.9,2-5    2/76*
CPI  H   HAGOPIAN 76 IS A SLAC 15GEV PI+ D EXPT.  ALL POSSIBLE TWO AND THREE    2/76*
CPI  H   BODY MASS COMBINATIONS WERE STUDIED FOR NARROW RESONANCES WITH MASS    2/76*
CPI  H   1.5-5GEV FOR MESONS AND 2-5GEV FOR BARYONS.  INDIVIDUAL LIMITS FOR     2/76*
CPI  H   TWO AND THREE BODY DECAY FROM MANY REACTIONS ARE GIVEN.                2/76*
CPI  H   VEES WERE STUDIED FOR THE POSSIBILITY OF A NEW LONG LIVED (MEAN        2/76*
CPI  H   LIFE 1E-11 SEC. OR MORE) NEUTRAL PARTICLE.  ONE CANDIDATE WITH MASS    2/76*
CPI  H   1.9-2 GEV WAS FOUND.  SECOND LONG LIVED LIMIT FOR M=1-1.9, 2-5 GEV.    2/76*

CP       CHARMED HADRON PRODUCTION CROSS SECTION (P NUCLEON)    (CM**2)
CP   A    0  1. E-33 OR LESS                AUBERT    75 SPEC    PI+ K-         2/76*
CP   A    0  4. E-33 OR LESS                AUBERT    75 SPEC    K+ PI-         2/76*
CP   A    0  1. E-33 OR LESS                AUBERT    75 SPEC    K+ K-          2/76*
CP   A    0  8. E-33 OR LESS                AUBERT    75 SPEC    PI+ PI-        2/76*
CP   A    0  7. E-33 OR LESS                AUBERT    75 SPEC    P K-           2/76*
CP   A    0  2. E-33 OR LESS                AUBERT    75 SPEC    K+ PBAR        2/76*
CP   A    0  4. E-32 OR LESS                AUBERT    75 SPEC    P PI-          2/76*
CP   A    0  2. E-33 OR LESS                AUBERT    75 SPEC    PI+ PBAR       2/76*
CP   A   AUBERT 75 IS A BNL 30 GEV EXPT.  LOOKS FOR P BE --> JPRIME ANYTHING    2/76*
CP   A   WHERE JPRIME DECAYED VIA THE CHANNEL SHOWN.  ABOVE VALUES ARE          2/76*
CP   A   FOR M=2.25GEV AND ASSUME A WIDTH SMALL COMPARED TO THE RESOLUTION.     2/76*
CP   A   UPPER LIMITS ARE ALSO GIVEN FOR THE ABOVE CHANNELS AND P PBAR FOR      2/76*
CP   A   M=3.1 AND 3.7 GEV.  THOSE LIMITS RANGE FROM 7E-36 TO 4E-33.            2/76*

Y        CHARMED HADRON (Y) EVIDENCE IN NEUTRINO NUCLEON --> 2 MUONS ANYTHING
Y    B   14MU+MU-   OMU-MU-   OMU+MU+      BENVENU1  75 SPEC    PREDOM. NEU BEAM   2/76*
Y    B   51MU+MU-   7MU-MU-   3MU+MU+      BENVENU3  75 SPEC    6/7 NEU BEAM       2/76*
Y    B    5MU+MU-   OMU-MU-   2MU+MU+      BENVENU5  75 SPEC    9/10ANTINEU BEAM   2/76*
Y    B   BENVENUTI 75 ARE FNAL NEUTRINO NUCLEON EXPERIMENTS WHICH LOOKED FOR    2/76*
Y    B   TWO OR MORE MUONS IN THE FINAL STATE.  NO TRIMUON EVENTS WERE SEEN.    2/76*
Y    B   AUTHORS STATE THAT THESE DIMUON EVENTS REQUIRE THE EXISTENCE OF ONE    2/76*
Y    B   OR MORE NEW PARTICLES WITH M=2-4GEV AND TAU=10**-10SEC. OR LESS.       2/76*
Y    B   BENVENUTI4 75 SHOW THAT THE OBSERVED PROPERTIES OF THESE EVENTS        2/76*
Y    B   DO NOT AGREE WITH HYPOTHESES OF HEAVY LEPTON OR INTERMEDIATE VECTOR    2/76*
Y    B   BOSON.  THEY SUGGEST A HADRON (Y) WITH A NEW QUANTUM NUMBER.           2/76*

VO       CHARMED HADRON EVIDENCE IN NEUTRINO NUCLEON --> MU- E+ VO ANYTHING
VO        WHERE THE VO IS A KOS OR A LAMBDA
VO   B    1 EVENT                        DEDEN     75 HLBC                    2/76*
VO   B    1 EVENT                        BLIETSCHA 75 HLBC                    2/76*
VO   V    4 EVENTS                       VONKROGH  76 HLBC                    2/76*
VO   B   THE DEDEN 75 AND BLIETSCHAU 75 EVENTS ARE FROM CERN                    2/76*
VO   B   GARGAMELLE NEUTRINO EXPOSURES.  THE MASSES OF THE E+ VO SYSTEM FOR     2/76*
VO   B   THE TWO EVENTS ARE 1.24, 1.91 GEV FOR LAMBDA OR 0.65, 1.57 FOR KO.     2/76*
VO   V   THE VON KROGH 76 EVENTS ARE FROM AN FNAL 15 FT NEON BUBBLE CHAMBER     2/76*
VO   V   EXPOSURE.  ALL FOUR E+ EVENTS FOUND HAVE ASSOCIATED KOS.               2/76*

BAR      CHARMED BARYON EVIDENCE IN NEUTRINO P --> MU- LAMBDA 3PI+ PI-
BAR  C    1 EVENT (3 CONSTRAINT FIT)    CAZZOLI   75 HBC       M=2.426+-.012GEV 2/76*
BAR  C   CAZZOLI 75 IS A BNL NEUTRINO EXPT.  AUTHORS INTERPRET THIS ONE         2/76*
BAR  C   EVENT AS EITHER A LARGE VIOLATION OF THE DS=DQ RULE OR AS A CHARMED    2/76*
BAR  C   BARYON DECAYING TO LAMBDA 3PI+ PI-.                                    2/76*

R1       CHARMED HADRON (Y) BRANCHING RATIO INTO (MU NEU ANYTHING)/HADRONS
R1   B    8     A FEW PERCENT               BENVENU2  75 SPEC    FNAL NEUTRINO NU  2/76*
R1   B   BENVENUTI2 75 LOOKS AT ANTINEUTRINO NUCLEON --> MUON HADRONS.  SEES    2/76*
R1   B   EXCESS EVENTS ABOVE INCIDENT ENERGY 30 GEV.  COMPARES BENVENUTI1 75    2/76*
R1   B   DIMUON EVENTS WITH EXCESS EVENTS TO GET BRANCHING RATIO.               2/76*

R2       CHARMED HADRON (ASSOC. VO) BRANCHING RATIO INTO SEMILEPTONICS/ALL
R2   B    2     0.1    OR MORE              BLIETSCHA 75 HLBC    M=2.5-4 GEV    2/76*
R2   B   THIS BR.RATIO AND MASS ARE REQD. BY OBSERVED RATE AND CHARM SCHEME.    2/76*

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REFERENCES FOR CHARMED HADRON SEARCHES


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AUBERT    75 PRL 35 416         +BECKER,BIGGS,BURGER,CHEN+         (MIT+BNL)
BENVENU1  75 PRL 34 419         BENVENUTI,CLINE,FORD+ (HARV,PENN,WISC,FNAL)
BENVENU2  75 PRL 34 597         BENVENUTI,CLINE,FORD+ (HARV,PENN,WISC,FNAL)
   ALSO   74 PRL 33 984         AUBERT,BENVENUTI+     (HARV,PENN,WISC,FNAL)
BENVENU3  75 PRL 35 1199        BENVENUTI,CLINE,FORD+ (HARV,PENN,WISC,FNAL)
BENVENU4  75 PRL 35 1203        BENVENUTI,CLINE,FORD+ (HARV,PENN,WISC,FNAL)
BENVENU5  75 PRL 35 1249        BENVENUTI,CLINE,FORD+ (HARV,PENN,WISC,FNAL)
BOYARSKI  75 PRL 35 196         +BREIDENBACH,BULOS,DAKIN,FELDMAN+(SLAC+LBL)
CAZZOLI   75 PRL 34 1125        +CNOPS,CONNOLLY,LOUTTIT,MURTAGH+      (BNL)
DEDEN     75 PL 58B 361              (AACH+BRUX+CERN+EPOL+MILA+ORSA+LOUC)
PERL      75 PRL 35 1489        +ABRAMS,BOYARSKI,BREIDENBACH +       (SLAC)
BLIETSCH  75 CERN/D.PH.II/PHYS 75-49  (AACH+BRUX+CERN+EPOL+MILA+ORSA+LOUC)
HAGOPIAN  76 PRL 36 296         +WILKINS,WIND,HAGOPIAN,ALBRIGHT+ (FSU+BRAN)
VONKROGH  76 (TO BE PUBL.)      +FRY,CAMERINI,CLINE+   (WISC+LBL+CERN+HAWA)
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Stable Particles

PARTICLE SEARCHES

For notation, see key at front of Listings.

OTHER STABLE PARTICLE SEARCHES

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       SEARCHES FOR STABLE PARTICLES (I.E. PARTICLES IMMUNE TO DECAY VIA
       THE STRONG INTERACTION) NOT AMONG ABOVE SEARCHES ARE LISTED HERE.

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D      HEAVY PARTICLE PRODUCTION DIFFERENTIAL CROSS SECTION (CM**2/SR-GEV)
D   A   0  1. E-31 OR LESS  CL=.90   APPEL     74 CNTR +- M=3.2-7.2 GEV      2/76*
D   J   0  8. E-35 OR LESS  CL=.90   JOVANOVIC 75 CNTR +- M=15-26 GEV        2/76*
D   J   0  1.5E-34 OR LESS  CL=.90   JOVANOVIC 75 CNTR Q=+-2, M=3-10 GEV     2/76*
D   J   0  6. E-35 OR LESS  CL=.90   JOVANOVIC 75 CNTR Q=+-2, M=10-26 GEV    2/76*
D   A  APPEL 74 IS NAL 300 GEV P+W EXPERIMENT.  STUDIES FORWARD PRODUCTION   2/76*
D   A  OF HEAVY (UP TO 24 GEV) CHARGED PARTICLES WITH MOMENTA 24-200GEV(-)   2/76*
D   A  AND 40-150GEV (+CHG).  ABOVE TYPICAL VALUE IS FOR 75 GEV.             2/76*
D   J  JOVANOVICH 75 IS A CERN ISR 26+26 AND 15+15 GEV P+P EXPERIMENT.       2/76*
D   J  FIG.4 COVERS RANGES Q=1/3 TO 2 AND M=3 TO 26 GEV.                     2/76*

F      HEAVY PARTICLE FLUX IN COSMIC RAYS (NUMBER/CM**2-SEC-SR)              1/76*
F   Y   5   6 E-9  OR MORE           YOCK      74 CNTR    M GT 6 GEV         1/76*
F   Y  YOCK 74 EVENTS COULD BE TRITONS.                                      1/76*

C      LIGHT (BETWEEN MU AND E MASSES) PARTICLE MASS(UNITS-ELECTRON MASSES)
C       0   NONE BETWEEN 2 AND 13    BLAGOV    75 CNTR SPINOR,TAU=2E-10SEC   2/76*
C       0   NONE BETWEEN 2 AND 10.6  BLAGOV    75 CNTR SCALAR,TAU=2E-10SEC   2/76*

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REFERENCES FOR OTHER STABLE PARTICLE SEARCHES


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APPEL    74 PRL 32 428         +BOURQUIN,GAINES,LEDERMAN,PAAR+  (COLU+NAL)
YOCK     74 NP B76 175         P.C.M.YOCK                (UNIV OF AUCKLAND)
BLAGOV   75 YAD.FIZ. 21,300    +KOMAR,MURASHOVA,SYREISHCHIKOVA+     (LEBD)
JOVANOVI 75 PL 56B 105         JOVANOVICH+ (MANI+AACH+CERN+GENO+HARV+TORI)

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Data Card Listings

For notation, see key at front of Listings.

Mesons

$\pi^{\pm}$, π^{0}, η, $\rho(770)$

S=0 MESON STATES

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π±

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8  CHARGED PION(140,JPG=0--) I=1

SEE STABLE PARTICLE DATA CARD LISTINGS
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π0

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9  NEUTRAL PION(135,JPG=0--) I=1

SEE STABLE PARTICLE DATA CARD LISTINGS
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η

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14  ETA(549,JPG=0-+) I=0

SEE STABLE PARTICLE DATA CARD LISTINGS
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ρ(770)

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9  RHO(770, JPG = 1-+) I=1
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                    9  RHO MASS (MEV)

M      WE NO LONGER LIST S-WAVE BREIT-WIGNER FITS, PBAR P DATA WITH HIGH
M      COMBINATORIAL BACKGROUND, AND INSIGNIFICANT OR DOUBTFUL DATA.

M   MIXED CHARGES
M      240 (752.0)                        ALITTI     63 HBC   -0 1.6 PI-P
M      290 (755.0)                        CHADWICK   63 HBC  +-0 0.0 PBAR P

M      CHARGED ONLY
M          (748.0)                        KENNEY     62 HBC   -  1.2 PI-P
M      130 (775.0)                        GUIRAGOSS  63 HBC   -  3.3 PI-P
M   R      (760.0)    (9.0)               CARMCNY    64 HBC   +  3.5 PI+P,TCUT 4
M   R      (768.0)    (5.0)               BLIEDEN    65 MMSP  -  3-5 PI- P        6/66
M   R      (765.0)    (5.0)               ALFF-STEI  66 HBC   +  2-3 PI+ P        6/66
M   R      (760.0)    (5.0)               HAGOPIAN1  66 HBC   -  3.0 PI- P        6/66
M   R      (765.0)    (5.0)               HAGOPIAN2  66 HBC   -  2.14 PI-,TCUT12  9/67
M   R 2775 (753.5)   (10.5)               JACOBS     66 HBC   -  2-3PI-,T CUT 20  6/68
M   R      (758.0)   (10.0)               JAMES      66 HBC   +  2.1 PI+,TCUT2.5  8/66
M   R      (749.0)    (3.0)               WEST       66 HBC   -  2.1 PI- P       10/66
M   Z  900  767.       6.                 EISNER     67 HBC   -  4.2 PI-,T CUT10  1/73
M   R      (768.0)    (5.0)               MILLER     67 HBC   -  2.7 PI-,T CUT20  9/66
M   R      (773.0)    (2.0)               BATCN      68 HBC   -  2.8 PI-,T CUT13  7/69
M     1700 (782.)     (5.)                FOSTER     68 HBC   +- PBAR P AT REST   1/73
M     9650  764.3      1.9       1.8      PISUT      68 RVUE  -  1.7-3.2PI-,CT10  6/68
M   A 9650 (764.3)   (19.2)     (3.3)     PISUT      68 RVUE  -  1.7-3.2PI-,CT10  6/68
M   A   ERRORS ARE 2 STD AND INCLUDE SYSTEMATIC UNCERTAINTIES FROM THEORY
M   X 1300  777.0      5.0                REYNOLDS   69 HBC   -  2.26 PI- P       1/73
M   X 6500  766.       7.                 BYERLY     73 OSPK  -  5. PI- P         2/74
M   X   SYSTEMATIC ERRORS ADDED CORRESP. TO SPREAD OF DIFFERENT FITS.
M          . . . . . . . . . .
M   AVG     765.9      2.2      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
M   STUDENT 765.6      1.9      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

MO  NEUTRAL ONLY
MO     190 (750.0)   (20.0)               SAMIOS     62 HBC    0 4.7 PI-P
MO  R  300 (760.0)   (10.0)               ABOLINS    63 HBC    0 3.5 PI+P
MO     160 (775.0)                        GUIRAGOSS  63 HBC    0 3.3 PI-P
MO  R  500 (770.0)   (10.0)               GOLDHABER  64 HBC    0 3.7 PI+P
MO  R      (750.0)    (5.0)               ALFF-STEI  66 HBC    0 2-3 PI+ P        6/66
MO  R      (775.0)    (5.0)               HAGOPIAN1  66 HBC    0 3.0 PI- P        6/66
MO  R      (770.)     (5.)                HAGOPIAN2  66 HBC    0 2.1 PI-,TCUT 12  2/67
MO  R 4207 (758.0)    (7.5)               JACOBS     66 HBC    0 2-3PI-,T CUT 20  6/68
MO  R      (765.0)    (8.0)               JAMES      66 HBC    0 2.1 PI+ P        6/66
MO  R      (760.0)    (3.0)               WEST       66 HBC    0 2.1 PI- P       10/66
MO  P 4000 (765.)     (5.0)               ASBURY 2   67 CNTR   0 GAMMA + PB       1/73
MO  R      (768.0)    (2.0)               BACON      67 HBC    0 1.7 PI-P         9/67
MO  R      (761.)     (3.)                HUWE       67 HBC    0 2.4 PI- P        7/67
MO  R      (770.0)    (4.0)               MILLER     67 HBC    0 2.7 PI-,T CUT20  9/66
MO  R      (775.0)    (2.0)               ARMENISE   68 DBC    0 5.1 PI+D         6/68
MO    1900 (776.)     (5.)                FOSTER     68 HBC    0 PBAR P AT REST   1/73
MO    2250  775.0      3.0                HYAMS      68 OSPK   011.2 PI- P      . 9/68
MO   13300  766.7      2.8                PISUT      68 RVUE   0 1.7-3.2PI-,CT10  1/73
MO  B      (754.0)    (9.0)               AUSLENDER  69 OSPK   0 E+E- COLL.BEAMS  2/74
MO  R      (768.4)    (2.4)               MALAMUD    69 RVUE   0 2-4 PI-P         1/73
MO X  1700  772.0      5.0                REYNOLDS   69 HBC    0 2.26 PI- P       1/73
MO X    SYSTEMATIC ERRORS ADDED CORRESP. TO SPREAD OF DIFFERENT FITS.
MO C        759.0      7.0                SCHAREN    69 HBC    0 2-4 PI- P        1/73
MO  P      (765.0)   (10.0)               ALVENSLEB  70 CNTR   0 GAMMA A,TCUT.01  1/73
MO  C12630 (760.0)                        BATON      70 HBC    0 2.8 PI- P        1/71
MO    140K  767.7      1.9                BIGGS      70 CNTR   OPHOTOPRODUCTION   1/73
MO C        761.0      5.0                BAILLCN    72 ASPK   0 15. PI- P        1/73
MO    1930  767.0      4.0                BALLAM     72 HBC    0 2.8 GAMMA P      1/73
MO    2430  770.0      4.0                BALLAM     72 HBC    0 4.7 GAMMA P      1/73
MO  B      (775.4)    (7.3)               BENAKSAS   72 OSPK   0 E+E- COLL.BEAMS  2/74
MO          772.3      5.9                BENAKSAS   72 RVUE  0 E+E- COLL.BEAMS   2/74
MO Z 11200  773.5      1.7                JACOBS     72 HBC    0 2.8 PI- P      . 1/73
MO    6800  764.0      3.0                RATCLIFF   72 ASPK   0 15. PI-P,TCUT.3. 2/74
MO  P      (775.)     (5.)                GLADDING   73 CNTR  0 2.9-4.7 GAMMA P   2/74
MO  H      (778.)     (2.)                HYAMS      73 ASPK  0 17 PI-P,N PI+PI-  1/74
MO C 32000  775.0      4.0                PROTOPOPE  73 HBC    0 7.1 PI+P,TCUT.4  2/74
MO    4100  767.       4.                 ENGLER     74 DBC    0 6. PI+N,PI+PI-P 12/75*
MO  H      (770.)     (9.)                ESTABROOK  74 RVUE   0 17 PI-P,PI+PI-N 12/75*
MO          771.       1.                 GRAYER     74 ASPK  0 17 PI-P,N PI+PI-  2/74
MO  H   FROM PHASE SHIFT ANALYSIS OF GRAYER 74 DATA.
MO  D      (776.3)    (0.4)               ROOS       75 RVUE   OPHASE SHIFTS     12/75*
MO  D   INCLUDES BATON 70,HYAMS 73,PROTOPOPESCU 73                               12/75*
MO         . . . . . . . . . .
MO  AVG     770.23     0.88     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
MO  STUDENT 770.25     0.82     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                              (SEE IDEOGRAM BELOW )

M       ----------NOTES----------

M   C   FROM POLE EXTRAPOLATICN
M   R   INCLUDED IN PISUT 68 RVUE
M   B   INCLUDED IN BENAKSAS 72 REVUE VALUE
M   P   FROM PHOTOPRODUCTION, MODEL DEPENDENT.
M   Z   MASS ERRORS ENLARGED BY US TO WIDTH/SQRT(N)
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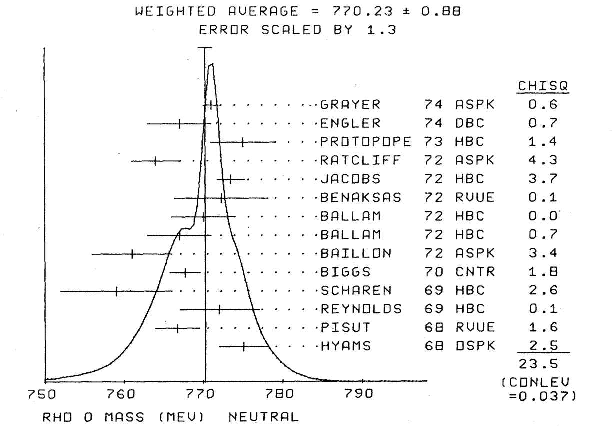


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               9  (RHO0) - (RHO+-) MASS DIFFERENCE (MEV)

D          2.4      2.1                PISUT      68 RVUE     PI N TO RHO N    6/68

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                    9  RHO WIDTH (MEV)

W      SEE NOTE ON RHO MASS ABOVE

W   MIXED CHARGES
W      290 (110.0)                        CHADWICK   63 HBC  +-0 0.0 PBAR P

W      CHARGED ONLY
W      130 (125.0)                        GUIRAGOSS  63 HBC   -  3.3 PI-P
W          (90.0)    (10.0)               SACLAY     63 HBC   +  2.8 PI+P
W       98 (180.0)                        BONDAR     64 HBC   -  4.1 PI-P
W   R      (77.0)    (20.0)               CARMCNY    64 HBC   +  3.5 PI+P,TCUT 4
W   R      (100.0)                        ALFF-STEI  66 HBC   +  2-3 PI+ P        6/66
W   R      (127.0)    (5.0)               BLIEDEN    66 MMSP  -  3-5 PI- P        6/66
W   R      (150.0)   (20.0)               HAGOPIAN1  66 HBC   -  3.0 PI- P        6/66
W   R      (135.0)   (20.0)               HAGOPIAN2  66 HBC   -  2.14 PI-,TCUT12  9/67
W   R 2775 (137.1)   (20.0)               JACOBS     66 HBC   -  2-3PI-,T CUT 20  6/68
W   R      (147.0)   (19.0)               JAMES      66 HBC   +  2.1 PI+,TCUT2.5  8/66
W   R      (149.0)    (13.0)              WEST       66 HBC   -  2.1 PI- P       10/66
W      900  146.      13.                 EISNER     67 HBC   -  4.2 PI-,T CUT10  9/67
W   R      (153.0)   (13.0)               MILLER     67 HBC   -  2.7 PI-,T CUT20  9/66
W   R      (150.0)    (5.0)               BATON      68 HBC   -  2.8 PI- P        7/69
W     1700 (145.0)   (10.0)               FOSTER     68 HBC   +- PBAR P AT REST   1/73
W     9650  147.3      4.0       3.9      PISUT      68 RVUE  -  1.7-3.2PI-,CT10  6/68
W   X 1300  154.0     13.0                REYNOLDS   69 HBC   -  2.26 PI- P       1/73
W   X 6500  146.      12.                 BYERLY     73 OSPK  -  5. PI- P         2/74
W   X   SYSTEMATIC ERRORS ADDED CORRESP. TO SPREAD OF DIFFERENT FITS.
W          . . . . . . . . . .
W   AVG     147.6      3.5      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT 147.6      3.7      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

WO  NEUTRAL ONLY
WO     190 (150.0)   (20.0)               SAMIOS     62 HBC    0 4.7 PI-P
WO  R  300  (90.0)   (10.0)               ABOLINS    63 HBC    0 3.5 PI+P
WO     160 (175.0)                        GUIRAGOSS  63 HBC    0 3.3 PI-P
WO  R  500 (130.0)                        GOLDHABER  64 HBC    0 3.7 PI+P
WO  R      (100.0)                        ALFF-STEI  66 HBC    0 2-3 PI+ P        6/66
WO  R      (120.0)   (10.0)               HAGOPIAN1  66 HBC    0 3.0 PI- P        6/66
WO  R      (135.0)   (20.0)               HAGOPIAN2  66 HBC    0 2.14 PI-P,LOW T  9/67
WO  R 4207 (122.2)   (15.0)               JACOBS     66 HBC    0 2-3PI-,T CUT 20  6/68
WO  R      (103.0)   (13.0)               JAMES      66 HBC    0 2.1 PI+ P        6/66
WO  R      (173.0)   (13.0)               WEST       66 HBC    0 2.1 PI- P       10/66
WO  P 4000 (130.)     (5.)                ASBURY 2   67 CNTR   0 GAMMA + PB       1/73
WO  R      (148.0)    (8.0)               BACON      67 HBC    0 1.7 PI-P         9/67
WO  R      (152.)    (15.)                HUWE       67 HBC    0 2.4 PI- P        7/67
WO  R      (160.0)   (15.0)               MILLER     67 HBC    0 2.7 PI-,T CUT20  9/66
WO  R      (167.0)    (6.0)               ARMENISE   68 DBC    0 5.1 PI+D         6/68
WO    1900 (132.)    (10.)                FOSTER     68 HBC    0 PBAR P AT REST   1/73
WO Z  2250  145.0     12.0                HYAMS      68 OSPK   011.2 PI- P      . 1/73
WO  P      (160.0)   (10.0)               LANZEROTT  68 CNTR   0 GAMMA P          1/73
WO  B      (105.0)   (20.0)               AUSLENDER  69 OSPK   0 E+E- COLL.BEAMS  2/74
WO  R      (132.0)   (13.0)               MALAMUD    69 RVUE   0 2-4 PI-P         1/73
WO X  1700  135.0     16.0                REYNOLDS   69 HBC    0 2.26 PI- P       1/73
WO X    SYSTEMATIC ERRORS ADDED CORRESP. TO SPREAD OF DIFFERENT FITS.
WO C        119.0     20.0                SCHAREN    69 HBC    0 2-4 PI- P        1/73
WO  P      (140.0)    (5.0)               ALVENSLEB  70 CNTR   0 GAMMA A,TCUT.01  1/73
WO  C12630 (131.0)                        BATON      70 HBC    0 2.8 PI- P        1/71
WO    140K  146.1      2.9                BIGGS      70 CNTR   OPHOTOPRODUCTION   1/73
WO C        108.0     20.0                BAILLON    72 ASPK   0 15. PI- P        1/73
WO Z  2430  155.0     12.0                BALLAM     72 HBC    0 4.7 GAMMA P      1/73
WO Z  1930  145.0     13.0                BALLAM     72 HBC    0 2.8 GAMMA P      1/73
WO  B      (149.6)   (23.2)               BENAKSAS   72 OSPK   0 E+E- COLL.BEAMS  2/74
WO          135.8     15.1                BENAKSAS   72 RVUE  0 E+E- COLL.BEAMS   2/74
WO   11200 (178.35)   (2.5)               JACOBS     72 HBC    0 2.8 PI- P        1/73
WO    6800  157.0      8.0                RATCLIFF   72 ASPK   0 15. PI-P,TCUT.3. 2/74
WO  P      (147.)    (11.)                GLADDING   73 CNTR  0 2.9-4.7 GAMMA P   2/74
WO  H      (152.)     (2.)                HYAMS      73 ASPK  0 17 PI-P,N PI+PI-  1/74
WO C 32000  160.0     10.0                PROTOPOPE  73 HBC    0 7.1 PI+P,TCUT.4  2/74
WO    4100  146.      14.                 ENGLER     74 DBC    0 6. PI+N,PI+PI-P 12/75*
WO  H      (143.)    (13.)                ESTABROOK  74 RVUE   0 17 PI-P,PI+PI-N 12/75*
WO          161.       4.                 GRAYER     74 ASPK  0 17 PI-P,N PI+PI-  2/74
WO  H   FROM PHASE SHIFT ANALYSIS OF GRAYER 74 DATA.
WO  D      (154.5)    (1.0)               ROOS       75 RVUE   OPHASE SHIFTS     12/75*
WO  D   INCLUDES BATON 70,HYAMS 73,PROTOPOPESCU 73                               12/75*
WO         . . . . . . . . . .
WO  AVG     150.3      2.7      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
WO  STUDENT 149.4      2.8      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                              (SEE IDEOGRAM BELOW )

W       ----------NOTES----------

W   C   FROM POLE EXTRAPOLATICN
W   R   INCLUDED IN PISUT 68 RVUE
W   B   INCLUDED IN BENAKSAS 72 REVUE VALUE
W   P   FROM PHOTOPRODUCTION, MODEL DEPENDENT.
W   Z   WIDTH ERRORS ENLARGED BY US TO 4*WIDTH/SQRT(N)
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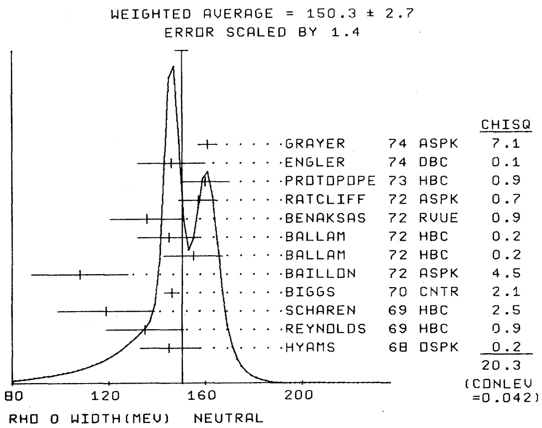
Mesons
ρ(770)

Data Card Listings
For notation, see key at front of Listings.

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                    9  RHO PARTIAL DECAY MODES

                                                          DECAY MASSES
P1     RHO INTO 2PI                                       139+ 139
P2     RHO INTO 4PI                                       139+ 139+ 139+ 139
P3     RHO INTO PI GAMMA                                  139+   0
P4     RHO INTO E+ E-                                      .5+  .5
P5     RHO INTO PI ETA (VIOLATES G)                       139+ 548
P6     RHO INTO MU+ MU-                                   105+ 105
P7     RHO INTO PI+ PI- PIO (VICLATES G)                  139+ 139+ 134
P8     RHO INTO ETA GAMMA                                 548+   0
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                    9  RHO BRANCHING RATIOS

R1     RHO INTO 4PI/2PI                                   (P2)/(P1)

R1     RHO+- INTO (PI+- PI+ PI- PIO) / (PI+- PIO)
R1          (0.026)OR LESS           BLIEDEN    66 MMSP  -  3-5 PI- P           6/66
R1          (0.01) OR LESS           DEUTSCHMA  66 HBC   +   8.0 PI+ P          6/66
R1          (0.002)OR LESS           FERBEL     66 HBC   +- PI+- P ABOVE 2.5 10/66
R1           0.0035    0.004         JAMES      66 HBC   +   2.1 PI+P          11/66

R1     RHOO INTO (PI+ PI- PI+ PI-) / (PI+ PI-)
R1          (0.008)OR LESS           JAMES      66 HBC    0 2.1 PI+P            6/66
R1          (0.002)OR LESS           CHUNG      68 HBC    0 3.2,4.2 PI-P        7/67
R1          (0.002)OR LESS  CL=.90   HUSCN      68 HLBC   0 16.0 PI- P          1/71
R1          (0.0015)OR LESS CL=.90   GERMAN CO  69 HBC    0 2.5-5.8 GAMMA P 10/67

R2     RHO INTO PI GAMMA/2PI   (UNITS 10**-3)             (P3)/(P1)
R2  M      (20.)    OR LESS          LANZEROTT  65 CNTR     GAMMA P(BREMS)   11/66
R2          (5.)    OR LESS  CL=.97  FIDECARO   66 OSPK  -                   10/66
R2          (7.)    OR LESS          HUSON      66 HLBC  -   15 PI-PB          6/66
R2  M       (2.)    OR LESS  CL=.90  GERMAN CO  69 HBC
R2   C       0.24      0.07          GOBBI      74 OSPK  - 23. PI-A,PI-PIOA 12/75*
R2   C  GOBBI 74 QUOTES THE PARTIAL WIDTH FOR RHO- INTO PI- GAMMA
R2   C  AS (35 +- 10) KEV
R2  M        ONE PION EXCHANGE MODEL USED IN THIS ESTIMATION
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Note on $\rho^0 \to e^+e^-$

Extraction of a ratio for $\rho^0 \to e^+e^-$ is complicated by interference with ω decay. In photoproduction, $\gamma A \to e^+e^- A$, there is substantial interference between the allowed $(\rho^0, \omega) \to e^+e^-$ decays. The interference in the colliding-beam reaction $e^+e^- \to \pi^+\pi^-$ is due to G-parity-violating mixing of the overlapping ρ^0 and ω resonances; it alters the results for the rate $\Gamma(\rho^0 \to e^+e^-)$ only by a small amount. Therefore at present we average only the values from the $e^+e^- \to \pi^+\pi^-$ experiments.

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R3     RHO INTO(E+ E-)/(PI+PI-) (UNITS 10**-4)            (P4)/(P1)
R3  P   94  (0.65)   (0.14)            ASBURY 1  67 CNTR     PHOTOPRODUCTION  9/67
R3  P        POSSIBLY LARGE RHO-OMEGA INTERFERENCE
R3  H       (0.65)   (1.1)     (0.5)   HERTZBACH 67 OSPK ASSUME SU(3)+MIXING.10/66
R3  H        NOT SEPARATED FROM OMEGA DECAY.
R3  A   33  (0.53)   (0.11)            ASTVACATU 68 OSPK ASSUME SU(3)+MIXING  6/68
R3  A        NOT SEPARATED FROM OMEGA DECAY. ERROR STATISTICAL ONLY.
R3           0.50     0.10             AUSLENDER 69 OSPK    E+E- COLLID.BEAM  9/68
R3  F       (0.49)   (0.12)    (0.15)  BIGGS     70 CNTR    PHOTOPRODUCTION   6/70
R3  F        ASSUMING RHO WIDTH 140 MEV. ERROR STATISTICAL ONLY.
R3           0.41     0.05             BENAKSAS  72 OSPK    E+E- COLL.BEAMS 12/72
R3          . . . . . . . . .
R3  AVG      0.428    0.045   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3  STUDENT  0.428    0.049   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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R4     RHO INTO (PI ETA)/(2PI)                            (P5)/(P1)
R4          (0.03) OR LESS           DEUTSCHMA 66 HBC  +    8.0 PI+ P        6/66
R4          (0.008)OR LESS           FERBEL    66 HBC  +- PI+- P ABOVE 2.5 11/66

R5     RHO INTO (MU+ MU-)/(PI+ PI-) (UNITS 10**-4)      (P6)/(P1)
R5
R5            SEE NOTE UNDER RHO INTO E+E- ABOVE
R5
R5   H        0.97      0.31      0.33  HYAMS     67 OSPK    11 PI- LI H       6/67
R5   H        HYAMS MASS RESOL. IS 20 MEV. THE OMEGA REGION WAS EXCLUDED.
R5   R        0.82      0.16      0.36  ROTHWELL  69 CNTR    PHOTOPRODUCTION . 4/70
R5   R        POSSIBLY LARGE RHO-OMEGA INTERFERENCE LEADS US TO INCREASE
R5   R        THE MINUS ERROR
R5            0.56      0.15            WEHMANN   69 OSPK     12 PI- ON C,FE   7/69
R5   W        RESULT CONTAINS (11 +- 11) PER CENT CORRECTION USING SU(3)
R5   W        FOR CENTRAL VALUE. THE ERROR ON THE CORRECTION TAKES ACCOUNT
R5   W        OF POSSIBLE RHO-OMEGA INTERFERENCE AND THE UPPER LIMIT AGREES
R5   W        WITH THE UPPER LIMIT OF (OMEGA INTO MU+ MU-) FROM THIS EXPT.
R5          . . . . . . . . .
R5  AVG       0.67      0.12    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R5  STUDENT   0.67      0.14    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R6     RHO  INTO (PI+ PI- PIO)/(PI+ PI-)                  (P7)/(P1)
R6  G       (0.01) OR LESS  CL=.84   ABRAMS    71 HBC    0 3.7 PI+ P          11/71
R6  G     MODEL DEPENDENT,ASSUMES I = 1,2,OR 3 FOR THE 3PI SYSTEM             11/71

R7     RHO INTO (ETA GAMMA)/TOTAL                         (P8)
R7          (.001)OR LESS  CL=.90   NORDBERG  74 ASPK    7-9 GAMMA+CU        12/75*

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REFERENCES FOR RHO


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ANDERSCN 61 PRL 6 365           ANDERSON,BANG,BURKE,CARMONY,SCHMITZ   (LRL)
ERWIN    61 PRL 6 628           A.R.,R.MARCH,W.C.WALKER,E.WEST       (WISC)
KENNEY   62 PR 126 736          V P KENNEY,W D SHEPHARD,C D GALL (KENTUCKY)
SAMIOS   62 PRL 9 139           SAMIOS,BACHMAN,LEA+    (BNL+CUNY+COLU+KNTY)
XUONG    62 PR 128 1849         NGUYEN HUU XUONG,GERALD R LYNCH       (LRL)

ABOLINS  63 PRL 11 381          ABOLINS,LANDER,MEHLHOP,NGUYEN,YAGER  (UCSD)
ALITTI   63 NC 29 515           ALITTI,BATON,ARMENISE+(SACL+ORSA+BARI+BGNA)
CHADWICK 63 PRL 10 62           CHADWICK,DAVIES,DERRICK,CRESTI + (OXF+PADO)
GUIRAGOS 63 PRL 11 85           ZAVEN GUIRAGOSSIAN                    (LRL)
SACLAY   63 SIENA CONF 1 239    SACLAY+ORSAY+BARI + BOLOGNA- COLLABORATION

BONDAR   64 NC 31 729           BONDAR+    (AACHEN+BIRM+BONN+DESY+LOIC+MPIM)
CARMONY  64 DUBNA CONF 1 486    CARMONY,HOA,LANDER,NG.H.XUONG,YAGER  (UCSD)
GOLDHABE 64 PRL 12 336          GOLDHABER,BROWN,KADYK,SHEN+       (LRL+UCB)

ALYEA    65 PL 15 82            ALYEA,CRITTENDEN,MARTIN,RHODE +   (INDIANA)
ARMENISE 65 NC 37 361           SACLAY+ORSAY+BARI+BOLOGNA    COLLABORATION
BLIEDEN  65 PL 19 444           CERN MISSING MASS SPECTROMETER GROUP (CERN)
CLARK    65 PR 139 B 1556       A CLARK,CHRISTENSON,CRONIN,TURLAY(PRINCETO)
GUTAY    65 NC 39 381           GUTAY,LANNUTTI,TULI                   (FSU)
LANZEROT 65 PRL 15 210          LANZEROTTI,BLUMENTHAL,EHN,FAISSLER + (HARV)
ZDANIS   65 PRL 14 721          ZDANIS,MADANSKY,KRAEMER +         (JHU+BNL)

ACCENSI  66 PL 20 557           ACCENSI,ALLES-BORELLI,FRENCH,FRISK+  (CERN)
ALFF-STE 66 PR 145 1072         ALFF-STEINBERGER,BERLEY,BRUGGER+(COLU+RUTG)
BALTAY   66 PR 145 1103         +FRANZINI,LUTJENS,SEVERINS,TYCKO+(COLUMBIA)
BLIEDEN  66 NC 43 71            CERN MISSING MASS SPECTROMETER GROUP (CERN)
CAMBRIDG 66 PR  146  994        CAMBRIDGE BUBBLE CHAMBER GROUP  (MIT+HARV+)
CASON    66 PR  148  1282       N M CASON                       (WISCONSIN)
DEUTSCHM 66 PL 20 82            DEUTSCHMANN,STEINBERG + (AACH+BERLIN+ CERN)
FERBEL   66 PL 21 111           FERBEL                          (ROCHESTER)
FIDECARO 66 PL  23  163         G+M FIDECARO,J POIRIER,P SCHIAVON    (CERN)
HAGOPIAN166 PR 145 1128         HAGOPIAN,SELOVE,ALITTI,BATON+ (PENN+SACLAY)
HAGOPIAN266 PR  152  1183       HAGOPIAN,PAN     (PENNSYLVANIA,LRL-BERKELEY)
HUSON    66 PL 20 91            HUSON,ALLARD,DRIJARD,HENNESSY+ (ORSAY+EPOL)
JACOBS   66 UCRL-16877          L.D.JACOBS                            (LRL)
JAMES    66 PR 142 896          F E JAMES,KRAYBILL         (YALE+BROOKHAVEN)
WEST     66 PR 149 1089         WEST,BOYD,ERWIN,WALKER          (WISCONSIN)

ALLES-BO 67 NC 50 A 776         ALLES-BORELLI,FRENCH,FRISK,+     (CERN+BONN)
ASBURY 1 67 PRL 19 869          +BECKER+BERTRAM+JOOS+JORDAN+     (DESY+COLU).
ASBURY 2 67 PRL 19 865          +BECKER+BERTRAM+JOOS+JORDAN+     (DESY+COLU)
BACON    67 PR 157 1263         +FICKINGER,HILL,HOPKINS,ROBINSON+     (BNL)
BANNER   67 PL  25 B  300       +FAYOUX,HAMEL,ZSEMBERY,CHEZE+ (SACLAY+CAEN)
BARLOW   67 NC 50A 701          +LILLESTOL+MONTANET+  (CERN+CDEF+IRAD+LIVP)
BATON    67 PL 25 B 419         J.BATON,G.LAURENS,J.REIGNIER       (SACLAY)
    ALSO 67 NP B 3  349         J.BATON,G.LAURENS,J.REIGNIER       (SACLAY)
CLEAR    67 NC 49A 399          +JOHNSTON+COOPER+MANNER+    (TNTO+ANL+WISC)
DANYSZ   67 NC 51 A 801         DANYSZ+FRENCH+SIMAK                  (CERN)
EISNER   67 PR 164 1699         +JOHNSON+KLEIN+PETERS+SAHNI+YEN+   (PURDUE)
FRENCH   67 NC 52A 442          +KINSON+MCDONALD+RIDDIFORD+     (CERN+BIRM)
HERTZBAC 67 PR 155  1461        HERTZBACH,KRAEMER,MADANSKI,ZDANIS+(JHU+BNL)
    ALSO 65 ZDANIS
HUWE     67 PL 24B 252          +MARQUIT+OPPENHEIMER+SCHULTZ+WILSON  (COLU)
HYAMS    67 PL 24B 634          +KOCH+PELLETT+POTTER+VONLINDERN+(CERN+MPIM)
MILLER   67 PR 153 1423         MILLER,GUTAY,JOHNSON,LOEFFLER +    (PURDUE)
POIRIER  67 PR 163 1462         +BISWAS,CASON,DERADO,KENNEY+    (NDAM+PENN)

ABC COLL 68 NP B4 501                     AACHEN+BERLIN+CERN COLLABORATION*
ARMENISE 68 NC 54A 999          +GHIDINI,FORINO+      (BARI+BGNA+FIRZ+ORSAY)
ASTVACAT 68 PL 27 B  45         ASTVACATUROV,AZIMOV,BALDIN+   (JINR+MOSCOW)
BATON    68 PR 176 1574         J.P. BATON, G. LAURENS             (SACLAY)
BLECHSCH 68 NC  53 A  1045      BLECHSCHMIDT,DOWD,ELSNER,+      (DESY+MCHS)
    ALSO 67 NC  52 A  1348
CHUNG    68 PR 165 1491         S.U.CHUNG,O.I.DAHL,J.KIRZ,D.H.MILLER  (LRL)
DONALD   68 NP B 6 174          +EDWARDS,FRODESEN,BETTINI+ (LIVP+OSLO+PADO)
FOSTER   68 NP B 6 107          +GAVILLET+LABROSSE+MONTANET+    (CERN+CDEF)
HUSON    68 PL 28B 208          +LUBATTI,SIX,VEILLET,+     (ORSA+MILA+UCLA)
HYAMS    68 NP B 7 1            +KOCH,POTTER,WILSON,VON LINDERN+(CERN+MPIM)
JONES    68 PR 166 1405         +BLEULER,CALDWELL,ELSNER,HARTING+    (CERN)
JOHNSON  68 PR 176 1651         +POIRIER,BISWAS,GUTAY+     (NDAM+PURD+SLAC)
KEY      68 PR 166 1430         +PRENTICE+COOPER+MANNER+    (TNTO+ANL+WISC)
LAMSA    68 PR 166 1395         +CASON+BISWAS+DERADO+GROVES+    (NOTREDAME)
LANZEROT 68 PR 166 1365         LANZEROTTI,BLUMENTHAL,EHN,FAISSLER + (HARV)
MARATECK 68 PRL 21 1613         +HAGOPIAN,+  (PENN+LRL+COLO+PURD+TNTO+WISC)
PISUT    68 NP B 6 325          J.PISUT,M.ROOS                       (CERN)

AUGUSTI1 69 PL 28 B 508         +BIZOT+BUON+HAISSINSKI+LALANNE+     (ORSAY)
AUGUSTI2 69 LNC 2 214           +LEFRANCOIS,LEHMANN,MARIN,+         (ORSAY)
AUSLENDE 69 SJNP 9  69          AUSLENDER,BUDKER,PANTUSCVA,PESTOV+   (NOVO)
GERMAN C 69 PR 188  2060        GERMAN BUBBLE CHAMBER COLL.          (DESY)
HAISSINS 69 ARGONNE CONF. 373   J.HAISSINSKI                        (ORSAY)
JUHALA   69 PR 184  1461        +LEACOCK,RHODE,KOPELMAN,LIBBY,+  (ISU+COLO)
MALAMUD  69 ARGONNE CONF.P.93   E.MALAMUD, P.SCHLEIN                 (UCLA)
MILLER   69 PR 178 2061         R.MILLER,LICHTMAN,WILLMANN         (PURDUE)
MOTT     69 PR 177 1966         +AMMAR,DAVIS,KROPAC,SLATE,DAGAN+ (NWES+ANL)
REYNOLDS 69 PR 184 1424         +ALBRIGHT,BRADLEY,BRUCKER,HARMS+      (FSU)
ROOS     69 NP B 10 563         M.ROOS,J.PISUT             (CERN+BRATISLAVA)
ROTHWELL 69 PRL 23 1521         +CHASE,EARLES,GETTNER,GLASS,WEINSTEI+(NEAS)
SCHAREN  69 ARGONNE CONF.306    SCHARENGUIVEL                      (PURDUE)
WEHMANN  69 PR 178  2095        +ENGELS,WILSON,+ (HARV+CASE+SLAC+CORN+MCGI)
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Data Card Listings

For notation, see key at front of Listings.

Mesons

$\rho(770)$, $\omega(783)$


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ALVENSLE 70 PRL 24 786          ALVENSLEBEN,BECKER,BERTRAM,CHEN,COHEN(DESY)
BATON    70 PL 33 B 528         +LAURENS,REIGNIER                  (SACLAY)
BIGGS    70 PRL 24 1197         +BRABEN,CLIFFT,GABATHULER,KITCHING+  (CARE)
BINGHAM  70 PRL 24 955          +FRETTER,MOFFEIT,BALLAM+    (LRL+SLAC+TUFT)
GALLOWAY 70 PR D 1 3077         +MOTT,ALYA,LEE,MARTIN,PRICKETT        (IND)

ABRAMS   71 PR D 4 653          +BARNHAM,BUTLER,COYNE,GOLDHABER,HALL,+(LBL)
BLOODWOR 71 NP B 35 133         BLOODWORTH,JACKSON,PRENTICE,YCON  (TORONTO)
DEERY    71 PR D 3 635          +BISWAS,CASON,GROVES,JOHNSCN,+ (NOTRE CAME)

BAILLON  72 PL 38 B 555         +CARNEGIE,KLUGE,LEITH,LYNCH,RATCLIFF+(SLAC)
BALLAM   72 PR D 5 545          +CHADWICK,BINGHAM,MILBURN,+ (SLAC+LBL+TUFT)
BASDEVAN 72 PL 41 B 178         BASDEVANT,FROGGATT,PETERSEN          (CERN)
BENAKSAS 72 PL 39 B 289         +COSME,JEAN-MARIE,JULLIAN,LAPLANCHE,+(ORSA)
DRIVER   72 NP B 38 1           +HEINLOTH,HOHNE,HOFMANN,RATHJE,+(DESY+HAMB)
EISENBER 72 PR D 5 15           EISENBERG,BALLAM,DAGAN,+   (REHO+SLAC+TELA)
GRAYER   72 PHIL.CCNF.PROC. 5 +HYAMS,JONES,SCHLEIN,BLUM,CIETL+(CERN+MPIM)
GRAYER   72 NP B 50 29          +HYAMS,JONES,WEILHAMMER,BLUM,+  (CERN+MPIM)
JACOBS   72 PR D 6 1291         L.D.JACOBS                         (SACLAY)
RATCLIFF 72 PL 38 B 345         +BULOS,CARNEGIE,KLUGE,LEITH,LYNCH,+  (SLAC)
TAKAHASH 72 PR D 6 1266         TAKAHASHI,BARISH,+      (TCHO+PENN+NCAM+ANL)

BYERLY   73 PR D 7 637          +ANTHONY,COFFIN,MEANLEY,MEYER,RICE,+ (MICH)
CHARLESW 73 NP B 65 253         CHARLESWORTH,EMMS,BELL,+   (RHEL+BIRM+DURH)
GLADDING 73 PR D 8 3721         +RUSSEL,TANNENBAUM,WEISS,THOMSON     (HARV)
HYAMS    73 NP B 64 134         +JONES,WEILHAMMER,BLUM,DIETL,+  (CERN+MPIM)
PROTOPOP 73 PR D 7 1280         PROTOPOPESCU,GARNJOST,GALTIERI,FLATTE+(LBL)

CARROLL  74 PR D 10 1430        +MATTHEWS,WALKER+      (SLAC+DUKE+WISC+TNTO)
ENGLER   74 PR D 10 2070        +KRAEMER,TOAFF,WEISSER,DIAZ+    (CARN+CASE)
ESTABROO 74 NP B 79 301         P.ESTABROCKS,A.D.MARTIN              (DURH)
GOBBI    74 PRL 33 1450         +ROSEN,SCOTT,SHAPIRO+      (NWES+ROCH+CARN)
GRAYER   74 NP B 75 189         G.GRAYER,HYAMS,BLUM,DIETL,+     (CERN+MPIM)
HABER    74 PR D10 1387         +HODOUS,HULSIZER,KISTIAKCWSKY,LEVY+   (MIT)
NORDBERG 74 PL 51 B 106         +ABRAMSON,ANDREWS,HARVEY,+      (CORN+ROCH)
SPITAL   74 PR D 9 126          R.SPITAL,D.R.YENNIE                  (CORN)

ROOS     75 NP B 97 165         M.ROOS                               (HELS)
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$\omega(783)$

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                 1  CMEGA(783,JPG=1--) I=0

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                 1  OMEGA MASS (MEV)

M       64 (779.4)    (1.4)            ARMENTERO 62 HBC    0.0 PBAR P K1K1. 2/74
M      800 (782.0)    (1.0)            ALFF      62 HBC    2.3-2.9 PI+P   . 2/74
M       34 (784.0)    (1.0)            ARMENTERO 63 HBC    0.0 PBAR P     . 2/74
M      220 (781.0)    (2.0)            KRAEMER   64 DBC    1.2 PI+D       . 2/74
M      170 (785.6)    (1.2)            MILLER D  65 HBC   SEEN WITH K+K-  . 2/74
M      666 (786.0)    (1.0)            JAMES     66 HBC    2.1 PI+P       . 2/74
M     2198  783.4      0.7             BALTAY    67 HBC   0.0 PBAR P        2/74
M      155 (779.5)    (1.5)            BARASH    67 HBC    0.0 PBAR P K1K1. 2/74
M          (784.8)    (1.1)            KEY       68 HBC    3 PI-P         . 2/74
M     2400  782.4      0.5             BIZZARRI  69 HBC    0 PBAR P         9/69
M      750  784.1      1.2             ABRAMOVIC 70 HBC    3.9 PI- P        2/74
M           784.0      0.7             ATHERTON  70 HBC   3.6 PBAR P, 7 PI. 2/74
M   F      (783.2)    (1.6)            BIGGS     70 CNTR  PHOTOPRODUCTICN   2/74
M   F   FROM CMEGA-RHO INTERFERENCE IN THE PI+PI- MASS SPECTRUM
M   F   ASSUMING OMEGA WIDTH 12.6 MEV.
M      260 (781.0)    (2.0)            CASCN     70 HBC    8.0 PI-P,4PI   . 2/74
M      250 (784.)     (1.)             DANBURG   70 DBC    1.2 PI+ D      . 2/74
M      500 (786.)     (1.)             DANBURG   70 CBC    1.4 PI+ D      . 2/74
M      600 (784.)     (1.)             DANBURG   70 DBC    1.7 PI+ D      . 2/74
M      500 (786.)     (1.)             DANBURG   70 DBC    1.9 PI+ D      . 2/74
M      400 (785.)     (1.)             DANBURG   70 CBC    2.1 PI+ D      . 2/74
M      200 (785.)     (2.)             DANBURG   70 DBC    2.3 PI+ D      . 2/74
M      248  783.4      1.0             BIZZARRI  71 HBC    0.0 P PBAR K+K- 11/71
M      510  781.0      0.6             BIZZARRI  71 HBC    0.0 P PBAR K1K1 11/71
M   C 4270 (784.1)    (0.3)            COYNE     71 HBC   3.7 PI+ P        11/71
M   C   FROM TOTAL SAMPLE OF COYNE 71.  THEY CBSERVE AN IMPORTANT
M   C   CORRELATICN BETWEEN SIGMA OF EXP. RESOLUTION AND THE MEAS. MASS.
M  D        783.7      1.0             COYNE     71 HBC   3.7 PI+ P        11/71
M  D        FROM BEST-RESOLUTICN SAMPLE OF COYNE 71                        11/71
M      369 (784.0)    (1.4)            MATTHEWS  71 DBC    6.95 PI+ D     . 2/74
M      418  782.5      0.8             AGUILAR   72 HBC   3.9,4.6 K- P     12/72
M  BN10000 (782.4)    (0.5)            BINNIE    73 CNTR  PI-P, CMEGA N    12/75*
M   N   BINNIE 73 SUPERSEDED BY KEYNE 76
M  S  4800  782.0      0.8             OREN      74 HBC   2.3 PBAR P,5PI   12/75*
M  S    ERROR INCLUDES 0.5 MEV MASS SCALE ERROR
M    29200 (782.9)    (0.3)            ROOS      74 RVUE  0-3.6 PBAR P     12/75*
M  B 10000  782.4      C.5             KEYNE     76 CNTR  PI-P, OMEGA N    12/75*
M  B    OBSERVED BY THRESHOLD-CROSSING TECHNIQUE. MASS RESOL.=4.8 MEV FWHM
M           . . . . . . . . .
M   AVG     782.61     0.30    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
M   STUDENT 782.66     0.27    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                       (SEE IDEOGRAM BELOW )
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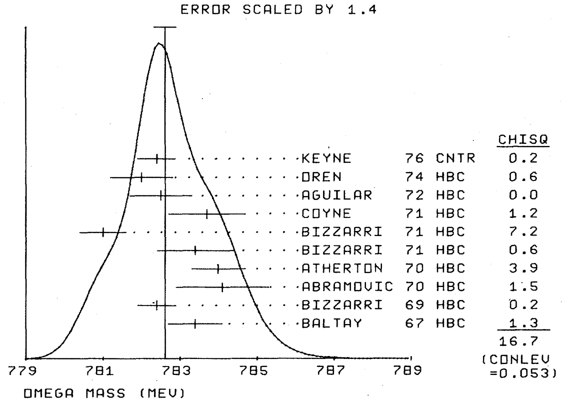
WEIGHTED AVERAGE = 782.61 ± 0.30
ERROR SCALED BY 1.4

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                 1  OMEGA FULL WIDTH (MEV)

W      34    9.0      3.C              ARMENTERO 63 HBC     0.0 PBAR P
W           13.4      2.0              MILLER D  65 HBC   SEEN WITH K+ K-
W     155  (12.3)    (2.0)             BARASH    67 HBC    SEEN WITH K1 K1 . 6/66
W   B 171   (5.8)    (2.8)             BARASH    67 HBC    0.0 PBAR P,K1 K1 11/71
W   B        UNFOLDED BY COYNE 71                                          11/71
W     750    8.8      3.0              ABRAMOVIC 70 HBC     3.9 PI- P        6/70
W           11.2      2.7              ATHERTON  70 HBC    3.6 PBAR P, 7 PI  5/70
W     510   10.3      1.4              BIZZARRI  71 HBC     0.0 P PBAR K1K1 11/71
W     248   12.8      3.0              BIZZARRI  71 HBC     0.0 P PBAR K+K- 11/71
W    4270    9.5      1.0              COYNE     71 HBC    3.7 PI+ P        11/71
W     418   13.3      2.               AGUILAR   72 HBC    3.9,4.6 K- P     12/72
W            9.1      0.8              BENAKSAS1 72 OSPK   E+E- COLL.BEAMS   2/73
W  E  940    7.70     1.65             BROWN     72 MMS    2.5 PI- P,N MMS  12/72
W  E    ERROR TAKES ACCCUNT OF SYSTEMATICS ADDED LINEARLY
W  BN10000  (10.2)   (0.6)             BINNIE    73 CNTR   PI-P, OMEGA N     1/74
W   N   BINNIE 73 SUPERSEDEC BY KEYNE 76
W  B 10000  10.22     0.43             KEYNE     76 CNTR   PI-P, OMECA N    12/75*
W  B    OBSERVED BY THRESHOLD-CROSSING TECHNIQUE. MASS RESOL.=4.8 MEV FWHM
W           . . . . . . . . .
W   AVG      10.05    0.33     AVERAGE (ERRCR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT  10.05    0.36     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                 1  CMEGA PARTIAL DECAY MODES

                                                     DECAY MASSES
P1     OMEGA INTO PI+ PI- PIO                        139+ 139+ 134
P2     OMEGA INTO PI+ PI- (VICLATES G)               139+ 139
P3     OMEGA INTO PIO GAMMA                          134+   0
P4     CMEGA INTO PI+ PI- GAMMA                      139+ 139+   0
P5     OMEGA INTO 2PIO GAMMA                         134+ 134+   0
P6     OMEGA INTO ETA GAMMA                          548+   0
P7     OMEGA INTO E+ E-                               .5+  .5
P8     OMEGA INTO MU+ MU-                            105+ 105
P9     OMEGA INTO ETA PIO (VIOLATES C)               548+ 134
P10    CMEGA INTO 3 GAMMA                              0+   0+   0
P11    CMEGA INTO PIO MU+ MU-                        134+ 105+ 105

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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

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      P 1       P 2       P 3
P 1  .8987+-.0056
P 2  -.5582  .0130+-.0027
P 3  -.8728     .0824  .0884+-.0046


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                 1  OMEGA BRANCHING RATIOS

R1     OMEGA INTO NEUTRAL/(PI+ PI- PIO)                      (P3+...)/(P1)
R1             0.17      0.04              ARMENTERO 63 HBC     0.0 PBAR P
R1        20   0.11      0.02              BUSCHBECK 63 HBC     1.5 K-P
R1        35   0.08      0.03              KRAEMER   64 DBC     1.2 PI+D
R1        65   0.10      0.04              ALFF-STEI 66 HBC CORR.BY SCHULTZ(COL)  9/66
R1       850   0.134     0.026             DIGIUGNO  66 CNTR    1.4 PI-P          9/66
R1       348   0.097     0.016             FLATTE    66 HBC     1.8 K-P           9/66
R1             0.06      0.05      0.02    JAMES     66 HBC     2.1 PI+P          6/66
R1        19   0.10      0.03              BARASH    67 HBC     0.0 PBAR P        7/67
R1        46   0.15      0.04              AGUILAR   72 HBC    3.9,4.6 K- P      12/72
R1           . . . . . . . . .
R1  AVG        0.1065    0.0088  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  STUDENT    0.106     0.010   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R1  FIT        0.0983    0.0057 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2     CMEGA INTO (PI+ PI-)/(PI+ PI- PIO). SEE ALSO R15 (P2)/(P1)
R2 R       (0.011)OR MCRE  CL=.95   ABRAMOVIC 70 HBC     3.9 PI- P       . 6/70
R2 R       (0.035)OR LESS  CL=.95   BIZZARRI  70 DBC     PBAR N AT REST  11/71
R2         (0.019)OR MORE  CL=.95   CHAPMAN   70 HBC    1.6-2.2 P PBAR    6/70
R2  F       (.002)OR MORE  CL=.90   FLATTE    70 HBC     1.5    K- P      8/69
R2  F      FLATTE 70 SEES NO SIGNAL AT 1.7, 2.1, 2.6 GEV/C.
R2         (0.0026)OR MORE CL=.84   HAGOPIAN  70 HBC     2.3 PI- P        1/71
R2         (0.040)OR LESS  CL=.84   HAGOPIAN  70 HBC     2.3 PI- P        1/71
R2 R        0.022     0.009    0.01 ROOS      70 RVUE                     6/70
R2 R       ROOS 70 COMBINES ABRAMOVICH 70 AND BIZZARRI 70
R2          0.028     0.006         BEHREND   71 ASPK   PHOTOPRODUCTICN  11/71
R2 S        0.021     0.028   0.009 RATCLIFF  72 ASPK   15.PI- P,N 2PI   12/72
R2 S   SIGNIFICANT INTERFERENCE EFFECT OBSERVED.NB OF OMEGA INTO 3PI     12/72
R2 S   COMES FROM AN EXTRAPOLATION.                                      12/72
R2         (0.0115)OR MORE          BURNS     73 HBC    .6-1.1 PBAR P    12/75*
R2           . . . . . . . . .
R2  AVG     0.0259    0.0049  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2  STUDENT 0.0259    0.0053  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R2  FIT     0.0144    0.0031 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.5)

R3     OMEGA INTO (PIO GAMMA) / (PI+ PI- PIO)             (P3)/(P1)
R3         (0.125)  (0.025)OR GRTR. BARMIN    64 PXBC    2.8 PI-P
R3          0.13     0.04           JACQUET   69 HLBC                    10/67
R3          0.081    0.020          BALDIN    71 HLBC   2.9 PI+ P        11/71
R3          0.109    0.025          BENAKSAS2 72 OSPK   E+E- COLL.BEAMS   2/73
R3  N      (0.079)  (0.012)         BINNIE    73 CNTR   PI-P, CMEGA N     1/74
R3  N   BINNIE 73 SUPERSECEC BY KEYNE 76
R3          0.084    0.013          KEYNE     76 CNTR   PI-P, OMEGA N    12/75*
R3           . . . . . . . . .
R3  AVG     0.0898   0.0097  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3  STUDENT 0.090    0.011   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R3  FIT     0.0983   0.0057 FROM FIT (ERRCR INCLUDES SCALE FACTOR OF 1.0)

R4     CMEGA INTO (PI+ PI- GAMMA)/(PI+ PI- PIO)           (P4)/(P1)
R4         (0.05) OR LESS  CL=.90   FLATTE    66 HBC     1.8 K-P          9/66
R4          (.066)OR LESS  CL=.90   KALBFLEI  75 HBC    2.2 K- P,GAMMA + 12/75*

R6     OMEGA INTO (MU+ MU-)/(PI+ PI- PIO)(UNITS 10**-3) (P8)/(P1)
R6         (1.2)   OR LESS          GALTIERI  65 HBC     2.7 K-P
R6         (1.7)   OR LESS CL=.74   FLATTE    66 HBC     1.8 K-P          9/66
R6         (0.2)   OR LESS          WILSON    69 OSPK    12 PI- ON C,FE   9/69
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Mesons

ω(783), M(940)

Data Card Listings

For notation, see key at front of Listings.

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R7      OMEGA INTO (2PIO GAMM)/(PIO GAMMA)                 (P5)/(P3)
R7           (0.1)  OR LESS             BARMIN    64 PXBC     1.3-2.8 PI-P
R7           (0.45)   (0.33)            STRUGALSK 69 HLBC     2.34 PI+ N       8/69
R7           (0.14) OR LESS             BALDIN    71 HLBC    2.9 PI+ P        11/71
R7           (0.15) OR LESS  CL=.90     BENAKSAS2 72 OSPK  · E+E- COLL. BEAMS  2/73

R8      CMEGA INTO (ETA PIO + ETA GAMMA)/(PI+ PI- PIO)   (P9+P6)/(P1)
R8           (0.017)OR LESS  CL=.90     FLATTE    66 HBC      1.8 K-P          9/66
R8           (0.045)OR LESS  CL=.95     JACQUET   69 HLBC                      4/70

R9      OMEGA INTO (NEUTRALS) / (CHARGED)                  (P3+...)/(P1+P2...)
R9            0.124     0.021           FELDMAN   67 OSPK     1.2 PI- P        3/67
R9            . . . . . . . . . .
R9  FIT       0.0969    0.0056 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R10     CMEGA INTO (2PIO GAMMA)/(PI+PI-PIO)                (P5)/(P1)
R10          (0.08) OR LESS  CL=.95     JACQUET   69 HLBC                      4/70

R11     OMEGA INTO (ETA GAMMA)/(PIO GAMMA)                 (P6)/(P3)
R11          (0.58)   (0.30)            STRUGALSK 69 HLBC     2.34 PI+ N       8/69
R11          (0.40) OR LESS             BALDIN    71 HLBC    2.9 PI+ P        11/71
R11           0.010     0.045           APEL      72 OSPK    4-8 PI- P,N 3GAM  2/73
R11          (0.27) OR LESS  CL=.90     BENAKSAS2 72 OSPK    E+E- COLL. BEAMS  2/73

R12     OMEGA INTO (PIO MU+ MU-) / TOTAL (UNITS 10**-3)  (P11)
R12          (2.)   OR LESS             WEHMANN   68 OSPK    12 PI- FE         6/68

R13     OMEGA INTO (E+ E-)/TOTAL (UNITS 10**-4)            (P7)
R13       3   2.        1.2             BINNIE    65 OSPK     PI-P NEAR THLD.  6/66
R13 B         MASS RESOLUTICN OF BINNIE 65 IS ABOUT 15 MEV.
R13 H        (1.0)    (1.7)    (0.75) HERTZBACH 67 OSPK ASSUME SU(3)+MIXING.10/66
R13 H         NOT RESOLVED  FRCM RHO DECAY.
R13 A    33  (0.65)   (0.13)            ASTVACATU 68 OSPK ASSUME SU(3)+MIXING  6/68
R13 A         NOT RESOLVED  FROM  RHO  DECAY. ERROR STATISTICAL ONLY.
R13           0.40      0.21            BOLLINI1  68 CNTR     1.7PI-P,NOTE Z   9/68
R13 Z         MASS RESOLUTION OF BOLLINI 1 IS +-10 MEV.HIS ERROR IS +-.15
R13 Z         WITHOUT RHO-OMEGA INTERFERENCE. COMPLETE INTERFERENCE WOULD
R13 Z         CHANGE VALUE BY +-35 PER CENT. THEREFORE WE INCREASED ERROR.
R13 E        (0.76)   (0.14)            AUGUSTI1  69 OSPK     SEE NOTE E       2/72
R13 E   FROM E+ E- COLLIDING BEAMS, ASSUMING OMEGA WIDTH 12.2+-1.3 MEV         4/69
R13           0.83      0.10            BENAKSAS1 72 OSPK    E+E- CCLL.BEAMS   2/73
R13           . . . . . . . . . .
R13 AVG       0.76      0.17     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)
R13 STUDENT   0.77      0.11     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R14     CMEGA INTO NEUTRALS / TCTAL                        (P3+...)
R14           0.084     0.015           BOLLINI   68 CNTR    2.1 PI- P         6/68
R14           0.079     0.019           DEINET    69 OSPK    1.5 PI- P         9/69
R14           0.075     0.025           BIZZARRI  71 HBC      0.0 P PBAR      11/71
R14      42   0.073     0.018           BASILE    72 CNTR    1.67 PI- P        2/73
R14           . . . . . . . . . .
R14 AVG       0.0788    0.0092   AVERAGE (ERROR INCLUDES SCALE FACTCR OF 1.0)
R14 STUDENT   0.0788    0.0098   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R14 FIT       0.0884    0.0046 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R15     CMEGA INTO (PI PI)/(TOTAL). SEE ALSO R2            (P2)
R15           0.032     0.028     0.019 AUGUSTI2  69 OSPK     E+E- COLL.BEAMS  8/69
R15          (0.003)OR MORE  CL=.95     GOLDHABER 69 HBC        3.7-4.0 PI+P  11/69
R15          (0.014)OR MORE  CL=.95     ALLISON   70 HBC     1.3-1.7 PBAR P  . 6/70
R15           0.0080    0.0028    0.0022BIGGS     70 CNTR    PHOTOPRODUCTICN   6/70
R15           0.0122    0.0030          ALVENSLEB 71 CNTR    PHOTOPRODUCTICN  11/71
R15           0.013     0.012     0.009 MOFFEIT   71 HBC     2.8,4.7 GAMMA P  11/71
R15           0.036     0.024     0.018 BENAKSAS  72 OSPK     E+E- COLL.BEAMS 12/72
R15          (.01)                      KRAMER    74 ASPK    3,4,6 PI+-P,N2PI 12/75*
R15           . . . . . . . . . .
R15 AVG       0.0102    0.0019   AVERAGE (ERRCR INCLUDES SCALE FACTOR OF 1.0)
R15 STUDENT   0.0102    0.0022   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R15 FIT       0.0130    0.0027 FRCM FIT (ERROR INCLUDES SCALE FACTOR OF 1.5)

R16     CMEGA INTO (ETA GAMMA) / (ALL NEUTRALS)            (P6)/(P3+...)
R16          (0.24) OR LESS  CL=.90     DEINET    69 OSPK                      9/69
R16          (0.36) OR LESS  CL=.90     DAKIN     72 OSPK    1.4 PI- P,N MMO  12/72

R17     OMEGA INTO (2 PIO GAMMA) / (ALL NEUTRALS)          (P5)/(P3+...)
R17          (0.19) OR LESS  CL=.90     DEINET    69 OSPK                      9/69
R17 D        (0.22)   (0.07)            CAKIN     72 OSPK    1.4 PI- P,N MMO  12/72
R17 D       SEE R18

R18     OMEGA INTO (PIO GAMMA) / (ALL NEUTRALS)            (P3)/(P3+...)
R18          (0.81) OR MORE  CL=.90     DEINET    69 OSPK                      9/69
R18 D        (0.78)   (0.07)            DAKIN     72 OSPK    1.4 PI- P,N MMO  12/72
R18 D       ERROR STATISTICAL ONLY.AUTHORS OBTAIN GOOD FIT ALSO ASSUMING      11/71
R18 D       PIO GAMMA AS THE ONLY NEUTRAL DECAY.                              11/71

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REFERENCES FOR CMEGA


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MAGLIC   61 PRL 7 178          B MAGLIC,ALVAREZ,ROSENFELD,STEVENSON  (LRL)
PEVSNER  61 PRL 7 421          PEVSNER,KRAEMER,NUSSBAUM,RICHARD+(JHU+NWES)
XUONG    61 PRL 7 327          NGUYEN HUU XUONG,GERALD R LYNCH       (LRL)

ALFF     62 PRL 9 325          ALFF,BERLEY,COLLEY,GELFAND + (COLU+RUTGERS)
ARMENTER 62 CERN CONF 90       R ARMENTEROS,R BUDDE +     (CERN+CDEF+EPOL)
STEVENSO 62 PR 125 687         STEVENSON,ALVAREZ,MAGLIC,RCSENFELD    (LRL)

ARMENTER 63 SIENA CONF 1 296   ARMENTEROS,EDWARDS,JACOBSEN+     (CERN+CDEF)
BARMIN   63 SIENA CONF 1 207   BARMIN,DOLGOLENKO,KRESTNIKOV+          (ITEP)
BUSCHBEC 63 SIENA CONF 1 166   BUSCHBECK,CZAPP+     (VIENNA+CERN+AMSTERDAM)
GELFAND  63 PRL 11 436         GELFAND,MILLER,NUSSBAUM,RATAU+  (COLU+RUTG)
MURRAY   63 PL 7 358           MURRAY,FERROLUZZI,HUWE,SHAFER,SOLMITZ+(LRL)

BARMIN   64 JETP 18 1289       BARMIN,DOLGCLENKO,KRESTNIKCV +         (ITEP)
KRAEMER  64 PR 136 B 496       KRAEMER,MACANSKY,MEER+       (JHU+NWES+WOOD)

BINNIE   65 PL 18 348          BINNIE,DUANE,JANE,W JCNES+       (LOIC+MCHS)
GALTIERI 65 PRL 14 279         A BARBARO GALTIERI,R D TRIPP           (LRL)
MILLER D 65 CU-237(NEVIS 131)  CAVID C MILLER  (THESIS)         (CCLUMBIA)
    INCLUDES CATA OF GELFAND 63 ABOVE
ALFF-STE 66 PR 145 1072        ALFF-STEINBERGER,BERLEY,BRUGGER+(COLU+RUTG)
ZDANIS   65 PRL 14 721         ZDANIS,MADANSKY,KRAEMER,HERTZBACH+(JHU+BNL)

DIGIUGNO 66 NC 44A 1272        DI GIUGNO,PERUZZI,TROISE+  (NAPL+FRAS+TRST)
FLATTE   66 PR  145  1050      +HUWE,MURRAY,BUTTON-SHAFER,SOLMITZ+   (LRL)
JAMES    66 PR 142 896         F E JAMES,KRAYBILL         (YALE+BROOKHAVEN)

BALTAY   67 PRL  18  93        +FRANZINI,SEVERIENS,YEH,ZANELLC  (CCLUMBIA)
BARASH   67 PR  156  1399      BARASH,KIRSCH,MILLER,TAN         (COLUMBIA)
FELDMAN  67 PR 159 1219        +FRATI,GLEESCN,HALPERN,NUSSBAUM+     (PENN)
HERTZBAC 67 PR 155, 1461       HERTZBACH,KRAEMER,MADANSKI,ZDANIS+(JHU+BNL)
    ALSO 65 ZCANIS
ASTVACAT 68 PL 27 B  45        ASTVACATUROV,AZIMOV,BALDIN+   (JINR+MOSCOW)
BOLLINI  68 NC 56 A 531        +BUHLER,DALPIAZ,MASSAM+     (CERN+BGNA+STRB)
BOLLINI1 68 NC 57 A 404        +BUHLER,DALPIAZ,MASSAM+     (CERN+BGNA+STRB)
KEY      68 PR 166 1430        +PRENTICE+COOPER+MANNER      (TNTO+ANL+WISC)
PISUT    68 NP B 6 325         J.PISUT,M.ROOS                         (CERN)
WEHMANN  68 PRL 20 748         +ENGELS+ (HARVARD+CASE+SLAC+CORNELL+MCGILL)

AUGUSTI1 69 PL 28 B 513        +BENAKSAS,BUCN,GRACCO,HAISSINSKI,+  (ORSAY)
AUGUSTI2 69 LNC 2 214          +LEFRANCOIS,LEHMANN,MARIN,+          (ORSAY)
BIZZARRI 69 NP B 14 169        +FOSTER,GAVILLET,MCNTANET,+     (CERN+CDEF)
DANBURG  69 UCRL-19275         JERCME S. CANBURG, THESIS              (LRL)
    ALSO DANBURG 70
DEINET   69 PL 30 B 426        +MENZIONE,MULLER,BUNIATOV+      (KARL+CERN)
ERWIN    69 NP B 9 364         +WALKER,GOSHAW,WEINBERG    (WISC+PRIN+VAND)
GOLDHABE 69 PRL 23,1351        +BUTLER,COYNE,HALL,MACNAUGHTON,TRILING(LRL)
JACQUET  69 NC 63 A 743        +NGUYEN-KHAC,HAATUFT,HALSTEINSLI(EPOL+BERG)
MILLER   69 PR 178 2061        R.MILLER,LICHTMAN,WILLMANN           (PURDUE)
STRUGALS 69 PL 29 B 532        +CHUVILO,FENYVES,+          (WARS+JINR+BUDA)
WILSCN   69 PRIVATE COMM.      RICHARD WILSCN (SEE ALSO PR 178 2095)(HARV)

ABRAMOVI 70 NP B 20 209        ABRAMOVICH,BLUMENFELD,BRUYANT,+        (CERN)
BIZZARRI 70 PRL 25 1385        +CIAPETTI,DORE,GASPERO,GUIDCNI,+(ROMA+SYRA)
ALLISON  70 PRL 24 618         +CCOPER,FIELDS,RHINES                   (ANL)
ATHERTON 70 NP B 18 221        +BLAIR,CELNIKER,DOMINGO,FRENCH+  (CERN+IPN)
BIGGS    70 PRL 24 1201        +CLIFFT,GABATHULER,KITCHING,RAND       (DARE)
CASON    70 PR D 1 851         +ANDREWS,BISWAS,GROVES,HARRINGTON,+  (NDAM)
CHAPMAN  70 NP B 24 445        +CAVIDSCN,GREEN,LYS,ROE,VANDER VELDE (MICH)
DANBURG  70 PR D 2 2564        +ABOLINS,DAHL,DAVIES,HOCH,KIRZ,MILLER+(LRL)
FLATTE   70 PR D 1 1           STANLEY M. FLATTE                      (LRL)
GOLDHABE 70 PHILA.CONF.P.59    GERSON GOLDHABER,REVIEW                (LRL)
HAGOPIAN 70 PRL 25 1050        S. AND V.HAGOPIAN,BOGART,SELOVE  (FSU+PENN)
ROOS     70 DNPL/R7 P.173      PROC. DARESBURY STUDY WEEKEND NO 1.  (CERN)

ABRAMS   71 PR D 4 653         +BARNHAM,BUTLER,COYNE,GOLDHABER,HALL,+(LBL)
ALVENSLE 71 PRL 27 888         ALVENSLEBEN,BECKER,BUSZA,CHEN,COHEN,+(DESY)
ANGELOW  71 SJNP 12 427        +GRAMENITSKY,KANASIRSKY,KERATSCHEW,+ (JINR)
BALDIN   71 SJNP 13 758        +YERGAKOV,TREBUKHOVSKY,SHISHOV         (ITEP)
BARCADIN 71 PR D4 2711         BARDADIN-OTWINOWSKA,HOFMCKL,MICHEJDA+(WARS)
BEHREND  71 PRL 27 61          +LEE,NORDBERG,WEHMAN,+     (ROCH+CORN+FNAL)
BIZZARRI 71 NP B 27 140        +MONTANET,NILSSCN,D-ANDLAU,+    (CERN+CDEF)
BLOODWGR 71 NP B 35 133        BLOCDWORTH,JACKSON,PRENTICE,YOON  (TORCNTO)
CHAPMAN  71 PR D 3 38          +FCRTNEY,FOWLER                        (DUKE)
COYNE    71 NP B 32 333        +BUTLER,FANG-LANDAU,MACNAUGHTON         (LRL)
FIELDS   71 PRL 27 1749        +COOPER,RHINES,ALLISON             (ANL+OXF)
MATTHEWS 71 PRL 26 400         +PRENTICE,YOON,CARROLL,WALKER,+ (TNTO+WISC)
MOFFEIT  71 NP B 29 349        +BINGHAM,FRETTER,BALLAM+(LRL+UCB+SLAC+TUFT)

AGUILAR  72 PR D 6 29          AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS   (BNL)
APEL     72 PL 41 B 234        +AUSLANDER,MULLER,BERTOLUCCI,+  (KARL+PISA)
BASILE   72 PHIL.CCNF.PROC153  +BOLLINI,BROGLIN,DALPIAZ,FRABETTI,+  (CERN)
BENAKSAS 72 PL 39 B 289        +COSME,JEAN-MARIE,JULLIAN,LAPLANCHE,+(ORSA)
BENAKSAS172 PL 42 B 507        +COSME,JEAN-MARIE,JULLIAN,LAPLANCHE+(ORSAY)
BENAKSAS272 PL 42 B 511        +COSME,JEAN-MARIE,JULLIAN,LAPLANCHE+(ORSAY)
BROWN    72 PL 42 B 117        +DOWNING,HOLLOWAY,HULD,BERNSTEIN+(ILL+ILLC)
DAKIN    72 PR D 6 2321        +HAUSER,KREISLER,MISCHKE         (PRINCETON)
EISENBER 72 PR D 5 15          EISENBERG,BALLAM,DAGAN,+   (REHO+SLAC+TELA)
RATCLIFF 72 PL 38 B 345        +BULOS,CARNEGIE,KLUGE,LEITH,LYNCH,+  (SLAC)

BINNIE   73 PR D 8 2789        +CARR,DEBENHAM,DUANE,GARBUTT,+  (LOIC+SHMP)
BURNS    73 PR D 7 1310        +CONDON,KIM,MANDELKERN,PRICE,SCHULTZ  (UCI)

ESTABROO 74 NP B 81 70         ESTABROOKS,HYAMS,JCNES,BLUM,    (CERN+MPIM)
GREGCRIO 74 NC 20 A 437        M.A.GREGORIO                 (ICTP,TRIESTE)
KRAMER   74 PRL 33 505         +AYRES,DIEBOLD,GREENE,PAWLICKI+         (ANL)
OREN     74 NP B 71 189        +COOPER,FIELDS,RHINES,ALLISCN+     (ANL+OXF)
ROOS     74  PREPRINT 72       M.ROOS,J.ROUSKU                    (HELSINKI)

EMMS     75 NP B98 1           +KINSON,STACEY,BELL,DALE+  (BIRM+DURH+RHEL)
KALBFLEI 75 PR D 11 987        KALBFLEISCH,STRAND,CHAPMAN         (BNL+MICH)
ROOS     75 NP B 97 165        M.ROOS                                 (HELS)

KEYNE    76 PR D               +BINNIE,CARR,DEBENHAM,GARBUTT,+ (LOIC+SHMP)
    ALSO 73 BINNIE
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M(940) →MM

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                  66  M(940)

                  EVIDENCE NOT COMPELLING.OMITTED FROM TABLE.

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                  66  M(940) MASS  (MEV)

M  N    55  940.5      1.7           CHESHIRE  72 MMS   0 2.4 PI- P,N MM   12/72
M  N    NOT SEEN BY BINNIE 72 AT THRESHOLD.
M  N    NOT SEEN BY BINNIE 74 AT 2 GEV/C                                    2/74
M  N    NOT SEEN BY BUTTRAM 75 AT 2.4 GEV/C                                12/75*

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                  66  M(940) WIDTH  (MEV)

W  N    55  (10.4)  OR LESS  CL=.90  CHESHIRE  72 MMS   0 2.4 PI- P,N MM   12/72

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                  66  M(940) BRANCHING RATICS

R1     M(940) INTO (NEUTRAL)/(TWO-CHARGE)/(FOUR-CHARGE)
R1            0.12      0.86      0.02  CHESHIRE  72 MMS   0 2.4 PI- P,N MM  12/72

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REFERENCES FOR M(940)


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CHESHIRE 72 PRL 28 520         +HOFFMAN,GARFINKEL,+          (IOWA+ANL+PURD)
BINNIE   72 PL 39 B 275        +CAMILLERI,DUANE,GARBUTT,BURTON+(LOIC+SHMP)
BINNIE   74 PRL 32 392         +CAMILLERI,CARR,DEBENHAM,+       (LOIC+SHMP)

BUTTRAM  75 PRL 35 970         +CRAWLEY,DUKE,LAMB,LEEPER,PETERSON     (ISU)
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Data Card Listings

For notation, see key at front of Listings.

Mesons

M(953), $\eta'(958)$

M(953) $\rightarrow \gamma\pi^+\pi^-$ $\not\rightarrow \gamma\rho^0$ →

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59  M(953,JPG=  +)

WHILE MASS AND WICTH ARE CONSISTENT WITH
ETA PRIME(958),THE PI+ PI- GAMMA DECAY
SHOWS NO RHO SIGNAL.
POSSIBLY SEEN IN MMS.
OMITTED FRCM TABLE.

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                  59  M MASS (MEV)

M       68  953.0       2.0               AGUILAR   70 HBC     3.9-4.6K-P,P K-M  1/71
M   M      (953.4)     (1.5)     (3.8)   MAGLICH   71 MMS     3.8 P D,HE3 XO    2/72
M   M   MISSING MASS SPECTRUM SHOWED THIS PEAK AT 953.4 INSTEAD OF
M   M   ETA PRIME (958).  PEAK LISTED UNDER M BECAUSE OF MASS
M   M   COINCIDENCE.  THE 1.5 MEV ERROR MAY BE UNDERESTIMATED BY
M   M   A FACTOR OF 2 (SEE BRODY 72, TABLE III).  OBSERVED PEAK COULD
M   M   THEN WELL CORRESPOND TO ETA PRIME.

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                  59  M WIDTH (MEV)

W       68  (10.0)  OR LESS  CL=.95   AGUILAR   70 HBC     3.9-4.6K-P,P K-M  1/71
W   M        (15.)  OR LESS           MAGLICH   71 MMS     3.8 P D,HE3 XO    2/72

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                  59  M PARTIAL DECAY MODES

                                                             DECAY MASSES
P1      M INTO PI+ PI- GAMMA                               139+ 139+   0
P2      M INTO RHOO GAMMA                                  773+   0
P3      M INTO PI+ PI- ETA                                 139+ 139+ 548
P4      M INTO PIO ETA                                     134+ 548
P5      M INTO PI+ PI- PIO                                 139+ 139+ 134

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                  59  M BRANCHING RATIOS

R1      M INTO (RHOO GAMMA)/(ALL PI+ PI- GAMMA)          (P2)/(P1)
R1       58    0.05      0.1          AGUILAR   70 HBC     3.9-4.6K-P,P K-M  1/71

R2      M INTO (PI+ PI- GAMMA)/(PI+ PI- ETA NEUTR.)      (P1)/(P3N)
R2       58    1.2       0.3          AGUILAR   70 HBC     3.9-4.6K-P,P K-M  1/71

R3      M INTO (PI+ PI- PIO)/TOTAL                        (P5)
R3       58    NOT OBSERVED           AGUILAR   70 HBC     3.9-4.6K-P,P K-M  1/71

R4      M INTO (PIO ETA NEUTR.)/TOTAL                     (P4N)
R4       58    NOT OBSERVED           AGUILAR   70 HBC     3.9-4.6K-P,P K-M  1/71

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                          REFERENCES FOR M

AGUILAR  70 PRL 25 1635          AGUILAR-BENITEZ,BASSANO,SAMIOS,BARNES+(BNL)

MAGLICH  71 PRL 27 1479          +OCSTENS,BRODY,CVIJANOVICH (RUTG+PENN+UPNJ)
ROSNER   71 PRL 26 933           J.L.ROSNER,E.W.COLGLAZIER        (MINN+CIT)

AGUILAR  72 PR D 6 29            AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS   (BNL)
BRODY    72 UPR-3E.SUBM.TO PR    +GROVES,NOREM,CVIJANOVICH,+(PENN+RUTG+UPNJ)

GRIGORIA 75 NP B91 232           GRIGORIAN,LADAGE,MELLEMA,RUDNICK,+   (UCLA)
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$\eta'(958)$

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 2  ETA PRIME(958,JPG=0-+) I=0
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Note on the J^P Assignment of $\eta'(958)$

From the Dalitz plot analyses of the $\eta' \rightarrow \pi\pi\eta$ and $\eta' \rightarrow \pi^+\pi^-\gamma$ decays, and from the observation of a $\eta' \rightarrow \gamma\gamma$ decay mode, all assignments except $J^{PC} = 0^{-+}$ and 2^{-+} are excluded. The Dalitz plot analyses favor spin 0, but cannot rule out spin 2. The indication of anisotropy in the decay of very forward produced η' (KALBFLEISCH 73) has not been confirmed by BALTAY 74, thus favoring strongly spin 0.

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                  2  ETA PRIME MASS (MEV)

M   O   ONLY EXPERIMENTS GIVING ERROR LESS THAN 2 MEV KEPT FOR AVERAGING    12/75*
M       85 (957.0)                    DAUBER    64 HBC     1.95 K-P
M   K      (958.0)     (1.0)          KALBFLE1  64 HBC     2.7 K-P            6/66
M   K       KALBFLEISCH 64 SUPERSEDED BY RITTENBERG 69
M   O      (957.0)     (3.0)          BADIER    65 HBC     3.0 K-P
M   O    8 (960.0)     (2.0)          TRILLING  65 HBC     3.65 PI+ P        12/75*
M   O    7 (955.0)    (10.0)          COHN      66 DBC     3.3 PI+D           6/66
M   O      (959.0)     (3.0)          LONDON    66 HBC     2.2 K-P            6/66
M   O      (960.0)     (5.0)          MOTT      69 HBC     4.1-5.5 K- P       7/69
M             957.      1.            RITTENBER 69 HBC     1.7-2.7 K- P       9/69
M   O        (956.0)   (2.0)          AGUILAR   70 HBC     3.9-4.6K-P        12/75*
M      3415   956.1     1.1           BASILE1   71 CNTR    1.6 PI- P,N XO    11/71
M       535   957.4     1.4           BASILE1   71 CNTR    1.6 PI- P,N XO    11/71
M      1414   958.2     0.5           DANBURG   73 HBC     2.2 K-P,LAM XO     2/74
M       400   958.      1.            JACOBS    73 HBC     2.9 K-P,LAM XO     1/74
M             957.46    0.33          DUANE     74 MMS     PI- P,N MM         1/74
M             . . . . . . . . .
M   AVG       957.57    0.25   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT   957.57    0.28   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                  2  ETA PRIME WIDTH (MEV)

W       85   (4.0)   OR LESS              DAUBER    64 HBC     1.95 K-P
W     3415   (8.)    OR LESS  CL=.90      BASILE1   71 CNTR    1.6 PI- P,N XO    11/71
W      514   (4.7)   OR LESS  CL=.95      DANBURG   73 HBC     2.2 K-P,LAM XO     2/74
W            (0.8)   OR LESS  CL=.95      DUANE     74 MMS     PI- P,N MM         1/74

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                  2  ETA PRIME PARTIAL DECAY MODES

                                                             DECAY MASSES
P1      ETA PRIME INTO PI+ PI- ETA                          139+ 139+ 548
                 P1(N)  ETAS DECAY INTO ALL NEUTRALS
                 P1(C)  ETAS DECAY CHARGED
P2      ETA PRIME INTO PIO PIO ETA                          134+ 134+ 548
                 P2(N)  ETAS DECAY INTO ALL NEUTRALS
                 P2(C)  ETAS DECAY CHARGED
P3      ETA PRIME INTO PI+ PI- GAMMA                        139+ 139+   0
                 (INCLUDING RHO GAMMA)
P4      ETA PRIME INTO GAMMA GAMMA                            0+   0
P6      ETA PRIME INTO RHOO GAMMA                             0+ 773
P10     ETA PRIME INTO PI+ PI- E+ E-                        139+ 139+  .5+  .5
P11     ETA PRIME INTO 2 PI                                 139+ 139
P12     ETA PRIME INTO 3 PI                                 139+ 139+ 134
P13     ETA PRIME INTO 4 PI                                 139+ 139+ 139+ 139
P14     ETA PRIME INTO 5 PI
P15     ETA PRIME INTO 6 PI
P16     ETA PRIME INTO PIO E+ E- (VIOLATES C IN             134+  .5+  .5
                                    BORN APPROX.)
P17     ETA PRIME INTO ETA E+ E- (VIOLATES C IN             548+  .5+  .5
                                    BORN APPROX.)
P18     ETA PRIME INTO PIO RHO O (VIOLATES C)               134+ 773
P19     ETA PRIME INTO PIO OMEGA (VIOLATES C)               134+ 783
P20     ETA PRIME INTO GAMMA OMEGA                            0+ 783

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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

```
        P 1          P 2         P 3         P 4
P 1  .4352+-.0174
P 2   -.5783   .2407+-.0198
P 3   -.3541    -.5478   .3039+-.0171
P 4    .0314    -.1430    -.0218   .0202+-.0027

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                  2  ETA PRIME BRANCHING RATIOS
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Note on $\eta'(958)$ Branching Fractions

In our calculation of the branching fractions of the $\eta'(958)$, we use the decay modes $\eta\pi\pi$ (including $\eta\pi^0\pi^0$), $\rho^0\gamma$, and $\gamma\gamma$. It is assumed that the rate $\eta \rightarrow$ neutrals is 71.1%.

In the fit we do not use the constraint

$$R = \Gamma(\eta' \rightarrow \eta\pi^+\pi^-)/\Gamma(\eta' \rightarrow \eta\pi^0\pi^0) = 2$$

from I-spin conservation. The result of the fit is in agreement with it: $R = 1.8 \pm 0.2$.

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R1      ETA PRIME INTO (PI+ PI-ETA (NEUTRAL DEC.))/TOTAL (PIN)
R1  K    68   (0.36)    (0.05)           KALBFLE2  64 HBC     2.7 K-P           10/66
R1  K           KALBFLE2 64 SUPERSEDED BY RITTENBERG 69
R1      281    0.314     0.026           RITTENBER 69 HBC     1.7-2.7 K-P        9/69
R1            . . . . . . . . .
R1  FIT        0.309     0.012  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2      ETA PRIME INTO (PI+ PI- NEUTRALS) / TOTAL          (P1N+P2C)
R2       33    0.35      0.06            BADIER    65 HBC     3.0 K-P           10/66
R2       39    0.4       0.1             LONDON    66 HBC     2.2 K-P           10/66
R2            . . . . . . . . .
R2  AVG        0.363     0.051   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2  STUDENT    0.363     0.056   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R2  FIT        0.379     0.010  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
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Mesons

$\eta'(958)$, $\delta(970)$

Data Card Listings

For notation, see key at front of Listings.

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R3      ETA PRIME INTO (PI+ PI- ETA (CHRGD.DECAY))/TOTAL (PIC)
R3  K   44   (0.12)    (0.02)           KALBFLE2  64 HBC      2.7 K-P          10/66
R3  K          KALBFLE2 64 SUPERSEDED BY RITTENBERG 69
R3       7   0.07      0.04             BADIER    65 HBC      3.0 K-P          10/66
R3      10   0.1       0.04             LONDON    66 HBC      2.2 K-P          10/66
R3     107   0.123     0.014            RITTENBER 69 HBC      1.7-2.7 K-P       9/69
R3           . . . . . . . . .
R3  AVG      0.116     0.013   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3  STUDENT  0.116     0.014   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R3  FIT      0.1258    0.0050 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4      ETA PRIME INTO (PI+ PI- NEUTRALS (EXCLUDING       (P2C)
R4          PI+ PI- ETA (NEUTR.DEC.))) / TOTAL
R4  K   10   (0.05)    (0.04)           KALBFLE2  64 HBC      2.7 K-P          10/66
R4  K          KALBFLE2 64 SUPERSEDED BY RITTENBERG 69
R4      42   0.045     0.029            RITTENBER 69 HBC      1.7-2.7 K-P       9/69
R4           . . . . . . . . .
R4  FIT      0.0696    0.0057 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R5      ETA PRIME INTO (NEUTRALS) / TOTAL               (P2N+P4)
R5  K   54   (0.25)    (0.05)           KALBFLE2  64 HBC      2.7 K-P          10/66
R5  K          KALBFLE2 64 SUPERSEDED BY RITTENBERG 69
R5      16   0.24      0.17             BADIER    65 HBC      3.0 K-P          10/66
R5      32   0.3       0.1              LONDON    66 HBC      2.2 K-P          10/66
R5     123   0.189     0.026            RITTENBER 69 HBC      1.7-2.7 K-P       9/69
R5     535   0.185     0.022            BASILE1   71 CNTR   1.6 PI- P,N X0     11/71
R5           . . . . . . . . .
R5  AVG      0.190     0.016   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R5  STUDENT  0.190     0.018   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R5  FIT      0.191     0.014  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R6      ETA PRIME INTO (PI+ PI- GAMMA (INCLUDING RHO GAMMA))/TOTAL
R6                                                      (P3)
R6  K   42   (0.22)    (0.04)           KALBFLE2  64 HBC      2.7 K-P          10/66
R6  K          KALBFLE2 64 SUPERSEDED BY RITTENBERG 69
R6      35   (0.34)    (0.09)           BADIER    65 HBC      3.0 K-P         .10/66
R6      20   0.2       0.1              LONDON    66 HBC      2.2 K-P          10/66
R6     298   0.329     0.033            RITTENBER 69 HBC      1.7-2.7 K-P       9/69
R6           . . . . . . . . .
R6  AVG      0.316     0.038   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
R6  STUDENT  0.317     0.035   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R6  FIT      0.304     0.017  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R7      ETA PRIME INTO (PI+ PI- GAMMA (INCLUDING RHO GAMMA))/(PI PI ETA)
R7                                                      (P3)/(P1+P2)
R7           0.25      0.14             DAUBER    64 HBC      1.95 K-P         10/66
R7           . . . . . . . . .
R7  FIT      0.450     0.037  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R8      ETA PRIME INTO (PIO E+ E-)/TOTAL                (P16)
R8          (0.013)OR LESS              RITTENBER 65 HBC            2.7 K-P    10/66

R9      ETA PRIME INTO (ETA E+ E-)/TOTAL                (P17)
R9          (0.011)OR LESS              RITTENBER 65 HBC            2.7 K-P    10/66

R10     ETA PRIME INTO (PIO RHO0)/TOTAL                 (P18)
R10         (0.04) OR LESS              RITTENBER 65 HBC            2.7 K-P    10/66

R11     ETA PRIME INTO(GAMMA OMEGA)/TOTAL               (P20)
R11 R       (0.08) OR LESS              RITTENBER 65 HBC            2.7 K-P    10/66
R11 R   INCLUDES PIO OMEGA
R11          (.05) OR LESS  CL=.90     KALBFLEI  75 HBC      2.2 K- P,GAMMA + 12/75*

R12     ETA PRIME INTO (PI+ PI- E+ E-)/TOTAL            (P10)
R12         (0.006)OR LESS              RITTENBER 65 HBC            2.7 K-P    10/66

R13     ETA PRIME INTO (2 PI)/TOTAL                     (P11)
R13         (0.07) OR LESS              LONDON    66 HBC      COMPILATION      10/66

R14     ETA PRIME INTO (3 PI)/TOTAL                     (P12)
R14         (0.07) OR LESS              LONDON    66 HBC      COMPILATION      10/66

R15     ETA PRIME INTO (4 PI)/TOTAL                     (P13)
R15         (0.01) OR LESS              LONDON    66 HBC      COMPILATION      10/66

R16     ETA PRIME INTO (6 PI)/TOTAL                     (P15)
R16         (0.01) OR LESS              LONDON    66 HBC      COMPILATION      10/66

R18     ETA PRIME INTO (RHO0 GAMMA)/(PI PI ETA)         (P6)/(P1+P2)
R18          0.31      0.15             DAVIS     68 HBC      5.5 K- P          9/68
R18          . . . . . . . . .
R18 FIT      0.450     0.037  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R19     ETA PRIME INTO (2 GAMMA)/TOTAL                  (P4)
R19      5   0.055     0.036     0.030 BOLLINI   68 CNTR     1.9 PI- P         12/72
R19      7   0.126     0.075           BENSINGER 70 DBC      2.2 PI+ D         12/72
R19     31   0.020     0.008     0.006 HARVEY    71 OSPK     3.65 PI- P,N X0   11/71
R19     68   0.0171    0.0033          DALPIAZ   72 CNTR     1.6 PI- P,N X0    12/72
R19           .025      .007           DUANE     74 MMS      PI-P,N MM         12/75*
R19          . . . . . . . . .
R19 AVG      0.0192    0.0027  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R19 STUDENT  0.0191    0.0031  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R19 FIT      0.0202    0.0027 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R20     ETA PRIME INTO (PI+PI-)/TOTAL                   (P11)
R20         (0.02) OR LESS              RITTENBER 69 HBC      1.7-2.7 K-P       9/69
R20         (0.08) OR LESS  CL=.95      DANBURG   73 HBC      2.2 K-P,LAM X0    2/74

R21     ETA PRIME INTO (PI+PI-PIO)/TOTAL                (P12)
R21         (0.05) OR LESS              RITTENBER 69 HBC      1.7-2.7 K-P       9/69
R21         (0.09) OR LESS  CL=.95      DANBURG   73 HBC      2.2 K-P,LAM X0    2/74

R22     ETA PRIME INTO (PI+PI+PI-PI-)/TOTAL             (P13)
R22         (0.01) OR LESS              RITTENBER 69 HBC      1.7-2.7 K-P       9/69
R22         (0.01) OR LESS  CL=.95      DANBURG   73 HBC      2.2 K-P,LAM X0    2/74

R23     ETA PRIME INTO (PI+PI+PI-PI-PIO)/TOTAL          (P14)
R23         (0.01) OR LESS              RITTENBER 69 HBC      1.7-2.7 K-P

R24     ETA PRIME INTO (PI+PI+PI-PI- NEUTRALS)/TOTAL    (P16+...)
R24         (0.01) OR LESS              RITTENBER 69 HBC      1.7-2.7 K-P       9/69

R25     ETA PRIME INTO (RHO0 GAMMA)/(ALL PI+ PI- GAMMA) (P6)/(P3)
R25          0.94      0.20             AGUILAR   70 HBC      3.9-4.6K-P        1/71
R25  E 473   1.15      0.10             DANBURG   73 HBC      2.2 K-P,LAM X0    2/74
R25  E 473  (0.95) OR MORE  CL=.95      DANBURG   73 HBC      2.2 K-P,LAM X0    2/74
R25  E  EQUIVALENT STATEMENTS
R25    137   1.01      0.15             JACOBS    73 HBC      2.9 K-P,LAM X0    1/74
R25          . . . . . . . . .
R25 AVG      1.082     0.077   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R25 STUDENT  1.082     0.086   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R26     ETA PRIME INTO (PIO PIO ETA INTO 3 PIO)/TOTAL   (P2N(3PIO))
R26      4   0.11      0.06             BENSINGER 70 DBC      2.2 PI+ D         1/71
R26          . . . . . . . . .
R26 FIT      0.0722    0.0060 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R27     ETA PRIME INTO (PI+ PI- GAMMA)/(PI+ PI- ETA(NEUTRAL DEC.))
R27                                                      (P3)/(P1N)
R27 K        (0.54)    (0.10)           AGUILAR   72 HBC      3.9,4.6 K- P     12/72
R27 K    NOT AVERAGED DUE TO COMPLICATION WITH M(953).SEE KALBFLEI 74.
R27    473   0.92      0.14             DANBURG   73 HBC      2.2 K-P,LAM X0    2/74
R27    192   1.11      0.18             JACOBS    73 HBC      2.9 K-P,LAM X0    1/74
R27          . . . . . . . . .
R27 AVG      0.99      0.11    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R27 STUDENT  0.99      0.12    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R27 FIT      0.982     0.078  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R28     ETA PRIME INTO (2 GAMMA)/(PIO PIO ETA(NEUTRAL DEC.))
R28                                                      (P4)/(P2(N))
R28     16   0.188     0.058            APEL      72 OSPK     3.8 PI- P,N X0    1/73
R28          . . . . . . . . .
R28 FIT      0.118     0.019  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                    2  ETA PRIME C-NONCONSERVING DECAY PARAMETER

        RELATED TEXT SECTION  VI C

A   DECAY ASYMMETRY PARAMETER FOR PI+ PI- GAMMA
A      152     .07       .08            RITTENBE  65 HBC     2.1-2.7 K-P       12/75*
A      103     .00       .10            KALBFLEI  75 HBC     2.2 K-P           12/75*
A      295    -.069      .078           GRIGORIA  75 STRC    2.1 PI-P          12/75*
A            . . . . . . . . .
A   AVG      -0.001     0.049   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
A   STUDENT  -0.001     0.056   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                          REFERENCES FOR ETA PRIME
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DAUBER   64 PRL 13 449        DAUBER,SLATER,SMITH,STORK,TICHO         (UCLA)JP
    ALSO 64 DUBNA CONF 1 418  DAUBER,SLATER,L T SMITH,STORK,TICHO  (UCLA)
GOLDBERG 64 PRL 12 546        +GUNDZIK,LICHTMAN,CONNOLLY,HART,+(SYRA+BNL)
GOLDBERG 64 PRL 13 249        +GUNDZIK,LEITNER,CONNOLLY,HART,+ (SYRA+BNL)
KALBFLE1 64 PRL 12 527        KALBFLEISCH,ALVAREZ,BARBARO-GALTIERI,+(LRL)JP
KALBFLE2 64 PRL 13 349        G.R.KALBFLEISCH,O.DAHL,A.RITTENBERG   (LRL)JP

BADIER   65 PL 17 337         BADIER,DEMOULIN,BARLOUTAUD+(EPOL+SACL+ZEEM)
KIENZLE  65 PL 19 438         KIENZLE,MAGLIC,LEVRAT,LEFEBVRES +    (CERN)
RITTENBE 65 PRL 15 556        RITTENBERG,KALBFLEISCH              (LRL+BNL)
TRILLING 65 PL 19 427         +BROWN,GOLDHABERS,KADYK,SCANIO          (LRL)

COHN     66 PL 21 347         COHN,MCCULLOCH,BUGG,CONDO  (ORNL+TENN+UCND)
LONDON   66 PR 143 1034       LONDON,RAU,SAMIOS,GOLDBERG + (BNL+SYRACUSE)IJP
MARTIN   66 PL 22,352         MARTIN,CRITTENDEN,SCHROEDER     (INDIANA U)I

BARBARO- 68 PRL 20 349        BARBARO-GALTIERI,MATISON,RITTENBERG+  (LRL)I=0
BARLOUTA 68 PL 26 B  674      BARLOUTAUD+     (SACLAY+AMST+BGNA+REHO+EPOL)I=0
BOLLINI  68 NC 58 A  289      +BUHLER,DALPIAZ,MASSAM+     (CERN+BGNA+STRB)
DAVIS    68 PL 27 B 532       +AMMAR,MOTT,DAGAN,DERRICK,FIELDS (NWES+ANL)

DUFEY    69 PL 29 B 605       +GOBBI,POUCHON,CNOPS,+      (ETHZ+CERN+SACL)IJP
MOTT     69 PR 177 1966       +AMMAR,DAVIS,KROPAC,SLATE,DAGAN+ (NWES+ANL)
RITTENBE 69  UCRL-18863       ALAN RITTENBERG (THESIS)              (LRL)I=0

AGUILAR  70 PRL 25 1635       AGUILAR-BENITEZ,BASSANO,SAMIOS,BARNES+(BNL)
BENSINGE 70 PL 33 B 505       BENSINGER,ERWIN,THOMPSON,W.D.WALKER  (WISC)

BARDADIN 71 PR D4 2711        BARDADIN-OTWINOWSKA,HOFMOKL,MICHEJDA+(WARS)
BASILE1  71 NC 3 A 371        +BOLLINI,DALPIAZ,FRABETTI,+(CERN+BGNA+STRB)
BASILE2  71 NP B 33 29        +BOLLINI,DALPIAZ,FRABETTI,+(CERN+BGNA+STRB)
HARVEY   71 PRL 27 885        +MARQUIT,PETERSON,RHOADES,+       (MINN+MICH)
OGIEVETS 71 PL 25 B 69        OGIEVETSKY,TYBOR,ZASLAVSKY            (DUBNA)

AGUILAR  72 PR D 6 29         AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS   (BNL)
APEL     72 PL 40 B 680       +AUSLANDER,MULLER,BERTOLUCCI,+  (KARL+PISA)
BINNIE   72 PL 39 B 275       +CAMILLERI,DUANE,GARBUTT,BURTON+(LOIC+SHMP)
BLOODWOR 72 NP B 39 525       BLOODWORTH,JACKSON,PRENTICE,YOON  (TORONTO)
DALPIAZ  72 PL 42 B 377       +FRABETTI,MASSAM,NAVARRIA,ZICHICHI   (CERN)
RADER    72 PR D 6 3059       +ABOLINS,DAHL,DANBURG,DAVIES,HOCH,+   (LBL)

DANBURG  73 PR D 8 3744       +KALBFLEISCH,BORENSTEIN,CHAPMAN,+(BNL+MICH)  JP
JACOBS   73 PR D 8 18         +CHANG,GAUTHIER,+        (BRAN+UMD+SYRA+TUFT)  JP
KALBFLEI 73 PRL 31 333        KALBFLEISCH,CHAPMAN,+          (BNL+MICH+LBL)  JP

BALTAY   74 PR D9 2999        +COHEN,CSORNA,HABIBI,KALELKAR,+ (COLU+BING)  JP
DUANE    74 PRL 32 425        +BINNIE,CAMILLERI,CARR,DEBENHAM+(LOIC+SHMP)
GAULT    74 NC 24 A 259       +JONES,SCADRON,THEWS          (DURH+LOIC+ARIZ)
KALBFLEI 74 PR D10 916        G.R.KALBFLEISCH                          (BNL)

GRIGORIA 75 NP B91 232        GRIGORIAN,LADAGE,MELLEMA,RUDNICK,+   (UCLA)
KALBFLEI 75 PR D11 987        KALBFLEISCH,STRAND,CHAPMAN          (BNL+MICH)
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$\delta(970)$ $\to \eta\pi, \cdots$

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36  DELTA(970,JPG=0+-) I=1
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Under this entry, we list three types of I=1 peaks near $K\bar{K}$ threshold:

1) Missing-mass peaks, mostly controversial.
2) $\eta\pi$ decays, peaking slightly below $K\bar{K}$ threshold. This defines $I^G = 1^-$ and J^P = Normal.
3) Threshold enhancements in the $(K\bar{K})^{\pm}$ system with I=1. The Q value is low and J^P therefore probably 0^+.

Data Card Listings

For notation, see key at front of Listings.

Mesons

$\delta(970)$, H(990), $S^*(993)$

In listing these types of peaks together under a common entry we do not imply that they are necessarily all related. However, the $K\bar{K}$ threshold enhancement may be due to a virtual bound state that could also be responsible for the $\eta\pi$ peaks (ASTIER 67). In a coupled-channel analysis of the most significant $\eta\pi$ and $K\bar{K}$ data, MORGAN 75 shows that the $\delta(970)$ probably is strongly coupled to both channels. It then constitutes the isovector member of the 0^+ nonet. MORGAN 75 gets a width much larger than what is observed in the $\eta\pi$ decays because of the strong $K\bar{K}$ coupling.

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                    36  DELTA(970) MASS  (MEV)

M  PEAKS  IN MISSING MASS EXPERIMENTS
M   K  262 (962.0)    (5.0)          KIENZLE   65 MMS   -  3-5 PI- P         9/66
M   K    NOT SEEN BY BANNER1 67 (1.8 PI- P)
M   K    NARROW PEAK NOT SEEN BY KALBFLEI 74 (1.3-1.6 PI-P)
M   O       (966.0)    (8.0)          OOSTENS   66 MMS  +  3.8 PP TO D + MM  9/66
M   O    NOT SEEN BY BANNER2 67 AND ANDERSON 71
M             975.0       6.0          ABOLINS   70 MMS  +  3.8-6.3 PP--D+MM  1/71
M   N  215 (962.9)    (1.7)          CHESHIRE  72 MMS   0 2.4 PI- P,N MM    12/72
M   N    NOT SEEN BY BINNIE 72 AT THRESHOLD.
M   N    NOT SEEN BY BINNIE 74 AT 2 GEV/C
M   N    NOT SEEN BY BUTTRAM 75 AT 2.4 GEV/C                                12/75*

M  ETA PI FINAL STATE ONLY.
M  S     30  980.0      10.0           AMMAR     68 HBC  +-     ,5.5K-,ETA PI  2/73
M  S     SEE ALSO AMMAR 70.
M        10 (960.)      APPROX.        CHUNG S   68 HBC   -  3.2 PI-P          5/70
M        80 (975.0)                    DEFOIX    68 HBC  +-  1.2 PB P,ETA PI   3/69
M        20  970.0      15.0           BARNES    69 HBC   -  4-5 K-P,PI-ETA    9/69
M            980.       10.            CAMPBELL  69 DBC  +- 2.7 PI+ D          1/73
M        15 (980.0)    (10.0)          MILLER    69 HBC   -  4.5 K-N,ETA PI    7/69
M        21  948.0      (7.0)          BARDADIN  71 HBC  +- 8 PI+P,P DO PI     2/72
M       150  972.       10.            DEFOIX    72 HBC  +- 0.7 PBAR P,7 PI    1/73
M        47 (980.)                     CONFORTO  73 OSPK -  4.5 PI-P,P X-      1/74
M            . . . . . . . . . .
M   AVG      976.4       5.4     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT 976.4       5.8     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

M  K KBAR ONLY, SEE THE TYPED NOTE ABOVE
M      143(1003.3)      7.0+SYSTEMATIC ROSENFELD 65 RVUE +-                 . 8/66
M           SCAT. LENGTH 2 TO 6 FERMIS.BALTAY    66 HBC      3.7 PBAR P       8/66
M   A  100(1016.)     (10.)           ASTIER    67 HBC  +-  0 PBAR P        . 7/67
M   A    SCATT.LENGTH ALSO FITS, SEE BELOW
M   .    SCATT.LENGTH +2.5 +-1. FERMI  ASTIER    67 HBC  +-  0-1.2 PBAR P      7/67
M        OR CMPLX, RE PART=-2.3 F      ......    .. ...  ..  ..... .... .      7/67
M                   IM PART=.5F OR LESS ......   .. ...  ..  ..... .... .      7/67
M   B        (1.8)      (0.4)      (0.3)  DUBOC     72 HBC     1.2 PBAR P,3PI2K 12/72
M   B  ABSOLUTE VALUE OF SCAT.LENGTH                                        12/72

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                    36  DELTA(970) WIDTH  (MEV)

W  PEAKS SEEN IN MISSING MASS EXPERIMENTS
W   S  262    (5.0)  OR LESS            KIENZLE   65 MMS   -  3-5 PI- P         9/66
W   S        (10.0)  OR LESS            OOSTENS   66 MMS  +  3.8 PP TO D + MM  9/66
W              60.0     16.0     10.0   ABOLINS   70 MMS  +  3.8-6.3 PP--D+MM  1/71
W   S  215    (5.9)  OR LESS  CL=.90    CHESHIRE  72 MMS   0 2.4 PI- P,N MM    12/72
W   S    SEE NOTES ON DELTA MASS ABOVE

W  ETA PI  FINAL STATE ONLY
W        30   80.0      30.0            AMMAR     68 HBC  +-     ,5.5K-,ETA PI  2/73
W        80  (25.0)                     DEFOIX    68 HBC  +-  1.2 PB P,ETA PI   3/69
W        20  (50.0)  OR LESS            BARNES    69 HBC   -  4-5 K-P,PI-ETA    9/69
W             40.       15.             CAMPBELL  69 DBC  +- 2.7 PI+ D          1/73
W        15   60.0      30.0            MILLER    69 HBC   -  4.5 K-N,ETA PI    2/74
W        21   31.0      28.0            BARDADIN  71 HBC  +- 8 PI+P,P DO PI   . 2/74
W       150  (30.)      (5.)            DEFOIX    72 HBC  +- 0.7 PBAR P,7 PI  . 2/74
W        47  (60.)     (50.)    (30.)   CONFORTO  73 OSPK -  4.5 PI-P,P X-      1/74
W            . . . . . . . . . .
W   AVG       46.9      11.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT   46.6      12.5     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

W  K KBAR ONLY, SEE THE TYPED NOTE ABOVE
W       143  (57.0)     13.0+SYSTEMATIC ROSENFELD 65 RVUE +-                  8/66
W   A  100   (25.) APPROX.              ASTIER    67 HBC  +- SEE NOTE A ABOVE  9/67
W   M        (120.) APPROX.             MORGAN    75 RVUE    1.2 PBAR P       12/75*
W   M    FROM COUPLED CHANNEL FIT TO DUBOC 72 DATA

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                    36  DELTA(970) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      DELTA(970)    INTO ETA PI                           548+ 134
P2      DELTA(970)    INTO RHO PI                           773+ 134

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                    36  DELTA(970) BRANCHING RATIOS

R1      DELTA(970)    INTO (RHO PI)/(ETA PI)                (P2)/(P1)
R1               (0.25) OR LESS  CL=.70   AMMAR      70 HBC  +- 4.1,5.5K-,ETA PI. 5/70

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                              REFERENCES FOR DELTA(970)

TURKOT    63 SIENNA CONF 1 661 +COLLINS,FUJII,KEMP+          (BNL+PITTSBURGH)

ARMENTER 65 PL 17 344          ARMENTEROS,EDWARDS, JACOBSEN +  (CERN+CDEF)
BARASH    65 PR  139 B  1659    +FRANZINI,KIRSCH,MILLER,STEINBERGER+ (COLU)
KIENZLE   65 PL   19  438       + MAGLIC,LEVRAT,LEFEBVRES +             (CERN)
ROSENFEL 65 OXFORD CONF 58     A H ROSENFELD                     (LRL--RVUE)

ALLEN D   66 PL 22  543         +GP FISHER,G GOODEN,L MARSHALL,SEARS (COLO)G=+
BALTAY    66 PR  142 B  932     +LACH,SANDWEISS,TAFT,YEH,STONEHILL+  (YALE)
FOCACCI   66 PRL  17  890       + KIENZLE,LEVRAT,MAGLIC,MARTIN         (CERN)
OOSTENS   66 PL   22  708       +CHAVANON,CROZON,TOCQUEVILLE  (SACLAY,CDEF)I=1

ALLISON   67 PL 25B 619         +CRUZ+        (OXF+MPIM+BIRM+RHEL+GLAS+LOIC)
ASTIER    67 PL  25 B  294      +MONTANET,BAUBILLIER,DUBOC+(CDEF+CERN+IRAD)
  ASTIER 67 INCLUDES DATA OF BARLOW 67,CONFORTO 67,ARMENTEROS 65.
BAILLON   67 NC 50A 393         +EDWARDS+D.ANDLAU+ASTIER+  (CERN+CDEF+IRAD)
BANNER 1 67 PL   25 B  300      +FAYOUX,HAMEL,ZSEMBERY,CHEZE+ (SACLAY+CAEN)
BANNER 2 67 PL 25 B 569         +CHEZE,HAMEL,MAREL,TEIGER+        (CDEF+SACL)
BARLOW    67 NC   50 A  701     +MONTANET,D,ANDLAU+    (CERN+CDEF+IRAD+LIVP)
CONFORTO 67 NP B3 469          CONFORTO,MARECHAL+     (CERN+CDEF+IPNP+LIVP)

AMMAR     68 PRL 21 1832        +DAVIS,KROPAC,DERRICK,FIELDS,+    (NWES+ANL)
CHUNG S   68 PR 165 1491        +O.DAHL, J. KIRZ, D.H.MILLER            (LRL)
DEFOIX    68 PL 28 B 253        +RIVET,SIAUD,CONFORTO+      (CDEF+IPNP+CERN)
GALTIERI 68 PRL 20 349         BARBARO-GALTIERI,MATISON,RITTENBERG+  (LRL)
JUHALA    68 PL 27 B 257        +LEACOCK,RHODE,KOPELMAN,LIBBY+  (IOWA+COLO)
SABRE CO 68 PL 26 B 674        BARLOUTAUD+          (SACL+AMST+BGNA+REHO+EPOL)

BARNES    69 PRL 23 610         +CHUNG,EISNER,BASSANO,GOLDBERG+  (BNL+SYRA)
CAMPBELL 69 PRL 22 1204        J.H.CAMPBELL,LICHTMAN,LOEFFLER,+    (PURDUE)
CRENNELL 69 PRL 22 1398        +KARSHON,KWAN WU LAI,+               (BNL+NYU)
JUHALA    69 PR 184  1461       +LEACOCK,RHODE,KOPELMAN,LIBBY,+  (ISU+COLO)
KRUSE     69 PR 177 1951        KRUSE,LOOS,GOLDWASSER               (ILLINOIS)
MILLER    69 PL 29 B  255       D.H.MILLER,S.L.KRAMER,D.D.CARMONY,+(PURDUE)
    ALSO 69 PR 188 2011        YEN,AMMANN,CARMONY,ELSNER,+          (PURDUE)
SCHROEDE 69 PR 188  2081       SCHROEDER,KERNAN,FISHER,LIBBY,+  (ISU+COLO)

ABOLINS   70 PRL 25 469         +GRAVEN,MCCARTHY,G.SMITH,L.SMITH+ (LRL+UCD)
AMMAR     70 PR D 2 430         +KROPAC,DAVIS,DERRICK+ (KANS+NWES+ANL+WISC)
COOPER    70 NP B 23 605        +HANNER,MUSGRAVE,POLLARD,VOYVODIC       (ANL)
YIOU      70  THESIS, A 646     TCHIU-PUNG YIOU                        (ORSAY)

ANDERSON 71 PRL 26 108         +DIXIT,+    (CHIC+ANL+CARL+LASL+CNRC+NAGOYA)
BARDADIN 71 PR D4 2711         BARDADIN-OTWINOWSKA,HOFMOKL,MICHEJDA+(WARS)

BINNIE    72 PL 39 B 275        +CAMILLERI,DUANE,GARBUTT,BURTON+(LOIC+SHMP)
CHESHIRE 72 PRL 28 520         +HOFFMAN,GARFINKEL,+           (IOWA+ANL+PURD)
DEFOIX    72 NP B 44 125        +NASCIMENTO,BIZZARRI,+            (CDEF+CERN)
DUBOC     72 NP B 46 429        +GOLDBERG,MAKOWSKI,DONALD,+       (LPNP+LIVP)
HOLLOWAY 72 PHIL.CONF.PROC.133+FULD,KOETZ,KRUSE,BERNSTEIN,+      (ILL+ILLC)

ATHERTON 73 PL 43 B 249        +FRANEK,FRENCH,GHIDINI,HILPERT,+      (CERN)
CONFORTO 73  AIX CONF.         BUTTERWORTH RAPPORTEUR TALK C1-195,FIG.39

BINNIE    74 PRL 32 392         +CAMILLERI,CARR,DEBENHAM,+        (LOIC+SHMP)
KALBFLEI 74 NP B69 279         KALBFLEISCH,VANDERBURG,+      (BNL+RUTG+IND)
MORGAN    74 PL 51B 71          D.MORGAN                                (RHEL)

BUTTRAM   75 PRL 35 970         +CRAWLEY,DUKE,LAMB,LEEPER,PETERSON     (ISU)
MORGAN    75  PREPRINT RL75133 D.MORGAN                                (RHEL)

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H(990)

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35  H(990,JPG=A -) I=0

THE EVIDENCE OF BENSON 66 HAS DISAPPEARED AFTER
RE-ANALYSIS (CHAUDHARY 70). NO SIGNIFICANT
OTHER EVIDENCE HAS BEEN PUBLISHED.
OMITTED FROM TABLE.

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                              REFERENCES FOR H

BARTSCH   64 PL   11  167       AACHEN-ZEUTHEN-BIRM-BONN-HAMB-MUNCHEN COLL
GOLDHABE 65 CORAL GABLES P.76 G. GOLDHABER                             (LRL)
BENSON    66 PRL 17 1234        +MARQUIT,ROE,SINCLAIR,VANDER VELDE    (MICH)IJP
COHN      67 NP B1 57           +MC CULLOCH,BUGG,CONDO       (ORNL+UNIV.TENN)
ROSENFEL 67 RMP 39 1,APPENDIX  ROSENFELD,BARBARO-GALTIERI+(LRL+CERN+YALE)
ARMENISE 68 PL 26B 336         +GHIDINI,FORINO+        (BARI+BGNA+FIRZ+ORSAY)
BARBARO- 68 PHILAD.CONF.P.137 A.BARBARO-GALTIERI,P.SODING              (LRL)
FUNG      68 PRL 21  47         +JACKSON+PU+BROWN+GIDAL      (U.C.RIVERS+LRL)
GOLDHABE 69 LUND CONF.P.271    G.GOLDHABER QUOTED BY B.MAGLIC          (LRL)
CHAUDHAR 70 PR D 2 2110        B.CHAUDHARY,E.MARQUIT               (MINNESOTA)
GORDON    70  COO 1195 179      THESIS,ILLINOIS                          (ILL)
MICHAEL   72 PRL 28 1475        W.MICHAEL,G.GIDAL                        (LBL)

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$S^*(993)$

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3  S*(993,JPG=0++) I=0

UNDER THIS ENTRY WE LIST PARAMETERS OF THE POLE IN THE
ISOSCALAR S-WAVE.FOR A MINI-REVIEW SEE UNDER EPSILON.
POSSIBLE EVIDENCE OF D-WAVE PI PI INTERACTIONS IN THIS
REGION IS LISTED SEPARATELY UNDER  ETA N(1080).

FOR EARLY WORK USING BREIT-WIGNER OR SCATTERING
LENGTH PARAMETRIZATION IN FITS TO THE (K KBAR) MASS
SPECTRUM SEE REFERENCE SECTION AND OUR 1972 EDITION.

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                    3  REAL PART OF THE S* POLE POSITION (MEV)

M  H        970.       30.       130.    HOANG      69 OSPK    4. PI-P,KS KS N    1/73
M  H        920.       80.        90.    HOANG      69 OSPK    5. PI-P,KS KS N    1/73
M  H    CALCULATED FROM SCATTERING LENGTH FIT OF HOANG 69.
M  B       (965.)                        BEUSCH     70 OSPK    4,6 PI-P         . 1/73
M  B    CALCULATED FROM SCATTERING LENGTH FIT OF BEUSCH 70.
M           997.        6.               PROTOPOPE 73 HBC     SHEET 2 7. PI+ P   1/74
M  S        987.        7.               BINNIE     73 CNTR    PI- P,S* N         1/74
M  S    OBSERVED BY THRESHOLD-CROSSING TECHNIQUE. POSSIBLY IMPORTANT
M  S    S-CHANNEL EFFECTS.
M          (997.)                        ESTABROOK 73 ASPK    17 PI-P,PI+PI-N  12/75*
M         (1012.)      (6.)              GRAYER     73 ASPK    17 PI-P,PI+PI-N  12/75*
M          1007.       20.               HYAMS      73 ASPK  0 17 PI-P,N PI+PI-   1/74
M   A      (986.)      (5.)              FUJII      75 RVUE    17 PI-P,PI+PI-N  12/75*
M   A   S* AMPLITUDES PARAMETRIZED IN TERMS OF POLE POSITIONS USING
M   A   HYAMS 73 PHASE SHIFTS
M          . . . . . . . . . .
M   AVG     993.2       4.4     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT 993.3       5.1     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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Mesons
S*(993), φ(1020)

Data Card Listings
For notation, see key at front of Listings.

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                    3  NEGATIVE IMAG. PART OF THE S* PCLE POSITICN  (MEV)
                   CORRESPONCS TO HALF-WIDTH, NOT FULL WIDTH.

W  H      40.      40.      60.     HOANG     69 OSPK    4. PI-P,KS KS N   1/73
W  H      30.      30.      70.     HOANG     69 OSPK    5. PI-P,KS KS N   1/73
W  B     (13.)                      BEUSCH    70 OSPK    4,6 PI-P          1/73
W  P      27.       8.              PROTOPOPE 73 HBC     7. PI+ P          1/74
W  P   ANOTHER SOLUTION HAS 52 MEV AND NO EPSILON POLE.
W  S      24.       7.              BINNIE    73 CNTR    PI- P,S* N        1/74
W  S   SEE NOTE S ABOVE
W        (5.)                       ESTABROOK 73 ASPK    17 PI-P,PI+PI-N  12/75*
W       (16.)     (5.)              GRAYER    73 ASPK    17 PI-P,PI+PI-N  12/75*
W         15.       5.              HYAMS     73 ASPK  0 17 PI-P,N PI+PI-  1/74
W   A   (19.)     (3.)              FUJII     75 RVUE    17 PI-P,PI+PI-N  12/75*
W   A  S* AMPLITUDES PARAMETRIZED IN TERMS OF POLE POSITIONS USING
W   A  HYAMS 73 PHASE SHIFTS
W         . . . . . . . . .
W   AVG      20.0     3.7    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT  20.1     4.2    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    3  S* WIDTH (MEV)

        (180.)   APPROX.            MORGAN    75 RVUE                     12/75*

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REFERENCES FOR S*


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WANG      61 JETP 13 323          WANG TSU-TSENG,VEKSLER,VRANA,+          (JINR)
BIGI      62 CERN CONF 247        A BIGI,S BRANDT, R CARRARA +            (CERN)
BINGHAM   62 CERN CONF 240        H H BINGHAM,M BLOCH +              (EPOL+CERN)
ERWIN     62 PRL 9 34             ERWIN,HOYER,MARCH,WALKER,WANGLER (WISC+BNL)
BALTAY    64 DUBNA CONF 1 409     BALTAY,LACH,CRENNELL,OREN,STUMP +(YALE+BNL)
BARMIN    64 DUBNA CONF 1 433     BARMIN,DOLGCLENKO,YEROFEEV,KRESTNI+  (ITEP)
CRENNELL  66 PRL 16 1025          CRENNELL,KALBFLEISCH,LAI,SCARR,SCHU+  (BNL)
HESS      66 PRL 17 1109          +CAHL+HARDY+KIRZ+MILLER                (LRL)

BARLOW    67 NC 50A 701           +LILLESTOL+MONTANET+  (CERN+COEF+IRAD+LIVP)
BEUSCH    67 PL 25 B 357          +FISCHER,GOBBI,ASTBURY+          (ETHZ+CERN)
DAHL      67 PR 163 1377          +HARDY+HESS+KIRZ+MILLER                (LRL)
ALITTI    68 PRL 21 1705          +BARNES,CRENNELL,FLAMINIO,GOLDBERG,+   (BNL)
LAI       68 PHILAD.CONF.P.303    KWAN WU LAI                            (BNL)
PHELAN    68  THESIS              JAMES J. PHELAN          (ANL+ST.LOUIS UNIV)
  ALSO    68 PRL 21 316           HOANG,EARTLY,PHELAN,ROBERTS+(ANL+CHIC+NDAM)
AGUILAR-  69 PL 29 B  241         M.AGUILAR-BENITEZ,J.BARLOW,+     (CERN+CDEF)
  ALSO    67 BARLOW
  ALSO    69 NP B 14 195          M.AGUILAR-BENITEZ,J.BARLOW,+     (CERN+CDEF)
HOANG     69 NC 61 A 325          T.F.HOANG                              (ANL)
HOANG     69 PR 184  1363         +EARTLY,PHELAN,ROBERTS,+          (ANL+ILLC)

BADIER    70 NP B 22 512          +BONNET,DREVILLON,BAUBILLIER,+   (EPOL+IPNP)
BATON     70 PL 33 B 528          +LAURENS,REIGNIER                   (SACLAY)
BEUSCH    70 PHILA.CONF.P.185     W.BEUSCH                         (ETHZ+CERN)
HYAMS     70 PHILA.CONF.P.41      +KOCH,BEUSCH,+    (CERN+MPIM+ETHZ+LOIC+HAWA)
  ALSO    70 NP B 22 189          HYAMS,KOCH,POTTER,VON LINDERN,+ (CERN+MPIM)
OH        70 PR D 1 2494          +GARFINKEL,MORSE,WALKER,PRENTICE(WISC+TNTO)
ALSTON-G  71 PL 36 B 152          ALSTON-GARNJOST,BARBARO-GALTIERI,+     (LBL)

BASDEVAN  72 PL 41 B 178          BASDEVANT,FROGGATT,PETERSEN           (CERN)
DAMERI    72 NC 9 A 1             +BORZATTA,GOUSSU,+          (GENO+MILA+SACL)
DUBOC     72 NP B 46 429          +GOLDBERG,MAKOWSKI,DCNALD,+      (LPNP+LIVP)
FLATTE    72 PL 38 B 232          +ALSTON-GARNJOST,BARBARO-GALTIERI,+    (LBL)
GRAYER    72 PHIL.CONF.PROC. 5    +HYAMS,JONES,SCHLEIN,BLUM,DIETL+(CERN+MPIM)
WILLIAMS  72 PR D 6 3178          P.K.WILLIAMS                           (FSU)

BINNIE    73 PRL 31 1534          +CARR,DEBENHAM,DUANE,GARBUTT,+   (LOIC+SHMP)
DIAMOND   73 PR D 7 1977          +BINKLEY,+         (WISC+DUKE+COLO+TNTO+OHIO)
ESTABROO  73  TALLAHASSEE         ESTABROOKS,MARTIN,GRAYER,HYAMS+ (CERN+MPIM)
FUJII     73 NC 13 A 311          Y.FUJII,M.KATO                        (TOKYO)
GRAYER    73  TALLAHASSEE         +HYAMS,JONES,BLUM,DIETL,KOCH+   (CERN+MPIM)
HYAMS     73 NP B 64 134          +JONES,WEILHAMMER,BLUM,DIETL,+  (CERN+MPIM)
OCHS      73 THESIS               W.OCHS                                (MPIM)
PROTOPOP  73 PR D 7 1280          PROTOPOPESCU,GARNJOST,GALTIERI,FLATTE+(LBL)

GRAYER    74 NP B 76 375          +HYAMS,JONES,BLUM,DIETL         (CERN+MPIM)
GRAYER    74 NP B75 189           +HYAMS,JONES,BLUM,DIETL,KOCH+   (CERN+MPIM)
MORGAN    74 PL 51B 71            D.MORGAN                              (RHEL)

FUJII     75 NP B85 179           Y.FUJII,M.FUKUGITA                    (TOKY)
MORGAN    75  PREPRINT RL75133    D.MORGAN                              (RHEL)
PAWLICKI  75 PR D12 631           +AYRES,DIEBCLD,GREENE,KRAMER,WICKLUND (ANL)
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φ(1020)

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4   PHI(1020,JPG=1-- ) I=0

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                    4   PHI MASS (MEV)

M   S   18(1019.0)   (2.0)            SCHLEIN   63 HBC   2.0 K- P          .12/75*
M   S   20(1018.6)   (0.5)            MILLER D  65 HBC    0.0 PBAR P        12/75*
M   S   41(1020.0)   (2.0)            LONDON    66 HBC    2.2 K-P           12/75*
M   S   46(1021.5)   (0.8)            ABRAMS    67 HBC   4.2 K- P           12/75*
M   S   15(1019.)    (3.)             BARLOW    67 HBC    1.2 PBAR P        12/75*
M   S   32(1021.0)   (4.0)            DAHL      67 HBC    1-4 PI- P         12/75*
M      165 1022.      1.5             MOSTEK    68 OSPK  1.8 GAMMA + C       6/68
M      136 1018.      0.5       0.35  HYAMS     70 OSPK  11. PI- P           6/70
M      107 1021.0     1.5             ALVENSLE  71 OSPK  GAMMA+C             1/72
M    D  70 1019.9     0.7             DIBIANCA  71 CBC   4.93 K- N          12/75*
M      410(1019.9)   (0.3)            STOTTLEMY 71 HBC   2.9 K-P,Y K KBAR   11/71
M    D 120 1019.6     0.5             AGUILAR   72 HBC   3.9,4.6 K- P       12/75*
M    D 100 1019.9     0.5             AGUILAR   72 HBC   3.9,4.6 K- P       12/75*
M       87 1020.8     0.8             BALAKIN   72 OSPK  E+ E- COLL.BEAMS   12/72
M      131 1020.4     0.5             COLLEY    72 HBC   10.K+ P,K+ P PHI   12/72
M      100 1020.3     0.4             BALLAM    73 HBC   2.8 - 9.3 G P       1/74
M      500 1019.5     0.6             AYRES     74 ASPK  3-6PI/K-P,K+K-     12/75*
M      984 1019.4     0.8             BESCH     74 CNTR  2 GAMMA P,PK+K-    12/75*
M       54 1018.7     0.8             BIZZARRI  74 CBC   0 PBAR N,K+K- PI.12/75*
M       71 1018.6      .7             BIZZARRI  74 DBC   0 PBAR N,KLKS PI   12/75*
M      170 1020.3     0.4             DE GROOT  74 HBC   4.2 K-P,L K+K-     12/75*
M          . . . . . . . . . .
M   AVG     1019.70   0.24   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.6)
M   STUDENT1019.84    0.20   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                     (SEE IDEOGRAM BELOW )

M   S   INSIGNIFICANT DATA WITH SMALL STATISTICS NC LONGER AVERAGED
M    D  MASS ERRORS ENLARGED BY US TO WIDTH/SQRT(N)
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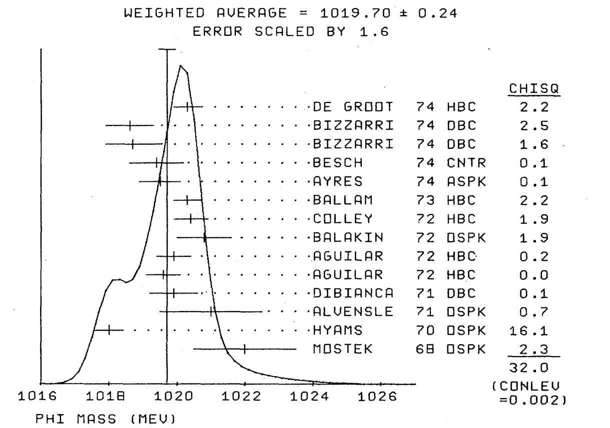


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                    4   PHI WICTH (MEV)

W   S   20  (3.5)   (1.0)           MILLER D  65 HBC    0.0 PBAR P        .12/75*
W   S   41  (6.0)   (4.0)           LONDON    66 HBC    2.2 K-P            12/75*
W   S   46  (1.8)   (3.0)   (1.5)   ABRAMS    67 HBC   4.2 K- P            12/75*
W      165  (4.5)   (3.0)   (2.0)   MOSTEK    68 OSPK  1.8 GAMMA + C        6/68
W      150   4.2     0.9            AUGUSTIN  69 OSPK  E+ E- COLL.BEAMS.12/72
W            4.09    0.29           BIZOT     70 OSPK  E+ E- COLL.BEAMS   12/72
W      136   3.3     1.5     0.9    HYAMS     70 OSPK  11. PI- P            6/70
W    D  87   4.67    2.02           BALAKIN   71 OSPK   E+ E- COLL.BEAM   12/75*
W    D  70   5.5     2.6            DIBIANCA  71 DBC   4.93 K- N           12/75*
W      110  (4.5)   (3.0)   (4.0)   STOTTLEMY 71 HBC   2.9 K-P,Y K KBAR   11/71
W    D 120   4.6     1.7            AGUILAR   72 HBC   3.9,4.6 K- P        12/75*
W    D 100   4.7     1.9            AGUILAR   72 HBC   3.9,4.6 K- P        12/75*
W    D 131   5.0     1.8            COLLEY    72 HBC   10.K+ P,K+ P PHI   12/75*
W    D 100   3.8     1.5            BALLAM    73 HBC   2.8 - 9.3 G P       12/75*
W            3.81    0.37           COSME 2   74 OSPK  E+E- COLL.BEAMS      2/74
W    D 500   4.5     0.8            AYRES     74 ASPK  3-6PI/K-P,K+K-      12/75*
W    D 984   4.4     0.6            BESCH     74 CNTR  2 GAMMA P,PK+K-     12/75*
W   S   54  (6.8)   (3.1)   (2.5)   BIZZARRI  74 CBC   0 PBAR N,K+K- PI   12/75*
W   S   71  (4.1)   (3.8)   (3.6)   BIZZARRI  74 CBC   0 PBAR N,KLKS PI   12/75*
W    D 170   4.2     1.3            DE GROOT  74 HBC   4.2 K-P,L K+K-      12/75*
W          . . . . . . . . .
W   AVG      4.09    0.19    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT  4.09    0.21    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

W   S   INSIGNIFICANT DATA WITH SMALL STATISTICS NO LONGER AVERAGED
W    D  WIDTH ERRORS ENLARGED BY US TO 4*WIDTH/SQRT(N)

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                    4   PHI PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      PHI INTO K+ K-                                        493+ 493
P2      PHI INTO KL KS                                        497+ 497
P3      PHI INTO PI+ PI- PIO (INCLUDING RHO PI)               139+ 139+ 134
P4      PHI INTO ETA GAMMA                                    548+   0
P5      PHI INTO E+ E-                                         .5+  .5
P6      PHI INTO MU+ MU-                                      105+ 105
P7      PHI INTO PIO GAMMA                                    134+   0
P8      PHI INTO PI+ PI- (VICLATES G)                         139+ 139
P9      PHI INTO PI+PI-GAMMA                                  139+ 139+   0
P10     PHI INTO OMEGA GAMMA (VICLATES C)                     783+   0
P11     PHI INTO ETA PIO (VICLATES C)                         548+ 134
P12     PHI INTO RHO GAMMA (VIOLATES C)                       773+   0
P13     PHI INTO ETA NEUTRALS
P14     PHI INTO 5PI

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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

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        P 1          P 2          P 3          P 4
P 1  .4661+-.0232
P 2   -.7766     .3503+-.0203
P 3   -.4924      -.1451     .1642+-.0145
P 4   -.0748      -.0598      -.0399     .0195+-.0035

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                    4   PHI BRANCHING RATIOS

R1      PHI INTO (K+ K-)/(KKBAR + PI+ PI- PIO)             (P1)/(P1+P2+P3)
R1  B    27   (0.26)   (0.06)           BADIER    65 HBC                        10/66
R1      252    0.48     0.04            LINDSEY   66 HBC      2.7 K-P           10/66
R1  C         (0.493)  (0.044)          BIZOT     70 OSPK   E+ E- COLL.BEAMS 11/71
R1  C SUPERSEDED BY CHATELLS 71                                                 11/71
R1             0.540    0.034           BALAKIN   71 OSPK    E+ E- COLL.BEAM 11/71
R1             0.486    0.044           CHATELUS  71 OSPK   E+ E- COLL.BEAMS 11/71
R1      270    C.49     0.06            DE GROOT  74 HBC    4.2 K-P,L PHI    12/75*
R1           . . . . . . . . . .
R1  AVG        0.505    0.021   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  STUDENT    0.504    0.024   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R1  FIT        0.475    0.024  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.6)
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Data Card Listings

For notation, see key at front of Listings.

Mesons

$\phi(1020)$, M(1033), $B_1(1040)$

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R2      PHI INTO (KL KS)/(KKBAR + PI+ PI- PIO)             (P2)/(P1+P2+P3)
R2  B   25   (0.23)    (0.06)          BADIER    65 HBC                       10/66
R2     167    0.40      0.04           LINDSEY   66 HBC      2.7 K-P          10/66
R2            0.257     0.038          BALAKIN   71 OSPK   E+ E- COLL.BEAMS. 1/73
R2     270    0.37      0.05           DE GROOT  74 HBC    4.2 K-P,L PHI     12/75*
R2         . . . . . . . . . .
R2  AVG       0.335     0.046   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)
R2  STUDENT   0.342     0.034   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R2  FIT       0.357     0.021  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.6)

R5      PHI INTO (KL KS)/(K KBAR)                          (P2)/(P1+P2)
R5      10    0.40      0.10           SCHLEIN   63 HBC      2.0 K-P          10/66
R5      52    0.48      0.07           BADIER    65 HBC      3.0 K-P          11/67
R5            0.44      0.07           LONDCN    66 HBC      2.2 K-P         .10/66
R5         . . . . . . . . . .
R5  AVG       0.448     0.044   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R5  STUDENT   0.448     0.048   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R5  FIT       0.429     0.025  FROM FIT (ERROR INCLUDES SCALE FACTCR OF 1.7)

R6      PHI INTO (PI+ PI- PIO (INCL.RHO PI))/(K KBAR)      (P3)/(P1+P2)
R6            0.30      0.15           LONDON    66 HBC      2.2 K-P          10/66
R6         . . . . . . . . . .
R6  FIT       0.201     0.021  FROM FIT (ERROR INCLUDES SCALE FACTCR OF 1.1)

R7      PHI INTO (PI+ PI- PIO (INCL.RHC PI))/(KL KS)       (P3)/(P2)
R7           (0.3)  OR LESS            BERLEY    65 HBC      2.9 PI+P         10/66
R7            0.69      0.14           BIZOT1    70 OSPK   E+ E- COLL.BEAM     1/71
R7            0.47      0.06           COSME 1   74 OSPK   E+E- COLL.BEAMS     2/74
R7         . . . . . . . . . .
R7  AVG       0.504     0.080   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
R7  STUDENT   0.501     0.063   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R7  FIT       0.469     0.053  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R8      PHI INTO (PI+ PI-)/(K KBAR) (SEE ALSO R18)         (P8)/(P1+P2)
R8           (0.2)  OR LESS            LONDON    66 HBC      2.2 K-P          10/66

R9      PHI INTO (E+ E-)/(K+ K-) (UNITS 10**-4)            (P5)/(P1)
R9       (SEE ALSO R16)
R9      40    6.1       1.7            BECKER    68 CNTR          GAMMA C      9/68

R10     PHI INTO (MU+ MU-)/TCTAL (UNITS 10**-4)            (P6)
R10           3.5       3.5       1.8  WEHMANN   68 CSPK    12 K- C            6/68
R10           2.34      1.01           MOY       69 CNTR     PHOTOPROD.       11/70
R10           2.17      0.60           EARLES    70 CNTR     6.0 BREMSSTR.    11/70
R10           2.69      0.46           HAYES     71 CNTR    PHCTOPROD.       .11/71
R10        . . . . . . . . . .
R10 AVG       2.50      0.34    AVERAGE (ERROR INCLUDES SCALE FACTCR OF 1.0)
R10 STUDENT   2.50      0.37    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R11     PHI INTO (ETA GAMMA)/TOTAL                         (P4)
R11     27    0.073     0.019          BASILE    72 CNTR    1.8 PI- P         12/72
R11     25    0.026     0.007          BENAKSAS  72 OSPK    E+E- COLL.BEAMS . 2/73
R11     54    0.015     0.004          COSME     75 OSPK    E+E- COLL.BEAMS  12/75*
R11        . . . . . . . . . .
R11 AVG       0.0195    C.0050  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
R11 STUDENT   0.0189    0.0042  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R11 FIT       0.0195    0.0035 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R12     PHI INTO (PI+ PI- GAMMA)/TOTAL                     (P9)
R12          (0.04) OR LESS            LINDSEY   65 HBC      2.7 K-P           2/74
R12          (0.007)OR LESS   CL=.90   COSME 1   74 OSPK    E+E- COLL.BEAMS    2/74
R12           (.06) OR LESS   CL=.90   KALBFLEI  75 HBC     2.2 K- P,GAMMA + 12/75*

R13     PHI INTO (ETA NEUTRALS)/(K KBAR)                   (P13)/(P1+P2)
R13          (0.15) OR LESS            LINDSEY   66 HBC      2.7 K-P          10/66

R14     PHI INTO (OMEGA GAMMA) / TOTAL                     (P10)
R14          (0.05) OR LESS            LINDSEY   66 HBC      2.7 K-P          10/66

R15     PHI INTO (RHO GAMMA) / TOTAL                       (P12)
R15          (0.02) OR LESS            LINDSEY   66 HBC      2.7 K-P          10/66

R16     PHI INTO (E+ E-)/TOTAL (UNITS 10**-4)              (P5)
R16      (SEE ALSO R9)
R16 A    5   (6.6)     (4.4)     (2.8) ASTVACATU 68 OSPK     4 PI- P           6/68
R16 A    ERROR OF ASTVACATUROV 68 DOES NOT INCLUDE SIGMA(PHI) UNCERTAINTY.     6/68
R16     27    7.2       3.9            BINNIE    68 OSPK    1.6 PI- P        . 6/68
R16      9    6.1       2.6            BOLLINI   68 CNTR    1.9 PI- P          9/68
R16 C        (3.45)    (0.27)          BIZOT     70 OSPK    E+ E- COLL.BEAMS 11/71
R16 C SUPERSEDED BY CHATELUS 71                                              11/71
R16           2.81      0.25           BALAKIN   71 OSPK     E+ E- CCLL.BEAM 11/71
R16           3.50      0.27           CHATELUS  71 OSPK    E+ E- COLL.BEAMS 11/71
R16           3.3       0.3            COSME 1   74 OSPK    E+E- COLL.BEAMS    2/74
R16        . . . . . . . . . .
R16 AVG       3.19      0.21    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
R16 STUDENT   3.21      0.19    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R17     PHI INTO (PIO GAMMA)/(TOTAL)                       (P7)
R17      7   (0.0025) (0.0012)         BENAKSAS  72 OSPK    E+E- COLL. BEAMS   2/73
R17     32    0.0014    0.0005         COSME     75 OSPK    E+E- COLL.BEAMS  12/75*

R18     PHI INTO (PI+ PI-)/(TOTAL) (UNITS 10**-4)          (P8)
R18      (SEE ALSO R8)
R18         (50.)    OR LESS  CL=.95   BIZOT2    70 OSPK    E+ E- COLL.BEAMS 11/71
R18         (80.)    OR LESS  CL=.95   BALAKIN   71 OSPK     E+ E- COLL.BEAM   1/71
R18          (2.7)   OR LESS  CL=.95   ALVENSLE  72 OSPK    GAMMA+C            1/72

R19     PHI INTO (KL KS)/(K+ K-)                           (P2)/(P1)
R19    144    0.89      0.10           AGUILAR   72 HBC     3.9,4.6 K- P      12/72
R19    125    1.15      0.15           COLLEY    72 HBC     10.K+ P,K+ P PHI  12/72
R19        . . . . . . . . . .
R19 AVG       0.97      0.12    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
R19 STUDENT   0.966     0.099   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R19 FIT       0.752     0.076  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.7)

R20     PHI INTO (PI+ PI- PIO(INCL.RHO PI)/(K+ K-)         (P3)/(P1)
R20     34    0.28      0.09           AGUILAR   72 HBC     3.9,4.6 K- P      12/72
R20        . . . . . . . . . .
R20 FIT       0.352     0.043  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R21     PHI INTO (2PI+ 2PI- PIO)/(K+ K-)
R21          (0.02) OR LESS  CL=0.95   AGUILAR   72 HBC     3.9,4.6 K- P     .12/72

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REFERENCES FOR PHI


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BERTANZA 62 PRL 9 180            BERTANZA,BRISSON,CCNNOLLY,HART + (BNL+SYRA)
GELFAND  63 PRL 11 438           GELFAND,MILLER,NUSSBAUM,KIRSCH+ (COLU+RUTG)
   GELFAND 63 CATA INCLUDED IN MILLER 65 BELOW
SCHLEIN  63 PRL 10 368           SCHLEIN,SLATER,SMITH,STORK,TICHO       (UCLA)

BADIER   65 PL 17 337            BADIER,DEMOULIN,BARLOUTAUC+       (SACL+ZEEM)
BERLEY   65 PR 139 B 1097        D BERLEY,N GELFAND             (BNL+COLUMBIA)
GALTIERI 65 PRL 14 279           A BARBARO GALTIERI,R D TRIPP            (LRL)
LINDSEY  65 PRL 15 221           JAMES S LINDSEY,GERALD A SMITH          (LRL)
   LINDSEY 65 CATA INCLUDED IN LINDSEY 66 BELOW
MILLER D 65 CU-237(NEVIS 131) CAVID C MILLER  (THESIS)             (COLUMBIA)
GRAY, L  66 PRL  17  501         +HAGERTY,BIZZARRI,CIAPETTI +     (SYRA+RCMA)JPG
LINDSEY  66 PR  147  915         JAMES S LINDSEY, GERALD A SMITH         (LRL)
LINDSEY1 66 PL 20 93             J.S.LINDSEY, G.A.SMITH                  (LRL)
   LINDSEY 1 66 CATA INCLUDED  IN LINDSEY 66 ABOVE
LONDCN   66 PR 143 1034          LCNDON,RAU,SAMICS,GOLDBERG + (BNL+SYRACUSE)

ABRAMS   67 MD TECH REP 720      GERALD ABRAMS , THESIS             (MARYLAND)
BARLOW   67 NC 50A 701           +LILLESTOL+MONTANET+  (CERN+CDEF+IRAD+LIVP)
CHASE    67 PRL 18 710           R.C.CHASE,P.RCTHWELL,R.WEINSTEIN (CEA+NEAS)
DAHL     67 PR 163 1377          +HARDY+HESS+KIRZ+MILLER                 (LRL)
HERTZBAC 67 PR 155  1461         HERTZBACH,KRAEMER,MADANSKI,ZDANIS+(JHU+BNL)
KHACHATU 67 PL 24B 349           KHACHATURYAN+AZIMOV+BALDIN+BELOUSOV+(DUBNA)

ABRAMS   68 PR 175 1697          +GLASSER,KEHOE,SECHI-ZORN,WOLSKY (MARYLAND)
ASTVACAT 68 PL 27 B  45          ASTVACATUROV,AZIMOV,BALDIN+    (JINR+MOSCOW)
    ALSC 67 PRL 19 869           ASBURY,BECKER,BERTRAM,TING+ (DESY+COLUMBIA)
BECKER   68 PRL 21 1504          +BERTRAM,BINKLEY,JORCAN,KNASEL+  (DESY+MIT)
BINNIE   68 PL 27B 106           +DUANE+FARUQI+HORSEY+             (LOIC+RHEL)
BOLLINI  68 NC 56 A 1171         +BUHLER,DALPIAZ,MASSAM+     (CERN+BGNA+STRB)
MOSTEK   68 PRL 20 1057          +EISENHANDLER,MCCLELLAN,MISTRY+   (CORNELL)
WEHMANN  68 PRL 20 748           +ENGELS+ (HARVARD+CASE+SLAC+CORNELL+MCGILL)

AUGUSTIN 69 PL 28 B 517          +BIZOT,BUCN,DELCOURT,HAISSINSKI,+   (ORSAY)
BALAKIN  69  IYAF 327 TRANS      +BUDKER,KORSHUNOV,MISHNEV,SIDOROV+   (NOVO)
    ALSO 69 SIDORCV
MOY      69  THESIS              KEN MIN MOY        (NORTHEASTERN UNIVERSITY)
SCOTTER  69 NC 62 A 1057         +ERSKINE,PALER,+  (BIRM+GLAS+LOIC+MPIM+OXF)
SIDOROV  69 LIVERPCOL SYMP.ON ELECTRCNS+PHOTONS,P.227, SIDOROV       (NOVO)

BALAKIN  70  PREPRINT            +BUTLER,PAKHTUSCVA,SIDOROV,SKRINSKY,+(NOVO)
BIZOT    70 PL 32 416            +BUCN,CHATELUS,JEANJEAN,LALANNE,+     (ORSA)
    ALSO 69 PEREZ-Y-JORBA, LIVERPOOL SYMP.69
BIZOT1   70  PRIV.COMM.          PEREZ-Y-JORBA                         (ORSA)
BIZOT2   70 LNC 4 1273           +DELCOURT,JEANJEAN,LALANNE,+         (ORSAY)
EARLES   70 PRL 25 1312          +FAISSLER,GETTNER,LUTZ,MOY,TANG,+     (NEAS)
HYAMS    70 NP B 22 189          +KOCH,PCTTER,V.LINDERN,LORENZ,LUTJENS(CERN)

ALVENSLE 71 PRL 27 441           ALVENSLEBEN,BECKER,BUSZA,CHEN,+  (MIT+DESY)
BALAKIN  71 PL 34 B 328          +BUDKER,PAKHTUSOVA,SIDOROV,SKRINSKY,+(NOVO)
DIBIANCA 71 NP B 35 13           +EINSCHLAG,ENDORF,ENGLER,FISK,+       (CORN)
CHATELUS 71  LAL 1247(THESIS) Y.CHATELUS                        (STRASBOURG)
HAYES    71 PR D 4 899           +IMLAY,JOSEPH,KEIZER,STEIN            (CORN)
STOTTLEM 71  ORO 2504 170        A.R.STOTTLEMYER,THESIS            (MARYLAND)

AGUILAR  72 PR D 6 29            AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS    (BNL)
ALVENSLE 72 PRL 28 66            ALVENSLEBEN,BECKER,BIGGS,BINKLEY+(MIT+DESY)
BALAKIN  72 PL 40 B 431          +BOKIN,PAKHTUSOVA,SIDOROV,+   (NOVOSIBIRSK)
BASILE   72 NP B 44 605          +DALPIAZ,FRABETTI,ZICHICHI+(CERN+BGNA+STRB)
BENAKSAS 72 PL 42 B 511          +COSME,JEAN-MARIE,JULLIAN,LAPLANCHE+(ORSAY)
COLLEY   72 NP B 50 1            +JOBES,RIDDIFORD,GRIFFITHS,+     (BIRM+GLAS)

BALLAM   73 PR D 7 3150          +CHADWICK,EISENBERG,BINGHAM,+    (SLAC+LBL)

AYRES    74 PRL 32 1463          +DIEBOLD,GREENE,KRAMER,LEVINE,+        (ANL)
BESCH    74 NP B70 257           +HARTMANN,KOSE,KRAUTSCHNEIDER,PAUL,+ (BONN)
BIZZARRI 74 NC 20A 393           +CIAPETTI,DIONISI,DORE,GASPERO+       (ROMA)
COSME 1  74 PL 48 B 155          +JEAN-MARIE,JULLIAN,LAPLANCHE,+      (ORSAY)
COSME 2  74 PL 48 B 159          +JEAN-MARIE,JULLIAN,LAPLANCHE,+      (ORSAY)
DE GROOT 74 NP B74 77            +HOOGLAND,JONGEJANS,METZGER+    (AMST+NIJM)

COSME    75  PREPRINT LAL1279 +COURAU,DUDELZAK,GRELAUD,JEAN-MARIE+(ORSAY)
KALBFLEI 75 PR D11 987           KALBFLEISCH,STRAND,CHAPMAN       (BNL+MICH)
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M(1033) →MM

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67  M(1033)

EVIDENCE NOT COMPELLING.OMITTED FROM TABLE.

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                 67  M(1033) MASS  (MEV)

M  N   240 1032.6      2.3          GARFINKEL 72 MMS   0 2.4 PI- P,N MM    1/74
M  N    NOT SEEN BY BINNIE 74 AT 2 GEV/C.
M  N    NOT SEEN BY BUTTRAM 75 AT 2.4 GEV/C                              12/75*

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                 67  M(1033) WIDTH  (MEV)

W      240   16.2       4.8      7.5  GARFINKEL 72 MMS   0 2.4 PI- P,N MM  12/72

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REFERENCES FOR M(1033)


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GARFINKE 72 PRL 29 1477          GARFINKEL,HOFFMAN,JACOBEL,+ (PURD+ANL+IOWA)
BINNIE   74 PRL 32 392           +CAMILLERI,CARR,DEBENHAM,+       (LOIC+SHMP)

BUTTRAM  75 PRL 35 970           +CRAWLEY,DUKE,LAMB,LEEPER,PETERSON    (ISU)
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$B_1(1040)$ $\rightarrow \omega\pi$

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48  B1(1040)  IG=1+

EVIDENCE NOT COMPELLING. OMITTED FROM TABLE.

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                 48  B1(1040) MASS (MEV)

M    S    (1040.)                    DEFOIX    73 HBC  +- 0.7 PBAR P,7 PI   1/74
M    S  SEEN IN DECAY OF A2 INTO B1 PI. NOT SEEN BY DIAZ 74.

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                 48  B1(1040) WIDTH (MEV)

W    S      (55.)                    DEFOIX    73 HBC  +- 0.7 PBAR P,7 PI   1/74

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                 48  B1(1040) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1     B1(1040) INTO CMEGA PI                            139+ 783

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Mesons

$B_1(1040)$, $\eta_N(1080)$, $A_1(1100)$

Data Card Listings

For notation, see key at front of Listings.

REFERENCES FOR B1(1040)

DEFOIX 73 PL 43 B 141 +DOBRZYNSKI,ESPIGAT,NASCIMENTO,+ (CDEF)
DIAZ 74 PRL 32 260 +DIBIANCA,FICKINGER,ANDERSCN,+ (CASE+CARN)

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$\eta_N(1080)$ $\to \pi\pi$

30 ETA N(1080, JPG=N +) I=0 J GREATER THAN 1
SOME EXPERIMENTS SUGGEST J=2.

OMITTED FROM TABLE

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Note on $\pi^+\pi^-$ Peaks Called $\eta_N(1080)$

The $\eta_N(1080)$ is seen in $\pi^-p \to \pi^+\pi^-n$ predominantly at backward decay angles, $\cos\theta < -0.75$. OH 70 state that this "bump is almost certainly the result of P-D interference."

Note that the selection made in some bubble chamber experiments to reduce the background under the $\eta_N(1080)$ in the reaction $\pi^-p \to \pi^+\pi^-n$ may lead to a sample of events ambiguous with $\pi^-p \to p\pi^-\pi^0\pi^0$ (BATON 70 and private communications from G. Laurens).

30 ETA N MASS (MEV)

M		1060.0	15.0		MILLER	68	HBC	4.0 PI- P	9/68
M	70	1085.0	10.0		WHITEHEAD	68	ASPK	3.1-3.6 PI-P	10/67
M		1120.0	100.0	40.0	OH	69	HBC	7.PI- P,PI+ D	9/69
M		1112.0	16.0		CLAYTON	70	HBC	2.5 PBAR P,4 PI	1/71
M		(1080.0)			DIAZ	70	HBC	0. PBAR P, 4 PI	5/70
M		1070.0	20.0		REYNOLDS	70	HBC	2.26-2.36 PI- P	1/71
M		. . . .							
M	AVG	1083.3	9.8	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)					
M	STUDENT	1083.0	8.3	AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT					

30 ETA N WIDTH (MEV)

W		(70.0)	OR LESS		MILLER	68	HBC	4.0 PI- P	9/68
W		(25.0)	OR LESS		WHITEHEAD	68	ASPK	3.1-3.6 PI-P	10/67
W		150.0	100.0	40.0	OH	69	HBC	7.PI- P,PI+ D	9/69
W		(80.0)			CLAYTON	70	HBC	2.5 PBAR P,4 PI	1/71
W		(80.0)			DIAZ	70	HBC	0. PBAR P, 4 PI	5/70
W		85.0	35.0		REYNOLDS	70	HBC	2.26-2.36 PI- P	1/71
W		. . . .							
W	AVG	98.0	31.3	AVERAGE (ERROR INCLUDES SCALE FACTOR CF 1.0)					
W	STUDENT	97.7	34.5	AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT					

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REFERENCES FOR ETA N

MILLER 68 PRL 21 1489 +GUTAY,JOHNSON,KENNEY+ (PURDUE+NDAM+SLAC)
WHITEHEA 68 NC 53 A 817 C.WHITEHEAD + (AERE+SHMP+LOIC)
OH 69 PRL 23 331 +WALKER,CARROLL,FIREBAUGH,+ (WISC+TNTO)
BATON 70 PL 33 B 528 +LAURENS,ZEIGNIER (SACLAY)
CLAYTON 70 NP B 22 85 +MASON,MUIRHEAD,RIGOPOULOS,+ (LIVP+ATEN)
DIAZ 70 NP B 16 239 +GAVILLET,LABROSSE,MONTANET,+ (CERN+CDEF)
REYNOLDS 70 NP B 21 77 +ALBRIGHT,BRADLEY,+ (OHIO+FSU+MINN+COLO)
WHITEHEA 72 NP B 48 365 WHITEHEAD,AULD,+ (AERE+RHEL+SHMP+LOUC)
DIAMOND 73 PR D 7 1977 +BINKLEY,+ (WISC+DUKE+COLO+TNTO+OHIO)

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$A_1(1100)$

10 A1(1100, JPG=1+-) I=1

The $A_1 \to \rho\pi$ bump has been mainly observed in the diffraction-like process $\pi N \to (\pi\pi\pi)N$ without quantum number exchange and at small momentum transfer. There are also observations of structure in the A_1 mass region in reactions where additional mesons are produced, in backward production (see however ABASHIAN 75), and in $\bar{p}p$ annihilations (see the Data Card Listings).

There is a special category of "diffractive mesons" consisting of statistically significant peaks like A_1, A_3, Q, and L (see the corresponding mini-reviews), which are not far above the respective $\rho\pi$, $f\pi$, $K^*(892)\pi$, and $K^*(1420)\pi$ thresholds. Because the behavior near threshold in these channels may be described by the Deck effect, a resonance interpretation is questionable. These peaks are included in the Meson Table, but we do not mean to imply that they are necessarily genuine resonances.

Other meson systems such as $K\omega$, $K\phi$, $K^*\bar{K}$ also exhibit low mass peaks when produced in reactions which may proceed without quantum number exchange (see for example DAVIS 72, CHUNG 74, THEOCHAROPOULOS 74, CARNEY 75, OTTER 75).

Partial-wave analyses of multi-meson systems in reactions like $\pi N \to (\pi\pi\pi)N$ are becoming available (ASCOLI 70). Several important assumptions are made in such analyses (see HANSEN 74, HERNDON 75 for detailed discussions), amongst which:

(a) for a given t, the 3π vertex is independent of the NN vertex;

(b) the 3π decay proceeds through quasi-two-body states ($\rho\pi, \epsilon\pi, \ldots$) in the spirit of the isobar model (a partial-wave analysis with unitarity corrections to the isobar model is applied to the 3π system in ASCOLI 75; see also AARON 75, AITCHISON 75, and references therein).

The dominant effect in the A_1 mass region is a broad $J^P=1^+$ $\rho\pi$ S-wave enhancement, with a maximum intensity at ~1100 MeV and a width ~300 MeV (ANTIPOV1 73, KRUSE 74, OTTER 74, TABAK 74, THOMPSON 74, EMMS1 75). The phase of the $J^P=1^+$ wave shows little variation relative to various other "background" waves (see however the A_3 and Q mini-reviews). In contrast the A_2 peak has been confirmed as a resonance with a Breit-Wigner-like phase change of the $J^P=2^+$ partial wave (ASCOLI 70, ANTIPOV1 73, OTTER 74, TABAK 74, THOMPSON 74).

These results suggest that at most a small part of the A_1 enhancement corresponds to a $J^P=1^+$ resonance. Indeed ASCOLI1 73 and ASCOLI 74 show that the partial-wave structure of the 3π

Data Card Listings

For notation, see key at front of Listings.

Mesons

$A_1(1100)$

system is qualitatively reproduced by a Reggeized pion exchange model.

BOWLER 75 attempt to explain the lack of variation of the 1^+ phase by allowing for a phase difference between the Deck amplitude and a direct "A_1 resonance" production amplitude. Good fits to the data are obtained, but the A_1 is predicted to have $M \sim 1300$ MeV, $\Gamma \sim 250$ MeV.

Recent analyses of the $(3\pi)^0$ system produced by charge exchange find no evidence for A_1 production. WAGNER 75 study the reaction $\pi^+p \to \pi^+\pi^-\pi^0\Delta^{++}$ at 7 GeV/c and are able to set an upper limit of 2 μb on the A_1 production cross section if $\Gamma < 150$ MeV. Analyzing $\pi^+n \to \pi^+\pi^-\pi^0p$ at 4 GeV/c, EMMS2 75 observe no A_1 with $M \sim 1100$ MeV, but cannot rule out resonance production above 1300 MeV.

References Not Included in the Data Card Listings

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- P. Theocharopoulos et al., Nucl. Phys. B83, 1 (1974).


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                  10   A1 MASS (MEV)

M    PRODUCED BY PI +
M          (1080.0)                      ADERHOLZ  64 HBC       4.0 PI+P
M          (1080.)    APPROX.            BOESEBECK 68 HBC  +    8 PI+ P           6/68
M          (1040.0)                      ARMENISE  70 HBC    0 9 PI+ N -- A1 P    1/71
M   F      (1128.)      (8.)             THOMPSO1  74 HBC  +  13 PI+P,P(3PI)+    12/75*
M
M    PRODUCED BY PI -
M          (1060.)                       ASCOLI    68 HBC   -0 5 PI-P          .  6/68
M          (1089.0)    (12.0)            BALLAM    68 HBC   - 16.0 PI- P          9/68
M          (1090.)    APPROX.            CHUNG     68 HBC   -  3.2,4.2 PI-P       2/67
M          (1055.0)     (6.0)            JUNKMANN  68 HBC   -  16. PI- P, 5PI     9/69
M    S     (1119.)     (30.)             KEY       68 HBC   -  3 PI-P             9/68
M    S      SHOULDER ON A2 ONLY
M          (1069.0)     (7.0)            CASO      70 HBC   - 11.2PI-P            5/70
M          (1120.0)                      CRENNELL  70 HBC   -  6. PI- P,F PI      5/70
M   F T    (1150.)                       ANTIPCV1  73 CNTR -  25.,40. PI- P       1/74
M     T  MASS AND WIDTH SEEN TO DEPEND ON T, UNIQUE DET. IMPOSSIBLE               1/74
M    PRODUCED BY PIONS,BACKWARDS SCATT.
M          (1115.0)    (20.0)            ANDERSON  69 MMS   -  16 PI- P,BACKW9    8/69
M
M    PRODUCED BY PBARS, SEE TYPED NOTE.
M          (1054.)      (7.)             DANYSZ    67 HBC  +-  3,3.6 PBAR P     . 7/67
M          (1042.)     (21.)             FRIDMAN   68 HBC  +-  5.7 PBAR P         6/68
M    A     (1076.)      (5.)             ATHERTON  73 HBC  +- 5.7 PBAR P          1/74
M    A   JP ANALYSIS GIVES SOME EVICENCE FOR RHO PI D-WAVE                        1/73
M
M    PRODUCED BY K-, SEE TYPED NOTE.
M          (1111.)     (10.)             ALLISON   67 HBC  +   6 K-P,LAM +5 PI    1/68
M          (1117.)     (3C.)             ALLISCN   67 HBC  +   6 K-P,LAM +4 PI    1/68
M          (1060.)     (15.)             JUHALA    67 HBC    0 4.6-5 K-P,5BCDY    1/68
M
M    PRODUCED BY K+, SEE TYPED NOTE.
M    K+    (1060.0)    (20.0)            ALEXANDER 69 HBC  +    9 K+P             9/69
M    K+    (1030.0)    (20.0)            BERLINGHI 69 HBC  + 0 12.7 K+ P          9/69
M    K+ FOR CONTRADICTORY EVIDENCE SEE RABIN 70 .
M
M   F    FRCM A FIT TO JP=1+ RHO PI PARTIAL WAVE
M
M    AVERAGING NOT MEANINGFUL

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                  10   A1 WICTH (MEV)

W    PRODUCED BY PIONS, RESONANCE INTERP. CONFUSED BY DECK EFFECT

W    PRODUCED BY PI +
W           (80.0)                       ADERHOLZ  64 HBC       4.0 PI+P
W          (130.)     APPROX.            BOESEBECK 68 HBC  +    8 PI+ P           6/68
W           (50.0)    OR LESS            ARMENISE  70 HBC    0 9 PI+ N -- A1 P    1/71
W   F      (300.)     APPROX.            RINAUDO   71 HBC  +  5. PI+P,P (3PI)+  11/71
W   F      (367.)      (30.)             THOMPSO1  74 HBC  +  13 PI+P,P(3PI)+    12/75*
W
W    PRODUCED BY PI -
W          (140.0)     (31.0)            BALLAM    68 HBC   - 16.0 PI- P          9/68
W          (125.)     APPROX.            CHUNG     68 HBC   -  3.2,4.2 PI-P       2/67
W           (77.0)     (17.0)            JUNKMANN  68 HBC   -  16. PI- P, 5PI     9/69
W    K      (76.)      (46.)             KEY       68 HBC   - 3.0 PI- P          11/67
W    K      SHOULDER ON A2 ONLY
W           (99.0)     (15.0)            CASO      70 HBC   - 11.2PI-P            5/70
W   F T    (300.)                        ANTIPOV1  73 CNTR -  25.,40. PI- P       1/74
W     T  MASS AND WIDTH SEEN TC DEPEND ON T, UNIQUE DET. IMPOSSIBLE               1/74
W
W    PRODUCED BY PIONS,BACKWARDS SCATT.
W          (98.0)      (45.0)    (20.0)  ANDERSON  69 MMS   -  16 PI- P,BACKW9    8/69
W
W    PRODUCED BY PBARS, SEE TYPED NOTE.
W           (33.)      (19.)             DANYSZ    67 HBC  +-  3,3.6 PBAR P       7/67
W          (130.)     APPROX.            FRIDMAN   68 HBC  +-  5.7 PBAR P         6/68
W    A      (36.)      (20.)     (15.)   ATHERTON  73 HBC  +- 5.7 PBAR P          1/74
W    A   JP ANALYSIS GIVES SOME EVIDENCE FOR RHO PI D-WAVE                        1/73
W
W    PRODUCED BY K-, SEE TYPED NOTE.
W           (50.)      (50.)             ALLISON   67 HBC  +   6 K-P,LAM +4 PI    1/68
W           (50.)      (25.)             ALLISON   67 HBC  +   6 K-P,LAM +5 PI    1/68
W          (120.)      (15.)             JUHALA    67 HBC    0 4.6-5 K-P,5BCDY    1/68
W
W    PRODUCED BY K+, SEE TYPED NOTE.
W          (160.0)     (20.0)            ALEXANDER 69 HBC  +    9 K+P             9/69
W    B     (120.0)     (30.0)            BERLINGHI 69 HBC       12.7 K+ P         8/69
W    K+ FOR CONTRADICTORY EVIDENCE SEE RABIN 70 .
W          (130.0)     (20.0)            BERLINGHI 69 HBC  + 0 12.7 K+ P          9/69
W
W   F    FROM A FIT TO JP=1+ RHO PI PARTIAL WAVE
W
W    AVERAGING NOT MEANINGFUL

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                  10   A1 PARTIAL DECAY MODES

                                                            DECAY MASSES
P1      A1 INTO RHO PI                                     773+ 139
P2      A1 INTO KBAR K                                     493+ 497

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                  10   A1 BRANCHING RATIOS

R1      A1 INTO (KBAR K)/(RHO PI)                        (P2)/(P1)
R1            (0.0025)OR LESS         DAHL      67 HBC   -  4.0 PI- P        .10/66

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                              REFERENCES FOR A1

BELLINI   63 NC 29 896          BELLINI,FIORINI,HERZ,NEGRI,RATTI    (MILAN)

ADERHOLZ  64 PL 10 226          AACH+BERL+BIRM+BONN+DESY+HAMBURG+LOIC+MPIM
GOLDHABE  64 PRL 12 336         GOLDHABER,BROWN,KADYK,SHEN+         (LRL+UCB)
LANDER    64 PRL 13 346 A       LANDER,ABOLINS,CARMONY,HENDRICKS +    (UCSD)  JP

ABCLINS   65 ATHENS(OHIO)CCNF.  +CARMONY,LANDER,XUONG,YAGER      (LA JOLLA)I=1
ALITTI    65 PL 15 69           ALITTI,BATON,DELER,CRUSSARD+     (SACL+BGNA)

ALLARD    66 NC 46A 737         +DRIJARD+HENNESSY+   (ORSAY+MILAN+SACL+UCB)
DEUTSCHM  66 PL 20 82           DEUTSCHMANN,STEINBERG +  (AACH+BERLIN+CERN)
HESS      66 UCRL-16832         R I HESS (THESIS, BERKELEY)              (LRL)

ALLISCN   67 PL 25B 619         +CRUZ+         (OXF+MPIM+BIRM+RHEL+GLAS+LOIC)
DAHL      67 PR 163 1377        +HARDY+HESS+KIRZ+MILLER                  (LRL)
DANYSZ    67 NC 51 A 801        DANYSZ+FRENCH+SIMAK                     (CERN)
JUHALA    67 PRL 19 1355        +LEACOCK+RHODE+KOPELMAN+           (IOWA+COLO)
SLATTERY  67 NC 50A 377         +KRAYBILL+FORMAN+FERBEL            (YALE+ROCH)  JP

ARMENISE  68 PL 26 B  336       +FORINO+CARTACCI+     (BARI+BGNA+FIRZ+ORSAY)
ASCOLI    68 PRL 21 113         +CRAWLEY,KRUSE,MORTARA,SCHAFER,+ (ILLINOIS)
BALLAM    68 PRL 21 934         +BRODY,CHADWICK,FRIES,GUIRAGOSSIAN+  (SLAC)JP
BOESEBEC  68 NP B 4 501         BOESEBECK,DEUTSCHMANN,+(AACHEN+BERLIN+CERN)
CASO      68 NC 54 A 983        +CONTE+CORDS+DIAZ+   (GENOVA+HAMB+MILA+SACL)
CHUNG     68 PR 165 1491        S.U.CHUNG,O.DAHL,J.KIRZ,D.H.MILLER     (LRL)
CNOPS     68 PRL 21 1609        +HOUGH,COHN,BUGG+ (BNL+ORNL+UCND+TENN+PENN)
FRIDMAN   68 PR 167 1268        +MAURER,MICHALON,OUDET+    (HEID+STRASBOURG)
JUNKMANN  68 NP 88 471          +COCCONI+           (AACH+BERL+BONN+CERN+WARS)
KEY       68 PR 166 1430        +PRENTICE+COOPER+MANNER+      (TNTO+ANL+WISC)

ALEXANDE  69 PR 183 1168        G.ALEXANDER,A.FIRESTONE,G.GOLDHABER   (LRL)
ALLABY    69 PL 29B 198         +BINON+DIDDENS+DUTEIL+KLOVNING+...   (CERN)
ANDERSCN  69 PRL 22 1390        +COLLINS,+                         (BNL+CARN)
BERLINGH  69 PRL 23 42          BERLINGHIERI,FARBER,+                  (ROCH)
DONALD    69 NP B 11 551        +EDWARDS,BURAN,BETTINI,+     (LIVP+OSLO+PADO)
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Mesons

$A_1(1100)$, M(1150), $A_{1.5}(1170)$, $\epsilon(1200)$

Data Card Listings

For notation, see key at front of Listings.


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FAYOLLE  69 NP B 13 40          +DE MONTAIGNAC,MORAND,STRACHMAN+    (PARIS)
JUHALA   69 PR 184  1461        +LEACOCK,RHODE,KOPELMAN,LIBBY,+  (ISU+COLO)
KENYON   69 PRL 23 146          +KINSON,SCARR,+               (BNL+UCND+ORNL)

ARMENISE 70 LNC 4  199          +GHIDINI,FORING,CARTACCI,+ (BARI+BGNA+FIRZ)
ASCOLI   70 PRL 25 962          +BROCKWAY,CRAWLEY,EISENSTEIN,HANFT,+  (ILL)  JP
BRANDENB 70 NP B16 369          +BRENNER,IOFFRECO,JOHNSON,KIM+     (HARVARD)
CASO     70 LNC 3  707          +CORDS,COSTA+     (GENO+DESY+HAMB+MILA+SACL)
    ALSO 68 CASO
CRENNELL 70 PRL 24 781          +KARSHON,LAI,SCARR,SIMS                (BNL)
CHIEN1   70  TORONTO PREPRINT +CHAO,JOHNSTON,PRENTICE,WALKER  (TNTO+WISC)
CHIEN2   70  JHU 7011           C.Y.CHIEN                  (JOHNS HOPKINS)
GARELICK 70 PHILAD.CONF.P.205 C.A.GARELICK,REVIEW           (NCRTHEASTERN)
RABIN    70 PRL 24 925          +GALTIERI,DERENZO,FLATTE,FRIEDMAN+     (LRL)
SHIH     70  BNL 14059-REV      +YOUNG                                 (BNL)

ASCOLI   71 PRL 26 929          ILLINOIS+GENO+HAMB+MIL+SACL+HARV+TNTO+WISC
BEMPORAD 71 NP B 33 397         +BEUSCH,MELISSINOS,+  (CERN+ETHZ+LOIC+MILA)
BERGER   71 PHENOMENOLOGY  IN PARTICLE PHYSICS, CALTECH 1971           (LRL)
RINAUDO  71 NC 5 A 239          +BOECKMANN,MAJOR+(TORI+BONN+DURH+NIJM+EPOL) JP .

BERENYI  72 NP B 37 621         +PRENTICE,STEENBERG,YOON,WALKER (TNTO+WISC)
BLOODWOR 72 NP B 46 402         BLOODWORTH,JACKSON,PRENTICE,YOON  (TORCNTO)
DIEBOLD  72  BATAV.CONF.        R.DIEBOLD  RAPPORTEUR TALK             (ANL)
LAMSA    72 NP B 41 388         +EZELL,GAIDOS,WILLMANN              (PURDUE)
MORSE    72 NP B 43 77          +OH,WALKER,JOHNSTON,YOON         (WISC+TNTO)

ANTIPOV1 73 NP B 63 153         +ASCOLI,BUSNELLO,FOCACCI,+       (CERN+SERP)  JP
ANTIPOV2 73 NP B 63 141         +ASCOLI,BUSNELLO,FOCACCI,+       (CERN+SERP)  JP
ARNOLD   73 NC 17 A 393         +ENGEL,ESCOUBES,GEMESY,JANCSSY,+(STRB+BUDA)
ASCOLI 1 73 PR D 8 3894         +JONES,WEINSTEIN,WYLD                  (ILL)
ASCOLI 2 73 PRL 31 795          +CHAPIN,CUTLER,HOLLOWAY,KOESTER,KRUSE+(ILL)  JP
ATHERTON 73 PL 43 B 249         +FRANEK,FRENCH,GHIDINI,HILPERT,+      (CERN)
READ     73 NP B 64 511         B.J.READ                              (DESY)

BOWLER   74 NP B74 493          +DAINTON,KADDOURA,AITCHISCN            (OXF)
ASCOLI   74 PR D9 1963          +CUTLER,JONES,KRUSE,ROBERTS,WEINSTEIN+(ILL)
KRUSE    74 PRL 32 1328         +ROBERTS,EDELSTEIN+    (ILL+CARN+NWES+ROCH)  JP
LICHTMAN 74 NP B81 31           +BISWAS,CASON,KENNEY,MCGAHAN,+        (NDAM)  JP
OTTER    74 NP B80 1            +RUDOLPH+          (AACH+BERL+BONN+CERN+HEID)  JP
TABAK    74  BOSTON             +RONAT,ROSENFELD,LASINSKI+       (LBL+SLAC)  JP
THOMPSO1 74 PR D9 560           THOMPSON,GAIDOS,MCILWAIN,WILLMANN     (PURD)  JP
THOMPSO2 74 NP B69 381          THOMPSON,BADEWITZ,GAIDOS,MCILWAIN+    (PURD)  JP

ABASHIAN 75 PRL 34 691          +BEAMER,BROSS,EISENSTEIN,+     (ILL+ANL+ISU)
BEUSCH   75 PL 55B 97           +POLGAR,FREUDENREICH+ (CERN+ETHZ+LOIC+MILA)
BOWLER   75 NP B97 227          +GAME,AITCHISON,DAINTON           (OXF+CARE)
DIAZ     75 PR 12 D 1272        +DIBIANCA,FICKINGER,DADO,ENGLER+(CASE+CARN)  JP
EMMS 1   75 NP B93 1            +JONES,KINSCN,BELL,DALE+    (BIRM+DURH+RHEL)  JP
EMMS 2   75 PL 60 B 109         +JONES,KINSON,BELL,DALE+    (BIRM+DURH+RHEL)  JP
HORNE    75 PR D11 996          +S.HAGOPIAN,V.HAGOPIAN,BENSINGER+(FSU+BRAN)
KANE     75  TENTH RENCONTRE DE MORIOND                               (MICH)
WAGNER   75 PL 58B 201          +TABAK,CHEW                            (LBL)  JP

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M(1150) →MM

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68  M(1150)

EVIDENCE NOT COMPELLING.OMITTED FROM TABLE.

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                  68  M(1150) MASS  (MEV)

M  N    65 1148.3     3.3             JACOBEL   72 MMS   0 2.4 PI- P,N MM   12/72
M  N    NOT SEEN BY BUTTRAM 75 AT 2.4 GEV/C                                 12/75*

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                  68  M(1150)  WIDTH  (MEV)

W       65   15.0      9.0     11.7   JACOBEL   72 MMS   0 2.4 PI- P,N MM   12/72

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                           REFERENCES FOR M(1150)

JACOBEL  72 PRL 29 671          +GARFINKEL,HOFFMAN,+          (IOWA+PURD+ANL)

BUTTRAM  75 PRL 35 970          +CRAWLEY,DUKE,LAMB,LEEPER,PETERSON     (ISU)

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$A_{1.5}(1170)$ →3π

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44  A 1.5(1170, JPG=  -) I=1

THIS ENTRY LISTS REFERENCES TO PEAKS OF LOW STATISTI-
CAL SIGNIFICANCE IN THE 3 PI SYSTEM BETWEEN THE A1 AND
THE A2. CMITTED FRCM TABLE.

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                           REFERENCES FOR A 1.5

BUTTERWO 67 HEIDELB.CONF.P.28 REVIEW TALK CN MESCNS  AT HEIDELBERG CONF.
CASON    67 PRL 18  880         +LAMSA,BISWAS,DERADO,GROVES,+   (NOTREDAME)
ASCOLI   68 PRL 21 113          +CRAWLEY,KRUSE,MORTARA,SCHAFER,+ (ILLINOIS)
DONALD   68 PL 26 B  327        +FRODESEN,BETTINI,+  (LIVERPOOL,OSLO,PADUA)
VCN KROG 68 PL 27B 253          +MIYASHITA,KOPELMAN,MARSHALL LIBBY   (COLO)
JUNKMANN 68 NP B8 471           +COCCONI+         (AACH+BERL+BONN+CERN+WARS)
ARMENISE 69 LNC 2 501           +GHIDINI,FORINO,CARTACCI+  (BARI+BGNA+FIRZ)
GALLOWAY 70 PR D 1 3077         +MOTT,ALYEA,LEE,MARTIN,PRICKETT        (IND)
MORSE    72 NP B 43 77          +OH,WALKER,JOHNSTON,YOON         (WISC+TNTO)

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$\epsilon(1200)$

14 PI PI S WAVE, CALLED EPSILON

S-Wave ππ Interactions in the Region 280-1800 MeV

In this note, we discuss information on the isoscalar ππ S-wave in terms of its phase shift δ_0^0, from threshold to 1800 MeV.

The threshold behavior of elastic ππ scattering involves S and P waves which can be sufficiently well described by the scattering lengths a_0^0, a_1^1, and a_0^2. In spite of many attempts (see PILKUHN 73, BONNIER 74, PASCUAL 74, RIESTER 75, SRINIVASAN 75), the determination of these parameters still meets with great difficulties (BASDEVANT 73, 75). The parameters a_0^0 and a_0^2 are strongly correlated and must lie in a narrow band in the (a_0^0, a_0^2)-plane (MORGAN2 70). Thus if a_0^0 is fixed, a_0^2 and a_1^1 are determined within small uncertainties (BASDEVANT 72, 75). However, all one knows is a region of finite extent within which a_0^0 must lie. It is therefore not established whether, e.g., the Weinberg predictions are supported by experiment.

Near threshold the S wave shows no resonant behavior. The so-called ABC and DEF effects (BOOTH 63, HALL 69, BRODY 70, 72, BANAIGS 71, 73) occur only on nuclear targets (d, H^3, He^3) and move when kinematical conditions change. Thus they must be kinematical effects (DUBAL 71, BRODY2 72, RISSER 73, BAR-NIR 75, BARRY 75).

The region of elastic ππ scattering is known to extend from threshold to about 990 MeV, near the $K\bar{K}$ threshold (BATON 70, CARROLL 72, PROTOPOPESCU 73, HYAMS 73, OCHS 73).

Up to the ρ meson mass region, δ_0^0 is (qualitatively) uniquely determined; it rises monotonically and reaches a value of 60° to 70° near 700 MeV (SONDEREGGER 69, BATON 70, BAILLON 72, CARROLL 72, FRENKIEL 72, GAIDOS 72, PROTOPOPESCU 73, HYAMS 73, OCHS 73, ENGLER 74, ESTABROOKS 74, 75, GRAYER 74); see Fig. 1.

In the mass region of 700 to 900 MeV, all energy-independent phase-shift analyses using the constraint $\eta_0^0 = 1$ find two solutions ("up-down ambiguity"). This ambiguity was resolved in favor of the "down" solution by the observation of a very rapid decrease in the S-wave amplitude

Data Card Listings

For notation, see key at front of Listings.

Mesons

ε(1200)

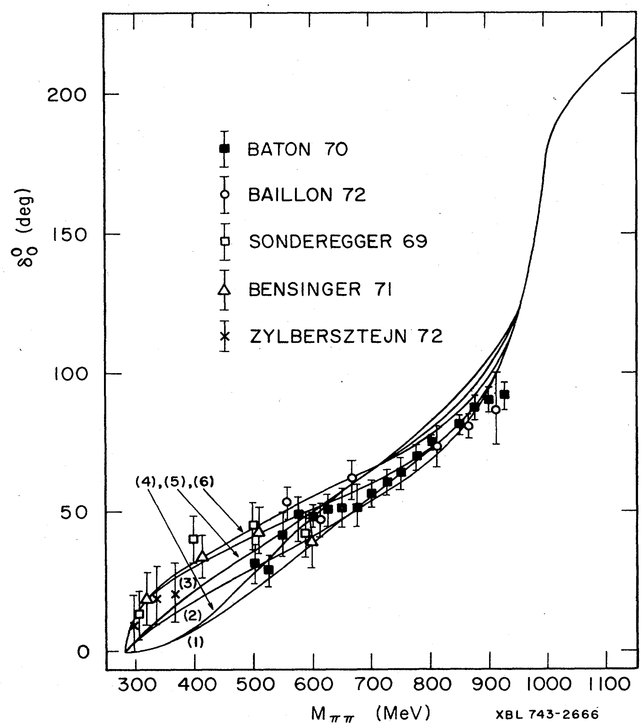

Fig. 1. The S-wave, I=0 ππ phase shift, as determined by several experiments. The curves are from BASDEVANT 73; solutions (1 - 3) were obtained by fitting the data of BATON 70, while (4 - 6) are from fits to the data of PROTOPOPESCU 73.

between 950 and 980 MeV (FLATTE 72, GAIDOS 72, HYAMS 73, BINNIE 73, ENGLER 74). The size of the observed drop corresponds to a change from nearly the unitarity limit to zero; see Fig. 2.

Independent evidence for the correctness of this "down" solution comes from studies of the $\pi^0\pi^0$ system (APEL 72, BRAUN 73, SKUJA 73, RIESTER 75). They observe a wide $\pi^0\pi^0$ enhancement of ∿800 MeV which is much better described by the "down" solution than the "up" solution. Furthermore, indirect information from elastic ππ scattering in the crossed channel (ELVEKJAER 72, NIELSEN 70, 72) is compatible with the "down", but not with the "up", solution.

The ambiguities of the phase-shift solutions stem from the fact that there are more helicity amplitudes than observables. Thus in the absence of polarization measurements one is obliged to make some supplementary assumptions (see, e.g., DONOHUE 75). Analyzing the same data (GRAYER 74) by different methods, HYAMS 75 find four solutions in the region 1.0-1.8 GeV, ESTABROOKS 74 find eight solutions above 1.2 GeV and four solutions below, whereas FROGGATT 75 find arguments to favor one of these solutions [solution B of ESTABROOKS 74 (see Fig. 3), essentially the same as HYAMS 75 solution +--].

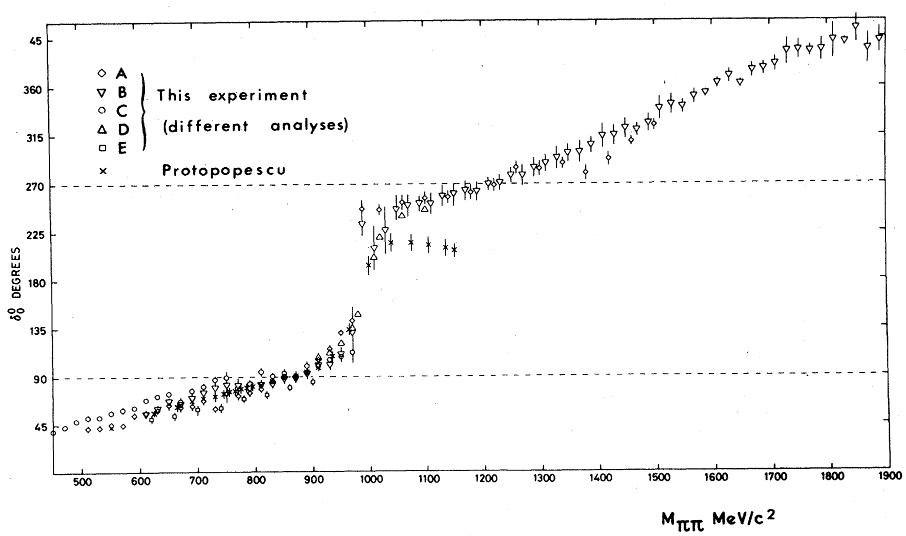

Fig. 2. The S-wave, I=0 ππ phase shift, as determined by various analyses of the data of GRAYER 74, compared with the previous results of PROTOPOPESCU 73. (Figure from GRAYER 74.)

Mesons
ε(1200)

Data Card Listings
For notation, see key at front of Listings.

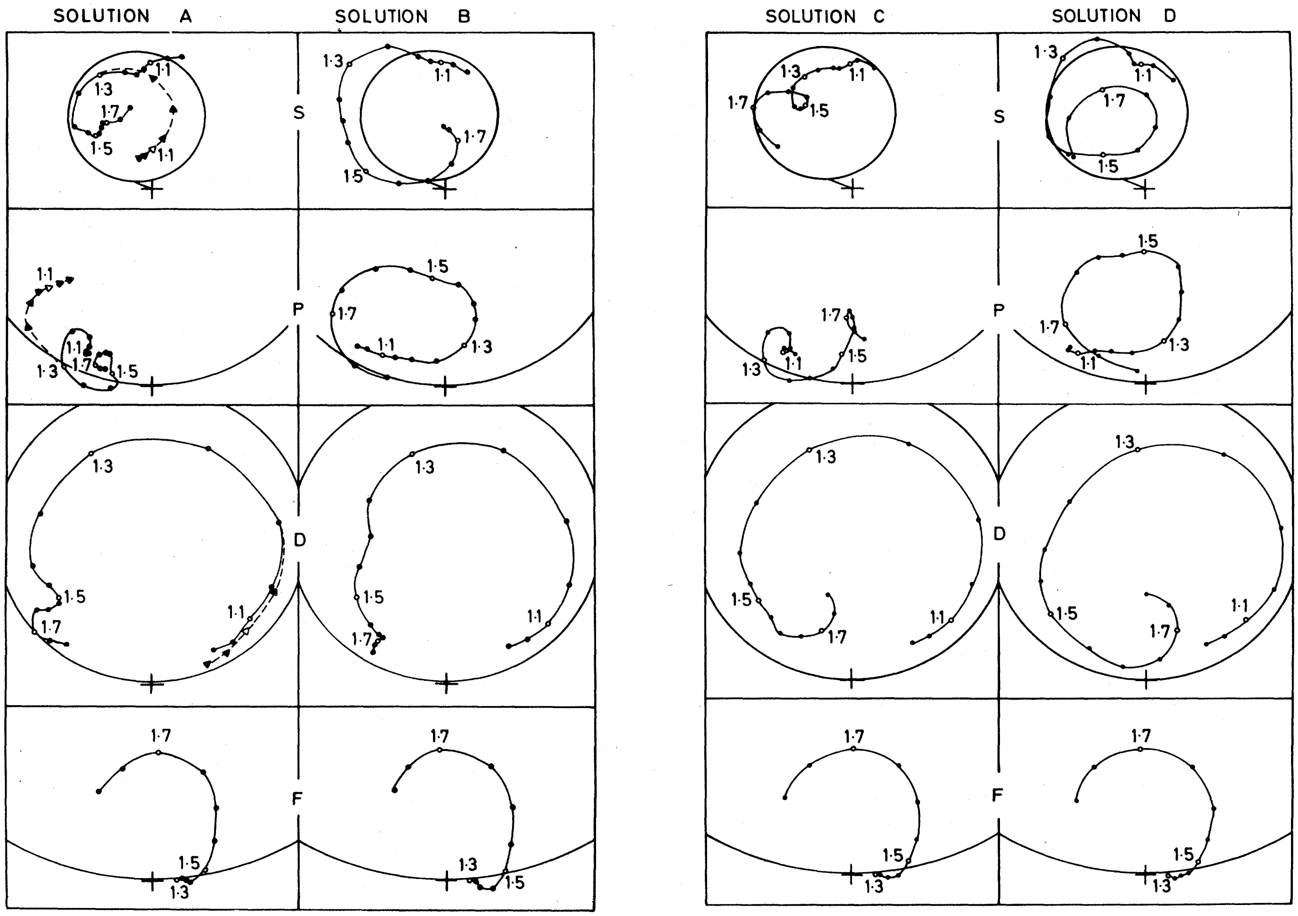

Fig. 3. Argand plots for ππ S, P, D, and F partial-wave amplitudes. Shown are solutions A-D of ESTABROOKS 75, obtained with the data of GRAYER 74. The points on the curves are at 50 MeV intervals. The diameters of the S-, P-, D-, and F-wave unitarity circles shown are given by 2/3, $\sqrt{3}$, $(2/3)\sqrt{5}$, and $\sqrt{7}$, respectively. An elastic I = 2 S-wave phase shift of 25° independent of $M_{\pi\pi}$ has been assumed. (Figure from ESTABROOKS 75.)

Near 1.2 GeV all δ_0^0 solutions based on the GRAYER 74 data, as well as independent analyses of other experiments (CARROLL 72, 74, ENGLER 75), exhibit $\delta_0^0 = 270°$.

It has now been made plausible (MORGAN 75) that all available data are compatible with the existence of just two poles: the $S^*(993)$ connected with the rapid variation of δ_0^0 near the $K\bar{K}$ threshold, and the ε(1200). The $S^*(993)$ is also responsible for the large $K\bar{K}$ I=0 S-wave scattering length.

The ε(1200) "replaces" the pole previously listed below 600 MeV. Note that although many analyses in the past found solutions with an ε(600) pole, they also found solutions without such a pole (PROTOPOPESCU 73, HYAMS 73).

Thus we have just the right number of isoscalar S-wave resonances to make up an SU(3) nonet, presumably together with the δ(970) and the κ(1250) mesons (MORGAN 75).

Note that, although there is general consensus about the position of the S^* pole on the second sheet, it is not clear whether it is accompanied by a companion pole on the third sheet or not (FUJII 75, MORGAN 75). The contrast between the width of 180 MeV of MORGAN 75, and the value of 40 MeV obtained as twice the imaginary part, reflects just this uncertainty.

Data Card Listings

For notation, see key at front of Listings.

Mesons

ε(1200), B(1235)

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                 14  EPSILON MASS (MEV)
M          1100 TO 1300                  MORGAN     75 RVUE                  12/75*
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                 14  EPSILCN WIDTH (MEV)
W          (640.)                        MORGAN     75 RVUE                  12/75*

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REFERENCES FOR EPSILCN


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SAMIOS    62 PRL 9 139             +BACHMAN,LEA+             (BNL+CUNY+COLU+KATY)

BLOKHINT  63 JETP 17 80            BLCKHINTSEVA,GREIBINNIK,ZHUKOV +      (DUBNA)
BOOTH     63 PR 132 2314           + ABASHIAN                              (LRL)
KIRZ      63 PR 130 2481           +SCHWARTZ + TRIPP                       (LRL)

BARISH    64 PR 135 B 416          BARISH,KURZ,PEREZ-MENDEZ,SCLOMCN        (LRL)
CRAWFORD  64 PRL 13 421            +GROSSMAN,LLOYD,PRICE,FOWLER            (LRL)
DEL FABR  64 PRL 12 674            DEL FABRO,DE PRETIS,JCNES+         (FRASCATI)
KALMUS    64 PRL 13  99            +KERNAN,PU,POWELL,DOWD        (LRL+WISCONSIN)

BATON     65 NC 36 1149            J.P.BATCN, J.REGNIER                 (SACLAY)
BIRGE     65 PR 139 B 1600         +ELY+GIDAL+KALMUS+CAMERINI+        (LRL+WISC)
BROWN     65 CORAL GABLES 219      BROWN+FAIER                    (NORTHWESTERN)
DURAND    65 PRL 14 329            L. DURAND AND Y.T. CHIU                (YALE)

JACOBS    66 PRL 16 669            +SELOVE                                 (LRL)
KOPELMAN  66 PL  22  118           +ALLEN,GODDEN,MARSHALL +    (COLORADO+IOWA)
LOVELACE  66 PL  22  332           LOVELACE,HEINZ,DONNACHIE               (CERN)

ANDERSON  67 PRL 18 89             +FUKUI+KESSLER+ (CHIC+ANL+CNRC+MCGILL+LOQM)
CLEGG     67 PR 163 1664           A.B.CLEGG                         (LANCASTER)
CORBETT   67 PR 156 1451           +DAMERELL+MIDDLEMAS+NEWTCN         (OXF+RHEL)
GUTAY     67 PRL 18 142            +JOHNSON+LOEFFLER+MCILWAIN+     (PURDUE+LRL)
JOHNSCN   67 PR 163 1497           +GUTAY,EISNER,KLEIN,PETERS,SAHNI,YEN+(PURD)
MALAMUD   67 PRL 19 1056           E.MALAMUD + P.E.SCHLEIN                (UCLA)
WALKER    67 RMP 39 695            W.D.WALKER                        (WISCONSIN)
WALKER    67 PRL 18 630            +CARROLL,GARFINKEL,OH             (WISCONSIN)

BANDER    68 PR 168 1679           +SHAW,FULCO             (UC IRVINE+S.BARBARA)
BISWAS    68 PL 27 B 513           +CASON,JOHNSON,KENNEY,POIRIER+         (NDAM)
BRAUN     68 PRL 21 1275           BRAUN,CLINE,SCHERER               (WISCONSIN)
DUTTA-RO  68 PR 169 1357           B. DUTTA-ROY, I.R. LAPIDUS             (STEV)
EISENHAN  68 PRL 20 758            EISENHANDLER,MISTRY,MOSTEK +        (CORNELL)
FOSTER    68 NP B 6 107            +GAVILLET+LABROSSE+MCNTANET+      (CERN+CDEF)
HYAMS     68 NP B7 1               +KOCH,POTTER,..VON LINDERN,LOREN(CERN+MPIM)
JONES     68 PR 166 1405           +CALDWELL+ZACHAROV+HARTING+BLEULER+  (CERN)
JOHNSON   68 PR 176 1651           +POIRIER,BISWAS,GUTAY+       (NDAM+PURD+SLAC)
LOVELACE  68 PL 28 B 264           C.LOVELACE                             (CERN)
MARATECK  68 PRL 21 1613           +HAGOPIAN,+  (PENN+LRL+COLC+PURD+TNTO+WISC)

BIZZARRI  69 NP B14 169(SEE P.190)+FOSTER,GAVILLET,GHESQUIERE+ (CERN+CDEF)
DAVISON   69 PR 180 1333           +BACASTOW,BARKAS,+                  (UCR+UCB)
DEINET    69 PL 30 B 359           +MENZIONE,MULLER,STAUDENMAIER,+ (KARL+CERN)
ELY       69 PR 180 1319           +GIDAL,HAGOPIAN,+              (UCB+LOUC+WISC)
FELDMAN   69 PRL 22 316            +FRATI,GLEESCN,HALPERN,NUSSBAUM,+      (PENN)
GUTAY     69 NP B 12 31            +CARMONY,CSONKA,LOEFFLER,MEIERE      (PURDUE)
HALL      69 NP B 12 573           +MURRAY,RIDDIFORD                (BIRMINGHAM)
HOPKINSO  69 NC 59 A 181           J.HOPKINSON,R.G.ROBERTS                (CERN)
MALAMUD   69 ARGONNE CONF.P.93 E.MALAMUD, P.SCHLEIN                       (UCLA)
MORGAN    69 NP B 10 261           D.MORGAN,G.SHAW                        (RHEL)
ROBERTS   69 PL 29 B 368           R.G. ROBERTS, F. WAGNER                (CERN)
SCHAREN1  69 ARGONNE CONF.306      SCHARENGUIVEL                        (PURDUE)
SCHAREN2  69 PR 186 1387           SCHARENGUIVEL(PURD+LRL+CERN+COLO+PENN+TNTO)
SMITH     69 PRL 23 335            G.A.SMITH, R.J.MANNING              (MSU+LRL)
SONDEREG  69  SEE BASDEVANT 72 SONDEREGGER,BONAMY                       (SACL)
STRUGALS  69 PL 29 B 518           +CHUVILO,FENYVES,+           (WARS+JINR+BUDA)
    ALSO  70 NP B 24 358           STRUGALSKI,CHUVILO,FENYVES,GEMESY,+ (DUBNA)
WAGNER    69 NC 64 A 189           F.WAGNER                               (CERN)

BARTSCH   70 NP B 22 1             +KEPPEL,GENSCH,MORRISCN,+  (AACH+BERL+CERN)
BATON     70 PL 33 B 528           +LAURENS,REIGNIER                    (SACLAY)
BRODY     70 PRL 24 948            +GROVES,VANBERG,MAGLIC+(PENN+RUTG+UPNJ+ANL)
DIAZ      70 NP B 16 239           +GAVILLET,LABROSSE,MONTANET+      (CERN+CDEF)
HYAMS     70 PHILAD.CONF.P.41      +SCHLEIN,BEUSCH,+(CERN+MPIM+ETHZ+LOIC+HAWA)
MAUNG     70 PL 33 B 521           +MASEK,MILLER,RUDERMAN,VERNON,+  (UCSD+LRL)
MORGAN1   70 SPRINGER TRACTS MOD.PHYS.,VOL.55,P.1. MORGAN,PISUT(RHEL+CERN)
MORGAN 2  70 PR D 2 520            D.MORGAN,G.SHAW                        (RHEL)
NIELSEN   70 NP B 22 525           +LYNG-PETERSEN,PIETARINEN           (NORDITA)
SCHARENG  70 NP B 22 16            SCHARENGUIVEL,GUTAY,MILLER,+     (PURD+PENN)
OH        70 PR D 1 2494           +GARFINKEL,MORSE,WALKER,PRENTICE(WISC+TNTO)
SHIBATA   70 PRL 25 1227           +FRISCH,WAHLIG                          (MIT)

ALSTON-G  71 PL 36 B 152           ALSTON-GARNJOST,BARBARO-GALTIERI,+      (LBL)
BANAIGS   71 NP B 28 509           +BERGER,DUFLO,GCLDZAHL,COTTEREA+(SACL+CAEN)
BEAUPRE   71 NP B 28 77            +DEUTSCHMANN,GRAESSLER,+    (AACH+BERL+CERN)
BENSINGE  71 PL 36 B 134           BENSINGER,ERWIN,THOMPSON,W.D.WALKER  (WISC)
DUBAL     71 NP B 32 535           L.DUBAL,D.J.BROWN                 (CNRC+CARL)
GUILLCU   71 NC 5 A 659            LE GUILLOU,MOREL,NAVELET               (CERN)
GUTAY     71 NP B 27 486           +SCHARENGUIVEL,FUCHS,GAIDOS,MILLER,+ (PURD)
HAMILTON  71 SPRINGER TRACTS MOD.PHYS.,VOL. 57,P.41 J.HAMILTCN   (NORDITA)
KIM       71 PR D 4 265            +BANDER                                 (UCI)
LYNG PET  71 PHYS.REPRTS 2 155 J.LYNG PETERSEN (REVIEW)                   (CERN)

APEL      72 PL 41 B 542           +AUSLANDER,MULLER,BERTOLUCCI,+  (KARL+PISA)
BAILLON   72 PL 38 B 555           +CARNEGIE,KLUGE,LEITH,LYNCH,RATCLIFF+(SLAC)
BASDEVAN  72 PL 41 B 178           BASDEVANT,FROGGATT,PETERSEN            (CERN)
BRODY 1   72 PRL 28 1215           +GROVES,MAGLICH,NOREM,+    (PENN+RUTG+UPNJ)
BRODY 2   72 PRL 28 1217           H.BRODY                        (PENNSYLVANIA)
CARROLL   72 PRL 28 318            +DIAMOND,FIREBAUGH,MATTHEWS,+   (WISC+TNTO)
ELVEKJAE  72 NP B 43 445           F.ELVEKJAER                          (AARHUS)
FLATTE    72 PL 38 B 232           +ALSTON-GARNJOST,BARBARO-GALTIERI,      (LBL)
FRENKIEL  72 NP B 47 61            +GHESQUIERE,LILLESTOL,CHUNG,+   (CDEF+CERN)
GAIDOS    72 NP B 46 449           +MCILWAIN,THOMPSON,WILLMANN          (PURDUE)
PRASAD    72 PR D 6 3216           +BREHM              (UNIV.OF MASSACHUSETTS)
NIELSEN   72 NP B 49 586           H.NIELSEN,G.OADES               (NORD+AARHUS)
WHITEHEA  72 NP B 48 365           WHITEHEAD,AULD,+      (AERE+RHEL+SHMP+LOUC)
WILLIAMS  72 PR D 6 3178           P.K.WILLIAMS                            (FSU)
ZYLBERSZ  72 PL 38 B 457           ZYLBERSZTEJN,BASILE,BOURQUIN,+  (GEVA+SACL)

ANJOS     73 NP B 67 37            +D.LEVY,A.SANTORO                    (SACLAY)
BANAIGS1  73 PL 43 B 535           +COTTEREAU,FABBRI,+        (SACL+CAEN+FRAS)
BANAIGS2  73 NP B 67 1             +BERGER,GOLDZAHL,CCTTEREAU,+    (SACL+CAEN)
BASDEVAN  73 AIX CONF.P.220        J.L.BASDEVANT RAPPORTEUR TALK    (PARIS VI)
BEIER     73 PRL 30 399            +BUCHHOLZ,MANN,PARKER,ROBERTS          (PENN)
BINNIE    73 PRL 31 1534           +CARR,DEBENHAM,DUANE,GARBUTT,+  (LOIC+SHMP)
BRAUN     73 PR D 8 3794           +D.CLINE                               (WISC)
HYAMS     73 NP B 64 134           +JONES,WEILHAMMER,BLUM,DIETL,+  (CERN+MPIM)
   FOR OTHER RESULTS ON SAME EXPERIMENT SEE GRAYER 74
OCHS      73 THESIS                THESIS                                 (MPIM)
PILKUHN   73 NP B 65 460           +SCHMIDT,MARTIN,+      (KARL+CERN+LOUC+NIJM)
PROTOPOP  73 PR D 7 1280           PROTOPOPESCU,GARNJOST,GALTIERI,FLATTE+(LBL)
RISSER    73 PL 43 B 68            T.RISSER,M.D.SHUSTER                   (SACL)
SKUJA     73 PRL 31 653            +WAHLIG,RISSER,PRIPSTEIN,NELSON,+       (LBL)
VILLET    73  PREPRINT             +DAVID,AYED,BAREYRE,BORGEEAUD,+        (SACL)

BASDEVAN  74 NP B 72 413           BASDEVANT,FROGGATT,PETERSEN     (LPTP+NORD)
BONNIER   74 NP B 83 440           B.BONNIER,N.JOHANNESSON                (CERN)
CARROLL   74 PR D 10 1430          +MATTHEWS,WALKER+        (SLAC+DUKE+WISC+TNTO)
ENGLER    74 PR D 10 2070          +KRAEMER,TOAFF,WEISSER,DIAZ+      (CARN+CASE)
ESTABROO  74 NP B 79 301           P.ESTABROOKS,A.D.MARTIN                (DURH)
GRAYER    74 NP B 76 375           +HYAMS,JCNES,BLUM,DIETL           (CERN+MPIM)
JONES     74 NP B 83 93            +ALLISON,SAXON                          (OXF)
MORGAN    74 PL 51 B 71            D.MORGAN                               (RHEL)
ORITO     74 PL 48 B 380           +FERRER,PAOLUZI,SANTONICO         (FRAS+ROMA)
PASCUAL   74 NP B 83 362           P.PASCUAL,F.J.YNDURAIN            (BARC+MADU)

BAR-NIR   75 NP B 87 109           +RISSER,SHUSTER             (CERN+UCSB+TELA)
BARRY     75 NP B 85 239           G.W.BARRY                              (PURD)
BASDEVAN  75 NP B 98 285           BASDEVANT,CHAPELLE,LOPEZ,SIGELLE       (LPTP)
DONOHUE   75 NC 25 A 409           J.T.DONOHUE,Y.LEROYER                  (BORD)
ESTABROO  75 NP B 95 322           P.ESTABROOKS,A.D.MARTIN                (DURH)
FROGGATT  75 NP B 91 454           C.D.FROGGATT,J.L.PETERSEN         (GLAS+NORD)
FUJII     75 NP B 85 179           Y.FUJII,M.FUKUGITA                     (TOKY)
HYAMS     75 NP B 100 205          +JONES,WEILHAMMER,BLUM,DIETL+     (CERN+MPIM)
MORGAN    75  PREPRINT RL75133 D.MORGAN                                   (RHEL)
RIESTER   75 NP B 96 407           +ARNOLD,ENGEL,PATY                     (STRB)
SHIMADA   75 NP B 100 225          T.SHIMADA                              (TOKY)
SRINIVAS  75 PR D 12 681           SRINIVASAN,HELLAND,LENNOX,KLEM+  (NCAM+ANL)

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B(1235)

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  11  B(1235,JPG=1++) I=1
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                  11  B MASS (MEV)

M       60(1220.0)                       ABOLINS   63 HBC  +   3.5 PI+P
M         (1220.0)                       GOLDHABER 65 HBC      3.7 PI+,PI-P
M      376 1200.      20.                BALTAY    67 HBC  +- 0.0 PBAR P      2/67
M          1259.0     27.0               BOESEBECK 68 HBC  +   8.0 PI+ P     10/67
M          1220.      20.                CHUNG     68 HBC  - 3.2,4.2 PI- P    9/67
M          1240.0     20.0               ANDERSON  70 CNTR  0 5-18 GAMMA P   11/70
M         (1272.0)   (15.0)              CASON     70 HBC  -   8.0 PI-P,4PI
M          1200.0    (10.0)              EROFEEV   70 HBC  -   3.25 PI- P     1/71
M          1225.0     22.0               HONES     70 HBC  +  18.5 PI+ P     11/70
M          1236.0     15.0               HOOGLAND  70 CBC  -   3.0 K- D       2/71
M          1200.0     15.0               MIYASHITA 70 HBC  -   6.7 PI-P,4PI
M  P      (1230.)    (10.)               POLS      70 HBC  +   5. PI+ P      11/71
M  P   HANDDRAWN BACKGROUND.ERRORS STATISTICAL ONLY.                         11/71
M  W      (1228.)    (5.)                FRENKIEL  72 HBC  +- 0. PBAR PI,5 PI 12/72
M  W   FIT REQUIRES AN ADDITIONAL JP=1- RESONANCE
M  W   AT 1256 MEV, WICTH 129 MEV.
M  O  1163 1243.      6.                 OTT       72 HBC  +  7.1 PI+ P,P B+  2/73
M  O   FROM FIT OF THE MASS SPECTRUM
M  A      (1252.)    (6.)                OTT       72 HBC  +  7.1 PI+ P,P B+  2/73
M  A   FROM FIT OF MASS SPECTRUM AND MOMENTS DISTRIBUTION WITH A STRONG
M  A   INTERFERENCE WITH THE BACKGROUND.
M          1235.      15.                AFZAL     73 HBC  +  11.7 PI+ P      2/73
M          1268.      16.                AFZAL     73 HBC  -  11.2 PI- P      2/73
M     1400 1222.      4.                 CHALOUPKA 74 HBC  - 3.9 PI-P,P B-  12/75*
M      600 1220.      7.                 KARSHON   74 HBC  + 4.9 PI+P,P B+  12/75*
M          . . . . . . . . . .
M  AVG     1227.7     4.0      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
M  STUDENT1226.4      3.6      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                    (SEE IDEOGRAM BELOW )
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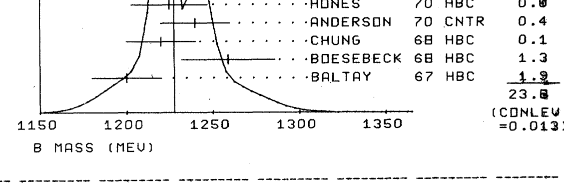


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Mesons

B(1235), ρ'(1250), f(1270)

Data Card Listings

For notation, see key at front of Listings.

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                     11  B WIDTH (MEV)

W       60  100.0      20.0              ABOLINS   63 HBC  +   3.5 PI+P
W           (80.0)                       GOLDHABER 65 HBC      3.7 PI+,PI-P
W      376  100.       30.               BALTAY    67 HBC  +- 0.0 PBAR P        2/67
W       25 (100.)    ESTIMATED           LEE       67 HBC  -   3.6 PI- P        1/68
W           203.       75.               BOESEBECK 68 HBC  +   8. PI+ P        11/67
W           150.       20.               CHUNG     68 HBC  - 3.2,4.2 PI- P      9/67
W   B  300  (83.)     (12.)              BIZZARRI  69 HBC  +-  0 PBAR P        12/72
W   B   SUPERSEDED BY FRENKIEL 72
W          (100.0)  APPROX.              ANDERSON  70 CNTR  0 5-18+GAMMA P     11/70
W   C      (150.0)                       CASO      70 HBC  - 11.2PI-P           2/73
W   C   SUPERSEDED BY AFZAL 73
W          (122.0)    (38.0)    (28.0)   CASON     70 HBC  -   8.0 PI-P,4PI
W           100.0      20.0              EROFEEV   70 HBC  -   3.25 PI- P       1/71
W            78.0      14.0      46.0    HONES     70 HBC  +  18.5 PI+ P       11/70
W           132.0      20.0              HOOGLAND  70 DBC  -   3.0 K- D         2/71
W           113.0      44.0              MIYASHITA 70 HBC  -   6.7 PI-P,4PI
W   P      (120.)     (20.)              POLS      70 HBC  +  5. PI+ P         11/71
W   P   HANDDRAWN BACKGROUND.ERRORS STATISTICAL ONLY.                          11/71
W   W      (126.)     (10.)              FRENKIEL  72 HBC  +- 0. PBAR PI,5 PI  12/72
W   W   SEE NOTE UNDER THE MASS ABOVE.
W   O 1163  134.       23.       26.     OTT       72 HBC  +  7.1 PI+ P,P B+    2/73
W   O   FROM FIT OF THE MASS SPECTRUM
W   A      (156.)     (21.)     (18.)    OTT       72 HBC  +  7.1 PI+ P,P B+    2/73
W   A   SEE NOTE UNDER THE MASS ABOVE.
W           120.       50.               AFZAL     73 HBC  +  11.7 PI+ P        2/73
W           130.       50.               AFZAL     73 HBC  -  11.2 PI- P        2/73
W     1400  135.       20.               CHALOUPKA 74 HBC  - 3.9 PI-P,P B-     12/75*
W      600  156.       22.               KARSHON   74 HBC  +  4.9 PI+P,P B+    12/75*
W           . . . . . . . . . .
W   AVG     124.3       7.1     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT 124.6       8.4     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                     11  B PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      B INTO OMEGA+PI                                    783+ 139
P2      B INTO 2PI+ 2PI-                                   139+ 139+ 139+ 139
P3      B INTO K KBAR                                      493+ 493
P4      B INTO PI PI                                       139+ 139
P5      B INTO PI PHI                                      134+1020
P6      B INTO ETA PI (FORBIDDEN BY G)                     548+ 139
P7      B INTO K KBAR PI                                   493+ 493+ 139

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                     11  B BRANCHING RATIOS

R10     D/S RATIO FOR B(1235) INTO OMEGA PI
R10
R10            0.3       0.1         CHALOUPKA 74 HBC  -  3.9-7.5 PI-P      1/74
R10     600    0.35      0.25        KARSHON   74 HBC  +  4.9 PI+P,P B+    12/75*
R10            0.21      0.08        CHUNG     75 HBC  +  7.1 PI+P         12/75*
R10          . . . . . . . . . .
R10 AVG        0.251     0.061   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R10 STUDENT    0.251     0.067   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R1      B INTO (4PI)/(OMEGA PI)                          (P2)/(P1)
R1             (0.5)  OR LESS        ABOLINS   63 HBC  +   3.5 PI+P

R2      B INTO (K KBAR)/(OMEGA PI)                       (P3)/(P1)
R2             (0.02) OR LESS        DAHL      67 HBC  -   1.6-4.2 PI- P   10/66
R2             (0.10) OR LESS  CL=.90 BALTAY   67 HBC  +-  0.0 PBAR P       2/67
R2             (0.08) OR LESS  CL=.95 BIZZARRI 69 HBC  +-  0 PBAR P         9/69

R3      B INTO (PI PI)/(PI OMEGA)                        (P4)/(P1)
R3             (0.3)  OR LESS        ADERHOLZ  64 HBC      4.0 PI+P         7/66
R3             (0.15) OR LESS  CL=.90 OTT      72 HBC  +  7.1 PI+ P        12/72

R4      B INTO (PI PHI) / (PI OMEGA)                     (P5)/(P1)
R4             (0.015)OR LESS        DAHL      67 HBC      1.6-4.2 PI- P   10/66
R4             (0.04) OR LESS  CL=.95 BIZZARRI 69 HBC  +-  0 PBAR P         9/69

R5      B INTO (ETA PI) / (PI OMEGA)                     (P6)/(P1)
R5             (0.25) OR LESS  CL=.90 BALTAY   67 HBC  +-  0.0 PBAR P       2/67

R6      B+- INTO ((K KBAR)+- PI0) / (PI OMEGA)
R6             (0.08) OR LESS  CL=.90 BALTAY   67 HBC  +-  0.0 PBAR P       2/67

R6      B+- INTO (KS KS PI+-) / (PI OMEGA)
R6             (0.02) OR LESS  CL=.90 BALTAY   67 HBC  +-  0.0 PBA- P       2/67

R6      B+- INTO (KS KL PI+-) / (PI OMEGA)
R6             (0.06) OR LESS  CL=.90 BALTAY   67 HBC  +-  0.0 PBAR P       2/67

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REFERENCES FOR B(1235)


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ABOLINS   63 PRL 11 381         ABOLINS,LANDER,MEHLHCP,XUCNG,YAGER    (UCSD)
BONDAR    63 PL 5 209           BONDAR,DODD+    (AACHEN+BIRM+HAMB+LOIC+MPIM)
ADERHOLZ  64 PL 10 240          AACHEN+BERLIN+BIRM + BONN+HAMBUR+LOIC+MPIM
CARMONY   64 PRL 12 254         CARMONY,LANDER,RINDFLEISCH,XUONG,YAGER(UCB) JP
GOLDHABE  65 PRL 15 118         G GOLDHABER,S GOLDHABER,KADYK,SHEN     (LRL)

BALTAY    67 PRL 18 93          +SEVERIENS+YEH+ZANELLO            (COLU+BNL)
DAHL      67 PR 163 1377        +HARDY+HESS+KIRZ+MILLER                (LRL)
LEE       67 PR 159 1156        +MOEBS,ROE,SINCLAIR,VANDERVELDE       (MICH)
SLATTERY  67 NC 50A 377         +KRAYBILL+FORMAN+FERBEL          (YALE+ROCH)

ASCOLI    68 PRL 20 1411        +CRAWLEY,MORTARA,SHAPIRO               (ILL)  JP
BOESEBEC  68 NP B 4 501         BOESEBECK,DEUTSCHMANN,+(AACHEN+BERLIN+CERN)
CASO      68 NC 54 A 983        +CONTE+CORDS+DIAZ+  (GENOVA+HAMB+MILA+SACL)
CHUNG     68 PR 165 1491        S.U.CHUNG,O.DAHL,J.KIRZ,D.H.MILLER     (LRL)
BIZZARRI  69 NP B 14 169        +FOSTER,GAVILLET,MCNTANET,+      (CERN+CDEF)

ANDERSON  70 PR D 1 27          +GUSTAVSON,JOHNSON,+    (SLAC+CIT+UCSB+NEAS)
CASO      70 LNC 3 707          +CONTE,TOMASINI,CORDS+(GENO+HAMB+MILA+SACL)
CASON     70 PR D 1 851         +ANDREWS,BISWAS,GROVES,HARRINGTCN,+  (NDAM)
EROFEEV   70 SJNP 11 450        +VETLITSKY,WLADIMIRSKY,GRIGOREV,+    (ITEP)
HONES     70 PR D 2 827         +CASON,BISWAS,HELLAND,KENNEY,MCGAHAN+(NDAM)
HOOGLAND  70 PL 33 B 631        SABRE COLLABOR.  (ZEEM+SACL+BGNA+REHO+EPOL)
MIYASHIT  70 PR D 1 771         MIYASHITA,VON KROGH,KOPELMAN,LIBBY   (COLO)
POLS      70 NP B 25 109        +BOECKMANN,CIRBA,+    (BONN+DURH+EPOL+TORI)
WERBROUC  70 LNC 4 1267         WERBROUCK,RINAUDO,+    (TORI+NIJM+BONN+LBL)JP
DEVONS    71 PRL 27 1614        +KOZLOWSKI,HORWITZ,+             (COLU+SYRA)

FRENKIEL  72 NP B 47 61         +GHESQUIERE,LILLESTOL,CHUNG,+   (CDEF+CERN)JP
OTT       72  LBL-1547          R.L.OTT  THESIS                       (LBL)JP
SISTERSO  72 NP B 48 493        SISTERSON,HARRISON,HEYDA,JCHNSCN,+(HARVARD)

AFZAL     73 NCL 15 A 61        +BASSLER,+        (DURH+GENC+DESY+MILA+SACL)  JP
ARMENISE  73 NC 17 A 707        +FORINO,CARTACCI,+               (BARI+BGNA+FIRZ)
ARMENISE  73 LNC 8 425          +FCRINO,CARTACCI,+               (BARI+BGNA+FIRZ)
ARNOLD    73 LNC 6 707          +ENGEL,ESCOUBES,KURTZ,LLORET,PATY,+  (STRB)
CASCN     73 PR D 7 1971        +BISWAS,KENNEY,MADDEN,SANDER,SHEPHARD(NDAM)
CASON 1   73 NP B 64 14         +MADDEN,BISHOP,BISWAS,KENNEY,+       (NDAM)
COHEN     73 PR D 8 23          +FERBEL,SLATTERY                (ROCHESTER)

BALLAM    74 NP B76 375         +CHACWICK,BINGHAM,FRETTER+  (SLAC+LBL+MPIM)
CHALOUPK  74 PL 51B 407         CHALOUPKA,FERRANDO,LOSTY,MONTANET    (CEFN)  JP
KARSHCN   74 PR D10 3608        +MIKENBERG,EISENBERG,PITLUCK,RCNAT+  (REHO)  JP

CHUNG     75 PR D11 2426        +PROTOPOPESCU,LYNCH,FLATTE,+ (BNL+LBL+UCSC)  JP
    ALSO  73 PL 47 B 526        +PROTOPOPESCU,LYNCH,FLATTE,+ (BNL+LBL+UCSC)  JP
DUBOVIKO  75 SJNP 20 229        M.S.DUBOVIKOV,I.A.EROFEEV            (ITEP)  JP
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ρ'(1250)

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69  RHO PRIME(1250,JPG=1-+) I=1

EVIDENCE NOT COMPELLING. OMITTED FROM TABLE.

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                  69  RHO PRIME(1250) MASS  (MEV)

M          1256.     10.            FRENKIEL  72 HBC  +- O.PBARP,CMEGA2PI  1/74

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                  69  RHO PRIME(1250) WIDTH  (MEV)

W          130.      20.            FRENKIEL  72 HBC  +- O.PBARP,CMEGA2PI  1/74

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REFERENCES FOR RHO PRIME(1250)


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ANDERSON  70 PR D 1 27          +GUSTAVSON,JOHNSON,+    (SLAC+CIT+UCSB+NEAS)
PODOLSKY  71  UCRL 20128        W.J.PODOLSKY,PH.D. THESIS              (LBL)
FRENKIEL  72 NP B 47 61         +GHESQUIERE,LILLESTOL,CHUNG,+   (CDEF+CERN)JP
WOLF      72 ITHACA N.Y. CONF.  G.WOLF,P.213                          (SLAC)

CHUNG     73 PL 47 B 526        +PROTOPOPESCU,LYNCH,FLATTE,+ (BNL+LBL+UCSC)
BRAMON    73 LNC 8 659          A.BRAMON                         (FRASCATI)

BALLAM    74 NP B76 375         +CHADWICK,BINGHAM,FRETTER+  (SLAC+LBL+MPIM)
CHALOUPK  74 PL 51B 407         CHALOUPKA,FERRANDO,LOSTY,MONTANET    (CERN)
CONVERSI  74 PL 52B 493         +PACLUZI,CERADINI,GRILLI+        (ROMA+FRAS)
ESTABROO  74 NP B79 301         P.ESTABROOKS,A.D.MARTIN              (DURH)
KARSHCN   74 PR D10 3608        +MIKENBERG,EISENBERG,PITLUCK,RONAT+  (REHO)  JP

ALLES     75 NC 30A 136         ALLES-BORELLI,BERNARDINI+  (CERN+BGNA+FRAS)
CHUNG     75 PR D11 2426        +PROTOPOPESCU,LYNCH,FLATTE,+ (BNL+LBL+UCSC)
ESTABROO  75 NP B95 322         P.ESTABROOKS,A.C.MARTIN              (DURH)
FROGGATT  75 NP B91 454         C.D.FROGGATT,J.L.PETERSEN       (GLAS+NORD)
HYAMS     75 NP B100 205        +JONES,WEILHAMMER,BLUM,DIETL+   (CERN+MPIM)
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f(1270)

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5  F(1270,JPG=2++) I=0

WE NO LONGER LIST EVERY PUBLISHED VALUE.                              1/73
WE AVERAGE ONLY THE MOST SIGNIFICANT                                  1/73
DETERMINATIONS OF MASS AND WIDTH.                                     1/73

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                   5  F MASS (MEV)

M          (1250.0)    (25.0)        SELOVE    62 HBC      3.0 PI- P          1/73
M      1416(1267.0)    (10.0)        JACOBS    66 HBC    2-3 PI-P,T CUT20    10/67
M           1276.       11.          RABIN     67 HBC    8.5 PI+ P            9/67
M  T   1960 1261.        5.          ARMENISE  68 CBC    5.1 PI+N,P PI+ -     1/73
M  T    360 1270.       10.          ARMENISE  68 DBC    5.1 PI+N,P PI0 0     1/73
M           1265.        8.          BOESEBECK 68 HBC    8 PI+ P              6/68
M   J       1268.0       6.0         JOHNSCN   68 HBC     3.7-4.2 PI- P       7/69
M   J       JOHNSON 68 INCLUDES BONDAR 63, LEE 64, DERADO 65, EISNER 67.
M           1275.0      13.0         ARMENISE  70 HBC     9 PI+ N -- F P      1/71
M           1273.0       7.0         ARMENISE  70 HBC     9 PI+ N -- MM P     1/71
M       600 1275.0      10.0         OH        70 HBC    1.26 PI- P,P F       1/71
M  E       (1273.0)     (6.0)        STUNTEBEC 70 HBC    8.PI-P,5.4 PI+D     11/71
M      5300 1277.0       4.0         FLATTE    71 HBC     7.0 PI+ P           6/71
M  E    300(1272.)                   KEMP      72 DBC    11.7 PI+ N          12/72
M      2000 1261.0      10.0         JACOBS    72 HBC     2.8 PI- P           1/73
M       600 1258.0      10.0         TAKAHASHI 72 HBC    8. PI- P,N 2PI       1/73
M      1200 1274.       12.          WHITEHEAD 72 ASPK   3.1-3.6 PI- P      . 2/73
M      4600 1272.        4.          ENGLER    74 CBC   0 6. PI+N,PI+PI-P   12/75*
M  IH      (1269.)      (4.)         ESTABROOK 75 RVUE   17 PI-P,PI+PI-N    12/75*
M  I        1275.        4.          HYAMS     75 ASPK    17 PI-P,PI+PI-N   12/75*
M  I    ERROR TAKES ACCOUNT OF SPREAD OF DIFFERENT PHASE-SHIFT SOLUTIONS
M
M  E    EVIDENCE FOR A STRUCTURE CLAIMED                                 12/72
M  T    MASS ERRORS ENLARGED BY US TO WIDTH/SQRT(N)
M   H   USES SAME DATA AS HYAMS 75
M           . . . . . . . . . .
M   AVG     1271.1       1.7     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT1271.3        2.0     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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Data Card Listings

For notation, see key at front of Listings.

Mesons

f(1270)

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                      5   F WIDTH (MEV)

W            (100.0)    (25.0)            SELOVE    62 HBC      3.0 PI-P
W       1416  (99.0)    (10.0)            JACOBS    66 HBC     2-3 PI-P,T CUT20 10/67
W             155.       17.              RABIN     67 HBC     8.5 PI+ P          9/67
W   T   1960  216.       20.              ARMENISE  68 DBC     5.1 PI+N,P PI+ -   1/73
W    T   360 (188.)     (40.)             ARMENISE  68 DBC     5.1 PI+N,P PIO 0   1/73
W             128.       23.              BOESEBECK 68 HBC     8 PI+ P            6/68
W     J       176.0      13.0             JOHNSON   68 HBC      3.7-4.2 PI- P     7/69
W     J      JOHNSON 68 INCLUDES BONDAR 63, LEE 64, DERADO 65, EISNER 67.
W             131.0      25.0             ARMENISE  70 HBC      9 PI+ N -- MM P   1/71
W   T         173.0      25.0             ARMENISE  70 HBC      9 PI+ N -- F P    2/74
W   T    600  120.0      20.0             OH        70 HBC     1.26 PI- P,P F     2/74
W    E       (196.0)    (18.0)            STUNTEBEC 70 HBC     8.PI-P,5.4 PI+D   11/71
W       5300  183.0      15.0             FLATTE    71 HBC     7.PI+P,DELTA++F    1/71
W   E    300 (143.)                       KEMP      72 DBC     11.7 PI+ N        12/72
W       2000  130.0      25.0             JACOBS    72 HBC      2.8 PI- P         1/73
W   T    600  166.0      28.0             TAKAHASHI 72 HBC     8. PI- P,N 2PI     1/73
W       1200 (217.)     (24.)             WHITEHEAD 72 ASPK    3.1-3.6 PI- P    , 2/73
W       4600  192.       16.              ENGLER    74 DBC    0 6. PI+N,PI+PI-P 12/75*
W   IH       (209.)     (10.)             ESTABROOK 75 RVUE    17 PI-P,PI+PI-N  12/75*
W   I         188.        4.              HYAMS     75 ASPK     17 PI-P,PI+PI-N 12/75*
W   I    ERROR TAKES ACCOUNT OF SPREAD OF DIFFERENT PHASE-SHIFT SOLUTIONS
W
W   E    EVIDENCE FOR A STRUCTURE CLAIMED                                       12/72
W   T    WIDTH ERRORS ENLARGED BY US TO 4*WIDTH/SQRT(N)
W    H   USES SAME DATA AS HYAMS 75
W             . . . . . . . . . .
W    AVG      181.1       5.6     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)
W    STUDENT 182.0        4.5     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                                  (SEE IDEOGRAM BELOW )
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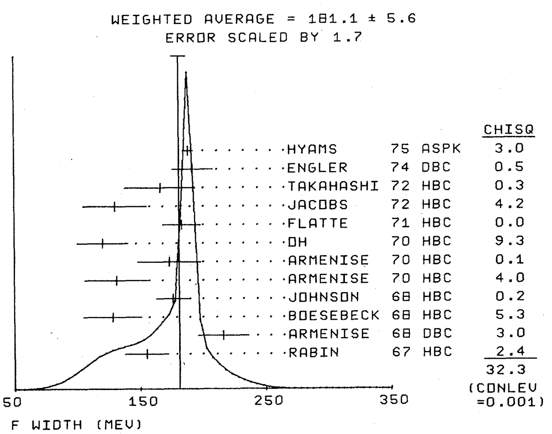


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                      5   F PARTIAL DECAY MODES

                                                            DECAY MASSES
P1       F INTO PI PI                                   139+ 139
P2       F INTO 2PI+ 2PI-                               139+ 139+ 139+ 139
P3       F INTO PI+ PI- 2PIO                            139+ 139+ 134+ 134
P4       F INTO K KBAR                                  497+ 497
P5       F INTO K KBAR PI                               497+ 497+ 139
P6       F INTO ETA PI PI                               548+ 139+ 139
P7       F INTO ETA ETA                                 548+ 548

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                      5   F BRANCHING RATIOS

R10    I=0,JP=2+ PI PI PARTIAL WAVE AMPLITUDE AT F RESONANCE MASS
R10         WE TABULATE X = 1/2 (1 + ETA).  THIS SHOULD BE PI PI FRACTION
R10         FOR PURE BW WITH NO BACKGROUND.
R10    600     0.8       0.04             OH        70 HBC     01.26 PI- P,P F    1/71
R10    250     0.85      0.05             BEAUPRE   71 HBC     08 PI+ P,DELTA++F  1/71
R10IH         (.82)     (.01)             ESTABROOK 75 RVUE     17 PI-P,PI+PI-N  12/75*
R10 H   USES SAME DATA AS HYAMS 75
R10I           .803      .003             HYAMS     75 ASPK     17 PI-P,PI+PI-N 12/75*
R10I    ERROR TAKES ACCOUNT OF SPREAD OF DIFFERENT PHASE-SHIFT SOLUTIONS
R10           . . . . . . . . . .
R10 AVG        0.8032    0.0030  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R10 STUDENT    0.8031    0.0032  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R1     F INTO (2PI+ 2PI-)/(PI PI)                          (P2)/(P1)
R1    ASCOLI 68 SUGGEST DECAY IS MAINLY RHO-RHO, 1/3 OF WHICH YIELD 2PI+ 2PI
R1             0.08      0.06             BONDAR    63 HBC      4.0 PI-P
R1    D        0.04      0.05             CHUNG     65 HBC      3.2 PI-P          11/71
R1    D  CORRECTED BY O.DAHL                                                     11/71
R1      50     0.07      0.04             ASCOLI    68 HBC     5 PI- P            6/68
R1             0.022     0.045     0.022  BARDADIN  71 HBC     8. PI+ P           2/72
R1             0.047     0.013            OH        70 HBC     1.26 PI- P,P F     2/73
R1     154     0.037     0.007            ANDERSON  73 DBC     6. PI+N,P FO       1/74
R1            (0.033)OR LESS  C.L.=.90    BUGG      73 DBC     8. PI+N,P FO       1/74
R1      70      .051      .025            EISENBERG 74 HBC     4.9 PI+P,DEL++FO 11/75*
R1     285      .043      .007      .011  LOUIE     74 HBC     3.9 PI- P,N FO  .11/75*
R1     160      .024      .006            EMMS      75 DBC     4.  PI+N,P FO     11/75*
R1            . . . . . . . . . .
R1  AVG        0.0344    0.0040  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
R1  STUDENT    0.0351    0.0047  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R2     F INTO (PI+ PI- 2PIO)/(PI PI)                       (P3)/(P1)
R2    SHOULD BE TWICE R1 IF DECAY IS RHO-RHO (SEE ASCOLI 68)
R2     600      .15       .06             EISENBERG 74 HBC     4.9 PI+P,DEL++FO 11/75*
R2             (.07)                      EMMS      75 DBC     4.  PI+N,P FO     11/75*
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R3     F INTO (K KBAR)/(PI PI)                             (P4)/(P1)
R3        WE ONLY AVERAGE EXPERIMENTS WHICH EITHER TAKE INTO ACCOUNT F-A2
R3        INTERFERENCE EXPLICITLY OR DEMONSTRATE THAT A2 PRODUCTION IS
R3        NEGLIGIBLE.
R3          (0.047)  (0.012)+ SYST.  BEUSCH    67 OSPK     5,7,12 PI-P        9/67
R3    D       0.05      0.05         DAHL      67 HBC      1.6-4.2 PI- P     10/66
R3    D       CORRECTED BY O.DAHL                                            11/71
R3      20    0.031     0.012        ADERHOLZ  69 HBC      8 PI+ P,K+K-PI-  12/75*
R3 L        (0.07) OR LESS  CL=.95   AGUILAR   72 HBC     3.9,4.6 K- P       12/72
R3 L     LIMIT ABOVE RESTATED FOR AVERAGING BELOW.                           12/72
R3 L          0.0       0.04         AGUILAR   72 HBC     3.9,4.6 K- P       12/72
R3            0.13      0.05         BISWAS    72 HBC     18.5 PI+- P         1/73
R3          (0.02) OR LESS  CL=.85   WHITEHEAD 72 ASPK    3.1-3.6 PI- P      12/72
R3            0.03      0.02         TOET      73 HBC     5 PI+P,P PI+ FO     1/74
R3             .025      .015        EMMS      75 DBC     4.  PI+N,P FO      11/75*
R3             .037      .012        PAWLICKI  75 ASPK    6.  PI-P,N FO      11/75*
R3          . . . . . . . . . .
R3  AVG       0.0328    0.0067  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3  STUDENT   0.0325    0.0073  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R4     F INTO (KO K- PI+ AND C.C.)/(PI PI)                 (P5)/(P1)
R4          (0.07) OR LESS  CL=.95   AGUILAR   72 HBC     3.9,4.6 K- P       12/72
R4          (.004)OR LESS   CL=.95   EMMS      75 DBC     4.  PI+N,P FO      11/75*

R5     F  INTO (ETA PI PI)/(PI PI)                         (P6)/(P1)
R5          (0.19) OR LESS  CL=.95   AGUILAR   72 HBC     3.9,4.6 K- P       12/72
R5          (.010)OR LESS   CL=.95   EMMS      75 DBC     4.  PI+N,P FO      11/75*

R6     F INTO (ETA ETA)/(PI PI)                            (P7)/(P1)
R6          (.09) OR LESS   CL=.95   EISENBERG 74 HBC     4.9 PI+P,DEL++FO 11/75*
R6          (.016)OR LESS   CL=.95   EMMS      75 DBC     4.  PI+N,P FO      11/75*

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REFERENCES FOR F


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SELOVE   62 PRL 9 272          SELOVE,HAGOPIAN,BRODY,BAKER,LEBOY      (PENN)
BONDAR   63 PL 5 153           BONDAR+   (AACHEN+BIRM+BONN+DESY+LOIC+MPIM)
GUIRAGOS 63 PRL 11 85          Z.G.T. GUIRAGOSSIAN                     (LRL)
HAGOPIAN 63 PRL 10 533         V HAGOPIAN,W SELOVE                    (PENN)
VEILLET  63 PRL 10 29          VEILLET,HENNESSY,BINGHAM,BLOCH+(EPOL+MILAN)

ADERHOLZ 64 PL 10 240          AACHEN¬BERLIN¬BERLIN¬BONN¬HAMBURG¬LOIC¬MPI  IJ
BRUYANT  64 PL 10 232          BRUYANT,GOLDBERG,HOLDER,FLEURY+ (CERN+EPOL) I
LEE      64 PRL 12 342         LEE,ROE,SINCLAIR,VANDERVELDE           (MICH)
SODICKSO 64 PRL 12 485         SODICKSON,WAHLIG,MANNELLI,FRISCH+      (MIT) I

BARMIN   65 SJNP 1 230         +DOLGOLENKO,ELENSKY,EROFEEV+  (ITEP MOSCOW) JP
BARMIN   65 SJNP 1 623         +DOLGOLENKO+EROFEEV+KRESTNIKOV+ (ITEP MOSC)
CHUNG    65 PRL 15 325         CHUNG,DAHL,HARDY,HESS,JACOBS,KIRZ      (LRL)
DERADO   65 PRL 14 872         DERADO,KENNEY,POIRIER,SHEPHARD (NOTRE DAME)
GUIRAGOS 65 PRL 11 85          Z G T GUIRAGOSSIAN                     (LRL)
WANGLER  65 PR  137 B 414      T P WANGLER,A R ERWIN,W WALKER  (WISCONSIN)

ACCENSI  66 PL 20 557          ACCENSI,ALLES-BORELLI,FRENCH,FRISK+  (CERN)
JACOBS   66 UCRL-16877         L.D.JACOBS,THESIS                       (LRL)
WAHLIG   66 PR  147  941       +SHIBATA,GORDON,FRISCH,MANNELLI  (MIT+PISA) J

BARLOW   67 NC 50A 701         +LILLESTOL+MONTANET+  (CERN+CDEF+IRAD+LIVP)
BEUSCH   67 PL 25 B 357        +FISCHER,GOBBI,ASTBURY+           (ETHZ+CERN)
DAHL     67 PR 163 1377        +HARDY+HESS+KIRZ+MILLER                 (LRL)
EISNER   67 PR 164 1699        +JOHNSON+KLEIN+PETERS+SAHNI+YEN+    (PURDUE)
POIRIER  67 PR 163 1462        +BISWAS,CASON,DERADO,KENNEY+     (NDAM+PENN)
RABIN    67 THESIS             M. RABIN                           (RUTGERS)

ARMENISE 68 NC 54 A 999        +FORINO+CARTACCI+ (BARI+BGNA+FIRENZE+ORSAY)
ASCOLI   68 PRL 21 1712        G.ASCOLI,H.B.CRAWLEY,D.W.MORTARA,+     (ILL)
BOESEBEC 68 NP B 4 501         BOESEBECK,DEUTSCHMANN,+(AACHEN+BERLIN+CERN)
FOSTER   68 NP B 6 107         +GAVILLET+LABROSSE+MONTANET+      (CERN+CDEF)
JOHNSON  68 PR 176 1651        +POIRIER,BISWAS,GUTAY+      (NDAM+PURD+SLAC)
LAMSA    68 PR 166 1395        +CASON+BISWAS+DERADO+GROVES+     (NOTREDAME)
WHITEHEA 68 NC 53A 817         +MCEWEN,OTT,AITKEN+          (AERE+SHMP+LOUC)

ADERHOLZ 69 NP B 11 259        +BARTSCH,+            (AACH+BERL+CERN+JAGL+WARS)
AGUILAR- 69 PL 29 B  241       M.AGUILAR-BENITEZ,J.BARLOW,+     (CERN+CDEF)
ARMENISE 69 LNC 2 501          +GHIDINI,FORINO,CARTACCI+  (BARI+BGNA+FIRZ)
CASO     69 NC 62 A 755        +CONTE,BENZ,+     (GENO+DESY+HAMB+MILA+SACL)
DONALD   69 NP B 11 551        +EDWARDS,BURAN,BETTINI,+    (LIVP+OSLO+PADO)

AGUILAR  70 PRL 25 58          AGUILAR-BENITEZ,BARNES,BASSANO,+ (BNL+SYRA)
ARMENISE 70 LNC 4  199         +GHIDINI,FORING,CARTACCI,+ (BARI+BGNA+FIRZ)
BADIER   70 NP B 22 512        +BONNET,DREVILLON,BAUBILLIER,+  (EPOL+IPNP)
OH       70 PR D 1 2494        +GARFINKEL,MORSE,WALKER,PRENTICE(WISC+TNTOJ)
STUNTEBE 70 PL 32 B 391        STUNTEBECK,KENNEY,DEERY,BISWAS,CASON+(NDAM)

BARDADIN 71 PR D4 2711         BARDANIN-OTWINOWSKA,HOFMOKL,+          (WARS)
BEAUPRE  71 NP B 28 77         +DEUTSCHMANN,GRAESSLER,+    (AACH+BERL+CERN)
FARBER   71 NP B 29 237        +DE PINTO,BISWAS,CASON,DEERY,KENNEY,+(NDAM)
FLATTE   71 PL 34 B 551        +ALSTON-GARNJOST,BARBARO-GALTIERI,+    (LBL)

AGUILAR  72 PR D 6 29          AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS    (BNL)
BISWAS   72 PR D 5 1564        +CASON,HARRINGTON,KENNEY,SHEPHARD     (NDAM)
FOGLI    72 NC 8 A 670         FOGLI-MUCIACCIA,PICCIARELLI           (BARI)
GRAYER   72 PHIL.CONF.PROC. 5 +HYAMS,JONES,SCHLEIN,BLUM,DIETL+(CERN+MPIM)
JACOBS   72 PR D 6 1291        L.D.JACOBS                          (SACLAY)
KEMP     72 NC 8 A 611         +MAJOR,CONTRI,+  (DURH+GENO+MILA+EPOL+LPNP)
SCARROTT 72 LNC 3 271          SCARROTT,KEMP                       (DURHAM)
TAKAHASH 72 PR D 6 1266        TAKAHASHI,BARISH,+      (TOHO+PENN+NDAM+ANL)
WHITEHEA 72 NP B 48 365        WHITEHEAD,AULD,+         (AERE+RHEL+SHMP+LOUC)

ANDERSON 73 PRL 31 562         +ENGLER,KRAEMER,TOAF,DIAZ,+      (CARN+CASE)
BUGG     73 PR D 7 3264        +CONDO,HART,COHN,ENDORF,+  (TENN+ORNL+CINC)
CHARLESW 73 NP B 65 253        CHARLESWORTH,EMMS,BELL,+   (RHEL+BIRM+DURH)
HYAMS    73 NP B 64 134        +JONES,WEILHAMMER,BLUM,DIETL,+  (CERN+MPIM)
TOET     73 NP B 63 248        +THUAN,MAJOR,RINAUDO,+(NIJM+BONN+DURH+TORI)

EISENBER 74 PL 52B 239         EISENBERG,ENGLER,HABER,KARSHON+       (REHO)
ENGLER   74 PR D10 2070        +KRAEMER,TOAFF,WEISSER,DIAZ+     (CARN+CASE)
GRAYER   74 NP B 75 189        G.GRAYER,HYAMS,BLUM,DIETL,+      (CERN+MPIM)
HOLLOWAY 74 PR D9 1161         +HULD,JORDAN,KOETZ,BERNSTEIN+    (ILL+ILLC)
LOUIE    74 PL 48B 385         +ALITTI,GANDOIS,CHALCUPKA+       (SACL+CERN)

EMMS     75 NP B96 155         +KINSON,STACEY,VOTRUBA+     (BIRM+DURH+RHEL)
ESTABROO 75 NP B95 322         P.ESTABROOKS,A.D.MARTIN                (DURH)
HYAMS    75 NP B100 205        +JONES,WEILHAMMER,BLUM,DIETL+    (CERN+MPIM)
PAWLICKI 75 PR D12 631         +AYRES,DIEBOLD,GREENE,KRAMER,WICKLUND (ANL)
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Mesons

D(1285), A_2(1310)

Data Card Listings

For notation, see key at front of Listings.

D(1285)

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8  D(1285,JPG=  +) I=0
(JP=0-,1+,2- WITH 1+ FAVORED.)
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                    8  D MASS (MEV)

M        (1290.)   APPROX.          BARLOW    67 HBC    1.2 PBAR P, 4PFS  5/67
M         1283.0     5.0            DAHL      67 HBC      1.6-4.2 PI- P  10/66
M         1290.      7.             D.ANDLAU  68 HBC  1.2 PBAR P, 5-6 PFS  6/68
M        (1310.0)                   DEFOIX    68 HBC     1.2 PB P,7 PI    3/69
M         1270.0    10.0            CAMPBELL  69 DBC     2.7 PI+ D        8/69
M         1285.      7.             LORSTAD   69 HBC  0.7 PB P, 4,5-BODY  9/69
M         1303.0     8.0            BARDADIN  71 HBC     8 PI+ P, P+6PI   9/69
M         1283.0     6.0            BOESEBECK 71 HBC    16.0 PI P,5 PI    6/71
M     150 1292.     10.             DEFOIX    72 HBC    0.7 PBAR P,7 PI   1/73
M     180 1286.      3.             DUBOC     72 HBC    1.2 PBAR P,2K4PI 12/72
M   S 500(1280.)    (3.)            THUN      72 MMS    13.4 PI- P       12/72
M   S   SEEN IN THE MISSING MASS SPECTRUM                                12/72
M           . . . . . . . . . .
M   AVG     1286.1     2.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
M   STUDENT1285.9      2.2     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    8  D WIDTH (MEV)

W   R      (35.0)    (10.0)         DAHL      67 HBC      1.6-4.2 PI- P  11/71
W  U        46.       20.           D.ANDLAU  68 HBC  1.2 PBAR P, 5-6 PFS  2/72
W  U    UNFOLDED BY DOBRZYNSKI 71
W   R      (40.0)                   DEFOIX    68 HBC     1.2 PB P,7 PI   11/71
W           30.0      15.0          CAMPBELL  69 DBC     2.7 PI+ D        8/69
W   R      (60.)     (15.)          LORSTAD   69 HBC  0.7 PB P, 4,5-BODY 11/71
W   R      (44.0)    (24.0)         BARDADIN  71 HBC     8 PI+ P, P+6PI  11/71
W           10.0      10.0          BOESEBECK 71 HBC    16.0 PI P,5 PI    6/71
W   R  150  (28.)     (5.)          DEFOIX    72 HBC    0.7 PBAR P,7 P9   1/73
W   R  180  (46.)     (9.)          DUBOC     72 HBC    1.2 PBAR P,2K4PI 12/72
W   S  500  (37.)     (5.)          THUN      72 MMS    13.4 PI- P       12/72
W   S   SEEN IN THE MISSING MASS SPECTRUM                                12/72
W   R  RESOLUTION NOT UNFOLDED                                           11/71
W           . . . . . . . . . .
W   AVG     20.6       9.6     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
W   STUDENT  20.6      9.2     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    8  D   PARTIAL CECAY MODES

                                                        DECAY MASSES
P1     D INTO K KBAR PI                                497+ 497+ 134
P2     D INTO PI PI RHO                                134+ 134+ 773
P3     D INTO ETA PI PI                                548+ 134+ 134
P4     D INTO DELTA PI                                 976+ 134
P5     D INTO 2PI+ 2PI-                                139+ 139+ 139+ 139

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                    8  C BRANCHING RATIOS

R1     D INTO (PI PI RHO) / (K KBAR PI)                 (P2)/(P1)
R1          (2.0)  OR LESS          DAHL      67 HBC     CHARGED PI ONLY 10/66
R1  D       (4.0)  OR LESS          DONALD    69 HBC     1.2 PBAR P,5P+ .
R1  D        THIS IS FOR (RHOO PI+ PI-)/(K KBAR PIO)

R2     D INTO (K KBAR PI)/(ETA PI PI)                   (P1)/(P3)
R2 K R       0.166     0.055        DEFOIX    68 HBC    1.2 PBAR P        1/73
R2   R  REVISEC BY DEFCIX 72
R2           0.16      0.08         CAMPBELL  69 DBC    2.7 PI+ D         1/73
R2 K         0.20      0.08         DEFOIX    72 HBC    0.7 PBAR P,7 PI   1/73
R2 K    K KBAR SYSTEM CHARACTERIZEC BY THE I=1 THRESHOLC
R2 K    ENHANCEMENT (SEE UNDER DELTA(970)).
R2          . . . . . . . . . .
R2  AVG      0.173     0.039   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2  STUDENT  0.173     0.042   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R3     D INTO (DELTA PI)/(ETA PI PI)                    (P4)/(P3)
R3           POSSIBLY SEEN          AMMAR     70 HBC      4.1,5.5K-,ETA  5/70
R3           POSSIBLY SEEN          OTWINOWSK 70 HBC    8 PI+ P, P+6PI    9/69
R3          (0.8)     (0.2)         DEFOIX    72 HBC    0.7 PBAR P,7 PI . 1/73

R4     D INTO (2PI+ 2PI- (INCL. RHO PI PI))/(ETA PI+ PI-)
R4                                                      (P5)/(2/3P3)
R4      50    (0.55) OR MORE        BOESEBECK 71 HBC    16. PI+- P,P 5PI 11/71

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                          REFERENCES FOR D

D.ANDLAU 65 PL 17 347          +BARLOW,ADAMSON,+       (CDEF+CERN+IRAD+LIVP)
MILLER   65 PRL 14 1074        +CHUNG,DAHL,HESS,HARDY,KIRZ,+      (LRL+UCB)
BARLOW   67 NC  50 A  701      +MONTANET,C-ANDLAU+   (CERN+CDEF+IRAD+LIVP)
DAHL     67 PR 163 1377        +HARDY+HESS+KIRZ+MILLER              (LRL)I JP
D.ANDLAU 68 NP  B 5  693       +ASTIER,BARLOW+        (CDEF+CERN+IRAD+LIVP)I JP
DEFOIX   68 PL 28 B 353        +RIVET,SIAUD,CONFORTO+     (CDEF+IPNP+CERN)

CAMPBELL 69 PRL 22 1204        +LICHTMAN,+                           (PURD)
DONALD   69 NP B 11 551        +EDWARDS,BURAN,BETTINI,+   (LIVP+OSLO+PADO)
LORSTAD  69 NP B 14 63         B.LORSTAD,D.ANDLAU,ASTIER,+     (CDEF+CERN)  JP
OTWINOWS 69 PL 29 B 529        S.OTWINOWSKI                        (WARSAW)

AMMAR    70 PR D2 430          +KROPAC,DAVIS,DERRICK+ (KANS+NWES+ANL+WISC)

BARDADIN 71 PR D4 2711         BARDADIN-OTWINOWSKA,HOFMOKL,MICHEJDA+(WARS)
BOESEBEC 71 PL 34 B 659            (AACH+BERL+BONN+CERN+CRAC+HEID+WARS)
GOLDBERG 71 LNC 1 627          +MAKOWSKI,TOUCHARD,DONALD,+       (IPN+LIVP)  JP

BERENYI  72 NP B 37 621        +PRENTICE,STEENBERG,YOON,WALKER (TNTO+WISC)
CHAPMAN  72 NP B 42 1          +CHURCH,LYS,MURPHY,RING,VANDER VELDE (MICH)
DEFOIX   72 NP B 44 125        +NASCIMENTO,BIZZARRI,+          (CDEF+CERN)
DUBOC    72 NP B 46 429        +GOLDBERG,MAKOWSKI,DONALD,+     (LPNP+LIVP)
THUN     72 PRL 28 1733        +BLIEDEN,FINOCCHIARO,BOWEN,+    (STON+NEAS)

VUILLEMI 75 LNC 14 165         VUILLEMIN,+       (LALS+NEUC+LPNP+LIVP+GLAS)  JP

HANDLER  76 NP                 +PLANO,BRUCKER,KOLLER+      (RUTG+STEV+SETO)

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A_2(1310)

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12  A2(1310,JPG=2+-) I=1

WE LIST THE A2 AS AN ORDINARY BREIT-WIGNER RESONANCE.
FOR DISCUSSION OF THE REPORTED SPLITTING SEE OUR
APRIL 72 AND APRIL 73 EDITION.

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                12  A2 MASS (MEV),  3PI MODE

M         (1320.0)                  ADERHOLZ  64 HBC      4.0 PI+P
M         (1335.0)  (10.0)          GOLDHABER 64 HBC  +-  3.7 PI+- P       12/75*
M     1425 1290.0    (5.0)          LEFEBVRES 65 MMSP  -  5.6,6.0 PI-P      1/73
M         (1290.0)  (10.0)          BARNES    66 HBC   -  6.0 PI-P          2/73
M         (1310.0)  (10.0)          BENSON    66 DBC   0 3.65 PI+D         12/75*
M     1060 1286.     (8.)           LEVRAT    66 MMS   -   6-7 PI- P        1/73
M   0 4000(1307.)   (16.)           CHIKOVANI 67 MMS   -  7 PI- P          12/75*
M      260 1311.0     6.0           ARMENISE  68 DBC   0 5.1 PI+D           9/67
M      120 1320.     10.            BOESEBECK 68 HBC   0 8 PI+ P            6/68
M   0     (1310.)   (20.)           CHUNG     68 HBC   -  2.7-4.5 PI- P     5/68
M         (1301.0)   (8.0)          VON KROGH 68 HBC   -  6.7 PI- P         9/68
M   A     (1300.0)   (4.0)          JUNKMANN  68 HBC   -  16. PI- P, 5PI    1/73
M   A     (1299.)   (14.)           LAMSA     68 HBC   -  8 PI- P           1/71
M   0     (1295.0)  (20.0)          ANDERSON  69 MMS   -  16 PI- P,BACKW9   8/69
M   A  241(1299.0)  (12.0)          ARMENISE  69 DBC   +  5.1 PI+D,3PI+-    5/70
M          1310.0    14.0           EISENBERG 69 HBC   + 4.3,5.3 GAMMA P   12/69
M          1305.     (3.)           ASCOLI    70 HBC   -  5 - 7.5 PI- P     1/71
M      941 1306.0     4.0           ALSTON-GA 70 HBC   + 7.0 PI+P,3PI P     1/71
M      280 1313.0     7.0           BOCKMANN  70 HBC    05. PI+P            5/70
M   A  581(1288.0)  (10.0)          CASO      70 HBC   - 11.2PI-P,PI RHO    1/73
M   0     (1335.0)  (15.0)          DIAZ      70 HBC  +- 0. PBAR P, 4 PI   12/75*
M   0     (1330.0)  (15.0)          GARFINKEL 70 DBC   -  4.5 K-D,LAMBDA   12/75*
M         (1274.0)  (22.0)          GORDON    70 DBC    0 4.2 PI+ D       . 1/71
M      360 1304.0     4.5           BARNHAM   71 HBC   +  3.7 PI+ P,(3PI)+ 11/71
M    10000 1307.      5.            BINNIE1   71 MMS   - PI-P NEAR A2 THR  11/71
M     5000 1309.      5.            BINNIE1   71 MMS   - PI-P NEAR A2 THR  11/71
M    28000 1299.0     6.0           BOWEN     71 MMS   - 5. PI- P          11/71
M    24000 1300.      6.0           BOWEN     71 MMS   + 5. PI+ P          11/71
M    17000 1309.0     4.0           BOWEN     71 MMS   - 7. PI- P          11/71
M      160 1307.      7.            BLOODWORT 72 HBC   +  5.45 PI+ P,P 3PI  1/73
M   P      1315.      5.            ANTIPOV1  73 CNTR -  25.,40. PI- P      1/74
M     1580 1306.      9.            CHALOUPKA 73 HBC  -  3.9 PI- P,P A2     2/73
M   P 1600 1318.      7.            EMMS      75 DBC    04.  PI+N,P A20    11/75*
M   P 1200 1298.      8.            WAGNER    75 HBC    07.  PI+P,DEL++A2  11/75*
M
M   0    CNLY EXPERIMENTS GIVING ERROR LESS THAN 15 MEV KEPT FOR AVERAGING   12/75*
M   A    ANALYSIS COMPLICATED BY NEARBY PEAK (A1.5) AND/OR A1
M   P    FROM A FIT TO JP=2+ RHO PI PARTIAL WAVE
M           . . . . . . . . . .
M   AVG     1307.7      1.4     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT1307.7      1.7     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                12  A2 MASS (MEV), K KBAR MODE

MK       80(1317.0)   (3.0)              BARLOW    67 HBC  +-  1.2 PBAR P, KK . 2/72
MK       60 1333.0    13.0               BARLOW    67 HBC  +-  1.2 PBAR P, KK   9/67
MK  N      (1344.0)   (7.)      (6.)     BEUSCH    67 OSPK   0 5-12 PI-P,K1K1  11/71
MK      130 1280.0    12.0               CONFORTO  67 HBC  +-  0. PBAR P IN KK. 9/67
MK          1317.2     4.0               DAHL      67 HBC   -  2.7-4.5 PI- P    8/67
MK  N      (1315.7)  (10.8)              DAHL      67 HBC    0 2.7-4.5 PI- P   11/71
MK  N      (1311.0)   (5.0)              CRENNELL  68 HBC    0 6.0 PI-P,K1K1   11/71
MK      132 1301.0     7.0               ALSTON-GA 70 HBC   +  7.0 PI+P,K+KS P  1/71
MK      190 1313.0     7.0               CRENNEL   71 HBC   - 4.5 PI- P,KSK-P  11/71
MK S   1500 1319.0     3.0               GRAYER    71 ASPK  - 17.2 PI-P,K-KS P  2/72
MK      730 1313.0     4.0               FOLEY     72 CNTR  - 20.3 PI- P,K- KS 12/72
MK
MK  N    THE NEUTRAL MODE CAN INTERFERE WITH THE F MESON
MK S     SYSTEMATIC ERROR IN MASS SCALE SUBTRACTEC
MK          . . . . . . . . . .
MK  AVG     1315.0      3.1     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)
MK  STUDENT1315.4      2.2     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                               (SEE IDEOGRAM BELOW )
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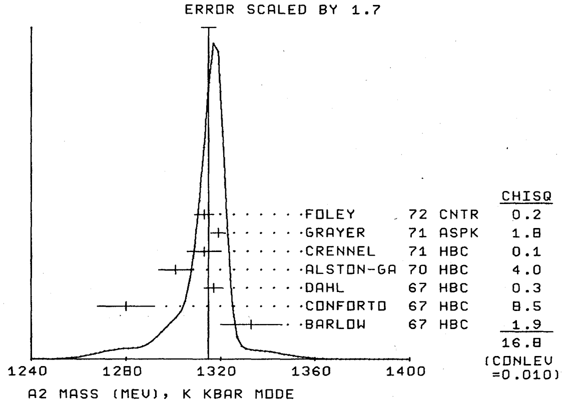
WEIGHTED AVERAGE = 1315.0 ± 3.1
ERROR SCALED BY 1.7

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Data Card Listings

For notation, see key at front of Listings.

Mesons

$A_2(1310)$

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                    12  A2 MASS (MEV),  ETA PI MODE

M       189 1312.0      7.0              ALSTON-GA 70 HBC   +  7.0 PI+P,PI ETA   1/71
M           1300.0     20.0              CASO      70 HBC   - 11.2PI-P,PI ETA    5/70
M        32 1300.0      8.               DZIERBA   70 HBC   -  8. PI- P,PI ETA   1/73
M        30 1288.       7.               JOHNSTON  70 HBC   -  7.PI-P,PI-ETA P   1/71
M           1320.      20.               ESPIGAT   72 HBC  +- 0.PBAR P,ETA 2PI  11/71
M  E   1000 1323.       8.               KEY       73 OSPK -  6.PI-P,P PI-ETA    1/74
M  EM  6200(1324.)     (8.)              CONFORTO  73 OSPK -  6.PI-P,P MMS-      1/74
M  E    ERROR INCLUDES 5 MEV SYSTEMATIC MASS-SCALE ERROR
M   M   MISSING MASS WITH ENRICHED MMS=ETA PI-, ETA = 2 GAMMA
M              . . . . . . . . .
M   AVG     1305.3      5.8      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.6)
M   STUDENT1306.0       5.0      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                              (SEE IDEOGRAM BELOW )
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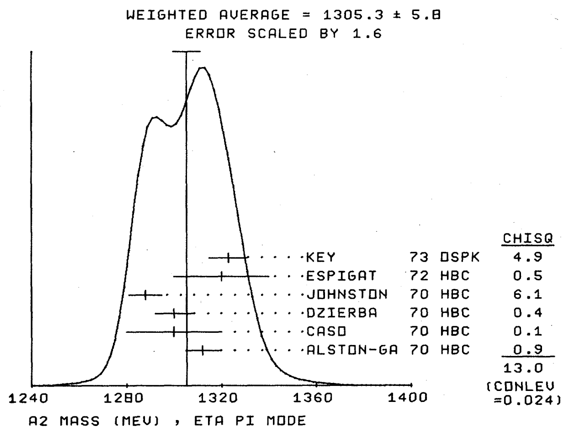


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                    12  A2 WIDTH (MEV), 3PI MODE

W          (100.0)                       ADERHOLZ  64 HBC       4.0 PI+P
W           (90.0)   (10.0)              GOLDHABER 64 HBC  +-  3.7 PI+- P        12/75*
W     1425   99.0    (15.0)              LEFEBVRES 65 MMSP  -  6.0 PI-P           1/73
W           (70.0)   (10.0)              BARNES    66 HBC   -  6.0 PI-P           2/73
W          (100.)    (15.)               BENSON    66 DBC    0 3.65 PI+D         12/75*
W     1060   98.      (5.)               LEVRAT    66 MMS   -  6,7 PI- P          1/73
W  O  4000  (90.)    (15.)               CHIKOVANI 67 MMS   -  7 PI- P           12/75*
W      260   96.0     16.0               ARMENISE  68 DBC    0 5.1 PI+D           9/67
W  O   120  (56.)    (21.)               BOESEBECK 68 HBC    0 8 PI+ P            1/73
W  O        (80.)    (20.)               CHUNG     68 HBC   -  2.7-4.5 PI- P      5/68
W           (40.0)   (25.0)              VON KROGH 68 HBC   -  6.7 PI- P          9/68
W  A        (52.0)   (16.0)              JUNKMANN  68 HBC   -  16. PI- P, 5PI     1/73
W  O        (90.0)   (10.0)     (50.0)   ANDERSON  69 MMS   -  16 PI- P,BACKW9  12/75*
W  AE  241 (164.0)   (20.0)              ARMENISE  69 DBC  +   5.1 PI+D,3PI++-   5/70
W  O        (80.0)   (30.0)              EISENBERG 69 HBC  +  4.3,5.3 GAMMA P   12/69
W      941   79.0     12.0               ALSTCN-GA 70 HBC  +  7.0 PI+P,3PI P     1/71
W  O   280  (70.0)   (29.0)              BOCKMANN  70 HBC   05. PI+P              5/70
W  A   581 (135.0)   (26.0)              CASO      70 HBC  - 11.2PI-P,PI RHO     1/73
W  O        (90.0)   (20.0)              DIAZ      70 HBC  +- 0. PBAR P, 4 PI    5/70
W  D        (35.0)   (35.0)              GARFINKEL 70 DBC  -   4.5 K-D,LAMBDA    1/71
W          (215.0)   (22.0)              GORDON    70 DBC   0 4.2 PI+ D          1/71
W      360  111.4     18.0               BARNHAM   71 HBC  +  3.7 PI+ P,(3PI)+ 11/71
W    10000 (100.)                        BINNIE1   71 MMS  - PI-P NEAR A2 THR 11/71
W     5000   72.      16.                BINNIE1   71 MMS  - PI-P NEAR A2 THR 11/71
W    28000  105.0      5.0               BOWEN     71 MMS  - 5. PI- P           11/71
W    24000   99.0      5.0               BOWEN     71 MMS  + 5. PI+ P           11/71
W    17000  103.0      5.0               BOWEN     71 MMS  - 7. PI- P           11/71
W  O   160  (72.)    (25.)               BLOODWORT 72 HBC  +  5.45 PI+ P,P 3PI 12/72
W  P        115.      15.                ANTIPOV1  73 CNTR -  25.,40. PI- P      1/74
W     1580   99.      15.                CHALOUPKA 73 HBC  -  3.9 PI- P,P A2     2/73
W  P  1600  112.      18.                EMMS      75 DBC   04.  PI+N,P A20    11/75*
W  P S1200  122.      14.                WAGNER    75 HBC   07.  PI+P,DEL++A2  11/75*
W
W   O    ONLY EXPERIMENTS GIVING MASS ERROR LT. 15 MEV KEPT FOR AVERAGING        12/75*
W   E    BACKGROUND SUBTRACTION MODEL-DEPENDENT.                                   5/70
W   D    MAY BE DIFFERENT OBJECT, ALTHOUGH JPC=2++. COMPARE CRENNELL 69.
W  A     ANALYSIS COMPLICATED BY NEARBY PEAK (A1.5) AND/OR A1
W    S   WIDTH ERRORS ENLARGEC BY US TO 4*WIDTH/SQRT(N)
W  P     FROM A FIT TO JP=2+ RHO PI PARTIAL WAVE
W            . . . . . . . . .
W   AVG     101.7      2.7      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
W   STUDENT 101.9      2.9      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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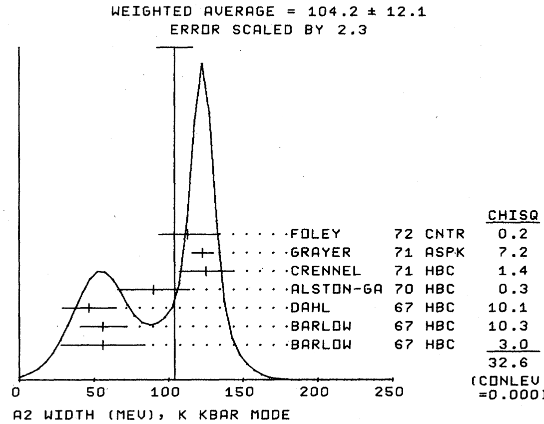
                    12  A2 WIDTH (MEV), K KBAR MODE

WK       60   56.0     28.0              BARLOW    67 HBC  +-  1.2 PBAR P, KK    9/67
WK       80   56.0     15.0              BARLOW    67 HBC  +-  1.2 PBAR P, KK    9/67
WK   N       (88.)    (23.)    (22.)     BEUSCH    67 OSPK   0 5-12 PI-P,K1K1  11/71
WK      130  (90.0)                      CONFORTO  67 HBC  +-  0. PBAR P IN KK   9/67
WK            47.      18.               DAHL      67 HBC   -  2.7-4.5 PI- P     8/67
WK   N       (80.5)   (36.5)             DAHL      67 HBC    0 2.7-4.5 PI- P    11/71
WK   N       (21.0)   (10.0)    (6.0)    CRENNELL  68 HBC    0 6.0 PI-P,K1K1    11/71
WK      132   90.0     24.0              ALSTON-GA 70 HBC  +  7.0 PI+P,K+KS P   1/71
WK      190  125.0     19.0     16.0     CRENNEL   71 HBC  - 4.5 PI- P,KSK-P   11/71
WK     1500  123.0      7.0              GRAYER    71 ASPK - 17.2 PI-P,K-KS P 11/71
WK      730  113.0     19.0              FOLEY     72 CNTR - 20.3 PI- P,K- KS 12/72
WK   N   THE NEUTRAL MODE CAN INTERFERE WITH THE F MESON
WK            . . . . . . . . .
WK   AVG     104.2     12.1     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.3)
WK   STUDENT 107.4      9.1     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                            (SEE IDECGRAM BELOW )
```

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                    12  A2 WIDTH (MEV), ETA PI MODE

W       189  103.0      20.0             ALSTCN-GA 70 HBC   +  7.0 PI+P,PI ETA    1/71
W           (120.0)                      CASO      70 HBC   - 11.2PI-P,PI ETA    5/70
W        32  (41.0)    (20.0)   (16.0)   DZIERBA   70 HBC   -  8. PI- P,PI ETA  11/70
W   T    30  (38.0)    (30.0)            JOHNSTON  70 HBC   -  7.PI-P,PI-ETA P   1/73
W             120.      30.              ESPIGAT   72 HBC  +- 0.PBAR P,ETA 2PI  11/71
W      1000  108.        9.              KEY       73 OSPK -  6.PI-P,P PI-ETA    1/74
W   M  6200 (104.)      (9.)             CONFORTC  73 OSPK -  6.PI-P,P MMS-      1/74
W   M   MISSING MASS WITH ENRICHED MMS=ETA PI-, ETA = 2 GAMMA
W   T   WIDTH ERRCRS ENLARGED BY US TO 4*WIDTH/SQRT(N)
W              . . . . . . . . .
W   AVG      108.1       7.9     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT  108.0       8.5     AVERAGE USING STUCENT10(H/1.11) -- SEE TEXT
```

```
                    12  A2 PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      A2 INTO RHO PI                                     773+ 139
P2      A2 INTO K KBAR                                     493+ 497
P3      A2 INTO ETA PI                                     548+ 139
P4      A2 INTO OMEGA PI PI                                139+ 139+ 783
P5 S    A2 INTO PI+ PI- PIO EXCL.RHO PI                    139+ 139+ 134
P6 S    A2 INTO PI+ PI- PI- EXCL.RHO PI                    139+ 139+ 139
P7 S    A2 INTO PI GAMMA                                   139+   0
P8 S    A2 INTO ETA PRIME PI                               958+ 139
P  S     SMALL, NOT USED IN THE FIT
```

FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

```
          P 1          P 2         P 3         P 4
P 1 .7094+-.0179
P 2   -.0332   .0471+-.0054
P 3   -.3024     -.0893   .1504+-.0119
P 4   -.7620     -.2008     -.3224   .0930+-.0186
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```
                    12  A2 BRANCHING RATIOS

R1      A2 (CHARGED ONLY) INTO (K KBAR)/(RHO PI)            (P2)/(P1)
R1  N       (0.13)    (0.03)           BEUSCH    67 OSPK   0 5,7,12 PI-+        9/67
R1  N   THE NEUTRAL MODE CAN INTERFERE WITH F.
R1     11    0.09      0.06      0.09  ASCOLI    68 HBC   -   5 PI-P             6/68
R1           0.054     0.022           CHUNG     68 HBC   -   3.2 PI-P         . 1/67
R1          (0.03)    (0.012)          DCNALD    68 HBC  +-   1.2 PBAR P       . 2/72
R1           0.06      0.03            ABRAMOVIC 70 HBC   -   3.93 PI- P         1/71
R1           0.07      0.03            NEF       70 MMS   -   7.0 PI- P          6/70
R1    113    0.097     0.018           ALSTON-GA 71 HBC  +    7.0 PI+ P          2/71
R1     50    0.056     0.014           CHALOUPKA 73 HBC  -  3.9 PI- P,P A2       2/73
R1            . . . . . . . . .
R1  AVG      0.0677    0.0089  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  STUDENT  0.067     0.010   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R1  FIT      0.0665    0.0078 FRCM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2      A2 INTO (ETA PI)/(RHO PI + K KBAR + ETA PI)         (P3)/(P1+P2+P3)
R2     34    0.15      0.04            BARNHAM   71 HBC  +  3.7 PI+ P           11/71
R2           0.13      0.04            ESPIGAT   72 HBC  +- 0.PBAR P,           11/71
R2            . . . . . . . . .
R2  AVG      0.140     0.028   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2  STUDENT  0.140     0.030   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R2  FIT      0.166     0.012   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
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Mesons

$A_2(1310)$

Data Card Listings

For notation, see key at front of Listings.

```
R3     A2 INTO (ETA PI) / (RHO PI)                                 (P3)/(P1)
R3            0.3        0.2                 ADERHOLZ  64 HBC        4.0 PI+P
R3            0.22       0.09                CONTE     67 HBC   -   11.0 PI-P           8/67
R3       22   0.23       0.08                ASCOLI    68 HBC   -   5 PI-P              6/68
R3            0.12       0.C8                CHUNG     68 HBC   -   3.2 PI-P           12/66
R3            0.16       0.10                KEY       68 HBC   -   3 PI-P            .11/67
R3  D        (0.18)     (0.06)               VETLITSKY 69 HBC   -   3.3 PI- P           9/68
R3            0.3        0.13                ABRAMCVIC 70 HBC   -   3.93 PI- P        . 1/71
R3       15   0.25       0.09                BOCKMANN  70 HBC   +   5.0 PI+P            9/69
R3            0.34       0.17      0.34      BOCKMANN  70 HBC    0 5.0 PI+ P            9/69
R3  D    39  (0.18)     (0.C7)               DZIERBA   70 HBC   -   8. PI- P           11/71
R3      167   0.246      0.042               ALSTON-GA 71 HBC   +   7.0 PI+ P           2/71
R3      149   0.211      0.044               CHALOUPKA 73 HBC   -  3.9 PI- P,P A2       2/73
R3       52   0.22       0.05                ANTIPCV   73 CNTR -  40. PI-P,P A2-        1/74
R3           . . . . . . . . .
R3  AVG       0.221      0.021   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3  STUDENT   0.222      0.023   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R3  FIT       0.212      0.019  FRCM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4     A2 INTO (ETA PRIME PI) / TOTAL                              (P8)
R4           (0.1)  OR LESS                  CHUNG     65 HBC   -  3.2 PI-P
R4           (0.02) OR LESS  CL=.S7          BARNHAM   71 HBC   +  3.7 PI+ P          . 2/72

R5     A2 INTO (ETA PRIME PI)/(RHC PI)                             (P8)/(P1)
R5            0.04       0.03      0.04      BOCKMANN  70 HBC    0 5.0 PI+ P            9/69
R5  D     8  (0.15)     (0.09)               DZIERBA   70 HBC   -  8. PI- P            11/71
R5  D       STRONGLY DEPENDENT ON BACKGROUND SUBTRACTION                               11/71
R5           (0.04) OR LESS                  ALSTCN-GA 71 HBC   +   7.0 PI+ P           2/71
R5           (0.011)OR LESS  CL=.90          EISENSTEI 73 HBC   -  5.PI- P,P 6PI        1/74

R6     A2 INTO (PI+ PI- PI0) / (RHO PI)                            (P5)/(P1)
R6           (0.17) OR LESS                  BENSON    66 DBC    0 3.7 PI+D

R7     A2 INTO (ETA PI)/(K KBAR)                                   (P3)/(P2)
R7  E        (3.0)  OR LESS                  FOSTER    68 HBC   -  PBAR P,PBA REST 11/71
R7  E SUPERSEDED BY ESPIGAT 72 (SEE UNDER R2 AND R8)                                   11/71
R7           . . . . . . . . .
R7  FIT       3.19       0.46   FROM FIT

R8     A2  INTO (K KBAR)/(RHO PI + K KBAR + ETA PI)                (P2)/(P1+P2+P3)
R8       17   0.06       0.03                BARNHAM   71 HBC   +  3.7 PI+ P,KSK+P    11/71
R8  A        (0.020)    (0.004)              ESPIGAT   72 HBC  +- 0.PBAR P,            2/72
R8  A   NOT AVERAGED BECAUSE OF DISCREPANCY BETWEEN MASSES
R8  A   FROM  (K KBAR)  AND  (RHO PI)  MODES
R8        8   0.03       0.02                DAMERI    72 HBC   -  11. PI- P           12/72
R8            0.05       0.02                TOET      73 HBC   +  5. PI+ P,P K+ KO  12/75*
R8            0.09       0.04                TOET      73 HBC    0 5.PI+P,PI+P K KB  12/75*
R8           . . . . . . . . .
R8  AVG       0.048      0.012   AVERAGE (ERROR INCLUDES SCALE FACTCR OF 1.0)
R8  STUDENT   0.048      0.014   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R8  FIT       0.0520     0.0C58 FRCM FIT (ERRCR INCLUDES SCALE FACTOR OF 1.0)

R9     A2 INTO (PI+ PI- PI-)/(RHO0 PI-)                            (P6C)/(P1C)
R9           (0.23) OR LESS  CL=.90          ABRAMCVIC 70 HBC   -  3.93 PI- P           1/71

R11    A2 INTO (PI GAMMA)/TCTAL                                    (P7)
R11 R        (0.005)    (0.005)  (0.003)EISENBERG 72 HBC        PHOTOPRODUCTICN   11/71
R11 R   PION EXCHANGE MODEL USED IN THIS ESTIMATION                                    11/71

R12    A2 INTO (OMEGA PI PI)/(RHO PI)                              (P4)/(P1)
R12 D         0.19       0.08                DEFOIX    73 HBC    0 0.7 PBAR P,7 PI      1/74
R12 D   DECAYS TO B1(1040) PI, B1 INTC CMEGA PI .
R12 D   ERROR INCREASED TO ACCOUNT FOR POSSIBLE SYST. ERRORS
R12 D   OF COMPLICATED ANALYSIS.
R12           0.08       0.05                GARNJOST  72 HBC    0 7.1 PI+ P            2/73
R12     279   0.10       0.05                CHALOUPKA 73 HBC   -  3.9 PI- P,P A2       2/73
R12      60   0.28       0.09                DIAZ      74 DBC    0 6.PI+N,P(5PI)0       1/74
R12 K 140     0.29       0.08                KARSHCN   74 HBC    0 4.9 PI+P,DEL++A2  12/75*
R12 K  60      .10        .04                KARSHON   74 HBC   +  4.9 PI+P,P A2+     12/75*
R12 K   KARSHON 74 SUGGEST AN ACDITIONAL I=0 STATE, STRONGLY COUPLED
R12 K   TO OMEGA PI PI  COULD EXPLAIN DISCREPANCIES IN BRANCHING RATIOS
R12 K   AND MASSES.
R12          . . . . . . . . .
R12 AVG       0.131      0.032   AVERAGE (ERROR INCLUDES SCALE FACTCR OF 1.4)
R12 STUDENT   0.127      0.027   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R12 FIT       0.131      0.029  FRCM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)
                                (SEE IDEOGRAM BELOW )
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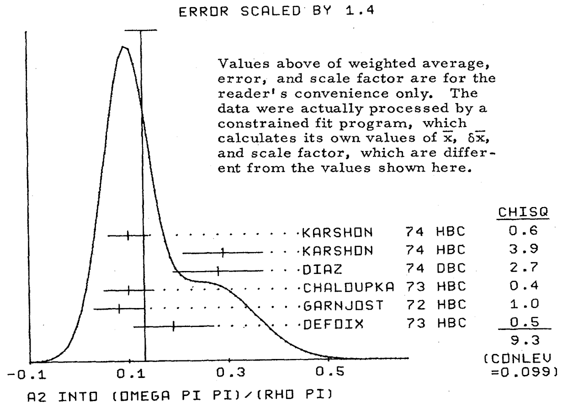
WEIGHTED AVERAGE = 0.131 ± 0.032
ERROR SCALED BY 1.4



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REFERENCES FOR A2

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ADERHCLZ 64 PL 10 248             (AACHEN+BERLIN+BIRM+BCNN+HAMBURG+LOIC+MPIM)
CHUNG    64 PRL 12 621            +DAHL,HARDY,HESS,KALBFLEISCH,KIRZ      (LRL)
GOLDHABE 64 DUBNA CONF   1 480 G GOLDHABER,S GOLDHABER,OHALLORAN,SHEN(LRL)
LANDER   64 PRL 13 346            +ABOLINS,CARMONY,HENDRIKS,XUONG+ (LA JOLLA)

ABOLINS  65 ATHENS(OHIO)CONF.  +CARMONY,LANDER,XUONG,YAGER      (LA JOLLA)I=1
ADERHOLZ 65 PR 138 B 897              (AACHEN+BERL+BIRM+BONN+HAMB+LOIC+MPIM)
ALITTI   65 PL 15 69              ALITTI,BATON,DELER,CRUSSARD+  (SACLAY+BGNA)  JP
CHUNG    65 PRL  15  325          +CAHL,HARDY,HESS,JACOBS,KIRZ,MILLER    (LRL)
FORINO   65 PL 19 68              +CESSAROLI+         (BGNA+BARI+FIRZ+ORSA+SACL)
LEFEBVRE 65 PL 19 434             CERN MISSING MASS SPECTROMETER GROUP (CERN)
SEIDLITZ 65 PRL 15 217            L SEIDLITZ,O I CAHL,D H MILLER         (LRL)

BARNES   66 PRL 16 41             BARNES,FOWLER,LAI,ORENSTEIN +     (BNL+CUNY)
BENSON   66 MICH COO-1112-4       G.C.BENSON, THESIS                    (MICH)
    ALSO 66 PRL 16 1177           G BENSON,LOVELL,MARQUIT,ROE  +        (MICH)
EHRLICH  66 PR 152 1194           R. EHRLICH,W.SELOVE,H.YUTA            (PENN)
FERBEL   66 PL 21 111             FERBEL                           (ROCHESTER)
LEVRAT   66 PL  22  714           CERN MISSING MASS SPECTROMETER GROUP (CERN)

ARMENISE 67 PL 25B 53             ARMENISE,FORINO,+      (BARI+BGNA+FIRZ+ORSAY)
BALTAY   67 PL 25B 160            +KIRSCH+KUNG+YEH+RABIN     (COLU+BNL+RUTGERS)
BARLOW   67 NC 50A 701            +LILLESTOL+MCNTANET+   (CERN+CDEF+IRAD+LIVP)
BARTSCH  67 PL 25B 48             +DEUTSCHMANN+GROTE+COCCONI+(AACH+BERL+CERN)
BEUSCH   67 PL 25 B 357           +FISCHER,GOBBI,ASTBURY+            (ETHZ+CERN)
CASON    67 PRL 18 880            +LAMSA,BISWAS,DERADO,GROVES,+    (NOTREDAME)
CHIKOVAN 67 PL 25B 44             CERN MISSING MASS SPECTROMETER GROUP (CERN)
CHUNG    67 PRL 18 100            +DAHL,HARDY,HESS,KIRZ,MILLER           (LRL)
    ALSO 66 UCRL-16832            RICHARD I HESS--THESIS,BERKELEY        (LRL)
COHN     67 NP B1 57              +MCCULLOCH+BUGG+CONDO       (ORNL+UNIV.TENN.)
CONFORTO 67 NP B3 469             +MARECHAL,MCNTANET+     (CERN+CDEF+IPN+LIVP)
CONTE    67 NC  51 A  175         +TOMASINI,CORDS+(GENOVA+HAMB+MILANO+SACLAY)
DAHL     67 PR 163 1377           +HARDY+HESS+KIRZ+MILLER                (LRL)
DANYSZ   67 NC 51 A 801           DANYSZ+FRENCH+SIMAK                   (CERN)
SLATTERY 67 NC 50A 377            +KRAYBILL+FORMAN+FERBEL          (YALE+ROCH)  JP

ARMENISE 68 PL 26B 336            ARMENISE,FORINO,+      (BARI+BGNA+FIRZ+ORSAY)
ASCOLI   68 PRL 20  1321          +CRAWLEY,MORTARA,SHAPIRO,BRIDGES+(ILLINOIS)  JP
BALLAM   68 PRL 21 934            +BRODY,CHADWICK,FRIES,GUIRAGOSSIAN+  (SLAC)
BENZ     68 PL 28 B 233           CERN MISSING MASS SPECTROMETER GROUP (CERN)
BOESEBEC 68 NP B 4 501            BOESEBECK,DEUTSCHMANN,+(AACHEN+BERLIN+CERN)
CASO     68 NC 54 A 983           +CONTE+CORDS+DIAZ+ (GENOVA+HAMB+MILAN+SACL)
CHUNG    68 PR 165 1491           S.U.CHUNG,O.DAHL,J.KIRZ,D.H.MILLER     (LRL)
CRENNELL 68 PRL 20 1318           +KARSHON+KWAN LAI,SCARR,SKILLICORN     (BNL)
DONALD   68 PL 26 B  327          +FRODESEN+BETTINI+    (LIVERPOOL+OSLO+PADUA)
FOSTER   68 NP B 8 174            +GAVILLET,LABROSSE,MCNTANET,+    (CERN+CDEF)
FRIDMAN  68 PR 167 1268           +MAURER,MICHALON,OUDET+(HEID    +STRASBOURG)
JUNKMANN 68 NP B8 471             +COCCONI,+          (AACH+BERL+BONN+CERN+WARS)
KEY      68 PR 166 1430           +PRENTICE+COOPER+MANNER+     (TNTO+ANL+WISC)
LAMSA    68 PR 166 1395           +CASON+BISWAS+DERADO+GROVES+     (NOTRECAME)
VON KROG 68 PL 27 B 253           +MIYASHITA,KOPELMAN,MARSHALL LIBBY    (COLO)

ADERHOLZ 69 NP B 11 259           +BARTSCH,+          (AACH+BERL+CERN+JAGL+WARS)
AGUILAR 169 PL 29 B  62           +BARLOW,JACOBS,DELLA NEGRA+(CERN+CDEF+LIVP)
AGUILAR 269 PL 29 B  241          M.AGUILAR-BENITEZ,J.BARLOW,+     (CERN+CDEF)
ANDERSON 69 PRL 22 1390           +COLLINS,+                        (BNL+CARN)
ARMENISE 69 LNC 2 501             +GHIDINI,FORINO,CARTACCI+  (BARI+BGNA+FIRZ)
CHIKOVAN 69 PL 28 B  526          CERN MISSING MASS SPECTROMETER GROUP (CERN) JP
CRENNELL 69 PRL 22 1327           +KARSHON,KWAN WU LAI,+                (BNL)IJP
DONALD   69 NP B 12 325           +EDWARDS,FOSTER,MOORE            (LIVERPOOL)
EISENBER 69 PRL 23 1322           EISENBERG,HABER,BALLAM,CHADWICK+(REHO+SLAC)
VETLITSK 69 SJNP 9 596            VETLITSKY,GRIGOREYEV,GRISHIN,+        (ITEP)

ABRAMOVI 70 NP B 29 466           ABRAMOVICH,BLUMENFELD,BRUYANT,+       (CERN)  JP
ALSTON-GA70 PL 33 B 607           +BARBARO,BUHL,DERENZO,EPPERSON,FLATTE+(LRL)
ASCOLI   70 PRL 25 962            +BROCKWAY,CRAWLEY,EISENSTEIN,HANFT,+  (ILL)  JP
BASILE   70 LNC 4 838             +CALPIAZ,FRABETTI,MASSAM,+ (CERN+BGNA+STRB)
BAUD1    70 PL 31B  397           CERN BOSON SPECTROMETER GROUP         (CERN)
BAUD2    70 PHILAD.CONF.P.311 CERN BOSON SPECTROMETER GROUP             (CERN)
BAUD3    70 PL 31 B 401           CERN BOSON SPECTROMETER GROUP         (CERN)
BOCKMANN 70 NP B 16 221           +MAJOR,POLS,+     (BONN+DURH+NIJM+EPOL+TORI)
BUTLER   70  UCRL 19845           THESIS                                 (LRL)
CAROLL   70 PRL 25 1393           +FIREBAUGH,GARFINKEL,MORSE,OH,+ (WISC+TNTO)
CASO     70 LNC 3 707             +CONTE,TOMASINI,CORDS+(GENO+HAMB+MILA+SACL)
DIAZ     70 NP B 16 239           +GAVILLET,LABROSSE,MCNTANET+    (CERN+CDEF)JP
DZIERBA  70 PR D 2 2544           +SHEPHARD,BISWAS,CASCN,JOHNSON,KENNEY(NDAM)
   ALSO  68 LAMSA
GARFINKE 70 PL 33 B 536           GARFINKEL,AMMANN,CARMCNY,YEN        (PURD)JPC
GORDON   70  COO 1195 179         THESIS,ILLINOIS                        (ILL)
JOHNSTCN 70 NP B 24 253           +KEY,PRENTICE,YOON,GARFINKEL,+  (TNTO+WISC)
KRUSE    70 PHILAD.CONF.P.359 U.KRUSE, PARTIAL WAVE ANALYSIS            (ILL)  JP
NEF      70  THESIS+PRIV.COMM.CERN BOSON SPECTROMETER GROUP             (CERN)
SUTHERLA 70 PHILAD.CCNF.P.369 G.SUTHERLAND,INTERFERING RESONANCE(GLASGOW)

AGUILAR  71 PR D 4 2583           AGUILAR-BENITEZ,EISNER,KINSON          (BNL)
ALSTON-GA71 PL 34 B 156           +BARBARO,BUHL,DERENZO,EPPERSON,FLATTE+(LRL)
BARNHAM  71 PRL 26 1494           +ABRAMS,BUTLER,COYNE,GOLDHABER,HALL,+ (LBL)
BEKETOV  71 SJNP 4 765            +SOMBKOWSKY,KONOWALOV,KRUTSCHININ,+  (ITEP)   JP
BINNIE1  71 PL 36 B 257           +CAMILLERI,DUANE,FARUQI,BURTON,+(LOIC+SHMP)
BINNIE2  71 PL 36 B 537           +CAMILLERI,DUANE,FARUQI,BURTON,+(LOIC+SHMP)
BOWEN    71 PRL 26 1663           +FARLES,FAISSLER,BLIEDEN,+       (NEAS+STON)
CRENNEL  71 PL 35 B 185           +GORDON,KWAN-WU LAI,SCARR              (BNL)
FARBER   71 NP B 29 237           +DE PINTO,BISWAS,CASON,DEERY,KENNEY,+(NCAM)
FOLEY    71 PRL 26 413            +LOVE,OZAKI,PLATNER,LINDENBAUM,+ (BNL+CUNY)
GRAYER   71 PL 34 B 333           +HYAMS,JONES,SCHLEIN,BLUM,DIETL+(CERN+MPIM)
LYNCH    71 UCRL 20022 AND 71 AMSTERDAM CONF.  G.LYNCH                  (LBL)
RINAUDO  71 NC 5 A 239            +BOECKMANN,MAJOR+(TORI+BONN+DURH+NIJM+EPOL) JP

ANKENBRA 72 PRL 29 1688           ANKENBRANDT,BRABSON,CRITTENDEN,HEINZ,+(IND)
BERENYI  72 NP B 37 621           +PRENTICE,STEENBERG,YOON,WALKER (TNTO+WISC)
BLOODWOR 72 NP B 37 203           BLCCDWORTH,JACKSCN,PRENTICE,YOON      (TNTO)
DAMERI   72 NC 9 A 1              +BORZATTA,GOUSSU,+            (GENO+MILA+SACL)
DAMGAARD 72  UNPUBLISHED MEMO +LECHANOINE,MARTIN                 (BOHR+GEVA)
DIEBOLD  72  BATAV.CONF.      R.DIEBCLD  RAPPCRTEUR TALK                 (ANL)
EISENBER 72 PR D 5 15             EISENBERG,BALLAM,DAGAN,+  (REHO+SLAC+TELA)
ESPIGAT  72 NP B 36 93            +GHESQUIERE,LILLESTOL,MONTANET  (CERN+CDEF)
FOLEY    72 PR D 6 747            +LOVE,OZAKI,PLATNER,LINDENBAUM,+ (BNL+CUNY)
GARNJOST 72  PRIV.COMMUNIC.   M.ALSTON-GARNJOST                          (LBL)
GETTNER  72  PREPRINT NUB2145 M.GETTNER                                 (NEAS)
KIENZLE  72  UNPUBLISHED MEMO W.KIENZLE                                 (CERN)
LASSILA  72 PRL 28 1491           LASSILA,YOUNG                         (IOWA)
MORSE    72 NP B 43 77            +OH,WALKER,JOHNSTCN,YOON         (WISC+TNTO)
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Data Card Listings

Mesons

For notation, see key at front of Listings. $A_2(1310)$, E(1420), $X_0(1430)$, $X_1(1440)$, f′(1514)


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AMMANN    73 PR D 7 1345        +CARMONY,GARFINKEL,GUTAY,MILLER+(PURD+IUPU)
ANKEBRAN 73 PR D 8 2785         ANKEBRANDT,BRABSCN,CRITTENCEN,HEINZ,+ (IND)
ANTIPOV  73 NP B 63 175         +ASCOLI,BUSNELLO,FOCACCI,+      (CERN+SERP)  JF
ANTIPOV1 73 NP B 63 153         +ASCOLI,BUSNELLO,FOCACCI,+      (CERN+SERP)  JP
ANTIPOV2 73 NP B 63 141         +ASCOLI,BUSNELLC,FOCACCI,+      (CERN+SERP)  JP
BLOODWOR 73  AIX CONF. PAPER    BLOODWORTH,FRIDMAN,JACKSON,PATEL,+   (IPPC)
CASON    73 NP B 64 14          +MACDEN,BISHOP,BISWAS,KENNEY,+       (NDAM)
CHALOUPK 73 PL 44 B 211         CHALOUPKA,DOBRZYNSKI,FERRANDO,LOSTY,+(CERN)
CONFORTO 73 PL 45 B 154         +MOBLEY,KEY,PERPOST,+  (EFI+FNAL+TNTO+WISC)
DEFOIX   73 PL 43 B 141         +DOBRZYNSKI,ESPIGAT,NASCIMENTO,+     (CDEF)
EISENSTE 73 PR D 7 278          EISENSTEIN,SCHULTZ,ASCOLI,IOFFREDO,+  (ILL)
KEY      73 PRL 30 503          +CONFORTO,MOBLEY,+     (TNTO+EFI+FNAL+WISC)
TOET     73 NP B 63 248         +THUAN,MAJOR,RINAUDO,+(NIJM+BONN+DURH+TORI)

DIAZ     74 PRL 32 260          +DIBIANCA,FICKINGER,ANDERSON,+  (CASE+CARN)
KARSHON  74 PRL 32 852          +MIKENBERG,PITLUCK,EISENBERG,RONAT+  (REHO)
OTTER    74 NP B80 1            +RUDOLPH+        (AACH+BERL+BCNN+CERN+HEID)  JP
TABAK    74  BOSTON             +RCNAT,ROSENFELD,LASINSKI+      (LBL+SLAC)  JP
THOMPSO1 74 PR D9 560           THOMPSON,GAIDOS,MCILWAIN,WILLMANN    (PURD)  JP
THOMPSO2 74 NP B69 381          THOMPSON,BADEWITZ,GAIDOS,MCILWAIN+   (PURD)  JP

ABASHIAN 75 PRL 34 691          +BEAMER,BROSS,EISENSTEIN,+    (ILL+ANL+ISU)
EMMS     75 PL 58B 117          +JONES,KINSON,STACEY,BELL+ (BIRM+DURH+RHEL)  JP
LOSTY    75 PL 56B 96           +CHALOUPKA,MONTANET,GANDOIS+    (CERN+SACL)  JP
UNDERWOO 75 PR D11 2345         UNDERWOOD,CONFORTO,KEY+(EFI+FNAL+TNTO+WISC)
   ALSO 73 CONFORTO, 73 KEY
WAGNER   75 PL 58B 201          +TABAK,CHEW                           (LBL)  JP
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E(1420)

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6  E(1420,JPG=A +) I=0

BAILLON 67 FAVOR JP=0-. DAHL 67 FAVOR 1+ BUT DO NOT
EXCLUDE 2-, 0-. LORSTAD 69 FIND 0- CR 1+.
VUILLEMI 75 FAVOUR 1+.

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                    6  E MASS (MEV)

M         1425.      7.            BAILLON   67 HBC    0. PBAR P       11/66
M         1420.     20.            DAHL      67 HBC    1.6-4.2 PI- P    9/66
M         1423.0    10.0           FRENCH    67 HBC     3-4 PBAR P      6/67
M     310 1420.      7.            LORSTAD   69 HBC  0.7 PB P, 4,5-BODY 9/69
M     170 1398.     10.            DEFOIX    72 HBC    0.7 PBAR P,7 PI  1/73
M     280 1406.      7.            DUBOC     72 HBC    1.2 PBAR P,2K4PI 12/72
M         . . . . . . . . . .
M   AVG     1415.5   4.3    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
M   STUDENT1416.0    4.3    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    6  E WIDTH (MEV)

W          80.      10.            BAILLON   67 HBC    0. PBAR P       11/66
W          60.0     20.0           DAHL      67 HBC    1.6-4.2 PI- P   10/66
W          45.      20.            FRENCH    67 HBC     3-4 PBAR P      6/67
W     310  60.      20.            LORSTAD   69 HBC  0.7 PB P, 4,5-BODY 9/69
W     170  50.      10.            DEFOIX    72 HBC    0.7 PBAR P,7 PI  1/73
W     280  50.      12.            DUBOC     72 HBC    1.2 PBAR P,2K4PI 12/72
W          . . . . . . . . . .
W   AVG     59.8     6.0    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
W   STUDENT 58.3     6.7    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    6  E PARTIAL DECAY MODES

                                                     DECAY MASSES
P1     E INTO K K*(892)                              497+ 892
P2     E INTO K KBAR PI                              497+ 497+ 139
P3     E INTO PI PI RHO                              134+ 134+ 773
P4     E INTO DELTA PI                               976+ 139
P5     E INTO ETA PI PI                              548+ 139+ 139

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                    6  E BRANCHING RATIOS

R1     E INTO (KBAR K*(892) + C.C.)/(K KBAR PI)      (P1)/(P2)
R1           .50       .10         BAILLCN   67 HBC     0.0 PBAR P     11/66

R2     E INTO (PI PI RHO) / (K KBAR PI)              (P3)/(P2)
R2          (2.0)   OR LESS        DAHL      67 HBC   0  1.6-4.2 PI- P .10/66

R3     E INTO (ETA 2 PI)/(K KBAR PI)                 (P5)/(P2)
R3          (1.5)   OR LESS  CL=.95 FOSTER   68 HBC   - 0.0 PBAR P      9/69
R3           1.5       0.8         DEFOIX    72 HBC     0.7 PBAR P      1/73

R4     E INTO (DELTA PI)/(ETA PI PI)                 (P4)/(P5)
R4           0.4       0.2         DEFCIX    72 HBC     0.7 PBAR P,7 PI  1/73

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REFERENCES FOR E


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BAILLON  67 NC 50A  393         +EDWARDS+D.ANDLAU+ASTIER+  (CERN+CDEF+IRAD)
BARASH   67 PR 156  1399        BARASH,KIRSCH,MILLER,TAN        (COLUMBIA)
DAHL     67 PR 163 1377         +HARDY+HESS+KIRZ+MILLER              (LRL)I JP
   ALSO 65 PRL 14 1074          MILLER,CHUNG,DAHL,HESS,HARDY,KIRZ+(LRL+UCB)
FRENCH   67 NC 52A 438          +KINSON+MCDONALD+RIDDIFORD+     (CERN+BIRM)

FOSTER   68 NP B 8 174          +GAVILLET,LABRCSSE,MCNTANET,+   (CERN+CDEF)
BETTINI  69 NC 62 A 1038        +CRESTI,LIMENTANI,BERTAUZA,BIGI+(PADO+PISA)IC
LORSTAD  69 NP B 14 63          B.LCRSTAD,D.ANDLAU,ASTIER,+     (CDEF+CERN)  JP
DEVONS   71 PRL 27 1614         +KOZLOWSKI,HORWITZ,+            (COLU+SYRA)

CHAPMAN  72 NP B 42 1           +CHURCH,LYS,MURPHY,RING,VANDER VELDE (MICH)
DEFOIX   72 NP B 44 125         +NASCIMENTO,BIZZARRI,+          (CDEF+CERN)
DUBOC    72 NP B 46 429         +GOLDBERG,MAKOWSKI,DCNALD,+     (LPNP+LIVP)

VUILLEMI 75 LNC 14 165          VUILLEMIN,+      (LAUS+NEUC+LPNP+LIVP+GLAS)  JP

HANDLER  76 NP                  +PLANO,BRUCKER,KOLLER+     (RUTG+STEV+SETO)
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$X_0(1430)$ $\rightarrow K_SK_S, \rho^0\rho^0$ →

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29  X(1430,JPG=    ) I=0

EVIDENCE NOT COMPELLING.OMITTED FROM TABLE.
PEAKS SEEN IN (KS KS) SPECTRA QUOTED UNDER
X(1440) (I=1) AS WELL.

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                    29  X(1430) MASS (MEV)

M     -------RHOO RHOO MODE-------
M        (1410.0)                  BETTINI   66 DBC   0 0. PBAR N,5 PI    2/74

M     -------KS KS MODE ----------
M     B      POSSIBLY SEEN         ABRAMS    67 HBC     4.25 K- P         5/67
M     B      THE AUTHORS ASSOCIATE THE PEAK WITH THE F PRIME, BUT BACKGROUND
M     B      ESTIMATION IS DIFFICULT
M            1412.       23.       BARLOW    67 HBC     1.2 PBAR P        5/67
M            1439.0       5.0    6.0 BEUSCH  67 OSPK    5,7,12 PI-P       9/67
M            . . . . . . . . .
M     AVG    1437.5       5.3   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M     STUDENT1437.7       5.9   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    29  X(1430) WIDTH (MEV)

W     -------RHOO RHOO MODE-------
W          (90.0)                  BETTINI   66 DBC   0 0. PBAR N,5 PI    2/74

W     -------KS KS MODE ----------
W          100.       70.          BARLOW    67 HBC     1.2 PBAR P        5/67
W           43.0      17.0   18.0  BEUSCH    67 OSPK    5,7,12 PI-P       9/67
W          . . . . . . . . .
W     AVG   46.4      17.0  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W     STUDENT 46.2    18.5  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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REFERENCES FOR X(1430)


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BETTINI  66 NC 42A 695          +CRESTI,LIMENTANI,LORIA,PERUZZO+(PACO+PISA)
ABRAMS   67 PRL 18 620          +KEHOE,GLASSER,SECHI-ZORN,WOLSKY (MARYLAND)
BARLOW   67 NC  50 A  701       +MCNTANET,C-ANDLAU+   (CERN+CDEF+IRAD+LIVP)
BEUSCH   67 PL 25 B 357         +FISCHER,GOBBI,ASTBU+           (ETHZ+CERN)
DONALD   69 NP B 11 551         +EDWARDS,BURAN,BETTINI,+   (LIVP+OSLO+PADO)
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$X_1(1440)$ $\rightarrow K_SK_S$ →

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38  X(1440,JPG=    ) I=1

EVIDENCE NOT COMPELLING.OMITTED FROM TABLE.
PEAKS SEEN IN (KS KS) SPECTRA QUOTED UNDER
X(1430) (I=0) AS WELL.

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                    38  X(1440) MASS (MEV)

M     B      POSSIBLY SEEN         ABRAMS    67 HBC     4.25 K- P         5/67
M     B      THE AUTHORS ASSOCIATE THE PEAK WITH THE F PRIME, BUT BACKGROUND
M     B      ESTIMATION IS CIFFICULT
M            1412.       23.       BARLCW    67 HBC     1.2 PBAR P        5/67
M            1439.0       5.0    6.0 BEUSCH  67 OSPK    5,7,12 PI-P       9/67
M           (1425.0)               FOLEY     71 CNTR  - 20.3 PI- P,K- KS  2/71
M           (1405.)                DEFOIX    73 HBC   0 0.7 PBAR P,7 PI   1/74
M            . . . . . . . . . .
M     AVG    1437.5       5.3   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M     STUDENT1437.7       5.9   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    38  X(1440) WIDTH (MEV)

W          100.       70.          BARLOW    67 HBC     1.2 PBAR P        5/67
W           43.0      17.0   18.0  BEUSCH    67 OSPK    5,7,12 PI-P       9/67
W          (20.0)   OR LESS        FOLEY     71 CNTR  - 20.3 PI- P,K- KS  2/71
W          (40.)                   DEFOIX    73 HBC   0 0.7 PBAR P,7 PI   1/74
W          . . . . . . . . . .
W     AVG   46.4      17.0  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W     STUDENT 46.2    18.5  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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REFERENCES FOR X(1440)


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ABRAMS   67 PRL 18 620          +KEHOE,GLASSER,SECHI-ZORN,WOLSKY (MARYLAND)
BARLOW   67 NC  50 A  701       +MONTANET,D'ANDLAU+   (CERN+CDEF+IRAD+LIVP)
BEUSCH   67 PL 25 B 357         +FISCHER,GOBBI,ASTBURY+         (ETHZ+CERN)
FOLEY    71 PRL 26 413          +LOVE,OZAKI,PLATNER,LINDENBAUM,+ (BNL+CUNY)
DEFOIX   73 PL 43 B 141         +DOBRZYNSKI,ESPIGAT,NASCIMENTO,+     (CDEF)
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f′(1514)

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13  F PRIME(1514,JPG=2++) I=0
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                    13  F PRIME MASS (MEV)

M       14(1480.0)                 CRENNELL  66 HBC      6.0 PI- P        8/66
M   B    5(1460.)    (10.)         ABRAMS    67 HBC     4.25 K- P         5/67
M   B   BACKGROUND ESTIMATION DIFFICULT.                                  5/67
M          1515.0     7.0          AMMAR     67 HBC      5.5 K-P          9/67
M   S   70(1513.0)   (7.0)         BARNES    67 HBC      4.6, 5. K- P    12/72
M   S   SUPERSEDED BY AGUILAR 72
M      100 1519.      7.           AGUILAR   72 HBC     3.9,4.6 K- P     12/72
M       46 1514.      4.           COLLEY    72 HBC     10.K+ P          12/72
M       47 1521.      7.           VIDEAU    72 HBC     4.K- P,L FPRIME  12/72
M          . . . . . . . . . .
M   AVG    1516.1     2.8    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT1516.1     3.1    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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Mesons

f'(1514), F_1(1540), ρ'(1600)

Data Card Listings

For notation, see key at front of Listings.

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                    13  F PRIME WICTH (MEV)

W  B    5  (53.)    (18.)          ABRAMS    67 HBC    4.25 K- P         5/67
W  B   BACKGROUND ESTIMATICN DIFFICULT.                                  5/67
W           35.0     25.0          AMMAR     67 HBC     5.5 K-P          9/67
W  S   70  (87.0)   (15.0)         BARNES    67 HBC     4.6, 5. K- P    12/72
W  S   SUPERSEDED BY AGUILAR 72
W     100   69.      22.           AGUILAR   72 HBC    3.9,4.6 K- P     12/72
W      46   28.      15.           COLLEY    72 HBC    10.K+ P          12/72
W  E   47   40.      20.           VIDEAU    72 HBC    4.K- P,L FPRIME  12/72
W  E   ERROR INCREASED BY US.SEE TYPED NOTE ON K* MASS.                 12/72
W         . . . . . . . . .
W  AVG      39.9      9.7     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W  STUDENT  39.3     11.0     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    13  F PRIME PARTIAL DECAY MODES

                                                         DECAY MASSES
P1     F PRIME INTO PI+ PI-                            139+ 139
P2     F PRIME INTO K KBAR                             497+ 497
P3     F PRIME INTO K K*(892)                          493+ 892
P4     F PRIME INTO ETA ETA                            548+ 548
P5     F PRIME INTO PI PI ETA                          139+ 139+ 548
P6     F PRIME INTC PI K KBAR                          139+ 497+ 497
P7     F PRIME INTO PI+ PI+ PI- PI-                    139+ 139+ 139+ 139

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                    13  F PRIME BRANCHING RATIOS

R1     F PRIME INTO (PI+ PI-)/(K KBAR)                     (P1)/(P2)
R1          (0.2)  OR LESS  CL=.67   AMMAR     67 HBC      5.5 K-P           9/67
R1          (0.36) OR LESS  CL=.95   AGUILAR   72 HBC     3.9,4.6 K- P      12/72
R1 M         (.01) OR LESS           BEUSCH    75 OSPK    8.9 PI-P,KO KO N  12/75*
R1 M    MODEL DEPENDENT

R3     F PRIME INTO (ETA ETA)/(K KBAR)                     (P4)/(P2)
R3          (0.50) OR LESS           BARNES    67 HBC      4.6, 5.0 K- P    10/67

R4     F PRIME INTO (PI PI ETA)/(K KBAR)                   (P5)/(P2)
R4          (0.3)  OR LESS  CL=.67   AMMAR     67 HBC                       10/67
R4  A       (0.25)  (0.13)           BARNES    67 HBC      4.6, 5.0 K- P    10/67
R4  A   SUPERSEDED BY AGUILAR 72
R4          (0.41) OR LESS  CL=.95   AGUILAR   72 HBC     3.9,4.6 K- P      12/72

R5     F PRIME INTO (PI K KEAR + K K*(892))/(K KBAR)       (P6+P3)/(P2)
R5          (0.4)  OR LESS  CL=.67   AMMAR     67 HBC                       10/67
R5          (0.35) OR LESS  CL=.95   AGUILAR   72 HBC     3.9,4.6 K- P      12/72

R6     F PRIME INTC (PI+ PI+ PI- PI-)/(K KBAR)             (P7)/(P2)
R6          (0.32) OR LESS  CL=.95   AGUILAR   72 HBC     3.9,4.6 K- P      12/72

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REFERENCES FOR F PRIME


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BARNES    65 PRL 15 322        +CULWICK,GUIDONI,KALBFLEISCH,GOZ+(BNL+SYRA)
CRENNELL  66 PRL  16  1025     + KALBFLEISCH,LAI,SCARR,SCHUMANN +    (BNL)I
ABRAMS    67 PRL 18 620        +KEHOE,GLASSER,SECHI-ZORN,WOLSKY (MARYLAND)
AMMAR     67 PRL  19  1071     +DAVIS,HWANG,DAGAN,DERRICK +    (NWES+ANL)  JP
BARNES    67 PRL  19  964      +DORNAN,GOLDBERG,LEITNER +  (BNL+SYRACUSE)ICJP
ALITTI    68 PRL 21 1705       +EARNES,CRENNELL,FLAMINIO,GOLDBERG,+  (BNL)

LORSTAD   69 NP B 14 63        B.LORSTAD,D.ANDLAU,ASTIER,+      (CDEF+CERN)
SCOTTER   69 NC 62 A 1057      +ERSKINE,PALER,+  (BIRM+GLAS+LOIC+MPIM+OXF)

AGUILAR   72 PR D 6 29         AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS   (BNL)
COLLEY    72 NP B 50 1         +JOBES,RIDDIFORD,GRIFFITHS,+     (BIRM+GLAS)
VIDEAU    72 PL 41 B 213       +VIDEAU,ROUGE,BARRELET,DEBRICN,+(EPCL+SACL)

BEUSCH    75 PL 60 B 101       +BIRMAN,WEBSDALE,WETZEL          (CERN+ETHZ)
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F_1(1540) $\to K\bar{K}\pi$

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47  F1(1540,JPG=   ) I=1

JP = 2-,1+ FAVCRED .

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                    47  F1 MASS (MEV)

M        10(1490.0)   (20.0)        ADERHOLZ  69 HBC  +   8 PI+ P,KKBARPI.11/69
M       142 1540.0      5.0         AGUILAR   69 HBC     0.7PBARP,KKBARPI 11/69
M        25(1543.0)    (3.0)        DUBOC     71 HBC   0 1.1-1.2 PBAR P .  2/72
M   B    70(1557.)    (10.)         BAKKEN    75 HBC  +  19 PP,PN3PI      12/75*
    B    DUBIOUS BACKGROUND SUBTRACTION

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                    47  F1 WIDTH (MEV)

W        10   (85.0)   (39.0)       ADERHOLZ  69 HBC  +   8 PI+ P,KKBARPI 11/69
W       142    40.0     15.0        AGUILAR   69 HBC     0.7PBARP,KKBARPI 11/69
W        25   (16.0)   (10.0)       DUBOC     71 HBC   0 1.1-1.2 PBAR P    2/72
W   B    70   (40.)    (10.)        BAKKEN    75 HBC  +  19 PP,PN3PI      12/75*
    B    DUBIOUS BACKGROUND SUBTRACTION

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                    47  F1 PARTIAL DECAY MODES

                                                      DECAY MASSES
P1      F1 INTO K KBAR PI                            134+ 497+ 497
P2      F1 INTO K*(892) KBAR                         892+ 497
P3      F1 INTO 3 PI                                 139+ 139+ 139

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REFERENCES FOR F1


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ADERHOLZ 69 NP B 11 259     +BARTSCH,+          (AACH+BERL+CERN+CRAC+WARS)
AGUILAR  69 PL 29 B 379     +BARLOW,JACOBS,D ANDLAU,ASTIER+ (CERN+CDEF)
AGUILAR  69 NP B 14 195     +BARLOW,JACOBS,D ANDLAU,ASTIER+ (CERN+CDEF)

DUBOC    71 PL 34 B 343     +GOLDBERG,MAKOWSKI,TOUCHARD,+     (IPNP+LIVP)

CHAPMAN  72 NP B 42 1       +CHURCH,LYS,MURPHY,RING,VANDER VELDE (MICH)
DUBOC    72 NP B 46 429     +GOLDBERG,MAKOWSKI,DONALD,+       (LPNP+LIVP)

BAKKEN   75 NP B90 227      +JACOBSEN,OLSSON,SKJEVLING             (OSLO)G=-
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ρ'(1600) $\to 4\pi$

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65  RHO PRIME(1600,JPG=1-+) I=1
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The ρ' was first seen in

$$\gamma \text{ (real or virtual)} \to \rho'^0 \to \rho^0\pi^+\pi^-$$

with the $\pi^+\pi^-$ pair apparently in an S wave (BINGHAM 72, DAVIER 73, SCHACHT 74, ALEXANDER 75). A peak seen in the cross section of the reaction $e^+e^- \to \pi^+\pi^-\pi^+\pi^-$ has also been claimed as evidence for the ρ' (BARBARINO 72, CONVERSI 74); however, exchange mechanisms can be invoked that reproduce these results without any ρ' (HIRSCHFELD 74).

Evidence for a 2π decay has been looked for in several phase-shift analyses of one $\pi^-p \to \pi^-\pi^+n$ experiment (GRAYER 74). The first phase-shift solution found yielded clear evidence for $\rho' \to \pi^+\pi^-$ (HYAMS 73, OCHS 73). Since then, however, it has been recognized that at least four distinct solutions fit the data, and at most two of these exhibit any ρ' effect (ESTABROOKS 74, HYAMS 75). In an attempt to constrain the solutions further (by requiring them to be compatible with fixed-t and fixed-u analyticity for negative values of t and u), FROGGATT 75 conclude that only one solution is favored: essentially solution B of ESTABROOKS 74 or solution +-- of HYAMS 75. This solution shows considerable evidence for the $\rho' \to \pi\pi$ signal.

Note that none of the solutions has any evidence for a ρ'(1250). Finally, there is indirect evidence for the ρ' from a model-independent analysis of the pion form factor data in the space-like and time-like regions (LANG 75).

The mass and width values listed below are only indicative, because for such a broad peak they are extremely dependent on the parametrization chosen (SMADJA 72). Note also that the mass dependence of the width will be strongly affected by the inelastic channels with their rather high thresholds. For the photoproduction data, possibly diffractive background could explain the observed energy dependence of the width (SCHACHT 74).

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Data Card Listings

For notation, see key at front of Listings.

Mesons

$\rho'(1600)$, $A_3(1640)$

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                    65  RHO PRIME MASS (MEV)

M   C      (1600.)    APPROX.           BARBARINO 72 OSPK  0 E+ E- TO 4 PI      1/73
M   C    SUPERSEDED BY CONVERSI 74
M      400 1430.        50.             BINGHAM   72  HBC  0 9.3 GAM P,P 4PI  12/72
M          1590.        20.             HYAMS     73 ASPK  0 17 PI-P,N PI+PI-  1/74
M          1550.        60.             CONVERSI  74 OSPK   0 E+ E- TO 4PI    12/75*
M      160 1550.        50.             SCHACHT   74 STRC   05.5-9 G P,P 4PI  12/75*
M      340 1450.       100.             SCHACHT   74 STRC   09-18 G P,P 4PI   12/75*
M       65 1570.        60.             ALEXANDER 75 HBC    07.5 GAM P,P 4PI  12/75*
M   P      (1600.)     (50.)            FROGGATT  75 RVUE    17 PI-P,PI+PI-N  12/75*
M   P    FROM PHASE SHIFT ANALYSIS OF HYAMS 73 DATA
M             . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.4)

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                    65  RHO PRIME WIDTH (MEV)

W      400  650.       100.             BINGHAM   72  HBC  0 9.3 GAM P,P 4PI  12/72
W           180.        50.             HYAMS     73 ASPK  0 17 PI-P,N PI+PI- 12/75*
W           360.       100.             CONVERSI  74 OSPK   0 E+ E- TO 4PI    12/75*
W  E   160  400.       120.             SCHACHT   74 STRC   05.5-9 G P,P 4PI  12/75*
W  E   340  850.       200.             SCHACHT   74 STRC   09-18 G P,P 4PI   12/75*
W  E    65  340.       160.             ALEXANDER 75 HBC    07.5 GAM P,P 4PI  12/75*
W   P      (220.)      (70.)            FROGGATT  75 RVUE    17 PI-P,PI+PI-N  12/75*
W   P    FROM PHASE SHIFT ANALYSIS OF HYAMS 73 DATA
W  E     WIDTH ERRORS ENLARGED BY US TO 4*WIDTH/SQRT(N)
W             . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 2.3)

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                    65  RHO PRIME PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      RHO PRIME INTO RHO PI PI                        139+ 139+ 773
P2      NEUTRAL RHO PRIME INTO ALL 4 CHARGED PI MODES   139+ 139+ 139+ 139
P3      RHO PRIME INTO RHO RHO                          773+ 773
P4      RHO PRIME INTO PI PI                            139+ 139
P5      RHO PRIME INTO KBAR K                           493+ 493
P6      RHO PRIME INTO PI OMEGA                         139+ 783
P7      RHO PRIME INTO PI+ PI- PIO PIO                  139+ 139+ 134+ 134

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                    65  RHO PRIME BRANCHING RATIOS

R1      RHO PRIME INTO (RHO PI+ PI-)/(4 PI, ALL CHARGED) (P1)/(P2)
R1 S        DOMINANT                    BARBARINO 72 OSPK  0 E+E- TO 4 PI      1/73
R1 S          (.80)                     BINGHAM   72  HBC  0 9.3 GAM P,P 4PI   1/73
R1      500     0.7        0.1          SCHACHT   74 STRC   05.5-18 G P,P 4PI 12/75*
R1 S     THE PI PI SYSTEM IS IN S WAVE                                         1/73

R2      RHO PRIME INTO (RHO 0 RHO 0)/(RHO 0 PI+ PI-)      (P3)/(P1)
R2            NONE    (FORBIDDEN BY I=1)BINGHAM   72  HBC  0 9.3 GAM P,P 4PI   1/73

R3      RHO PRIME INTO (PI+ PI-)/(4 PI, ALL CHARGED)      (P4)/(P2)
R3             (.2)  OR LESS  2 SIGMA  BINGHAM   72  HBC  0 9.3 GAM P,P 2PI   1/73
R3            (0.14) OR LESS  ESTIMATE DAVIER    73 STRC  0 6-18 G P,P 4PI    1/74

R4      RHO PRIME INTO (KBAR K)/(4 PI, ALL CHARGED)       (P5)/(P2)
R4             (.04) OR LESS  2 SIGMA  BINGHAM   72  HBC  0 9.3 GAM P        . 1/73

R5      RHO PRIME INTO (PI+PI-)/TOTAL                     (P4)
R5  E         (0.15) OR LESS           EISENBERG 73 HBC   0 5 PI+ P,DEL++2PI  1/74
R5  E    ESTIMATED USING OPE MODEL.
R5             0.25       0.05         HYAMS     73 ASPK  0 17 PI-P,N PI+PI-  1/74
R5  P          (.35)      (.10)        FROGGATT  75 RVUE    17 PI-P,PI+PI-N  12/75*
R5  P    FROM PHASE SHIFT ANALYSIS OF HYAMS 73 DATA

R6      RHO PRIME INTO (PI+ PI- PIO PIO)/(4PI, ALL CHARGED)
R6                                                        (P7)/(P2)
R6            (1.)    OR LESS  ESTIMATE DAVIER    73 STRC  0 6-18 G P,P 4PI    1/74

R7      RHO PRIME INTO (PI+ PI- + NEUTRALS)/(4PI,ALL CHARGED)
R7                                                        (P7+....)/(P2)
R7  U         (2.6)      (0.4)         BALLAM    74 HBC    0 9.3 GAMMA P     12/75*
R7  U    UPPER LIMIT. BACKGROUND NOT SUBTRACTED

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REFERENCES FOR RHO PRIME


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ALVENSLE 71 PRL 26 273        ALVENSLEBEN,BECKER,BERTRAM,CHEN,+(DESY+MIT) G
BRAUN    71 NP B30 213        +FRIDMAN, GERBER, GIVERNAUD,+  (STRASBOURB) G
BULOS    71 PRL 26 149        +BUSZA,KEHOE,BENISTON,+  (SLAC+UMD+IBM+LBL) G

BACCI    72 PL 38B 551        +PENSO,SALVINI,STELLA,BALDINI-CE(ROMA+FRAS) JPC
BARBARIN 72 LNC 3 689         BARBARINO,CERADINI,+   (FRAS+ROMA+PADO+UMD)IGJP
BARTOLI  72 PR D 6 2374       +FELICETTI,OGREN,+          (FRAS+ROMA+NAPL)IGJP
BINGHAM  72 PL 41B 635        +RABIN,ROSENFELD,SMADJA,YOST+(LBL,UCB,SLAC)IGJP
BRAMON   72 LNC 3 693         +GRECO (THEORETICAL PAPER)        (FRASCATI)
DIEBOLD  72  BATAV.CONF.      R.DIEBOLD  RAPPORTEUR TALK             (ANL)
EISENBER 72 PR D 5 15         EISENBERG,BALLAM,DAGAN,+    (REHO+SLAC+TELA)
LAYSSAC  72 NC 10A 407        J.LAYSSAC,F.M.RENARD                  (MONT)
SMADJA   72 PHIL.CONF.PROC349 +BINGHAM,FRETTER,BALLAM,CHADWICK+(LBL+SLAC)

CERADINI 73 PL 43 B 341       +CONVERSI,EKSTRAND,GRILLI,+(ROMA+FRAS+PADO)IGJP
DAVIER   73 NP B 58 31        +DERADO,FRIES,LIU,MOZLEY,ODIAN,PARK,+(SLAC)
EISENBER 73 PL 43 B 149       EISENBERG,KARSHON,MIKENBERG,PITLUCK,+(REHO)
HYAMS    73 NP B 64 134       +JONES,WEILHAMMER,BLUM,DIETL,+  (CERN+MPIM)
KREUZER  73 PR D 8 1431       H.J.KREUZER,A.N.KAMAL    (UNIV. OF ALBERTA)
OCHS     73 THESIS            THESIS                                (MPIM)
PARK     73 NP B 58 45        J.C.H.PARK                            (MPIM)  JP

BALLAM   74 NP B76 375        +CHADWICK,BINGHAM,FRETTER+  (SLAC+LBL+MPIM)
BERNABEI 74 LNC 11 261        +D.ANGELO,SPILLANTINI,VALENTE   (ROMA+FRAS)
CONVERSI 74 PL 52B 493        +PAOLUZI,CERADINI,GRILLI+       (ROMA+FRAS)
ESTABROO 74 NP B79 301        P.ESTABROOKS,A.D.MARTIN               (DURH)
FERBEL   74 PR D9 824         T.FERBEL AND P.SLATTERY               (ROCH)
GRAYER   74 NP B 75 189       G.GRAYER,HYAMS,BLUM,DIETL,+     (CERN+MPIM)
HIRSHFEL 74 NP B74 211        A.C.HIRSHFELD,G.KRAMER                (HAMB)
SCHACHT  74 NP B81 205        +DERADO,FRIES,PARK,YOUNT              (MPIM)

ALEXANDE 75 PL 57B 487        ALEXANDER,BENARY,GANDSMAN,LISSAUER+  (TELA)
ALLES    75 NC 30A 136        ALLES-BORELLI,BERNARDINI+  (CERN+BGNA+FRAS)
ESTABROO 75 NP B95 322        P.ESTABROOKS,A.D.MARTIN               (DURH)
FROGGATT 75 NP B91 454        C.D.FROGGATT,J.L.PETERSEN        (GLAS+NORD)
HYAMS    75 NP B100 205       +JONES,WEILHAMMER,BLUM,DIETL+   (CERN+MPIM)
LANG     75 PL 58B 450        C.B.LANG,I.S.STEFANESCU               (KARL)
LANGACKE 75 PREPRINT UPR0049T P.LANGACKER,G.SEGRE                   (PENN)
ROOS     75 NP B 97 165       M.ROOS                                (HELS)

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$A_3(1640)$

34 A3(1640, JPG=2--) I = 1

The $A_3(1640)$ is seen as a bump in the diffractive-like process $\pi N \rightarrow (\pi\pi\pi)N$. The dominant effect is a $\sim$300 MeV wide enhancement in the $J^P=2^-$ $f\pi$ S-wave system, starting from $f\pi$ threshold. Neither additional (narrower) structure in the 3π mass distribution, nor other decay modes, have been clearly established. The situation would appear to be similar to that of the A_1, but there are certain additional complications:

a) Experiments with incident π^- observe little variation of the $J^P=2^-$ $f\pi$ phase in the A_3 mass region (ANTIPOV1 73, ASCOLI1 73), whereas experiments with incident π^+ show evidence for variations consistent with a resonance interpretation (OTTER 74, THOMPSON 74).

b) The A_3 region is not well described by the Deck-like model of Ascoli et al., although the agreement could probably be improved by a series of more or less well motivated adjustments to the model (ASCOLI2 73, ASCOLI 74). Nevertheless, relative phase variations of $\sim 40^\circ$ through the A_3 mass region are predicted for the 2^- $f\pi$ wave.

c) Other partial waves contribute strongly in the A_3 region. The 2^- $\rho\pi$ P wave may exhibit a broad enhancement; no phase variation relative to 2^- $f\pi$ is observed (ANTIPOV1 73, ASCOLI1 73, OTTER 74, THOMPSON 74). ANTIPOV1 73 show some evidence for an enhancement in the 2^+ $f\pi$ P wave with M $\sim$ 1750 MeV, $\Gamma \sim$ 200 MeV. The relative phases are not inconsistent with a resonance interpretation.

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                    34  A3 MASS (MEV)

M        30(1600.0)                  FORINO    65 DBC    04.5 PI+ D          10/66
M        20(1630.0)    (30.0)        VETLITSKY 66 HBC  -  4.7 PI- P          12/75*
M          (1630.)     (10.)         BALTAY    68 HBC  +  7, 8.5 PI+ P       12/75*
M          (1660.0)    (16.0)        BARTSCH   68 HBC  +  8. PI+ P,3PI P     12/75*
M          (1610.)     (19.)         LAMSA     68 HBC  -  8.0 PI-P, PI-F     12/75*
M       297(1673.0)    (40.0)        ARMENISE  69 DBC  +  5.1 PI+D,3PI++-    12/75*
M          (1680.)     (20.0)        CASO      69 HBC  -  11 PI- P            5/70
M          (1660.0)    (20.0)        CASO      69 HBC  -  11 PI-P, PI-F      12/75*
M          (1645.0)    (10.0)        CRENNELL  70 HBC  -  6. PI- P,F PI      12/75*
M   M      (1633.0)    (12.0)        MIYASHITA 70 HBC  -  6.7 PI-P,PI-F       1/71
M   M   BACKGROUND SUBTRACTION DIFFICULT.
M          (1672.0)                  BEKETOV   71 HBC  -  4.45 PI- P         11/71
M          (1600.)     (50.)         PALER     71 DBC  + 13.PI+ D,D(3PI)+.12/75*
M       260(1660.)     (25.)         CASO      72 HBC  + 11.7 PI+ P          12/75*
M   F      (1658.)      (8.)         HARRISON  72 HBC  - 13.,20. PI- P       12/72
M   F   FIT ASSUMES AN ADDITIONAL PEAK AT 1830 MEV.                          12/72
M   F   EVIDENCE FOR A SUBSTANTIAL DECAY INTO 5PI CLAIMED
M  P       (1650.)     (30.)         ANTIPOV1  73 CNTR - 25.,40. PI- P       12/75*
M  P       (1660.)     (10.)         ASCOLI 1  73 HBC  - 5.-25.PI- P,P A3 12/75*
M  P E     (1600.)     (10.)         THOMPSON  74 HBC  + 13. PI+ P,P A3+    12/75*
M    E  EVIDENCE FOR A ROTATION OF THE PHASE CLAIMED.
M       575(1640.)     (10.)         KALELKAR  75 HBC  + 15 PI+P,P PI+F      12/75*
M  P    FROM A FIT TO JP=2- F PI PARTIAL WAVE
M
M  AVERAGING NOT MEANINGFUL

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Mesons

$A_3(1640)$, $\omega(1675)$


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                    34  A3 WICTH (MEV)

W       20 (100.)                       VETLITSKY 66 HBC   -  4.7 PI-P              6/66
W  M         (70.)     (40.)            BALTAY    68 HBC   +  7, 8.5 PI+ P          6/68
W           (115.0)    (45.0)           BARTSCH   68 HBC   +  8. PI+ P,3PI P   12/75*
W  M        (100.)     (50.)     (30.)  LAMSA     68 HBC   -  8.0 PI-P   PI-F    11/67
W  A   297 (240.0)     (50.0)           ARMENISE  69 CBC   +  5.1 PI+D,3PI++-    5/70
W  A   BACKGROUND SUBTRACTION MODEL-DEPENDENT.                                   5/70
W           (130.)                      CASO      69 HBC   -  11 PI- P            6/68
W           (150.0)                     CASO      69 HBC   - 11.0 PI-P,PI- F      6/68
W           (130.0)    (30.0)           CRENNELL  70 HBC   -  6. PI- P,F PI   . 5/70
W  M         (37.0)    (24.0)           MIYASHITA 70 HBC   -  6.7 PI-P,PI-F       1/71
W  M   BACKGROUND SUBTRACTICN DIFFICULT.
W           (128.0)                     BEKETOV   71 HBC   -  4.45 PI- P         11/71
W           (220.)     (80.)            PALER     71 CBC   + 13.PI+ D,D(3PI)+.12/75*
W P          200. TO 400.               CASO      72 HBC   + 11.7 PI+ P           1/72
W      260 (190.)     (100.)            CASO      72 HBC   + 11.7 PI+ P        12/75*
W  F         (53.)     (20.)     (16.)  HARRISON  72 HBC   - 13.,20. PI- P       12/72
W  F   FIT ASSUMES AN ACDITIONAL PEAK AT 1830 MEV.                              12/72
W  F   EVIDENCE FOR A SUBSTANTIAL DECAY INTO 3PI CLAIMEC
W P         (300.)     (50.)            ANTIPOV1  73 CNTR - 25.,40. PI- P      12/75*
W P         (270.)     (60.)            ASCOLI 1  73 HBC  - 5.-25.PI- P,P A3 12/75*
W P E       (310.)     (40.)            THCMPSON  74 HBC  + 13. PI+ P,P A3+  12/75*
W   E  EVIDENCE FOR A ROTATION OF THE PHASE CLAIMED.
W      575 (240.)      (30.)            KALELKAR  75 HBC  + 15 PI+P,P PI+F    12/75*
W P    FROM A FIT TO JP=2- F PI PARTIAL WAVE
W
W   AVERAGING NCT MEANINGFUL

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                    34  A3 PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      A3 INTO 3 PI                                     134+ 134+ 134
P2      A3 INTO RHO PI                                   134+ 773
P3      A3 INTO ETA PI                                   134+ 548
P4      A3 INTO 5 PI
P5      A3 INTO K K*(892)                                497+ 892
P6      A3 INTO K KBAR PI                                497+ 497+ 134
P7      A3 INTO K KBAR                                   497+ 497
P8      A3 INTO F PI                                    1271+ 134
P9      A3 INTO OMEGA PI PI                              783+ 134+ 134

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                    34  A3 BRANCHING RATIOS

R2      A3+- INTO (PI+- RHOO)/(ALL PI+- PI+ PI-)          (P2C)/(P1C)
R2          (0.3)  OR LESS          BARTSCH   68 HBC  +  8. PI+ P,3PI P    8/69
R2          (0.4)  OR LESS          FERBEL    68 RVUE +-                 . 9/68
R2          (.18) OR LESS  CL=.95   PALER     71 DBC  + 13.P++ D,D(3P+)+ 11/71

R3      A3+- INTO (PI+- F)/(ALL PI+- PI+ PI-)             (P8)/(P1C)
R3                 (WITH F INTO PI+ PI-)
R3          INDICATICN SEEN         LUBATTI   66 HLBC     16 PI-          11/66
R3          (0.59)FOR JP=2-         BARTSCH   68 HBC  +  8. PI+ P,3PI P    8/69
R3          (0.51)FOR JP=1+         BARTSCH   68 HBC  +  8. PI+ P,3PI P    8/69
R3          (0.20)FOR JP=0-         BARTSCH   68 HBC  +  8. PI+ P,3PI P    8/69
R3          (0.35)   (0.20)         BALTAY    68 HBC  + 7-8.5 PI+P       . 5/68
R3          CONSISTENT WITH 1.0     CASO      68 HBC  -  11 PI- P          6/68
R3          (0.76)   (0.24)   (0.34) ARMENISE 69 CBC  +  5.1 PI+D,3PI++-   5/70
R3          CONSISTENT WITH 1.0     CRENNELL  70 HBC  -  6. PI- P,F PI   . 5/70
R3          (.85) OR MORE  CL=.95   PALER     71 DBC  + 13.P++ D,D(3P+)+ 11/71
R3          CONSISTENT WITH 1.0     LICHTMAN  74 HBC  +- 18.5 PI+-P,P 3PI 12/75*
R3          CONSISTENT WITH 1.0     KALELKAR  75 HBC  +  15 PI+P,P 3PI   12/75*

R5      A3+- INTO (PI+- ETA)/(ALL PI+- PI+ PI-)           (P3)/(P1C)
R5                 (ALL ETA DECAYS)
R5          (0.09) OR LESS          BALTAY    68 HBC  + 7-8.5 PI+P         5/68
R5          (0.10) OR LESS          CRENNELL  70 HBC  -  6. PI- P,F PI     5/70

R6      A3+- INTO (PI+- 2PI+ 2PI-)/(ALL PI+- PI+ PI-)     (P4C)/(P1C)
R6          (0.1)  OR LESS          BALTAY    68 HBC  + 7,8.5 PI+ P        6/68
R6          (0.10) OR LESS          CRENNELL  70 HBC  -  6. P+- P,F P+     5/70

R8      A3+- INTO (RHO PI)/(F PI)                         (P2)/(P8)
R8          (0.03)   (0.37)   (0.03) CASO     69 HBC  -  11 PI- P        12/75*

R9      A3+- INTO (PI+- PI+ PI-)/(F PI)                   (P1C-P8)/(P8)
R9          (0.06)   (0.47)   (0.06) CASO     69 HBC  -  11 PI- P        12/75*
R9        POSSIBLY SEEN             HARRISON  72 HBC  - 13.,20. PI- P    12/72

R10     A3+- INTO (UNCORREL.PI+- PI+ PI-)/(ALL PI+- PI+ PI-)
R10 M       (.05) OR LESS  CL=.95   PALER     71 DBC  + 13. PI+D,D(3PI)+ 11/71
R10 M     MODEL DEPENDENT FIT                                           11/71

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                          REFERENCES FOR A3

FORINO   65 PL 19 68           +GESSAROLI+       (BGNA+BARI+FIRZ+ORSA+SACL)
FOCACCI  66 PRL  17  890       CERN MISSING MASS SPECTRGMETER GROUP (CERN)
LEVRAT   66 PL  22  714        CERN MISSING MASS SPECTRGMETER GROUP (CERN)
LUBATTI  66 THESIS BERKELEY    H.J.LUBATTI                        (LRL)1-2-
VETLITSK 66 PL  21  579        VETLITSKY,GUSZAVIN,KLIGER,ZOLGANOV+  (ITEP)
DANYSZ   67 NC 51 A 801        DANYSZ+FRENCH+SIMAK                  (CERN)
DUBAL    67 NP B3 435          CERN MISSING MASS SPECTROMETER GROUP (CERN)
  ALSC   68 THESIS 1456        L.DUBAL                            (GENEVE)

BALTAY   68 PRL 20 887         +KUNG+YEH+FERBEL+     (COLU+ROCH+RUTG+YALE)I=1
BARTSCH  68 NP B 7 345         +KEPPEL,KRAUS,+            (AACH+BERL+CERN) JP
CASO     68 NC 54 A 983        +CONTE+CORDS+DIAZ+  (GENOVA+HAMB+MILA+SACL)
FERBEL   68 PHILA.CONF.335     T.FERBEL                        (ROCHESTER)
IOFFREDO 68 PRL 21 1212        +BRANDENBURG,BRENNER,EISENSTEIN+  (HARVARD)
LAMSA    68 PR 166 1395        +CASON+BISWAS+DERADO+GROVES+    (NOTREDAME)

ARMENISE 69 LNC 2 501          +GHIDINI,FCRINO,CARTACCI+  (BARI+BGNA+FIRZ)
BARNES   69 PRL 23 142         +CHUNG,EISNER,FLAMINIO,+              (BNL)
CASO     69 LNC 2 437          +CCNTE,TOMASINI,CANTORE+   (GENO+MILA+SACL)
  ALSO   68 CASO

BRANDENB 70 NP B16 369         +BRENNER,IOFFREDO,JOHNSON,KIM+    (HARVARD)
CRENNELL 70 PRL 24 781         +KARSHON,LAI,SCARR,SIMS               (BNL)
CHIEN    70 PHILAD.CONF.P.275  C.Y.CHIEN, REVIEW          (JOHNS HOPKINS)
MIYASHIT 70 PR D 1 771         MIYASHITA,VCN KROGH,KOPELMAN,LIBBY   (COLO)

BEKETCV  71 SJNP 4 765         +SCMBKOWSKY,KONGWALOV,KRUTSCHININ,+  (ITEP)  JP
PALER    71 PRL 26 1675        +BADEWITZ,BARTON,MILLER,PALFREY,TEBES(PURD)

ALEXANDE 72 NP B 45 29         ALEXANDER,BAR-NIR,BENARY,CAGAN,+     (TELA)
ARMENISE 72 LNC 4 201          +FCRINO,CARTACCI,+         (BARI+BGNA+FIRZ)
CASO     72 NP B 36 349        +MADDOCK,BASSLER+(DURH+GENC+DESY+MILA+SACL)
HARRISON 72 PRL 28 775         +HEYDA,JOHNSON,KIM,LAW,MUELLER,+     (HARV)
SALZBERG 72 NP B 41 397        +HARRISON,HEYDA,JOHNSON,KIM,LAW,+    (HARV)

ANTIPOV1 73 NP B 63 153        +ASCOLI,BUSNELLC,FOCACCI,+      (CERN+SERP)  JP
ANTIPOV2 73 NP B 63 141        +ASCOLI,BUSNELLC,FOCACCI,+      (CERN+SERP)  JP
ASCOLI 1 73 PR D 7 669         INTERNAT. COLLABORATICN              (ILL+)  JP
ASCOLI 2 73 PR D 8 3894        +JONES,WEINSTEIN,WYLD                (ILL)   JP

ASCOLI   74 PR D9 1963         +CUTLER,JONES,KRUSE,ROBERTS,WEINSTEIN+(ILL)
LICHTMAN 74 NP B81 31          +BISWAS,CASON,KENNEY,MCGAHAN,+       (NDAM)
OTTER    74 NP B80 1           +RUDOLPH+         (AACH+BERL+BONN+CERN+HEID)  JP
TABAK    74  BOSTCN            +RCNAT,ROSENFELD,LASINSKI+      (LBL+SLAC)   JP
THCMPSCN 74 PRL 32 331         +BADEWITZ,GAIDOS,MCILWAIN,PALER,+    (PURD)  JP
    ALSO 74 NP B69 381         THOMPSON,BADEWITZ,GAIDOS,MCILWAIN+   (PURD)  JP

BEKETOV  75 SJNP 20 379        +ZCMBKOVSKII,KAIDALCN,KONGVALOV+     (ITEP)
EMMS     75 PL 60 B 109        +JONES,KINSON,BELL,DALE+   (BIRM+DURH+RHEL)  JP
HCRNE    75 PR D11 996         +S.HAGOPIAN,V.HAGOPIAN,BENSINGER+(FSU+BRAN)
KALELKAR 75 THESIS(NEVIS 207)  M.S.KALELKAR                         (COLU)
WAGNER   75 PL 58B 201         +TABAK,CHEW                           (LBL)  JP
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$\omega(1675)$ $\to\rho^0\pi^0$

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45  OMEGA(1675,JPG=3--) I=0.

THIS RESONANCE OVERLAPS IN ITS 3PI MCDE WITH THE A3,
BUT IN SOME EXPERIMENTS ONE CAN ESTABLISH THE DECAY
MODE RHOO PIO,THUS I=0.WAGNER 74 FINCS JP=3- UNIQUELY.
THE DECAYS INTO 5PI AND OMEGA PI+PI- NEED FURTHER
CONFIRMATICN(SEE ALSO X(1690)).

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                    45  CMEGA(1675) MASS (MEV)

M          1636.      20.             ARMENISE  68 CBC     5.1 PI+N,P(3PI)0  9/68
M          1670.      20.             KENYON    69 DBC     8.  PI+N,P(3PI)0  8/69
M      200 1679.      17.             MATTHEWS  71 CBC     7.0 PI+N,P(3PI)0. 1/71
M      500 1678.      14.             DIAZ      74 DBC     6.  PI+N,P(3PI)0  1/74
M    Q 200 1660.      13.             DIAZ      74 DBC     6.  PI+N,P(5PI)0  1/74
M    Q  FROM (CMEGA PI PI) MOCE
M  P   600 1669.      11.             WAGNER    75 HBC     7. PI+P,DEL++3PI 11/75*
M  P    FROM A FIT TO I=0, JP=3- RHO PI PARTIAL WAVE
M          . . . . . . . . . .
M   AVG    1667.1      6.0     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT1667.5      6.7     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    45  OMEGA(1675) WIDTH (MEV)

W           112.      60.             ARMENISE  68 CBC     5.1 PI+N,P(3PI)0  9/68
W           100.      40.             KENYCN    69 CBC     8.  PI+N,P(3PI)0  8/69
W    S 200  155.      40.             MATTHEWS  71 DBC     7.0 PI+N,P(3PI)0 11/75*
W      500  167.      40.             DIAZ      74 CBC     6.  PI+N,P(3PI)0  1/74
W    Q 200  122.      39.             DIAZ      74 CBC     6.  PI+N,P(5PI)0  1/74
W    Q  FRCM (CMEGA PI PI) MODE
W  P S 600  173.      28.             WAGNER    75 HBC     7. PI+P,DEL++3PI 11/75*
W  P    FROM A FIT TO I=0, JP=3- RHO PI PARTIAL WAVE
W    S  WIDTH ERRORS ENLARGEC BY US TO 4*WIDTH/SQRT(N)
W          . . . . . . . . . .
W   AVG     145.8     15.6     AVERAGE (ERRCR INCLUDES SCALE FACTCR CF 1.0)
W   STUDENT 146.0     17.9     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    45  OMEGA(1675) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      OMEGA(1675) INTO 3 PI (INCL. RHO PI)             134+ 134+ 134
P2      OMEGA(1675) INTO 5 PI (INCL. OMEGA PI+PI-)       134+ 134+ 134+ 134
P3      OMEGA(1675) INTC RFO PI                          773+ 134
P4      OMEGA(1675) INTO OMEGA PI+ PI-                   783+ 134+ 134
P5      OMEGA(1675) INTO B(1235) PI                     1228+ 134

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                    45  OMEGA(1675) BRANCHING RATIOS

R1      OMEGA(1675) INTO (5 PI)/(3 PI)                    (P2)/(P1)
R1           (0.10)    (0.10)          KENYON    69 DBC    8.  PI+N,P(3PI)0. 8/69
R1      200    0.97      0.28          DIAZ      74 DBC    6.  PI+N,P(5PI)0  1/74

R2      OMEGA(1675) INTC (RHO PI)/(3 PI)                  (P3)/(P1)
R2      200  (0.70) OR MORE            MATTHEWS  71 CBC    7.0 PI+N,P(3PI)0 11/71

R3      OMEGA(1675) INTO (OMECA PI+ PI-)/(RHO PI)         (P4)/(P3)
R3      100    0.47      0.18          DIAZ      74 DBC    6.  PI+N,P(5PI)0  1/74

R4      OMEGA(1675) INTC (B(1235) PI)/(RHO PI)            (P5)/(P3)
R4          POSSIBLY SEEN              DIAZ      74 CBC    6.  PI+N,P(5PI)0  1/74

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                      REFERENCES FOR CMEGA(1675)

ARMENISE 68 PL 26B 336      +CHIDINI,FORINO+ (BARI+BGNA  +FIRZ  +ORSAY)

KENYON   69 PRL 23 146      +KINSON,SCARR,+               (BNL+UCND+ORNL)

ARMENISE 70 LNC 4 199       +CHIDINI,FCRINO,CARTACCI,+ (BARI+BGNA+FIRZ)

MATTHEWS 71 PR D 3 2561     +PRENTICE,YOON,CARROLL,+          (TNTO+WISC)
MATTHEW1 71 LNC 1 361       +PRENTICE,YOON,CARROLL,+          (TNTO+WISC)

DIAZ     74 PRL 32 260      +DIBIANCA,FICKINGER,ANDERSON,+  (CASE+CARN)

WAGNER   75 PL 58B 201      +TABAK,CHEW                            (LBL)  JP
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Data Card Listings

For notation, see key at front of Listings.

Mesons
g(1680)

g(1680)

15 G(1680,JPG = 3-+) I=1

This entry contains the 2π, 4π, ωπ, $K\bar{K}$, and $K\bar{K}\pi$ peaks in the region of 1700 MeV. The spin-parity determination and the mass and width in the Meson Table come from the 2π mode. An elasticity of 24% is found at resonance in the ππ elastic partial-wave analysis (HYAMS 75); this is consistent with the assumption that at least some of the effects listed are due to g decay into various channels. On the other hand, some discrepancies in masses, widths, and branching ratios reported indicate that there may be more than one $I^G=1^+$ meson in this region (BARNHAM 70, HOLMES 72, THOMPSON 74). Although we have collected all the data here under a common entry, we do not imply that they are necessarily all related.

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                   15  G MASS (MEV)

M      PI+ PI- MODE
M
M         (1700.0)  (100.0)           BELLINI   65 HLBC   0 6.1 PI-P        12/75*
M         (1640.0)                    FORINO    65 CBC    0 4.5 PI+D         6/66
M          1670.0     30.0            GOLDBERG  65 HBC    0 6 PI+D, 8 PI-P
M         (1683.)    (13.)            ARMENISE  68 DBC    0 5.1 PI+ D      . 6/68
M          1720.0     20.0            CRENNELL  68 HBC    0 6.0 PI- P       12/68
M         (1655.0)   (10.0)           JOHNSTON  68 HBC    0 7.0 PI- P      . 6/68
M          1737.0     23.0            ARMENISE  70 DBC    0 9 PI+ N          1/71
M          1687.      21.             STUNTEBEC 70 HCBC  0 8. PI-P,5.4 PI+D  2/72
M          1678.      12.             MATTHEWS  71 DBC   0  7. PI+ N         2/72
M          1652.      13.             MATTHEWS  71 HBC   0  7. PI- P         2/72
M  E   600 1690.       7.             ENGLER    74 CBC    0 6. PI+N,PI+PI-P 12/75*
M  G       1693.       8.             GRAYER    74 ASPK   0 17 PI-P,PI+PI-N  2/74
M  GI     (1692.)    (12.)            ESTABROOK 75 RVUE    17 PI-P,PI+PI-N  12/75*
M   I     (1722.)     (3.)            HYAMS     75 ASPK   0 17 PI-P,PI+PI-N 12/75*
M
M  E    MASS ERRORS ENLARGEC BY US TO WIDTH/SQRT(N)
M   I   FROM PHASE-SHIFT ANALYSIS
M       ERROR TAKES ACCOUNT OF SPREAD OF DIFFERENT PHASE-SHIFT SOLUTICNS
M  G    USES SAME DATA AS HYAMS 75
M          . . . . . . . . .
M   AVG    1687.8      6.4     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
M   STUDENT1688.7      4.9     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                           (SEE IDEOGRAM BELOW )

M      (2PI)+- MODE
M
M          1640.0     25.0            CRENNELL  68 HBC    -  6.0 PI- P       12/68
M      122 1650.0     35.0            BARTSCH   70 HBC   +  8 PI+ P,2 PI      5/70
M         (1632.)     (5.)            THOMPSON  74 HBC   +  13 PI+ P         12/75*
M          . . . . . . . . .
M   AVG    1643.4     20.3     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT1643.4     21.9     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

M      K KBAR + K KBAR PI MOCE
M
M         (1675.)                     EHRLICH   66 HBC   +-  7.9 PI-P,K KBAR  2/72
M  K      (1700.)                     FRENCH    67 HBC      0 3,3.6 PBAR P    7/67
M  K    OBSERVED IN NEUTRAL(K* KBAR) MODE  (G-PARITY UNKNOWN)
M  F      (1740.)                     FRENCH    67 HBC   (KO K+-) 3-4 PBAR P  7/67
M  F       SEE FIG. 9 CF FRENCH 67
M          1640.0     20.0     25.0   CRENNELL  68 HBC   +-  6.0 PI-P,KBAR K 12/68
M          1690.0     16.0            ADERHOLZ  69 HBC   +    8 PI+ P,KKBARPI  8/69
M          1692.       6.             BLUM      75 ASPK    018.4 PI-P,N K+K- 11/75*
M          . . . . . . . . .
M   AVG    1688.7      8.6     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.6)
M   STUDENT1689.5      6.1     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

M      (4PI)+- MODE
M
M          1720.      15.             BALTAY    68 HBC   +   7, 8.5 PI+ P     6/68
M  J      (1675.0)   (10.0)           JOHNSTCN  68 HBC    -  7.0 PI- P        6/68
M      144 1680.0     40.0            BARTSCH   70 HBC   +  8 PI+ P,4 PI      4/71
M       90(1640.0)   (20.0)           BARTSCH   70 HBC   +  8 PI+ P,A2 PI     4/71
M  F   102(1689.0)   (20.0)           BARTSCH   70 HBC   +  8 PI+ P,2 RHO     4/71
M          1705.0     21.0            CASO      70 HBC    - 11.2PI-P,RHO 2PI  5/70
M      300(1710.)                     ARMENISE  72 HBC   -  9.1 PI- P,P 4PI  12/72
M          1630.      15.             HOLMES    72 HBC   +  10.-12. K+ P      1/73
M          1687.      20.             CASON     73 HBC   -  8.,18.5 PI- P     1/74
M  F      (1685.)    (14.)            CASCN     73 HBC   -  8.,18.5 PI- P     1/74
M  F    66(1733.)     (9.)            KLIGER    74 HBC    - 4.5 PI-P,P 4PI   12/75*
M          1670.      10.             THCMPSON  74 HBC   +  13 PI+ P         12/75*
M
M  F    FROM (RHO+- RHO0) MODE
M          . . . . . . . . .
M   AVG    1677.1     13.0     AVERAGE (ERRCR INCLUDES SCALE FACTOR OF 2.0)
M   STUDENT1677.9      9.0     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                           (SEE IDEOGRAM BELOW )
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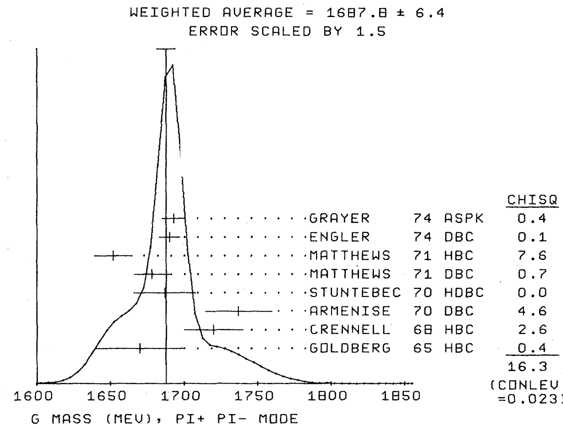

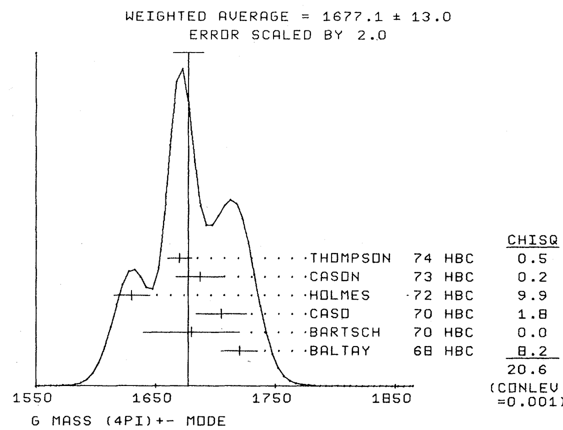


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M      RHO0 RHO0 MODE
M
M         (1700.0)                    MAURER    70 HBC     05.7 PBAR P,7 PI . 2/71
M         (1700.0)                    BRAUN     71 HBC     05.7 PBAR P,7 PI  11/71

M      CMEGA PI  MODE
M
M          1654.      24.             BARNHAM   70 HBC   +  10 K+ P,OMEGA PI  6/70
M          1630.0     11.0            CASO      70 HBC    - 11.2PI-P,PI OMEG  5/70
M         (1666.)    (50.)            CASON     73 HBC   -  8.,18.5 PI- P     1/74
M          1686.       9.             THCMPSCN  74 HBC   +  13 PI+ P         12/75*
M          . . . . . . . . .
M   AVG    1662.8     18.7     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.8)
M   STUDENT1665.4     14.0     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

M       R PEAKS FRCM MMS. (FOR DIFFICULTIES WITH MMS EXPTS. SEE
M                          THE A2 MINI-REVIEW IN THE 1973 EDITION)
M
M  NR1    (1632.)    (15.)            FOCACCI   66 MMS   -   7-12 PI-P,P MMS 12/72
M  NR2    (1700.)    (15.)            FOCACCI   66 MMS   -   7-12 PI-P,P MMS 12/72
M  NR3    (1748.)    (15.)            FOCACCI   66 MMS   -   7-12 PI-P,P MMS 12/72
M  N     NCT SEEN BY BOWEN 72
M   R     (1700.0)   (47.0)           ANDERSON  69 MMS   -  16 PI- P,BACKW    8/69

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                   15  G WIDTH (MEV)

W      PI+ PI- MODE
W
W          (40.0)                     FORINO    65 DBC    0 4.5 PI+D         6/66
W          180.0     40.0             GOLDBERG  65 HBC    0 6 PI+D, 8 PI-P
W          188.      49.              ARMENISE  68 DBC    0 5.1 PI+ D        6/68
W          200.0    100.0             CRENNELL  68 HBC    0 6.0 PI- P       12/68
W          (80.0)   (20.0)            JOHNSTCN  68 HBC    0 7.0 PI- P      . 6/68
W          171.0     65.0             ARMENISE  70 DBC    0 9 PI+ D          1/71
W         267.       72.      46.     STUNTEBEC 70 HDBC  0 8. PI-P,5.4 PI+D  2/72
W          156.      36.              MATTHEWS  71 CBC   0  7. PI+ N         2/72
W           73.      36.              MATTHEWS  71 HBC   0  7. PI- P         2/72
W       600 167.     40.              ENGLER    74 CBC    0 6. PI+N,PI+PI-P 12/75*
W  G       200.      18.              GRAYER    74 ASPK   0 17 PI-P,PI+PI-N  2/74
W  GI     (240.)    (30.)             ESTABROOK 75 RVUE    17 PI-P,PI+PI-N  12/75*
W   I     (267.)    (30.)             HYAMS     75 ASPK   0 17 PI-P,PI+PI-N 12/75*
W
W   I   FROM PHASE-SHIFT ANALYSIS
W       ERROR TAKES ACCOUNT OF SPREAD OF DIFFERENT PHASE-SHIFT SOLUTICNS
W  G    USES SAME CATA AS HYAMS 75
W          . . . . . . . . .
W   AVG    177.2     15.2      AVERAGE (ERROR INCLUDES SCALE FACTOR CF 1.3)
W   STUDENT 181.2    14.6      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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Mesons
g(1680)


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W     (2PI)+- MODE
W
W          200.0     100.0               CRENNELL  68 HBC   -  6.0 PI- P          12/68
W     122  180.0      30.0               BARTSCH   70 HBC   +  8 PI+ P,2 PI        5/70
W          (42.)     (20.)               THOMPSON  74 HBC   +  13 PI+ P           12/75*
W          . . . . . . . . . .
W   AVG    181.7      28.7     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT 181.6     31.0     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

W     K KBAR + K KBAR PI MODE
W
W   F     (120.)    APPROX.              FRENCH    67 HBC  (KO K+-) 3-4 PBAR P 11/69
W   F        ABOVE VALUE ESTIMATED FROM FIG. 9 OF FRENCH 67
W           79.0      70.0      25.0     CRENNELL  68 HBC  +-  6.0 PI-P,KBAR K 12/68
W          112.0      60.0               ADERHOLZ  69 HBC   +   8 PI+ P,KKBARPI  8/69
W          205.       20.                BLUM      75 ASPK   018.4 PI-P,N K+K- 11/75*
W          . . . . . . . . . .
W   AVG    179.6      33.8     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)
W   STUDENT 182.6     23.1     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

W     (4PI)+- MODE
W
W          100.       35.                BALTAY    68 HBC   +   7, 8.5 PI+ P       6/68
W   J      (90.0)    (20.0)              JOHNSTON  68 HBC   -   7.0 PI- P          6/68
W   J      NOT SEPARATED FROM 2 PI DECAY
W     144  135.0      30.0               BARTSCH   70 HBC   +  8 PI+ P,4 PI        4/71
W      90 (180.0)    (30.0)              BARTSCH   70 HBC   +  8 PI+ P,A2 PI       4/71
W   F 102 (160.0)    (30.0)              BARTSCH   70 HBC   +  8 PI+ P,2 RHO
W         (160.0)                        CASO      70 HBC   - 11.2PI-P,RHO 2PI   5/70
W     300 (200.)                         ARMENISE  72 HBC   -  9.1 PI- P,P 4PI  12/72
W          130.       30.                HOLMES    72 HBC   +  10.-12. K+ P        1/73
W          169.       70.       48.      CASON     73 HBC   -  8.,18.5 PI- P       1/74
W   F     (125.)     (83.)     (35.)     CASON     73 HBC   -  8.,18.5 PI- P       1/74
W   F  66 (150.)                         KLIGER    74 HBC   - 4.5 PI-P,P 4PI    12/75*
W          106.       25.                THOMPSON  74 HBC   +  13 PI+ P           12/75*
W
W   F   FROM (RHO+- RHO0) MODE
W          . . . . . . . . . .
W   AVG    120.6      14.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT 120.6     15.7     AVERAGE USING STUDENT10(F/1.11) -- SEE TEXT

W     OMEGA PI  MODE
W
W          130.       73.       43.      BARNHAM   70 HBC   +  10 K+ P,OMEGA PI    6/70
W          (60.0)                        CASO      70 HBC   - 11.2PI-P,PI OMEG   5/70
W         (194.)     (94.)     (60.)     CASON     73 HBC   -  8.,18.5 PI- P       1/74
W           89.       25.                THOMPSON  74 HBC   +  13 PI+ P           12/75*
W          . . . . . . . . . .
W   AVG     95.4      23.0     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT  95.3     25.0     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

W       R PEAKS FROM MMS. (FOR DIFFICULTIES WITH MMS EXPTS. SEE
W                          THE A2 MINI-REVIEW IN THE 1973 EDITION)
W
W  NR1       (21.)    OR LESS            FOCACCI   66 MMS   -   7-12 PI-P,P MMS 12/72
W  NR2       (30.)    OR LESS            FOCACCI   66 MMS   -   7-12 PI-P,P MMS 12/72
W  NR3       (38.)    OR LESS            FOCACCI   66 MMS   -   7-12 PI-P,P MMS 12/72
W  N    NOT SEEN BY BOWEN 72
W   R        (195.0)                     ANDERSON  69 MMS   -  16 PI- P,BACKW     8/69

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                    15  G PARTIAL DECAY MODES

                                                            DECAY MASSES
P1      G INTO PI PI                                      139+ 139
P2      G INTO 4PI                                        139+ 139+ 139+ 139
P3      G INTO 2 RHO                                      773+ 773
P4      G INTO PI PI RHO                                  139+ 139+ 773
P5      G INTO A2 PI                                     1310+ 139
P6      G INTO K KBAR                                     497+ 497
P7      G INTO OMEGA PI                                   139+ 783
P8      G INTO K KBAR PI                                  497+ 497+ 139
P9      G INTO PHI PI                                    1020+ 139
P10     G INTO ETA PI                                     548+ 139
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                    15  G BRANCHING RATIOS

R1      G INTO (2PI)/TOTAL                               (P1)
R1  P          (0.4)                     BARTSCH   70 HBC  +  8. PI+ P            2/72
R1  P          (0.22)    (0.04)          MATTHEWS  71 HDBC  0  7. PI+N,PI-P       2/72
R1  P    OPE MODEL USED IN THIS ESTIMATION
R1  G          (.245)    (.006)          ESTABROOK 75 RVUE    17 PI-P,PI+PI-N  12/75*
R1  G    FROM PHASE-SHIFT ANALYSIS OF HYAMS 75 DATA
R1 S            .24       .01            HYAMS     75 ASPK   0 17 PI-P,PI+PI-N 12/75*
R1 S     ERROR TAKES ACCOUNT OF SPREAD OF 4 DIFFERENT PHASE-SHIFT SOLUTIONS

R2      G INTO (PI+- PI0) / (ALL PI+- PI+ PI- PI0)       (P1)/(P2C)
R2  D          (0.08) OR LESS            BALTAY    68 HBC  +   7-8.5 PI+ P         6/68
R2  D           USING DATA OF DEUTSCHMANN 65 ON PI+P TO PI+ PI0 P                 6/68
R2              0.8        0.2           JOHNSTON  68 HBC  -    7. PI- P          2/72
R2              0.8        0.15          BARTSCH   70 HBC  +  8. PI+ P            2/72
R2             (0.12) OR LESS            BALLAM    71 HBC  -    16. PI- P       . 2/72
R2             (0.2)  OR LESS            HOLMES    72 HBC  +  10.-12. K+ P      ' 1/73
R2              0.35       0.11          CASON     73 HBC  -  8.,18.5 PI- P       1/74
R2            . . . . . . . . . .
R2  AVG         0.56       0.16    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.0)
R2  STUDENT     0.57       0.12    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R3      G+- INTO (2PI)/(2RHO)                            (P1)/(P3)
R3  S          (0.48) OR LESS            BISWAS    68 HBC  -    8. PI- P          2/72
R3  S    SUPERSEDED BY CASON 73                                                  1/74

R4      G+- INTO (K KBAR)/(2PI)                          (P6)/(P1)
R4              0.08       0.08     0.03 CRENNELL  68 HBC       6.0 PI- P        12/68
R4              0.08       0.03          BARTSCH   70 HBC  +    8. PI+ P          1/71
R4            . . . . . . . . . .
R4  AVG         0.080      0.026   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R4  STUDENT     0.080      0.028   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R5      G+- INTO (K KBAR PI)/(2PI)                       (P8)/(P1)
R5              0.10       0.03          BARTSCH   70 HBC  +  8. PI+ P            2/72

R6      G+- INTO (RHO 2PI)/(ALL 4PI)                     (P4)/(P2)
R6              CONSISTENT WITH 1.       CASO      68 HBC   -   11 PI- P          6/68
R6              1.         0.15          BARTSCH   70 HBC  +  8. PI+ P            2/72
R6              0.88       0.15          BALLAM    71 HBC  -    16. PI- P         2/72
R6            . . . . . . . . . .
R6  AVG         0.94       0.11    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R6  STUDENT     0.94       0.12    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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R7      G+- INTO (2RHO)/(ALL 4PI)                        (P3)/(P2)
R7              0.7        0.15          BARTSCH   70 HBC  +  8. PI+ P            2/72
R7             (0.92)                    ARMENISE  72 HBC  -  9.1 PI- P,P 4PI    12/72
R7  A          (0.78)    (0.33)          CASON     73 HBC  -  8.,18.5 PI- P       1/74
R7  A    ASSUMING (ALL 4PI)=(RHO RHO) + (OMEGA PI)
R7       66    (.56)                     KLIGER    74 HBC   - 4.5 PI-P,P 4PI     12/75*
R7  T          (0.13)    (0.09)          THOMPSON  74 HBC  +  13 PI+ P           12/75*
R7  T    RHO RHO AND A2 PI MODES ARE INDISTINGUISHABLE

R8      G+- INTO (2 RHO)/(ALL RHO 2PI)                   (P3)/(P4)
R8              0.48       0.16          CASO      68 HBC   -   11 PI- P          6/68
R8             (0.75) OR MORE            BISWAS    68 HBC  -    8. PI- P          2/72

R9      G+- INTO (PI+- A20)/(ALL 4PI)
R9                          (WITH A20 INTO (PI+ PI- PI0))
R9              0.40       0.20          BALTAY    68 HBC  +    7,8.5 PI+P        6/68
R9              NOT SEEN                 JOHNSTON  68 HBC   -   7 PI- P           6/68
R9             (0.6)     (0.15)          BARTSCH   70 HBC  +  8. PI+ P            2/72
R9              NOT SEEN                 CASON     73 HBC  -  8.,18.5 PI- P       1/74

R10     G+- INTO (PI OMEGA)/(ALL 4PI)                    (P7)/(P2)
R10                         (WITH OMEGA INTO(PI+ PI- PI0))
R10             0.25       0.10          BALTAY    68 HBC  +    7-8.5 PI+P        5/68
R10              .25       0.10          JOHNSTON  68 HBC   -   7.0 PI- P         6/68
R10             0.12        0.07         BALLAM    71 HBC  -    16. PI- P         2/72
R10 A          (0.22)    (0.08)          CASON     73 HBC  -  8.,18.5 PI- P       1/74
R10 A    ASSUMING (ALL 4PI)=(RHO RHO) + (OMEGA PI)
R10            (.09) OR LESS             KLIGER    74 HBC   - 4.5 PI-P,P 4PI     12/75*
R10             0.33       0.07          THOMPSON  74 HBC  +  13 PI+ P           12/75*
R10           . . . . . . . . . .
R10 AVG         0.233      0.050   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
R10 STUDENT     0.236      0.051   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R11     G+- INTO (PI PHI)/(ALL 4PI)                      (P9)/(P2)
R11            (0.11) OR LESS            BALTAY    68 HBC  +    7,8.5 PI+P        6/68

R12     G+- INTO (PI+- 2PI+ 2PI- PI0)/(ALL PI+- PI+ PI- PI0)
R12            (0.15) OR LESS            BALTAY    68 HBC  +    7,8.5 PI+ P       6/68

R13     G+- INTO (PI ETA)/(ALL 4PI)                      (P10)/(P2)
R13            (0.02) OR LESS            THOMPSON  74 HBC  +  13 PI+ P           12/75*

R14     GO INTO (2PI+ 2PI-)/(2PI)                        (P2C)/(P1)
R14     GO INTO (2PI+ 2PI-) FORBIDDEN IF 4PI MODE IS (RHO RHO)
R14             0.44       0.20          KALELKAR  75 HBC    015 PI+P            12/75*

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REFERENCES FOR G


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BELLINI  65 NC 40 A 948         BELLINI,DI CORATO,DUIMIO,FIORINI   (MILANO)
DEUTSCHM 65 PL 18 351           M.DEUTSCHMANN ET AL     (AACHEN+BERLIN+CERN)
FORINO   65 PL 19 65            FORINO,GESSAROLI +    (BOLOGNA+ORSAY+SACLAY)
GOLDBERG 65 PL 17 354           GOLDBERG+ (CERN+EPOL+ORSAY+MILANO+CEA-SACL)

EHRLICH  66 PR 152 1194         R. EHRLICH,W.SELOVE,H.YUTA    (PENNSYLVANIA)
FOCACCI  66 PRL  17  890        CERN MISSING MASS SPECTROMETER GROUP (CERN)
LEVRAT   66 PL  22  714         CERN MISSING MASS SPECTROMETER GROUP (CERN)
SEGUINOT 66 PL 19 712           CERN MISSING MASS SPECTROMETER GROUP (CERN)

ABRAMS   67 PRL 18 620          +KEHOE+GLASSER+SECHI-ZORN+WOLSKY (MARYLAND)
DANYSZ   67 PL 24B 309          +FRENCH+KINSON+SIMAK+       (CERN+LIVERPOOL)
DUBAL    67 NP B3 435           +FOCACCI+KIENZLE+LECHANOINE+LEVRAT+   (CERN)
   ALSO  68 THESIS 1456         L.DUBAL                             (GENEVE)
FRENCH   67 NC 52A 442          +KINSON+MCDONALD+RIDDIFORD+      (CERN+BIRM)

ARMENISE 68 NC 54 A 999         +FORINO+CARTACCI+(BARI+BGNA +FIRENZE+ORSAY)I
BALTAY   68 PRL 20 887          +KUNG+YEH+FERBEL+        (COLU+ROCH+RUTG+YALE)I=1
BISWAS   68 PRL 21 50           +CASON,DZIERBA,GROVES,KENNEY,+          (NDAM)
BOESEBEC 68 NP B 4 501          BOESEBECK,DEUTSCHMANN,+(AACHEN+BERLIN+CERN)
CASO     68 NC 54 A 983         +CONTE+CORDS+DIAZ+  (GENOVA+HAMB+MILA+SACL)
CRENNELL 68 PL 28 B 136         +KARSHON,LAI,SCARR,SKILLICORN           (BNL)
JOHNSTON 68 PRL 20 1414         +PRENTICE,STEENBERG,YOON       (TORONTO+WISC)IJP

ADERHOLZ 69 NP B 11 259         +BARTSCH,+          (AACH+BERL+CERN+JAGL+WARS)
ANDERSON 69 PRL 22 1390         +COLLINS,BLIEDEN+                  (BNL+CARN)
BARISH   69 PR 184  1375        +SELOVE,BISWAS,CASON,+       (PENN+NDAM+ROCH)
CASO     69 NC 62 A 755         +CONTE,BENZ,+      (GENO+DESY+HAMB+MILA+SACL)
VETLITSK 69 SJNP 9 461          +GUZHAVIN,KLIGER,KOLGANOV,LEBEDEV+    (ITEP)

ARMENISE 70 LNC 4  199          +GHIDINI,FORINO,CARTACCI,+ (BARI+BGNA+FIRZ)
BARNHAM  70 PRL 24 1083         +COLLEY,JOBES,KENYON,PATHAK,RIDDIFORD(BIRM)
BARTSCH  70 NP B 22 109         +KRAUS,TSANOS,GROTE,KOTZAN+(AACH+BERL+CERN)
CASO     70 LNC 3 707           +CONTE,TOMASINI,CORDS+(GENO+HAMB+MILA+SACL)
KRAMER   70 PRL 25 396          +BARTON,GUTAY,LICHTMAN,MILLER,+     (PURDUE)
MAURER   70  THESIS NO.588      G.MAURER                        (STRASBOURG)
STUNTEBE 70 PL 32 B 391         STUNTEBECK,KENNEY,DEERY,BISWAS,CASON+(NDAM)

BALLAM   71 PR D 3 2606         +CHADWICK,GUIRAGOSSIAN,JOHNSON,+       (SLAC)
BRAUN    71 NP B 30 213         +FRIDMAN,GERBER,GIVERNAUD,KAHN,+       (STRB)
GRAYER   71 PL 35 B 610         +HYAMS,JONES,SCHLEIN,BLUM,+      (CERN+MPIM)JP3-
MATTHEWS 71 NP B 331            +PRENTICE,YOON,CARROLL,+         (TNTO+WISC)JP3-

ARMENISE 72 LNC 4 205           +FORINO,CARTACCI,+            (BARI+BGNA+FIRZ)
    ALSO 75 LNC 14 177          +FOGLI-MUCIACCIA,FORINO+   (BARI+BGNA+FIRZ)  JP
BOWEN    72 PRL 29 890          +EARLES,FAISSLER,BLIEDEN,+         (NEAS+STON)
CLAYTON  72 NP B 47 81          +MASON,MUIRHEAD,RIGOPOULOS,+       (LIVP+PATR)
GRAYER   72 PHIL.CONF.PROC. 5 +HYAMS,JONES,SCHLEIN,BLUM,DIETL+(CERN+MPIM)
HOLMES   72 PR D 6 3336         +FERBEL,SLATTERY,WERNER                (ROCH)

ARNOLD   73 LNC 6 707           +ENGEL,ESCOUBES,KURTZ,LLORET,PATY,+  (STRB)
CASON    73 PR D 7 1971         +BISWAS,KENNEY,MADDEN,SANDER,SHEPHARD(NDAM)
CASON 1  73 NP B 64 14          +MADDEN,BISHOP,BISWAS,KENNEY,+         (NDAM)
HYAMS    73 NP B 64 134         +JONES,WEILHAMMER,BLUM,DIETL,+  (CERN+MPIM)
ROBERTSO 73 PR D 7 2554         ROBERTSON,WALKER,DAVIS             (DUKE+WISC)

DUBOVIKO 74 SJNP 19 568         DUBOVIKOV,MATSYUK,NILOV,SOKOLOV        (ITEP)
ENGLER   74 PR D10 2070         +KRAEMER,TOAFF,WEISSER,DIAZ+       (CARN+CASE)
GRAYER   74 NP B 75 189         G.GRAYER,HYAMS,BLUM,DIETL,+        (CERN+MPIM)
KLIGER   74 SJNP 19 428         +BEKETOV,GRECHKO,GUZHAVIN,DUBOVIKOV+ (ITEP)
OREN     74 NP B71 189          +COOPER,FIELDS,RHINES,WHITMORE,+  (ANL+OXF)
THOMPSON 74 NP B69 220          +GAIDOS,MC ILWAIN,MILLER,MULERA,+      (PURD)

BLUM     75 PL 57B 403          +CHABAUD,DIETL,GARELICK,GRAYER+ (CERN+MPIM) JP
ESTABROO 75 NP B95 322          P.ESTABROOKS,A.D.MARTIN                (DURH)
HYAMS    75 NP B100 205         +JONES,WEILHAMMER,BLUM,DIETL+    (CERN+MPIM)
KALELKAR 75 THESIS(NEVIS 207) M.S.KALELKAR                        (COLU)I=1
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Data Card Listings

For notation, see key at front of Listings.

Mesons

X(1690), X⁻(1795), A₄(1900), S(1930)

X(1690) →ωππ

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64  X(1690)

THIS ENTRY CONTAINS (OMEGA PI PI) PEAKS ARCUND
1690 MEV. EVIDENCE NOT COMPELLING. OMITTED FROM TABLE.

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                64  X(1690) MASS (MEV)

M   N     (1689.)     (10.)          DANYSZ    67 HBC    0 3,3.6 PBAR P     2/74
M   N   NOT SEEN IN HIGH STATISTICS EXP. OF OREN 74
M          1670.0      18.0          YOST      68 HBC    04.3 K-P,LMBD.5PI. 2/74
M          1695.0      20.0          BARNES    69 HBC    0 4.6 K-P,CMEG2PI  2/74
M          . . . . . . . . .
M   AVG    1681.2      13.4     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT1681.1      15.1     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                64  X(1690) WIDTH (MEV)

W   N       (38.)     (18.)          DANYSZ    67 HBC    0 3,3.6 PBAR P     1/73
W   N   NOT SEEN IN HIGH STATISTICS EXP. OF OREN 74
W            50.0      15.0          YOST      68 HBC    04.3 K-P,LMBD.5PI. 1/73
W            90.       20.           BARNES    69 HBC    0 4.6 K-P,CMEG2PI  1/73
W          . . . . . . . . .
W   AVG      64.4      19.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.6)
W   STUDENT  63.8      14.7     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                        REFERENCES FOR X(1690)

DANYSZ   67 NC 51 A 801      CANYSZ+FRENCH+SIMAK                    (CERN)
YOST     68  UMD  T.REPORT849 +YODH,EINSCHLAG,DAY,GLASSER           (UMD)
BARNES   69 PRL 23 142       +CHUNG,EISNER,FLAMINIO,+                (BNL)
OREN     74 NP B71 189       +COOPER,FIELDS,RHINES,WHITMORE,+  (ANL+OXF)

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X⁻(1795)

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63  X-(1795,JPG=   ) I=1

SEEN AS A (PBAR N) BOUND STATE IN PBAR D ANNIHILATIONS
AT REST. NEEDS FURTHER CONFIRMATION.OMITTED FROM TABLE.

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                63  X-(1795) MASS (MEV)

M   D     1794.5      1.4           GRAY      71 DBC  -  0.PBAR D          1/72
M   D     DECAYS TC FOUR CR MORE PICNS

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                63  X-(1795) WIDTH(MEV)

W   D       (8.)    OR LESS  CL=.95  GRAY      71 DBC  -  0.PBAR D          1/72
W   D     DECAYS TO FOUR OR MORE PIONS.

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                        REFERENCES FOR X-(1795)

GRAY     71 PRL 26 1491       +HAGERT,KALOGEROPOULOS              (SYRA)
BOGDANOV 72 PRL 28 1418       BCGDANOVA,DALKAROV,SHAPIRO          (ITEP)
GRAY     73 PRL 30 1091       +PAPADOPOULOU,KARAGEROPOULCS,+ (ATEN+SYRA)

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A₄(1900)

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43  A4(1900,JPG=  -)  I=1

OMITTED FRCM TABLE.

THIS ENTRY CCNTAINS THE DIFFRACTIVE-LIKE 3PI AND 5PI
BUMPS IN THE REGION OF 1900 MEV,AS WELL AS VARIOUS
PEAKS NEARBY.NOTE THAT THE EXISTENCE OF AN S-WAVE
GPI THRESHOLD BUMP (AS A CONTINUATICN TO A1 AND A3)
IS NOT UNEXPECTED.  OMITTED FROM TABLE.

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                43  A4 MASS  (MEV)

M          (1900.)                   HUSCN     68 HLBC -  16.PI-A,A 5PI     2/74
M          (1830.)                   SALZBERG  72 HBC  -  13,20 PI-P,P 3PI  2/74
M   B    40(1960.)     (30.)         BASTIEN   73 CBC  -  15.PI-D,D 3PI     2/74
M   B    MARGINAL STATISTICAL SIGNIFICANCE.
M          (1800.)                   DEUTSCHM  75 HBC  +  16 PI+P,P 3PI    12/75*
M       208(2080.)     (40.)         KALELKAR  75 HBC  +  15 PI+P,P PI+G   12/75*

M        VARIOUS PEAKS
M   K      (1820.)     (12.)         FRENCH    67 HBC     0 3,3.6 PBAR P    7/67
M   K         OBSERVED IN (KS KO PIO...) MODE  (G-PARITY UNKNOWN)
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                43  A4 WIDTH  (MEV)

W           (130.)                   SALZBERG  72 HBC  -  13,20 PI-P,P 3PI  2/74
W   B    40 (200.)                   BASTIEN   73 CBC  -  15.PI-D,D 3PI     2/74
W       208 (340.)     (80.)         KALELKAR  75 HBC  +  15 PI+P,P PI+G   12/75*

W        VARIOUS PEAKS
W   K        (50.)     (20.)         FRENCH    67 HBC     0 3-4 PBAR P      7/67

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                43  A4 PARTIAL DECAY MCDES

                                                        DECAY MASSES
P1      A4 INTO 3PI                                   139+ 139+ 139
P2      A4 INTO RHO PI                                773+ 139
P3      A4 INTO F PI                                 1271+ 139
P4      A4 INTO G PI                                 1690+ 139

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                43  A4 BRANCHING RATIOS

R1      A4 INTO (G PI)/(ALL 3PI)                         (P4)/(P1)
R1           DOMINANT                   KALELKAR  75 HBC  +  15 PI+P,P 3PI     12/75*

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                            REFERENCES FOR A4

DANYSZ   67 NC 51A 801           DANYSZ+FRENCH+SIMAK                  (CERN)
FRENCH   67 NC 52A 442           +KINSON+MCDONALD+RIDDIFORD+     (CERN+BIRM)

HUSON    68 PL 28 B 208          +LUBATTI,BELLINI,BINGHAM,+  (ORSA+MILA+LBL)

BEMPORAD 71 NP B 33 397          +DUFEY,CODLING,+        (CERN+ETHZ+LOIC+MILA)

CLAYTON  72 NP B 47 81           +MASON,MUIRHEAD,RIGGPOULOS,+    (LIVP+PATR)
HARRISON 72 PRL 28 775           +HEYDA,JOHNSON,KIM,LAW,MUELLER,+     (HARV)
SALZBERG 72 NP B 41 397          +HARRISON,HEYCA,JOHNSON,KIM,LAW,+    (HARV)

BASTIEN  73 UPPSALA CONF. 73     +DUNN,HARRIS,LUBATTI,BINGHAM,+   (SEAT+UCB)

OREN     74 NP B71 189           +COOPER,FIELDS,RHINES,WHITMORE,+  (ANL+OXF)

DEUTSCHM 75 NP B99 397           DEUTSCHMANN,+       (ABBCCHW COLLABCRATION)
KALELKAR 75 THESIS(NEVIS 207) M.S.KALELKAR                           (COLU)

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S(1930) REGION

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31  S(1930,JPG=  )
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This entry contains the structure observed in s-channel $\bar{N}N$ annihilations, as well as various peaks claimed in this region by production experiments. The resonant interpretation of the broad structure observed in $\bar{p}p$ backward elastic scattering (CLINE 70, D'ANDLAU 75) has been criticized (PINSKY 71, BIZZARRI 72). Although accurate measurements of both total and elastic scattering have produced evidence for a narrow bump in this region (CARROLL 74, MARZANO 76), the charge-exchange reaction shows no such structure (GARNJOST 75, MARZANO 76). Measurements of exclusive channel cross sections and of the spectator momentum distribution in $\bar{p}d$ annihilations have suggested more complicated structure (DEFOIX 75, KALOGEROPOULOS 75). We prefer to wait for further clarification before entering the S meson into the table of established resonances.

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                31  S MASS (MEV)

M        S CHANNEL NBAR N
M   C      (1940.)      (8.)                 CLINE     70 HBC   0  .25-.74 PBAR P    2/72
M   B      (1968.)                           BENVENUTI 71 HBC   0  .1 - .8 PBAR P    2/72
M   S      (1932.)      (2.)                 CARROLL   74 CNTR    S CHAN.PBAR P,D   12/75*
M   C      (1942.)      (5.)                 D.ANDLAU  75 HBC   0 .175-.750 PBAR P  12/75*
M          (1897.)      (1.)                 KALOGERO  75 DBC  -  PBAR N ANNIH      12/75*
M          (1934.4)     (2.6)      (1.4)     KALOGERO  75 DBC   - PBAR N ANNIH      12/75*
M   A      (1940.)                           DEFOIX    75 HBC    OPBAR P,5PI        12/75*
M   S      (1935.9)     (1.0)                MARZANO   76 HBC    OPBAR P TOT,ELAS   12/75*
M
M
M
M        PEAKS FRCM PRODUCTICN EXPERIMENTS
M   N   226(1929.0)    (14.0)                CHIKOVANI 66 MMSP  -   12.0 PI-P        12/75*
M       100(1900.)     (40.)                 BOESEBECK 68 HBC  +    8 PI+ P,PI+ PIO 12/75*
M        30(1973.0)    (15.0)                CASO      70 HBC   - 11.2PI-P,RHO 2PI  12/75*
M   K    40(1975.0)    (12.0)                KRAMER    70 HBC  +  13.1 PI+ P,2PI     11/70
M       100(1898.)     (18.)                 THCMPSON  74 HBC  +  13 PI+ P,2RHO     12/75*
M        50(1895.)     (19.)                 ABASHIAN  75 STRC -  8 PI-P,P 3PI      12/75*
M
M
M   A    FROM ENERGY DEPENDENCE OF 5PI CROSS-SECTION.
M   B    SEEN AS A BUMP IN THE PBAR P - KS KL  CROSS SECTION WITH JPC=1--.
M        NOT SEEN BY CARSON 72 WITH EQUAL STATISTICS.
M   C    FROM ENERGY DEPENDENCE OF FAR BACKWARD ELASTIC SCATTERING.
M        SCME INDICATION OF ADDITICNAL STRUCTURE.
M   K    2PI PEAK CF KRAMER NOT SEEN IN SAME EXP WITH MORE DATA(THOMPSON 74)
M   N    SEEN IN 3 CHARGED MODE.NOT SEEN BY BOWEN 73 WITH 6X STATISTICS.
M   S    NARROW BUMP SEEN IN TOTAL PBAR P,D CROSS-SECTIONS.ISOSPIN UNCERTAIN
M        NOT SEEN IN PBAR P CEX BY GARNJOST 75,MARZANO 76

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Mesons

S(1930), h(2040), $\rho(\sim 2100)$, T(2200)

Data Card Listings

For notation, see key at front of Listings.

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                         31   S WIDTH (MEV)

W        S CHANNEL NBAR N
W    C       (49.)      (9.)                 CLINE      70 HBC    0  .25-.74 PBAR P    2/72
W    B       (35.)                           BENVENUTI 71 HBC    0  .1 - .8 PBAR P    2/72
W    S        (9.)      (4.)       (3.)      CARROLL    74 CNTR    S CHAN.PBAR P,D  12/75*
W    C       (57.5)     (5.)                 D.ANDLAU   75 HBC    0 .175-.750 PBAR P 12/75*
W            (25.)      (6.)                 KALOGERO   75 DBC  -  PBAR N ANNIH      12/75*
W            (11.)     (11.)       (4.)      KALOGERO   75 DBC   - PBAR N ANNIH      12/75*
W    A       (60.)                           DEFOIX     75 HBC    OPBAR P,5PI        12/75*
W    S        (8.8)     (4.3)      (3.2)     MARZANO    76 HBC    OPBAR P TOT,ELAS   12/75*
W
W
W
W        PEAKS FROM PRODUCTION EXPERIMENTS
W    N  226  (35.0)   OR LESS                CHIKOVANI 66 MMSP  -   12.0 PI-P         12/75*
W       100 (216.)    (105.)                 BOESEBECK 68 HBC   +   8 PI+ P,PI+ PIO 12/75*
W        30  (80.0)                          CASO       70 HBC   - 11.2PI-P,RHO 2PI 12/75*
W        40  (52.0)   OR LESS  CL=.90        KRAMER     70 HBC   +  13.1 PI+ P,2PI   12/75*
W       100 (108.)      (41.)      (27.)     THCMPSON   74 HBC   +  13 PI+ P,2RHO    12/75*
W        50 (123.)      (66.)                ABASHIAN   75 STRC  -  8 PI-P,P 3PI     12/75*
W
W
W    A   FROM ENERGY DEPENCENCE OF 5PI CROSS-SECTION.
W    B   SEEN AS A BUMP IN THE PBAR P - KS KL  CROSS SECTION WITH JPC=1--.
W        NOT SEEN BY CARSON 72 WITH EQUAL STATISTICS.
W    C   FROM ENERGY DEPENDENCE OF FAR BACKWARD ELASTIC SCATTERING.
W        SOME INDICATION OF ADDITIONAL STRUCTURE.
W    K   2PI PEAK OF KRAMER NOT SEEN IN SAME EXP WITH MORE DATA(THOMPSON 74)
W    N   SEEN IN 3 CHARGED MODE.NOT SEEN BY BOWEN 73 WITH 6X STATISTICS.
W    S   NARROW BUMP SEEN IN TOTAL PBAR P,D CROSS-SECTIONS.ISOSPIN UNCERTAIN
W        NOT SEEN IN PBAR P CEX BY GARNJOST 75,MARZANO 76

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REFERENCES FOR S


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CHIKOVAN 66 PL  22  233       CERN MISSING MASS SPECTROMETER GROUP (CERN)
FOCACCI  66 PRL  17  890      CERN MISSING MASS SPECTROMETER GROUP (CERN)
BOESEBEC 68 NP B 4 501        BOESEBECK,DEUTSCHMANN,+(AACHEN+BERLIN+CERN)
CLINE    68 PRL 21 1268       +ENGLISH,REEDER,TERRELL,TWITTY  (WISCONSIN)

CASO     70 LNC 3  707        +CORDS,COSTA,+   (GENO,DESY,HAMB,MILA,SACL)
CLINE    70  PREPRINT         D.CLINE,J.ENGLISH,D.D.REEDER         (WISC)J
  ALSO   70  KIEV CONF.       ASTIER RAPPORTEUR TALK
KRAMER   70 PRL 25 396        +BARTON,GUTAY,LICHTMAN,MILLER,+    (PURDUE)

BENVENUT 71 PRL 27 283        BENVENUTI,CLINE,RUTZ,REEDER,SCHERER  (WISC)
CLINE    71  REVIEW           D.CLINE,TALK AT ANL WORKSHOP JULY 71 (WISC)
PINSKI   71 PRL 27 1548       STEPHEN S. PINSKY              (UTAH+ARGCNNE)

BIZZARRI 72 PR D 6 160        +GUIDONI,MARZANO,CASTELLI,+      (RCMA+TRST)
BOWEN 1  72 PRL 29 890        +EARLES,FAISSLER,BLIEDEN,+       (NEAS+STON)
DIEBOLD  72  BATAV.CONF.      R.DIEBOLD  RAPPORTEUR TALK              (ANL)

BOWEN    73 PRL 30 332        +EARLES,FAISSLER,BLIEDEN,+       (NEAS+STCN)
BURNS    73 PR D 8 1286       +CONDON,DONAHUE,MANDELKERN,PRICE,+    (UCI)
KIENZLE  73 PR D 7 3520       W.KIENZLE                              (CERN)

ASTBURY  74  CERN 74-18       A.ASTBURY REVIEW AT PRAGUE 74          (RHEL)
BURNS    74 NC 20A 463        +CONDON,MANDELKERN,PRICE,SCHULTZ        (UCI)
CARROLL  74 PRL 32 247        +CHIANG,KYCIA,LI,MAZUR,MICHAEL,+        (BNL)
KALOGERO 74  BOSTON 74        T.E.KALOGEROPOULOS (REVIEW) PG.97
THOMPSON 74 NP B69 220        +GAIDOS,MCILWAIN,MILLER,MULERA,+       (PURD)

ABASHIAN 75 PRL 34 691        +BEAMER,BROSS,EISENSTEIN,+    (ILL+ANL+ISU)
D.ANDLAU 75 PL 58B 223        +COHEN-GANOUNA,LALOUM,LUTZ,PETRI(CDEF+PISA)  JP
DEFOIX   75  PALERMO CONF.    B.FRENCH, RAPPORTEURS TALK             (CDEF)
GARNJOST 75 PRL 35 1685       +KENNEY,POLLARD,ROSS,TRIPP,+     (LBL+MHCO)
KALOGERO 75 PRL 34 1047       KALOGEROPOULOS,TZANAKOS                (SYRA)
WEINGART 75 PRL 34 1201       WEINGARTEN,OKUBO                       (ROCH)

MARZANO  76 PL    PRIVATE COMMUNICATION FROM F.MARZANO  (CERN+MONS+PADO+)
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h(2040)

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16   H(2040,JPG=4++) I=0

APEL 75 AND BLUM 75 ESTABLISH JP AS 4+.
SINCE BOTH 2PIO AND K KBAR DECAY MODES ARE SEEN, I=0.
ADDITIONAL EVIDENCE FOR THE H MESON IS REPORTED
IN WAGNER 74.

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                         16   H MASS (MEV)

M      700 2030.       30.                APEL      75 CNTR    40.  PI-P,N 2PIO 11/75*
M          2050.       25.                BLUM      75 ASPK    18.4 PI-P,N K+K- 11/75*
M          . . . . . . . . . .
M    AVG   2041.8      19.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M    STUDENT2041.8     20.9     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                         16   H WIDTH (MEV)

W      700  180.       60.                APEL      75 CNTR    40.  PI-P,N 2PIO 11/75*
W           225.      120.      70.       BLUM      75 ASPK    18.4 PI-P,N K+K- 11/75*
W          . . . . . . . . . .
W    AVG    192.8      50.7     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W    STUDENT 192.8     54.8     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                         16   H PARTIAL DECAY MODES

                                                            DECAY MASSES
P1      H INTO PI PI                                       139+ 139
P2      H INTO K KBAR                                      497+ 497

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REFERENCES FOR H


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WAGNER    74  LONDON CONF.     F. WAGNER, RAPPORTEURS TALK            (MPIM)
APEL      75 PL 57B 398        +AUGENSTEIN+       (KARL+PISA+SERP+WIEN+CERN)  JP
BLUM      75 PL 57B 403        +CHABAUD,DIETL,GARELICK,GRAYER+ (CERN+MPIM)  JP
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$\rho(\sim 2100)$ REGION →

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51   RHO(2100, JPG=  +)

THIS ENTRY CONTAINS REFERENCES TO PARTIAL WAVE ANALYSES OF
THE REACTION PBAR P TO PI+ PI- OVER THE MASS RANGE 2-2.5 GEV.
WITHOUT POLARISATION DATA IT SEEMS UNLIKELY THAT SUCH ANALYSES
CAN PROVIDE UNIQUE SOLUTIONS.WE PREFER NOT TO LIST RESONANCE
PARAMETERS YET. OMITTED FROM TABLE.

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REFERENCES FOR RHO(2100)


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NICHOLSO 69 PRL 23 603        NICHOLSON,BARISH,DELORME,+    (CIT+RCCH+BNL)
EHRLICH  72 PRL 28 1147       +ETKIN,GLODIS,HUGHES,KONDO,LU,MORI,+ (YALE)
DONNACHI 73 LNC 7 285         A.DONNACHIE,P.R.THOMAS         (MANCHESTER)
EISENHAN 73 PL 47 B 536       EISENHANDLER,+         (LOQM+LIVP+DARE+RHEL)
NICHOLSO 73 PR D 7 2572       NICHOLSON,DELORME,CARROLL,+  (CIT+ROCH+BNL)
HYAMS    74 NP B 73 202       +JONES,WEILHAMMER,BLUM,+         (CERN+MPIM)
DONNACHI 75 NC 26 A 317       A.DONNACHIE,P.R.THOMAS         (MANCHESTER)
EISENHAN 75 NP B 96 109       EISENHANDLER,GIBSON,+ (LOQM+LIVP+DARE+RHEL)
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T(2200) REGION →

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32   T(2200,JPG=    )

THIS ENTRY CONTAINS THE BUMP OBSERVED IN S CHANNEL
NBAR N , AND VARIOUS PEAKS NEAR 2200 MEV.
OMITTED FROM TABLE.
FOR A REVIEW SEE ASTBURY 74.

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                         32   T MASS (MEV)

M        S CHANNEL NBAR N
M    B       2190.       10.              ABRAMS     70 CNTR    S CHANNEL PBAR N  1/73
M    B   SEEN AS BUMP IN I=1 STATE. SEE ALSO COOPER 68.
M    B   BRICMAN (69) SEES NO BUMP, SPIN LESS THAN 5 IS SO EXCLUDED
M    B   PEASLEE 75 CONFIRM PBAR P RESULTS OF ABRAMS 70,NC NARROW STRUCTURE
M     K     (2190.0)                      KALBFLEIS 69 HBC    0 S-CHANNEL PBARP   7/69
M     K      SEEN IN PBAR P TO RHCO RHOO PIO. IG=1-.
M     K  NOT SEEN BY BACON 73.
M            2193.       2.               ALSPECTOR 73 CNTR    S CHANNEL PBAR P. 1/74
M      S    (2141.)                       DONALD     73 HBC   0 S CHANNEL PBAR P  1/74
M      S  SEEN IN FINAL STATE (OMEGA PI+ PI-)
M          . . . . . . . . . .
M    AVG     2192.9      2.0      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M    STUDENT2192.9       2.1      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

M        PEAKS FROM PRODUCTION EXPERIMENTS
M    N      (2195.0)   (15.0)             CHIKOVANI 66 MMSP  -   12.0 PI-P          12/72
M    N   NOT SEEN BY BOWEN 73.
M            2207.       13.              ALLES-BOR 67 HBC    0 5.7 PBAR P         12/66
M    A       ALLES-BORELLI 67 SEE NEUTRAL MODE ONLY (PI+PI-PIO)
M            2190.0      10.0             CLAYTON    67 HBC  +- 2.5PBAR,A2+OMEGA  10/67
M   T       (2086.)     (38.)             ANDERSON  69 MMS   -  16 PI-P,BACKW     12/75*
M   T       (2260.)     (18.)             ANDERSON  69 MMS   -  16 PI-P,BACKW     12/75*
M   T    TWO SEPARATE PEAKS
M            2207.0      22.0             CASO       70 HBC   - 11.2PI- P,NOTE C. 5/70
M    C       SEEN IN RHO- PI+ PI- (OMEGA AND ETA ANTISELECTED IN 4 PI SYSTEM)   5/70
M            2157.0      10.0             KRAMER     70 HBC  +  13.1 PI+ P,2PI   .11/70
M        50(2070.)                        TAKAHASHI 72 HBC     8. PI-P,N 2PI      12/75*
M          . . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 2.0)

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                         32   T WIDTH (MEV)

W        S CHANNEL NBAR N
W    B       (85.)                        ABRAMS     67 CNTR    S CHANNEL PBAR N  7/67
W    B         SEE NOTE B UNDER T(2200) MASS ABOVE.
W    K       BETWEEN 20 AND 80 MEV        KALBFLEIS 69 HBC    0 S-CHANNEL PBARP   7/69
W             98.        8.               ALSPECTOR 73 CNTR    S CHANNEL PBAR P  1/74
W      S     (14.)                        DONALD     73 HBC   0 S CHANNEL PBAR P  1/74
W      S  SEEN IN FINAL STATE (OMEGA PI+ PI-)

W        PEAKS FROM PRODUCTION EXPERIMENTS
W    N       (13.0)   OR LESS             CHIKOVANI 66 MMSP  -   12.0 PI-P          8/66
W             62.       52.               ALLES-BOR 67 HBC    0 5.7 PBAR P         12/66
W   T       (150.)                        ANDERSON  69 MMS   -  16 PI-P,BACKW     12/75*
W   T        (25.)    OR LESS             ANDERSON  69 MMS   -  16 PI-P,BACKW     12/75*
W   T    TWO SEPARATE PEAKS
W           (130.0)                       CASO       70 HBC   - 11.2PI- P,NOTE C. 5/70
W    C       SEEN IN RHO- PI+ PI- (OMEGA AND ETA ANTISELECTED IN 4 PI SYSTEM)   5/70
W             68.0      22.0              KRAMER     70 HBC  +  13.1 PI+ P,2PI    11/70
W        50 (160.)                        TAKAHASHI 72 HBC     8. PI-P,N 2PI      12/75*
W          . . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                  32   SIGMA (MB) FOR FORMATION BY NUCLEON ANTINUCLEON

CS A         (5.5)                        ABRAMS     70 CNTR    S CHANNEL PBAR N  1/71
CS A     FOR I=1 NEAR N
CS            2.3       0.13      0.08    ALSPECTOR 73 CNTR    S CHANNEL PBAR P  1/74

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REFERENCES FOR T


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CHIKOVAN 66 PL  22  233       CERN MISSING MASS SPECTROMETER GROUP (CERN)
FOCACCI  66 PRL  17  890      CERN MISSING MASS SPECTROMETER GROUP (CERN)
ABRAMS   67 PRL 18 1209       +COOL,GIACOMELLI,KYCIA,LEONTIC,LI,+   (BNL)
ALLES-BO 67 NC 50 A 776       ALLES-BORELLI,FRENCH,FRISK,+    (CERN+BONN)G=-
CLAYTON  67 HEIDBG.CONF.P.57  +MASON,MUIRHEAD,FILIPPAS+(LIVERPOOL+ATHENS)
COOPER   68 PRL 20 1059       +HYMAN,MANNER,MUSGRAVE,VOYVODIC         (ANL)

ANDERSON 69 PRL 22 1390       +COLLINS,BLIEDEN+                 (BNL+CARN)
BRICMAN  69 PL 29 B 451       +FERRO-LUZZI,BIZARD,+       (CERN+CAEN+SACL)
CASO     69 NC 62 A 755       +CONTE,BENZ,+      (GENO+DESY+HAMB+MILA+SACL)
KALBFLEI 69 PL 29 B  259      G.KALBFLEISCH,R.STRAND,V.VANDERBURG     (BNL)
MONTANET 69 LUND CONF.P.189   L.MONTANET, RAPPORTEUR                 (CERN)

ABRAMS   70 PR D 1 1917       +COOL,GIACOMELLI,KYCIA,LEONTIC,LI,+    (BNL)
CASO     70 LNC 3 707         +CONTE,TOMASINI,CORDS+(GENO+HAMB+MILA+SACL)
KALBFLEI 70 PHILAD.CONF.P.409 G.KALBFLEISCH AND D.MILLER REVUES      (BNL)
KRAMER   70 PRL 25 396        +BARTON,GUTAY,LICHTMAN,MILLER,+    (PURDUE)

BACON    71 NP B 32 66        +BUTTERWORTH,MILLER,PHELAN,+     (RHEL+LIVP)
FIELDS   71 PRL 27 1749       +COOPER,RHINES,ALLISON              (ANL+OXF)
YOH      71 PRL 26 922        +BARISH,CAROLL,LOBKOVICZ+     (CIT+BNL+ROCH)
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Data Card Listings

For notation, see key at front of Listings.

Mesons

T(2200), U(2360), $N\bar{N}_{I=0}$(2375), X(2500–3600)


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ALEXANDE 72 NP B 45 29           ALEXANDER,BAR-NIR,BEVARY,CAGAN,+        (TELA)
BERTANZA 72  CHEXBRES (CERN 72-10)  L.BERTANZA, REVIEW TALK             (PISA)
BUGG     72 PR D 6 3047          +CONDO,HART,COHN,ENDCRF,+   (TENN+ORNL+CINC)
CLAYTCN  72 NP 8 47 81           +MASON,MUIRHEAC,RIGOPOULOS,+    (LIVP+PATR)
DIEBOLD  72  BATAV.CONF.         R.DIEBOLD  RAPPCRTEUR TALK               (ANL)
DONALD   72 PL 40 B 586          +GALLETLY,EDWARDS,DE BILLY,+    (LIVP+LPNP)
MING MA  72 NP B 51 77           +EASTMAN,OH,PARKER,SMITH,SPRAFKA        (MSU)
TAKAHASH 72 PR D 6 1266          TAKAHASHI,BARISH,+      (TOHO+PENN+NDAM+ANL)

ALSPECTO 73 PRL 30 511           ALSPECTOR,COHEN,CVIJANOVICH,+   (RUTG+UPNJ)
BACON    73 PR D 7 577           +BUTTERWORTH,                   (RHEL+LIVP)
BETTINI  73 NC 15 A 563          +GARNJOST,BIGI,+         (PADO+LBL+PISA+TORI)
BOWEN    73 PRL 30 332           +EARLES,FAISSLER,BLIEDEN,+      (NEAS+STON)
DONALD   73 NP B 61 333          +EDWARDS,GIBBINS,BRIAND,DUBOC,+ (LIVP+LPNP)
KIENZLE  73 PR D 7 3520          W.KIENZLE                              (CERN)

ASTBURY  74  CERN 74-18          A.ASTBURY REVIEW AT PRAGUE 74          (RHEL)
BERTANZA 74 NC 23A 209           +BIGI,CASALI,LARICCIA,+      (PISA+PADO+TORI)

HANDLER  75 NP B101 35           +JACQUES,JONES,PANDOULAS,+ (RUTG+STEV+ALBA)
HUESMAN  75 NC 25A  91           +GARNJOST,ROSS,+         (LBL+PADO+PISA+TORI)
PEASLEE  75 PL 57B 189           +DEMARZO,GUERRIERO,+     (CANB+PARI+BROW+MIT)

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U(2360) REGION

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33  U(2360,JPG=    ) I=1

THIS ENTRY CONTAINS THE BROAD BUMP OBSERVED
IN THE S CHANNEL NBAR N, AND VARIOUS OTHER PEAKS,
MOSTLY CONTROVERSIAL. OMITTED FROM TABLE.
FOR A REVIEW SEE ASTBURY 74.

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                  33  U(2360)  MASS (MEV)

M        S CHANNEL NBAR N
M   A       2350.      10.            ABRAMS    70 CNTR    S CHANNEL NBAR N  1/73
M   A    FOR I=1 NBAR N
M    N     (2360.0)   (25.0)          OH        70 HDBC  -OPBAR(P,N),K*K2PI  1/73
M    N      NO EVIDENCE FOR THIS BUMP SEEN IN THE PBAR P DATA OF CHAPMAN 71  1/73
M    N      NARROW STATE NOT CONFIRMED BY OH 73 WITH MORE DATA.            12/75*
M    I     (2359.)    (2.)            ALSPECTOR 73 CNTR    S CHANNEL PBAR P  1/74
M    I   ISOSPINS 0 AND 1 NOT SEPARATED

M        PEAKS FROM PRODUCTION EXPERIMENTS
M    M     (2382.0)   (24.0)          CHIKOVANI 66 MMS   -  12.0 PI-P       12/72
M    N   NOT SEEN BY BOWEN 73.
M           2370.      17.            ANDERSON  69 ASPK  - 16 PI- BKSCAT    11/69
M   B   126 2340.      20.            BALTAY    75 HBC +   15 PI+P,P5PI     12/75*
M   B   DOMINANT DECAY INTO RHO RHO PI
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.1)

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                  33  U(2360)  WIDTH (MEV)

W        S CHANNEL NBAR N
W          (140.)                     ABRAMS    67 CNTR    S CHANNEL PBAR N  1/73
W   N        (60.0)  OR LESS          OH        70 HDBC  -OPBAR(P,N),K*K2PI 11/71
W   N       NO EVIDENCE FOR THIS BUMP SEEN IN THE PBAR P DATA OF CHAPMAN 71 11/71
W    N      NARROW STATE NOT CONFIRMED BY OH 73 WITH MORE DATA.            12/75*
W    I     (165.)     (18.)     (8.)  ALSPECTOR 73 CNTR    S CHANNEL PBAR P  1/74
W    I   ISOSPINS 0 AND 1 NOT SEPARATED

W        PEAKS FROM PRODUCTION EXPERIMENTS
W    M      (30.0)  OR LESS           CHIKOVANI 66 MMS   -  12.0 PI-P        8/66
W    N   NOT SEEN BY BOWEN 73.
W          (57.)                      ANDERSON  69 ASPK  - 16 PI- BKSCAT    11/69
W   B   126  180.      60.            BALTAY    75 HBC +   15 PI+P,P5PI     12/75*
W   B   DOMINANT DECAY INTO RHO RHO PI

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                  33  SIGMA (MB) FOR FORMATION BY NUCLEON ANTINUCLEON

CS  A       (3.2)                     ABRAMS    70 CNTR    S CHANNEL NBAR N  1/71
CS  A    FOR I=1 NBAR N
CS  I       (2.1)     (0.2)     (0.1) ALSPECTOR 73 CNTR    S CHANNEL PBAR P  1/74
CS  I    ISOSPINS 0 AND 1 NOT SEPARATED

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                          REFERENCES FOR U(2360)

CHIKOVAN 66 PL  22  233          CERN MISSING MASS SPECTROMETER GROUP (CERN)
FOCACCI  66 PRL  17  890         CERN MISSING MASS SPECTROMETER GROUP (CERN)

ABRAMS   67 PRL 18 1209          +COOL,GIACOMELLI,KYCIA,LEONTIC,LI,+   (BNL)

ANDERSON 69 PRL 22 1390          +BLESER,BIRNBAUM,EDELSTEIN,+     (BNL+CARN)
BRICMAN  69 PL 29 B 451          +FERRO-LUZZI,BIZARD,+       (CERN+CAEN+SACL)
CASO     69 LNC 3 707            +CONTE,BENZ,+    (GENO+DESY+HAMB+MILA+SACL)

ABRAMS   70 PR D 1 1917          +COOL,GIACOMELLI,KYCIA,LEONTIC,LI,+   (BNL)
OH       70 PRL 24 1257          +PARKER,EASTMAN,SMITH,SPRAFKA,MA      (MSU)

CHAPMAN  71 PR D4 1275           +GREEN,LYS,MURPHY,RING,+             (MICH)
FIELDS   71 PRL 27 1749          +COOPER,RHINES,ALLISON            (ANL+OXF)
YOH      71 PRL 26 922           +BARISH,CAROLL,LOBKOVICZ+    (CIT+BNL+ROCH)

ASTBURY  72  CERN 72-10          A.ASTBURY REVIEW AT CHEXBRES 72      (RHEL)
DIEBOLD  72  BATAV.CONF.         R.DIEBOLD  RAPPORTEUR TALK            (ANL)
EASTMAN  72 NP B 51 29           +MING MA,OH,PARKER,SMITH,SPRAFKA      (MSU)
MING MA  72 NP B 51 77           +EASTMAN,OH,PARKER,SMITH,SPRAFKA      (MSU)

ALSPECTO 73 PRL 30 511           ALSPECTOR,COHEN,CVIJANOVICH,+   (RUTG+UPNJ)
BOWEN    73 PRL 30 332           +EARLES,FAISSLER,BLIEDEN,+      (NEAS+STON)
DONNACHI 73 LNC 7 285            A.DONNACHIE,P.R.THOMAS        (MANCHESTER)
KIENZLE  73 PR D 7 3520          W.KIENZLE                           (CERN)
OH       73 NP B 51 57           +EASTMAN,MING MA,PARKER,SMITH,+       (MSU)

ASTBURY  74  CERN 74-18          A.ASTBURY REVIEW AT PRAGUE 74        (RHEL)
MING MA  74 NP B68 214           +MOUNTZ,ZEMANY,SMITH                 (MICH)

BALTAY   75 PRL 35 891           +CAUTIS,COHEN,KALELKAR,PISELLO,+(COLU+BING)
KEMP     75 NC 27 A 155          +LOTTS,CONTRI,TEODORO+(DURH+GENO+MILA+LPNP)

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$N\bar{N}_{I=0}$(2375)

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41  N NBAR(2375,JPG=    ) I=0

EVIDENCE FOR RESONANCE PRELIMINARY.
OMITTED FROM TABLE.
FOR A REVIEW SEE ASTBURY 74.

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                  41  N NBAR(2375) MASS

M           2375.      10.            ABRAMS    70 CNTR    S CHANNEL NBAR N  1/71
M    I     (2359.)    (2.)            ALSPECTOR 73 CNTR    S CHANNEL PB1R P  1/74
M    I   ISOSPINS 0 AND 1 NOT SEPARATED

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                  41  N NBAR(2375) WIDTH

W          (190.)                     ABRAMS    70 CNTR    S CHANNEL NBAR N  1/71
W    I     (165.)     (18.)     (8.)  ALSPECTOR 73 CNTR    S CHANNEL PBAR P  1/74
W    I   ISOSPINS 0 AND 1 NOT SEPARATED

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                  41  N NBAR(2375) SIGMA (MB) FOR FORMATION BN

CS          (2.5)                     ABRAMS    70 CNTR                      1/71
CS   I      (2.1)     (0.2)     (0.1) ALSPECTOR 73 CNTR    S CHANNEL PBAR P  1/74
CS   I   ISOSPINS 0 AND 1 NOT SEPARATED

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                          REFERENCES FOR N NBAR (2375)

BRICMAN  69 PL 29 B 451          +FERRO-LUZZI,BIZARD,+       (CERN+CAEN+SACL)
ABRAMS   70 PR D 1 1917          +COOL,GIACOMELLI,KYCIA,LEONTIC,LI,+   (BNL)
EASTMAN  72 NP B 51 29           +MING MA,OH,PARKER,SMITH,SPRAFKA      (MSU)
MING MA  72 NP B 51 77           +EASTMAN,OH,PARKER,SMITH,SPRAFKA      (MSU)
ALSPECTO 73 PRL 30 511           ALSPECTOR,COHEN,CVIJANOVICH,+   (RUTG+UPNJ)

ASTBURY  74  CERN 74-18          A.ASTBURY REVIEW AT PRAGUE 74        (RHEL)
MING MA  74 NP B68 214           +MOUNTZ,ZEMANY,SMITH                 (MICH)

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X(2500–3600)

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46  X(2500-3600)

THIS ENTRY CONTAINS VARIOUS HIGH MASS NON-STRANGE
PEAKS. OMITTED FROM TABLE.
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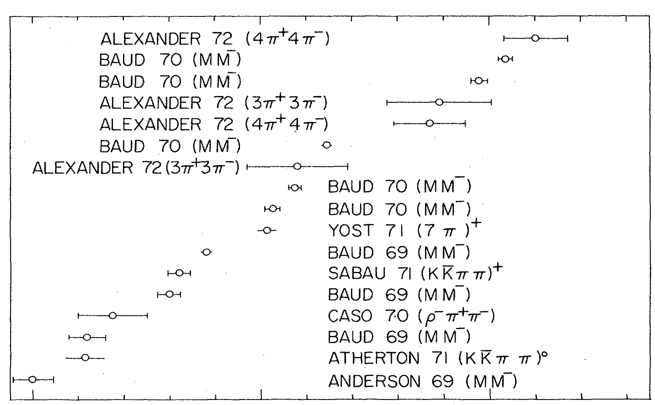
The high mass region is covered nearly continuously by evidence for peaks of various widths and decay modes (see figure). As a satisfactory grouping into particles is not yet possible, we list all the Y=0 bumps with M > 2400 MeV together, ordered by increasing mass. Note that ANTIPOV 72 ($\pi^- p \to pMM^-$ at 25 and 40 GeV/c) see no narrow bumps.



Masses and widths of reported enhancements with Y = 0, M > 2400 MeV. (–o– indicates that upper limit only was reported for the width.)

Mesons

X(2500–3600), K±, K0, K*(892)

Data Card Listings

For notation, see key at front of Listings.

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                   46  X(2500-3600)  MASSES AND WIDTHS  (MEV)
M           2500.0     32.0          ANDERSCN  69 MMS  -  16 PI- P,BACKW9  8/69
W            (87.0)                  ANDERSCN  69 MMS  -  16 PI- P,BACKW9  8/69

M       550 2620.      20.           BAUD      69 MMS  -  8.-10. PI- P     9/69
W       550   85.      30.           BAUD      69 MMS  -  8.-10. PI- P     9/69

M           2676.0     27.0          CASO      70 HBC  - 11.2PI- P,NOTE C  5/70
W           (150.0)                  CASO      70 HBC  - 11.2PI- P,NOTE C  5/70
W    C      SEEN IN RHO- PI+ PI- (OMEGA AND ETA ANTISELECTED IN 4 PI SYSTEM) 5/70

M       640 2800.      20.           BAUD      69 MMS  -  8.-10. PI- P     9/69
W       640   46.      10.           BAUD      69 MMS  -  8.-10. PI- P     9/69

M   C    15 2820.      10.           SABAU     71 HBC  + 8. PI+ P         11/71
W   C    15   50.      10.           SABAU     71 HBC  + 8. PI+ P         11/71
W   C       SEEN IN (K KBAR PI PI)+ MASS DISTRIBUTION                     11/71

M   D    90 2850.       5.           BRAUN     75 DBC    05.5 PBAR N      12/75*
W   D    90 (39.)    OR LESS         BRAUN     75 DBC    05.5 PBAR N      12/75*
    D    DECAYS TO NBAR N AND NBAR N PI

M       230 2880.      20.           BAUD      69 MMS  -  8.-10. PI- P     9/69
W       230 (15.)    OR LESS         BAUD      69 MMS  -  8.-10. PI- P     9/69

M   Y    43 3013.       5.           YOST      71 HBC  + 11.PI+ P,P(8PI)+ 11/71
W   Y    43 (40.)    OR LESS         YOST      71 HBC  + 11.PI+ P,P(8GI)   5/71
W   Y       4.3 S.D. EFFECT  . DECAY TO 7 PIONS                           11/71
    Y    NOT SEEN BY KALELKAR 75 WITH 5 TIMES MORE DATA

M           3025.0     20.0          BAUD      70 MMS  - 10.5-13 PI- P     5/70
W            (25.0)  APPROX.         BAUD      70 MMS  - 10.5-13 PI- 7

M           3075.0     20.0          BAUD      70 MMS  - 10.5-13 PI- P     5/70
W            (25.0)  APPROX.         BAUD      70 MMS  - 10.5-13 PI- P     5/70

M   D       3080.      20.           ALEXANDER 72 HBC  0 6.94 PBAR P       1/73
W   D        220.      70.           ALEXANDER 72 HBC  0 6.94 PBAR P       1/73
    D    DECAYS TO 3PI+ 3PI-
    D    NOT SEEN BY KALELKAR 75 WITH 1.5 TIMES MORE DATA

M           3145.0     20.0          BAUD      70 MMS  - 10.5-15 PI- P     5/70
W            (10.0)  OR LESS         BAUD      70 MMS  - 10.5-15 PI- P     5/70

M   D       3370.      10.           ALEXANDER 72 HBC  0 6.94 PBAR P       1/73
W   D        150.      40.           ALEXANDER 72 HBC  0 6.94 PBAR P       1/73
    D    DECAYS TO 4PI+ 4PI-

M   D       3390.      20.           ALEXANDER 72 HBC  0 6.94 PBAR P       1/73
W   D        220.     100.           ALEXANDER 72 HBC  0 6.94 PBAR P       1/73
    D    DECAYS TO 3PI+ 3PI-
    D    NOT SEEN BY KALELKAR 75 WITH 1.5 TIMES MORE DATA

M           3475.0     20.0          BAUD      70 MMS  - 14-15.5 PI- P     5/70
W            (30.0)  APPROX.         BAUD      70 MMS  - 14-15.5 PI- P     5/70

M           3535.0     20.0          BAUD      70 MMS  - 14-15.5 PI- P     5/70
W            (30.0)  APPROX.         BAUD      70 MMS  - 14-15.5 PI- P     5/70

M   D       3600.      20.           ALEXANDER 72 HBC  0 6.94 PBAR P       1/73
W   D        140.      20.           ALEXANDER 72 HBC  0 6.94 PBAR P       1/73
    D    DECAYS TO 4PI+ 4PI-

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                          REFERENCES FOR X(2500-3600)

ANDERSON 69 PRL 22 1390          +COLLINS,+                         (BNL+CARN)
BAUD     69 PL  30B 129          CERN BOSON SPECTROMETER GROUP          (CERN)
ALEXANDE 70 PRL 25 63            +BAR-NIR,DAGAN,GIDAL,GRUNHAUS+   (TEL-AVIV)
BAUD     70 PL 31 B 549          CERN BOSON SPECTROMETER GROUP          (CERN)
CASO     70 LNC 3 707            +CONTE,TOMASINI,CORDS+(GENO+HAMB+MILA+SACL)
SABAU    71 LNC 1 514            +URETSKY                         (BUCH+ANL)
YOST     71 PR D 3 642           +MORRIS,ALBRIGHT,BRUCKER,LANNUTTI     (FSU)
ALEXANDE 72 NP B 45 29           ALEXANDER,BAR-NIR,BEVARY,DAGAN,+     (TELA)
ANTIPOV  72 PL 40B 147           +BAUD,BUSNELLO,DAMGAARD,+       (IHEP+CERN)
BRAUN    75  PREPRINT CRN 24     +BRICK,FRIDMAN,GERBER,JUILLOT,+      (STRB)
KALELKAR 75 THESIS(NEVIS 207)    M.S.KALELKAR                         (COLU)

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S=±1 MESON STATES

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K±

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10  CHARGED K(494,JP=0-) I=1/2

SEE STABLE PARTICLE DATA CARD LISTINGS

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K0

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11  NEUTRAL K(498,JP=0-) I=1/2

SEE STABLE PARTICLE DATA CARD LISTINGS

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K*(892)

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18  K*(892,JP=1-) I=1/2
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                        18  K*(892) MASS (MEV)

M  CHARGED ONLY. THIS IS WHAT APPEARS CN MESON TABLE
M   S  100 (898.0)    (5.0)       CHADWICK  63 HBC  +   1.5 K+P(K PI)     12/75*
M  W  1700  891.0      1.2        WOJCICKI  64 HBC  -   1.7 K-P(KO PI-)   12/75*
M   SD 200 (889.5)    (3.6)       ADELMAN   65 HBC  -   1.5 K-P           12/75*
M   S  300 (891.0)    (3.0)       FERRO-LUZ 65 HBC  +      K+P            12/75*
M   S  300 (895.0)    (3.0)       GELSEMA   65 HBC  -   1.5 K-P(KO PI-)   12/75*
M   SD 190 (895.)     (3.6)       BOMSE     67 HBC  +  2.3 K+P (KO PI+)   12/75*
M    D 620  891.       2.3        DE BAERE  67 HBC  +  3.5 K+P (KO PI+)   12/75*
M   SD 260 (892.5)    (3.3)       DE BAERE  67 HBC  +  3.5 K+P (K+ PIO)   12/75*
M   SD  70 (898.)     (9.0)       SALLSTRCM 67 HBC  +  3. K+ P (KO PI+)   12/75*
M   SD  50 (883.)     (7.0)       SALLSTRCM 67 HBC  +  3. K+ P (K+ PIO)   12/75*
M      720  890.       3.0        BARLCW    67 HBC  +- 1.2 PBARP(KO PI)   12/75*
M      600  889.       3.0        BARLOW    67 HBC  +- 1.2 PBARP(K PI)    12/75*
M   S  300 (896.0)    (5.0)       CONFORTO  67 HBC  +- 0. PBARP(KO PI)    12/75*
M   S  430 (893.)     (3.0)       DE WIT    68 CBC  - 3.0 K-P(KOPI-)      12/75*
M    D 540  888.       2.5        DE WIT    68 HBC  - 3.0 K-P             12/75*
M   S      (891.)     (4.0)       FICENEC1  68 HBC  -   1.3 K-P (K-PIO)   12/75*
M   S      (887.)     (3.0)       FICENEC1  68 HBC  -   1.3 K-P (KOPI-)   12/75*
M   S      (890.0)    (5.0)       FICENEC2  68 HBC  -   2.7 K- P(K-PIO)   12/75*
M   S      (892.0)    (3.0)       FICENEC2  68 HBC  -   2.7 K- P(KOPI-)   12/75*
M   S  115 (896.0)    (4.0)       SCHWEINGR 68 HBC  -   4.1 K-P(KO PI-)   12/75*
M    D 341  892.0      2.6        SCHWEINGR 68 HBC  -   5.5 K-P(KO PI-)   12/75*
M   S  175 (884.0)    (5.0)       KANG      68 HBC  -   4.6 K-P(K PI)     12/75*
M     1000  891.0      2.0        CRENNELL  69 CBC  -   3.9 K-N (KOPI-)   12/75*
M     2886  894.       1.0        FRIEDMAN  69 HBC  -   2.1 K-P(KO PI-)   12/75*
M      728  892.       2.         FRIEDMAN  69 HBC  - 2.45 K-P(KO PI-)    12/75*
M     3229  892.       1.0        FRIEDMAN  69 HBC  - 2.6  K-P(KO PI-)    12/75*
M    D1027  892.       1.6        FRIEDMAN  69 HBC  - 2.7  K-P(KO PI-)    12/75*
M   SD 127 (895.)     (4.5)       LIND      69 HBC  +   9. K+ P           12/75*
M     4404  892.2      1.5        AGUILAR1  71 HBC  -   3.9,4.6 K- P      11/71
M    D 765  894.2      2.0        CLARK     73 HBC  - 3.13 K-P(KO PI-)    12/75*
M  W D1150  894.3      1.5        CLARK     73 HBC  -  3.3 K-P,P PI- KO   12/75*
M   I 9000 (891.9)    (0.7)       PALER     75 HBC  - 14.3 K-P,K*- X+     12/75*
M             . . . . . . . . .
M   AVG     892.24     0.43   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT 892.19     0.51   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

M  NEUTRAL ONLY.
M   S   70 (897.0)   (10.0)       COLLEY    62 HBC   0 2.0 PI-P           12/75*
M   S  120 (899.)     (4.0)       BARLOW    67 HBC   0 1.2 PBAR P         12/75*
M   S  310 (897.)     (4.0)       BARLOW    67 HBC   0 1.2 PBAR P         12/75*
M   S      (889.0)    (5.0)       CCNFORTO  67 HBC   0 0. PBAR P          12/75*
M    D1040  894.7      1.4        DAUBER    67 HBC   02.0 K-P(K-PI+)      12/75*
M   AS 490 (892.0)    (4.0)       GEORGE    67 HBC   0 5.0 K+ P           12/75*
M   SD     (895.)     (4.0)       FICENEC1  68 HBC   0 1.3 K-P (K-PI+)    12/75*
M   SD     (901.)     (4.0)       FICENEC2  68 HBC   0 2.7 K-P (K-PI+)    12/75*
M   SD 150 (896.0)    (4.5)       SCHWEINGR 68 HBC   0 4.1 K-P(K-PI+)     12/75*
M   SD120  (903.0)    (5.0)       SCHWEINGR 68 HBC   0 5.5 K-P(K-PI+)     12/75*
M   S  200 (899.0)    (5.0)       KANG      68 HBC   0 4.6 K-P(K-PI+)     12/75*
M    10700  893.7      2.0        DAVIS     69 HBC   0 12. K+P(K+PI-)     12/75*
M  WAD2200 (890.0)    (1.3)       DE BAERE  69 HBC   0 5.0 K+P(K+PI-)     12/75*
M  W  4300  895.0      1.0        HABER     70 DBC   0 3. K-N (K-PI+)     12/75*
M    D?934  897.9      1.1        AGUILAR1  71 HBC   0 3.9,4.6 K- P       12/75*
M    D5362  898.0      0.7        AGUILAR1  71 HBC   0 3.9,4.6 K- P       12/75*
M  D  1700  898.4      1.3        BUCHNER   72 DBC   04.6 K+ N,K+ PI-     12/72
M     3186  896.0      1.0        LEWIS     73 HBC   02.1-2.7 K+P          2/74
M    C      894.0      1.3        LINGLIN   73 HBC   02-13 K+P,K+PI-      12/75*
M    10600  896.0      0.6        FOX       74 RVUE  0 2 K-P,K-PI+N       12/75*
M           896.0      0.6        FOX       74 RVUE  0 2 K+N,K+PI-P       12/75*
M    C      896.       2.         MATISON   74 HBC   012 K+P,K+PI-        12/75*
M     3600  895.5      1.0        MCCUBBIN  75 HBC   0 3.6 K-P,K-PI+N     12/75*
M   I  22K (897.1)    (0.7)       PALER     75 HBC   014.3 K-P,K*0 X0     12/75*
M             . . . . . . . . .
M   AVG     896.23     0.36   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
M   STUDENT 896.12     0.33   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                              (SEE IDEOGRAM BELOW )

   A   INCLUDED IN LINGLIN 73 WORLD K+P DST
    C  FROM POLE EXTRAPOLATICN.
  D          ERRORS ENLARGED BY US TO   GAMMA/SQRT(N). SEE TYPED NOTE.
   I   INCLUSIVE REACTION. COMPLICATED BACKGROUND AND PHASE-SPACE EFFECTS
   S   DATA WITH MASS ERROR OF 3 MEV OR MORE NOT AVERAGED
  W    NUMBER OF EVENTS IN PEAK REEVALUATED BY US
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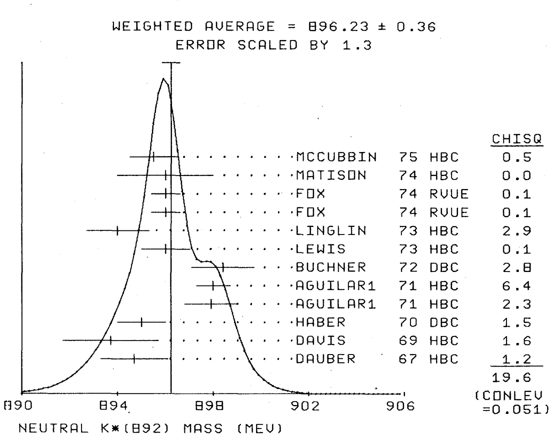


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Data Card Listings

For notation, see key at front of Listings.

Mesons

K*(892)

Note on $K^*(892)$ Masses and Mass Differences

Unrealistically small errors are reported by some experiments. We use simple "realistic" tests for the minimum errors on the determination of mass and width from a sample of N events:

$$\delta_{min}(m) = \frac{\Gamma}{\sqrt{N}}\ , \quad \delta_{min}(\Gamma) = 4\,\frac{\Gamma}{\sqrt{N}}\ .$$

(For detailed discussion see the April 1971 edition of this note.) We consistently increase unrealistic errors before averaging.

Although in the past we have argued against taking the mass difference $m(K^{*0}) - m(K^{*\pm})$ from the separate averages of $m(K^{*0})$ and $m(K^{*\pm})$, we no longer see any reason for such caution. In fact, the difference between the separate averages agrees with direct measurements of the mass difference, and it has a smaller statistical error.

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                    18  K*(0) - K*(+-) MASS DIFF. (MEV)

D  W   283     6.3      4.1                BARASH     67 HBC      0 PBAR P          12/75*
D   SD1400    (6.5)    (5.0)               FICENEC1   68 HBC       1.3 K- P         12/75*
D   SD1600    (9.5)    (5.0)               FICENEC2   68 HBC       2.7 K- P         12/75*
D     7338     5.7      1.7                AGUILAR1   71 HBC    -0 3.9,4.6 K- P     11/71
D           . . . . . . . . .
D   AVG        5.8      1.6     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D   STUDENT    5.8      1.7     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

   D         ERRORS ENLARGEC BY US TO   GAMMA/SQRT(N). SEE TYPED NOTE.
    S   DATA WITH MASS ERROR OF 3 MEV OR MORE NOT AVERAGED
   W    NUMBER OF EVENTS IN PEAK REEVALUATED BY US

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                    18  K*(892) WIDTH (MEV)

W  CHARGED ONLY. THIS IS WHAT APPEARS ON MESON TABLE
W   S  100  (46.0)    (8.0)              CHADWICK  63 HBC  +   1.5 K+P(K PI )  12/75*
W  W D1700   46.0      5.0               WOJCICKI  64 HBC   -  1.7 K-P(KO PI-) 12/75*
W   SD 200  (51.0)   (15.0)              ADELMAN   65 HBC   -  1.5 K-P         12/75*
W   SD 300  (47.0)   (11.0)              FERRO-LUZ 65 HBC  +   3.0 K+P         12/75*
W   SD 300  (50.0)   (12.0)              GELSEMA   65 HBC   -  1.5 K-P(KO PI-) 12/75*
W   SD 190  (50.)    (15.0)              BOMSE     67 HBC  +   2.3 K+P(KO PI+) 12/75*
W    D 620   56.0      9.0               DE BAERE  67 HBC  +   3.5 K+P(KO PI+) 12/75*
W   SD 260  (53.)    (13.0)              DE BAERE  67 HBC  +  3.5 K+P (K+ PIO) 12/75*
W   SD  70  (68.)    (33.0)              SALLSTRCM 67 HBC  +  3. K+ P (KO PI+) 12/75*
W   SD  50  (47.)    (27.0)              SALLSTRCM 67 HBC  +  3. K+ P (K+ PIO) 12/75*
W   SD 210  (44.)    (12.0)              BARLOW    67 HBC  +-  1.2 PBAR P      12/75*
W      720   43.       9.0               BARLOW    67 HBC  +- 1.2 PBARP(KO PI) 12/75*
W    D 600   53.       9.0               BARLOW    67 HBC  +- 1.2 PBARP(K PI)  12/75*
W   SD 430  (58.)    (12.0)              DE WIT    68 DBC   -  3. K- D         12/75*
W    D 540   44.0      8.0               DE WIT    68 DBC   -  3. K- D         12/75*
W   S       (58.)    (16.0)              FICENEC1  68 HBC   -  1.3 K-P (K-PIO) 12/75*
W   S       (44.)    (13.0)              FICENEC1  68 HBC   -  1.3 K-P (KOPI-) 12/75*
W   SD 115  (41.0)   (16.0)              SCHWEINGR 68 HBC   -  4.1 K-P(KO PI-) 12/75*
W   SD 341  (47.0)   (10.0)              SCHWEINGR 68 HBC   -  5.5 K-P(KO PI-) 12/75*
W   S       (57.0)   (13.0)              FICENEC2  68 HBC   -  2.7 K- P(K-PIO) 12/75*
W   S       (48.0)    (9.0)              FICENEC2  68 HBC   -  2.7 K- P(KOPI-) 12/75*
W   SD 175  (52.0)   (16.0)              KANG      68 HBC   -  4.6 K- P        12/75*
W    D2886   53.       4.0               FRIEDMAN  69 HBC   -  2.1 K-P(KO PI-) 12/75*
W    D 728   49.       7.3               FRIEDMAN  69 HBC   -  2.45K-P(KO PI-) 12/75*
W    D3229   46.       3.2               FRIEDMAN  69 HBC   -  2.6 K-P(KO PI-) 12/75*
W    D1027   49.       6.1               FRIEDMAN  69 HBC   -  2.7 K-P(KO PI-) 12/75*
W   SD 127  (50.)    (18.0)              LIND      69 HBC  +   9. K+ P         12/75*
W    D4404   54.3      3.3               AGUILAR1  71 HBC   -  3.9,4.6 K- P    12/75*
W    D 765   46.3      6.7               CLARK     73 HBC  -  3.13K-P,P PI- KO 12/75*
W  W D1150   48.2      5.7               CLARK     73 HBC  -  3.3 K-P,P PI- KO 12/75*
W   I 9000  (52.1)    (2.2)              PALER     75 HBC  - 14.3 K-P,K*- X+   12/75*
W          . . . . . . . . .
W   AVG      49.5      1.5    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT  49.4      1.8    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

W  NEUTRAL CNLY.
W   SD  70  (60.0)    (29.0)              COLLEY    62 HBC   0 2.0 PI-P         12/75*
W   S  310  (53.)     (13.0)              BARLOW    67 HBC   0 1.2 PBAR P       12/75*
W   SD 120  (34.)     (12.5)              BARLOW    67 HBC   0 1.2 PBAR P       12/75*
W    D1040   44.        5.5               DAUBER    67 HBC   0  2.0 K- P        12/75*
W   S       (52.)     (12.0)              FICENEC1  68 HBC   0 1.3 K-P (K-PI+)  12/75*
W   S       (50.0)     (8.0)              FICENEC2  68 HBC   0 2.7 K- P(K-PI+)  12/75*
W   SD 200  (48.0)    (16.0)              KANG      68 HBC   0 4.6 K-P(K-PI+)   12/75*
W   SD 120  (51.0)    (19.0)              SCHWEINGR 68 HBC   0 5.5 K-P(K-PI+)   12/75*
W   SD 150  (53.0)    (17.5)              SCHWEINGR 68 HBC   0 4.1 K-P(K-PI+)   12/75*
W  D 10700   53.2       2.1               DAVIS     69 HBC   0 12. K+P(K+PI-)   12/75*
W  DAW2200  (58.0)     (5.0)              DE BAERE  69 HBC   0 5.0 K+P(K+PI-)   12/75*
W  W D4300   54.0       3.3               HABER     70 DBC   0 3. K-N (K-PI+)   12/75*
W     2934   55.8       4.2        3.4    AGUILAR1  71 HBC   0 3.9,4.6 K- P     11/71
W    D5362   48.5       2.7               AGUILAR1  71 HBC   0 3.9,4.6 K- P     12/75*
W  D  1700   51.4       5.0               BUCHNER   72 CBC  0 4.6 K+ N,K+ PI-P  12/72
W    D3186   46.0       3.3               LEWIS     73 HBC  0 2.1-2.7 K+P       12/75*
W   C       (46.5)     (1.5)              LINGLIN   73 HBC  0 2-13 K+P,K+PI-     1/74
W    10600   47.        2.                FOX       74 RVUE  0 2 K-P,K-PI+N     12/75*
W            51.        2.                FOX       74 RVUE  0 2 K+N,K+PI-P     12/75*
W   C       (47.)      (3.)               MATISON   74 HBC   012 K+P,K+PI-      12/75*
W     3600   48.        3.         2.     MCCUBBIN  75 HBC   0 3.6 K-P,K-PI+N   12/75*
W   I  22K  (50.6)     (2.5)              PALER     75 HBC   014.3 K-P,K*O XO   12/75*
W          . . . . . . . . . .
W   AVG      50.0       1.0     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
W   STUDENT  49.9       1.1     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

   A   INCLUDED IN LINGLIN 73 WORLD K+P DST
    C  FRCM POLE EXTRAPCLATICN.
  D          ERRORS ENLARGED BY US TO 4*GAMMA/SQRT(N). SEE TYPED NOTE.
   I   INCLUSIVE REACTION. COMPLICATED BACKGROUND AND PHASE-SPACE EFFECTS
   S   DATA WITH MASS ERRCR OF 3 MEV OR MORE NOT AVERAGED
  W    NUMBER OF EVENTS IN PEAK REEVALUATED BY US

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                    18  K*(892) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1     K*(892) INTO K PI                                493+ 139
P2     K*(892) INTO K PI PI                             493+ 139+ 139
P3     K*(892) INTO K GAMMA                             493+   0

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                    18  K*(892) BRANCHING RATIOS

R1     K*(892) INTO (K PI PI)/(K PI)                    (P2)/(P1)
R1        0   (0.002)OR LESS           WOJCICKI2 64 HBC   -  1.7 K-P

R2     K*(892)  INTO (K  GAMMA)/TCTAL  (UNITS 10**-3)   (P3)
R2           (1.6)  OR LESS  CL=.95   BEMPORAD  72 CNTR +  10.-16. K+A,COUL  1/73
R2            1.5         0.7         CARITHERS 75 CNTR  0 8-16KOBAR A,COUL 12/75*

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REFERENCES FOR K*(892)


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ALSTCN    61 PRL 6 300           ALSTON,ALVAREZ,EBERHARD,GOOD,GRAZIANO+(LRL)
ALEXANDE  62 PRL 8 447           ALEXANDER,KALBFLEISCH,MILLER,G SMITH  (LRL)
COLLEY    62 CERN CONF 315       D COLLEY,N GELFAND +      (COLUMBIA+RUTGERS)

CHADWICK  63 PL 6 309            CHADWICK,CRENNELL,CAVIES,BETTINI+(OXF+PADO)
GOLDHABE  63 ATHENS CONF 92      SULAMITH GOLDHABER                    (LRL)

WOJCICKI  64 PR 135 B 484        STANLEY G WOJCICKI                    (LRL)

ADELMAN   65 ATHENS 527          STUART LEE ADELMAN              (CAVENDISH)
FERRO-LU  65 NC 36 1101          FERRO-LUZZI,GEORGE,HENRI,JONGEJANS   (CERN)
FERRO-LU  65 NC 39 417           FERRO-LUZZI,GEORGE,GOLDSCHMIDT-CLER+ (CERN)
GELSEMA   65 THESIS              E.S.GELSEMA (SEE ALSO PL 10 341)(AMSTERDAM)
WANGLER   65 PR 137 B 414        WANGLER,ERWIN,WALKER            (WISCONSIN)

BARASH    67 PR  156  1399       BARASH,KIRSCH,MILLER,TAN         (COLUMBIA)
BARLOW    67 NC  50 A  701       +MONTANET,D.ANDLAU+   (CERN+CDEF+IRAD+LIVP)
BOMSE     67 PR 158 1298         +BORENSTEIN+COLE+GILLESPIE+  (JOHN HOPKINS)
CONFORTO  67 NP B3 469           +MARECHAL,MONTANET+CERN+CDEF+IPN+LIVERPOOL
DAUBER    67 PR 153 1403         +SCHLEIN,SLATER,TICHO                (UCLA)
DE BAERE  67 NC 51 A 401         +GOLDSCHMIDT-CLERMCNT,HENRI+    (BRUX+CERN)
FRENCH    67 NC 42A 442          +KINSON+MCDONALD+RIDDIFORD+     (CERN+BIRM)
GEORGE    67 NC 49A 9            +GOLDSCHMIDT-CLERMCNT+HENRI+    (CERN+BRUX)
SALLSTRO  67 NC 49A 348          SALLSTROM+OTTER+EKSPCNG         (STOCKHOLM)

DE WIT    68  THESIS             S. DE WIT                       (AMSTERDAM)
FICENEC1  68 PR 169 1034         +HULSIZER+SWANSON+TROWER              (ILL)
FICENEC2  68 PR 175 1725         FICENEC, GORDON, TROWER          (ILLINOIS)
KANG      68 PR 176 1587         Y.W.KANG                             (IOWA)
SCHWEING  68 PR 166 1317         SCHWEINGRUBER,DERRICK,FIELDS+    (ANL+NWES)

CRENNELL  69 PRL 22  487         +KARSHON,LAI,ONEALL,SCARR             (BNL)
DAVIS     69 PRL 23 1071         +DERENZO,FLATTE,ALSTON,LYNCH,SOLMITZ  (LRL)
DE BAERE  69 NC 61 A 397         +GOLDSCHMIDT-CLERMCNT,HENRI,+   (BELG+CERN)
FRIEDMAN  69  UCRL-18860         J.FRIEDMAN,PH.D. THESIS               (LRL)
JUHALA    69 PR 184  1461        +LEACOCK,RHODE,KOPELMAN,LIBBY,+ (ISU+COLO)
LIND      69 NP B 14 1           +ALEXANDER,FIRESTONE,FU,GOLDHABER     (LRL)

ATHERTCN  70 NP B 16 416         +FRANEK,FRENCH,FRISK,BEDNAR+    (CERN+PRAG)
DE BAERE  70  CERN PHYS 70 41    +DEBAISIEUX,DE WOLF,DUFOUR,+    (BELG+CERN)
HABER     70 NP B 17 289         +SHAPIRA,ALEXANDER+   (REHO+SACL+BGNA+EPOL)

AGUILAR   71 PRL 26 466          +BARNES,BASSANO,EISNER,KINSON,SAMIOS  (BNL)
AGUILAR1  71 PR D 4 2583         +EISNER,KINSON                        (BNL)
BARNHAM   71 NP B 28 171         +COLLEY,JOBES,GRIFFITHS,HUGHES,+(BIRM+GLAS)
BUCHNER   71 NP B 29 381         +DEHM,GOEBEL,GOLDSCHMIDT,+ (MPIM+CERN+BELG)
CORDS     71 PR D 4 1974         +CARMONY,ERWIN,MEIERE,+      (PURD+UCD+IUPU)
MERCER    71 NP B32 381          +ANTICH,CALLAHAN,CHIEN,COX,+ (JOHN HOPKINS)
YUTA      71 PRL 26 1502         +DERRICK,ENGELMANN,MUSGRAVE       (ANL+EFI)

ABRAMOVI  72 NP B 39 189         ABRAMCVICH,CHALOUPKA,CHUNG,HILPERT,+ (CERN)
BINGHAM   72 NP B 41 1           +          (INTERNATIONAL K+ COLLABORATION)
BEMPORAD  72 NP B 51 1           +BEUSCH,FREUDENREICH,+      (CERN+ETHZ+LOIC)
BRUNET    72 NP B 37 114         +DANYSZ,GOLDSACK,+     (CDEF+SACL+LOIC+LOWC)
BUCHNER   72 NP B 45 333         +DEHM,CHARRIERE,CORNET,+   (MPIM+CERN+BRUX)
CHARRIER  73 NP B 51 317         CHARRIERE,ORIJARD,DE BAERE,+    (CERN+BELG)
CRENNELL  72 PR D 6 1220         +GCRDON,KWAN-WU LAI,SCARR             (BNL)
DEUTSCHM  72 NP B 36 373         DEUTSCHMANN,+           (ABCLV COLLABCRATION)
ENGELMAN  72 PR D 5 2162         ENGELMANN,MUSGRAVE,FORMAN,+       (ANL+EFI)
ROUGE     72 NP B 46 29          +VIDEAU,VOLTE,DE BRICN,+        (EPCL+SACL)
TIECKE    72 NP B 39 596         +GRIJNS,HEINEN,DE GROOT,+       (NIJM+ZEEM)
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Mesons

K*(892), κ(1250)

Data Card Listings

For notation, see key at front of Listings.


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BERTHCN   73 NP B 63 54      +MONTANET,PAUL,BERTRANET,+        (CERN+SACL)
CLARK     73 NP B 54 432     +LYONS,RADOJICIC                      (OXFORD)
LEWIS     73 NP B 60 283     +ALLEN,JACOBS,DANYSZ,BORG,+(LOWC+LOIC+CDEF)
LINGLIN   73 NP B 55 408     D.LINGLIN                               (CERN)
WALUCH    73 PR D 8 2837     +FLATTE,FRIEDMAN                         (LBL)

FOX       74 NP B80 403      G.C.FOX,M.L.GRISS                        (CIT)
MATISCN   74 PR D9 1872      +GALTIERI,GARNJOST,FLATTE,FRIEDMAN,+     (LBL)

BRANDENB  75 PL 59 B 405     BRANDENBURG,CARNEGIE,CASHMCRE,DAVIER+(SLAC)
CARITHER  75 PRL 35 349      CARITHERS,MUHLEMANN,UNDERWOOD,+ (ROCH+MCGI)
MCCUBBIN  75 NP B86 13       N.A.MCCUBBIN,L.LYONS                     (OXF)
PALER     75 NP B96 1        +TOVEY,SHAH,SPIRO,CHAURAND+(RHEL+SACL+EPCL)
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κ(1250)

19 K PI S WAVE, CALLED KAPPA

S-Wave Kπ Interactions in the Region 750-1700 MeV

Kπ interactions in the $I(J^P)=1/2(0^+)$ wave can be described by the elastic phase shift δ_0^1 from the Kπ threshold (∼630 MeV) up to at least 1100 MeV (BINGHAM 72). The first inelastic S-wave thresholds are Kπππ and Kη, neither of which is known to be important below 1400 MeV. Apart from the inelastic thresholds, the S-wave ππ and Kπ interactions are reminiscent of each other.

All phase-shift solutions (MERCER 71, BINGHAM 72, FIRESTONE 71, 72, MATISON 72, 74, BAKER 73, GALTIERI 73, YUTA 73, FOX 74, LAUSCHER 75) share the following intrinsic ambiguities:

1) The standard modulo-180° ambiguity.
2) If one amplitude is dominant [the P wave near $K^*(892)$ or the D wave near $K^*(1420)$], then the observed S-P or S-D interference can be explained by two ambiguous S-wave solutions, known as "up" and "down". For an illustration see our 1972 edition.

The resulting "up-down" ambiguity of the S-wave phase shift in the $K^*(892)$ region (BINGHAM 72) was restricted by an analysis of 12 GeV/c $K^+p \to K^+\pi^-\Delta^{++}$ (MATISON 72, 74, GALTIERI 73) to only two points at 890 and 900 MeV, where the P wave goes through 90°. The "up" solution is therefore excluded, except for a possibility of a very narrow (Γ < 7 MeV) S-wave resonance. Moreover, CHUNG 72 imposes positivity on physical-region Kπ moments, and finds a narrow resonance most unlikely.

FIRESTONE 71 and 72 have continued Kπ partial-wave analysis up to 1700 MeV. They find that δ_0^1 crosses 90° near 1300 MeV, and indeed shows the "up-down" ambiguity near the $K^*(1420)$.

Meanwhile several groups have attempted to clarify the situation around 1300 MeV. CORDS 72, FRATI 72, ROUGE 72, and LAUSCHER 75 give support to the resonant S-wave interpretation of FIRESTONE 71. The other groups (AGUILAR 72, BUCHNER 72, CRENNELL 72, ENGELMANN 72, BAKER 73) agree that the S wave is important but not necessarily resonant.

In a review of the status of the 0^+ nonet, MORGAN 75 shows that the resonant interpretation, κ(1250), is consistent with the information on the other S-wave systems, ππ, $K\bar{K}$, and ηπ (see the corresponding mini-reviews), suggesting a non-ideally mixed nonet.

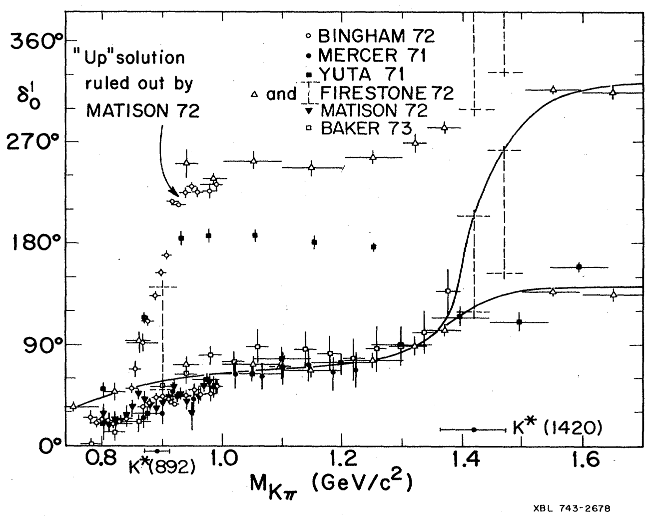

Fig. 1. The S-wave Kπ phase shift. An "up-down" ambiguity occurs at the mass of K*(892), K*(1420), ..., which can be resolved by precise measurement of σ(Kπ). At K*(892), the "up" solution was ruled out by MATISON 72; earlier "up" solutions are plotted only to show historical progress.

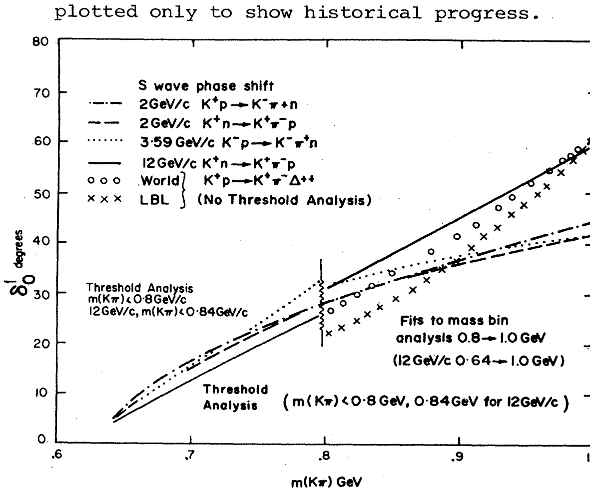

Fig. 2. Summary of six different S-wave Kπ phase-shift analyses, including four solutions of FOX 74. (Figure from FOX 74.)

Data Card Listings

For notation, see key at front of Listings.

Mesons

κ(1250), Q

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                 19  KAPPA MASS (MEV)

M        1250.    100.            MORGAN   75 RVUE            12/75*
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                 19  KAPPA WIDTH (MEV)

W        (450.)   APPROX.         MORGAN   75 RVUE            12/75*
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                              REFERENCES FCR KAPPA

TRIPPE   68 PL 28 B 203          +CHIEN,MALAMUD,MELLEMA,SCHLEIN,+     (UCLA)

CRENNELL 69 PRL 22 487           +KARSHON,LAI,O.NEALL,SCARR             (BNL)
DODD     69 PR 177 1994          +JOLDERSMA,PALMER,SAMIOS               (BNL)
GOLDBERG 69 PL 30 B 434          SABRE COLLABOR.  (SACL+AMST+BGNA+REHO+EPOL)
SCHLEIN  69 ARGONNE CONF. 446 P.SCHLEIN                               (UCLA)

FIRESTON 71 PRL 26 1460          A.FIRESTONE,G.GOLDHABER,D.LISSAUER     (LRL)
MERCER   71 NP B32 381           +ANTICH,CALLAHAN,CHIEN,COX,+ (JOHN HOPKINS)
YUTA     71 PRL 26 1502          +DERRICK,ENGELMANN,MUSGRAVE        (ANL+EFI)

AGUILAR  72 PR D 6 11            AGUILAR-BENITEZ,CHUNG,EISNER           (BNL)
BINGHAM  72 NP B 41 1            +            (INTERNATIONAL K+ COLLABORATION)
BUCHNER  72 NP B 45 333          +DEHM,CHARRIERE,CORNET,+   (MPIM+CERN+BRUX)
CHUNG    72 PRL 29 1570          +EISNER,AGUILAR-BENITEZ                (BNL)
CRENNELL 72 PR D 6 1220          +GORDON,KWAN-WU LAI,SCARR              (BNL)
DIEBOLD  72  BATAV.CONF.         R.DIEBOLD  RAPPORTEUR TALK             (ANL)
ENGELMAN 72 PR D 5 2162          ENGELMANN,MUSGRAVE,FORMAN,+        (ANL+EFI)
FIRESTON 72 PR D 5 2188          +GOLDHABER, LISSAUER, TRILLING      (LBL)PWA
FRATI    72 PR D 6 2361          +HALPERN,HARGIS,SNAPE,CARNAHAN,+(PENN+CINC)
ROUGE    72 NP B 46 29           +VIDEAU,VOLTE,DE BRION,+         (EPOL+SACL)
MATISON  72 LBL 1537 (THESIS) REVISED VERSION WILL GO TC PHYS.REV.   LBL

BAKER    73  IC/HEP/73/12        +BANNERJEE,CAMPBELL,HALL,ISLAM,+(LOIC+LOWC)
CORDS    73 NP B 54 109          +CARMONY,LANDER,MEIERE,+    (PURD+UCD+IUPU)
GALTIERI 73  PREP.LBL 1772       +MATISON,GARNJOST,FLATTE,FRIEDMAN,+    (LBL)
LINGLIN  73 NP B 55 408          D.LINGLIN                             (CERN)
YUTA     73 NP B 52 70           +ENGELMANN,MUSGRAVE,FCRMAN,+       (ANL+EFI)

FOX      74 NP B80 403           G.C.FOX,M.L.GRISS                      (CIT)
MATISON  74 PR D9 1872           +GALTIERI,GARNJCST,FLATTE,FRIEDMAN,+   (LBL)
   ALSO  72 MATISON,73 GALTIERI
MORGAN   74 PL 51B 71            D.MORGAN                              (RHEL)

BAKER    75 NP B99 211           +BANERJEE,CAMPBELL,ALLEN,MARCH+ (LOIC+LOWC)
LAUSCHER 75 NP B86 189           +OTTER,WIECZOREK,+     (ABCLV COLLABORATION)
MORGAN   75  PREPRINT RL75133 D.MORGAN                                 (RHEL)

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Q REGION, $K\pi\pi$(1240–1400)

28 Q REGION (1200–1400) MEV I=1/2

The main effect in the Q region is a broad bump in the $K\pi\pi$ spectrum between 1200 and 1400 MeV (not far above the $K^*(892)\pi$ threshold), produced by K beams without charge exchange. In particular, it has been observed in coherent K^+d interactions (FIRESTONE 72) and in coherent interactions on heavy nuclei (BINGHAM 73). Throughout the entire region, $J^P = 1^+$ and $I = 1/2$.

Evidence for narrower states in the Q region has been reported from reactions with incident π^- and $\bar{p}$ (ASTIER 69, CRENNELL 67, 72, DAVIDSON 74, DORE 75). FIRESTONE1 72 observe a bump in the backward direction with a shape similar to that of the Q. WERNER 73 find no evidence for narrow states in the charge-exchange reaction $K^-p \to (K\pi\pi)^0 n$, but the data can accommodate some broad Q production. The $(K\pi\pi)^0$ system appears to have an important $J^P=1^+$ contribution (OTTER1 75).

The broad Q peak does not have a simple Breit-Wigner shape. It can be fitted at all energies by a superposition of two Breit-Wigner amplitudes (FIRESTONE 70, BARNHAM 71, BOWLER 71, BARLOUTAUD 73).

Dalitz plot analyses of the interference between the $K^*\pi$ and $K\rho$ modes show the relative magnitude and relative phase of the two decay amplitudes varying with $K\pi\pi$ mass. The $K\rho$ mode has a maximum intensity below that of $K^*\pi$. This is suggestive of the presence of two $J^P=1^+$ states, possibly mixtures of the strange members of the $J^{PC}=1^{++}$ ("A_1") and 1^{+-} (B) nonets (GOLDHABER 67, BARNHAM 71, BOWLER 71, GARFINKEL 71, BINGHAM 72, FIRESTONE 72, BOWLER 74). In addition to the dominant modes $K^*\pi$ and $K\rho$, there is some evidence for a $K\pi\pi$ mode, with the $\pi\pi$ or the $K\pi$ system in an S wave (ALEXANDER 69, BARNHAM 71, DAVIS 72, BARLOUTAUD 73).

Recent partial-wave analyses have confirmed the rather complex situation in the Q region (DEUTSCHMANN 74, ANTIPOV 75, OTTER2 75, OTTER3 75, TOVEY 75, BRANDENBURG 76). Although $J^P=1^+$ is the dominant contribution, other spin-parity states are necessary to describe the whole Q enhancement. Moreover, the $K^*\pi$ and $K\rho$ modes are not produced coherently and have different polarization properties (OTTER2 75, OTTER3 75, TOVEY 75, BRANDENBURG 76). Whereas the $K\rho$ mode approximately conserves s-channel helicity, the $K^*\pi$ mode is approximately t-channel helicity-conserving.

ANTIPOV 75 do not require the $K\rho$ decay mode to be present at 40 GeV/c.

ANTIPOV 75 and OTTER2 75 find no variation in the phase of the 1^+ $K^*\pi$ wave. On the other hand BRANDENBURG 76, with high-statistics spectrometer data, observe sufficient phase variation of both the 1^+ $K\rho$ and $K^*\pi$ waves to warrant proposing the existence of two 1^+ mesons, superposed on a large 1^+, mainly $K^*\pi$, Deck background. The first state has $M \sim 1300$ MeV, $\Gamma \sim 200$ MeV and decays mainly to $K\rho$; the second has $M \sim 1400$ MeV, $\Gamma \sim 160$ MeV and decays mainly to $K^*\pi$.

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Mesons

Q

Data Card Listings

For notation, see key at front of Listings.

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                    28  Q REGION MASS  (MEV)

M    PRODUCED BY BEAMS CTHER THAN K MESONS
M  A       1242.0      9.0      10.0  ASTIER     69 HBC    0 PBAR P          . 9/69
M  A    THIS IS THE C MESCN.
M       45(1300.)                     CRENNELL  67 HBC    0 6 PI- P,LK2PI     7/67
M       40(1300.)                     CRENNELL  72 HBC    0 4.5PI-P,LK2PI    12/72
M       40(1278.)     (5.)            DAVIDSCN  74 HBC  +- 1.6-2.2 PBAR P    12/75*
M       43(1235.)    (10.)            DORE      75 OSPK   06.2 PI-P,L MM     12/75*

M    PRODUCED BY K BEAMS
M       12(1320.0)   (25.0)           ALMEIDA   65 HBC  +   3-5 K+  P        12/72
M   C     (1230.0)   (15.0)           BASSOMPIE 67 HBC  +   5. K+ P          11/67
M   C   35(1280.0)   (10.0)           BASSOMPIE 67 HBC  +   5. K+ P          11/67
M   C     (1320.0)   (15.0)           BASSOMPIE 67 HBC  +   5. K+ P          11/67
M   C   SPLIT THE Q REGICN INTO 3 BUMPS
M         (1270.)    APPROX.          DE BAERE  67 HBC  +   3.5 K+ P          7/67
M         (1335.0)    (6.0)           BARTSCH   68 HBC      10. K-P,K NPI   .12/75*
M         (1300.)    APPROX.          BARBARO   69 HBC  +   12.K+ P (K 2PI)   9/69
M       45(1301.0)   (10.0)           BISHCP    69 HBC  +   3.5 K+P(K* PI)   12/75*
M       21(1300.0)   (10.0)           ERWIN     69 HBC    0 3.5 K+P(K* PI)   12/75*
M         (1281.)     (7.)            FRIEDMAN  69 HBC  -   2.6,2.7 K- P     12/75*
M         (1300.0)   (10.0)           ABRAMS    70 HBC  +   2.5-3.2 K+ P     12/75*
M         (1260.)    (20.)            FARBER    70 HBC  +   12.7 K+ P       .12/75*
M         (1325.0)                    DENEGRI   71 DBC  - 12.6 K-D,K 2PI D  12/75*
M         (1296.)     (5.)            BARLOUTAU 73 HBC  -  14.3 K-P,P K-2PI  12/75*
M         (1283.)     (6.)            BARLOUTAU 73 HBC  -  14.3 K-P,P K02PI  12/75*
M         (1315.)     (7.)            BINGHAM   73 HLBC -  5.5-12.7 COH K-A  12/75*
M         (1260.)    (10.)            LEWIS     73 HBC  +  2.1-2.7 K+ P      12/75*
M   F     (1260.)     (5.)            LEWIS     73 HBC  +  2.1-2.7 K+ P      12/75*
M   F   FROM NON-PERIPHERAL EVENTS (T GT 0.8)
M
M    AVERAGING NOT MEANINGFUL

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                    28  Q LCW (QA)  MASS  (MEV)

ML F    FRCM EXPERIMENTS SPLITTING Q REGION INTO TWO PEAKS
ML
ML        (1280.)                     SHEN      66 HBC  + 0 4.6 K+P,5 BODY   12/72
ML        (1260.0)   (10.0)           ALEXANDER 69 HBC      9.0 K+ P         12/75*
ML        (1240.0)    (5.0)           BARNHAM   70 HBC  +  10.0 K+P,K 2PI    12/75*
ML        (1243.)     (8.)            GARFINKEL 71 DBC  +  9. K+ D           12/75*
ML        (1228.)    (14.)            ANDERSON  72 DBC  -  7.3 K- D          12/75*
ML        (1260.)                     DAVIS     72 HBC  +  12. K+ P          12/72
ML        (1234.)    (12.)            FIRESTONE 72 DBC  +  12. K+ D           2/73
ML C      (1300.)    APPROX.          BRANDENB  76 ASPK +- 13 K+-P,(KPIPI)P  12/75*
ML C    COUPLES MAINLY TO RHO K
ML
ML   AVERAGING NOT MEANINGFUL

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                    28  Q HIGH (QB)  MASS  (MEV)

MH F    FROM EXPERIMENTS SPLITTING Q REGICN INTO TWO PEAKS
MH
MH      70(1320.0)   (10.0)           SHEN      66 HBC  +   4.6 K+  P        12/75*
MH        (1380.0)   (20.0)           ALEXANDER 69 HBC      9.0 K+ P         12/75*
MH        (1420.0)    (5.0)           BARNHAM   70 HBC  +  10.0 K+P,K 2PI    12/75*
MH        (1344.)     (8.)            GARFINKEL 71 DBC  +  9. K+ C           12/75*
MH        (1414.)    (15.)            ANDERSON  72 DBC  -  7.3 K- D          12/75*
MH        (1420.)                     DAVIS     72 HBC  +  12. K+ P          12/72
MH         1368.      18.             FIRESTONE 72 DBC  +  12. K+ D          12/75*
MH D      (1400.)    APPROX.          BRANDENB  76 ASPK +- 13 K+-P,(KPIPI)P  12/75*
MH D    COUPLES MAINLY TO K* PI
MH
MH   AVERAGING NOT MEANINGFUL

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                    28  Q  REGICN WIDTH  (MEV)

W    PRODUCED BY BEAMS OTHER THAN K MESONS
W          127.0       7.0      25.0  ASTIER    69 HBC    0 PBAR P          . 9/69
W      45  (60.)                      CRENNELL  67 HBC    0 6 PI- P           7/67
W      40  (60.)                      CRENNELL  72 HBC    0 4.5PI-P,LK2PI    12/72
W  D   40  (25.)     (15.)            DAVIDSON  74 HBC  +- 1.6-2.2 PBAR P    12/75*
W  D   ERROR INCREASED BY US. SEE K* TYPED NOTE.
W      43  (30.)     (25.)    (18.)   DORE      75 OSPK   06.2 PI-P,L MM     12/75*

W    PRCDUCED BY K BEAMS
W      12  (60.0)    (20.0)           ALMEIDA   65 HBC  +   3-5 K+P          12/72
W  C       (60.0)    (20.0)           BASSOMPIE 67 HBC  +   5. K+ P          11/67
W  C   35  (80.0)    (20.0)           BASSOMPIE 67 HBC  +   5. K+ P          11/67
W  C       (60.0)    (20.0)           BASSCMPIE 67 HBC  +   5. K+ P          11/67
W  C   SPLIT THE Q REGION INTO 3 BUMPS
W         (200.)     APPROX.          DE BAERE  67 HBC  +  3.5 K+ P           7/67
W         (196.0)    (16.0)           BARTSCH   68 HBC     10. K- P,K NPI   .12/75*
W  B        250. APPROX.              BARBARO   69 HBC  +   12.K+ P (K 2PI)   9/69
W  B        NO BACKGROUND SUBTRACTION.
W      45  (40.0)    (10.0)           BISHOP    69 HBC  +   3.5 K+P(K* PI)   12/75*
W      21  (40.0)    (15.0)           ERWIN     69 HBC    0 3.5 K+P(K* PI)   12/75*
W          (51.)     (22.)            FRIEDMAN  69 HBC  -   2.6,2.7 K- P     12/75*
W          (80.0)    (20.0)           ABRAMS    70 HBC  +   2.5-3.2 K+ P     12/75*
W         (180.)     (28.)            FARBER    70 HBC  +   12.7 K+ P       .12/75*
W         (180.0)                     DENEGRI   71 CBC  - 12.6 K-D,K 2PI D   5/71
W         (326.)     (17.)            BARLOUTAU 73 HBC  -  14.3 K-P,P K-2PI  12/75*
W         (266.)     (21.)            BARLOUTAU 73 HBC  -  14.3 K-P,P K02PI  12/75*
W         (150.)     (70.)            LEWIS     73 HBC  +  2.1-2.7 K+ P      12/75*
W  F       (47.)     (18.)            LEWIS     73 HBC  +  2.1-2.7 K+ P      12/75*
W  F   FROM NON-PERIPHERAL EVENTS (T GT 0.8)
W
W    AVERAGING NOT MEANINGFUL

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                    28  Q LCW (QA)  WIDTH  (MEV)

WL F    FROM EXPERIMENTS SPLITTING Q REGION INTO TWO PEAKS
WL
WL        (100.0)    (20.0)           SHEN      66 HBC  + 0 4.6 K+P,5 BODY   12/75*
WL         (40.0)    (10.0)           ALEXANDER 69 HBC      9.0 K+ P         12/75*
WL        (110.0)    (15.0)           BARNHAM   70 HBC  +  10.0 K+P,K 2PI    12/75*
WL         (70.)     (26.)    (18.)   GARFINKEL 71 DBC  +  9. K+ D           12/75*
WL        (111.)     (33.)            ANDERSON  72 DBC  -  7.3 K- D          12/75*
WL        (120.)                      CAVIS     72 HBC  +  12. K+ P          12/72
WL        (188.)     (21.)            FIRESTONE 72 DBC  +  12. K+ D          12/75*
WL C      (200.)     APPROX.          BRANDENB  76 ASPK +- 13 K+-P,(KPIPI)P  12/75*
WL C    COUPLES MAINLY TC RHO K
WL
WL   AVERAGING NOT MEANINGFUL

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                    28  Q HIGH (QB)  WIDTH  (MEV)

WH F    FROM EXPERIMENTS SPLITTING Q REGICN INTO TWO PEAKS
WH
WH      70  (80.0)   (20.0)           SHEN      66 HBC  +   4.6 K+P          12/75*
WH         (120.0)   (20.0)           ALEXANDER 69 HBC      9.0 K+ P         12/75*
WH         (120.0)   (15.0)           BARNHAM   70 HBC  +  10.0 K+P,K 2PI    12/75*
WH          (60.)    OR LESS          GARFINKEL 71 DBC  +  9. K+ D           12/72
WH          (89.)    (24.)            ANDERSON  72 CBC  -  7.3 K- D          12/75*
WH          (80.)                     DAVIS     72 HBC  +  12. K+ P          12/72
WH         (241.)    (30.)            FIRESTONE 72 DBC  +  12. K+ D          12/75*
WH D       (160.)    APPRCX.          BRANDENB  76 ASPK +- 13 K+-P,(KPIPI)P  12/75*
WH D    COUPLES MAINLY TO K* PI
WH
WH   AVERAGING NOT MEANINGFUL

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                    28  Q REGION PARTIAL DECAY MODES

                                                            DECAY MASSES
P1      Q REGION INTO K*(892) PI                          892+ 139
P2      Q REGION INTO K RHO                               497+ 773
P3      Q REGION INTO K PI                                497+ 139
P4      Q REGION INTO K ETA                               497+ 548
P5      Q REGION INTO K CMEGA                             497+ 783
P6      Q REGION INTO K PI PI                             497+ 139+ 139

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                    28  Q REGICN BRANCHING RATIOS

     PRODUCED BY BEAMS OTHER THAN K MESONS
R1      Q REGION INTO (K RHO)/TOTAL (UNITS OF 10**-2)      (P2)
R1            75.0       10.0          ARMENTERO 64 HBC      0.0 PBAR P        6/66
R1          DOMINANT                   CRENNELL  72 HBC    0 4.5PI-P,LK2PI    12/72

R2      Q REGICN INTO (K* PI)/TOTAL (UNITS OF 10**-2)      (P1)
R2            25.0       10.0          ARMENTERO 64 HBC      0.0 PBAR P        6/66

R3      Q REGICN INTO (K+ PI-) / (K+0 PIO+ PI-)
R3            (0.2)  OR LESS  CL=.90   CRENNELL  67 HBC    0 6.0 PI-P          7/67

R4      Q REGION INTO (KO PI+ PI- PIO) / (K+0 PIO+ PI-)
R4            (0.1)  OR LESS  CL=.90   CRENNELL  67 HBC    0 6.0 PI-P          7/67

     PRODUCED BY K BEAMS
R10     Q REGICN INTO (K PI) / (K*(892) PI)                (P3)/(P1)
R10           (0.8)  OR LESS           SHEN      66 HBC     4.6 K+P, 5 BODY  11/67
R10         Q REGION       INTO K*(892) PI AND K RHO (OVERLAPPING BANDS)(P1+P
R10      70   (1.0)                    SHEN      66 HBC  +   4.6 K+P           8/66

R11     Q REGICN INTO (K OMEGA)/(K*(892) PI)               (P5)/(P1)
R11           (0.1)  OR LESS           SHEN      66 HBC  +   4.6 K+P          10/66

R12     Q REGICN INTO (K PI) / (K*(892) PI)                (P3)/(P1)
R12           (0.30) OR LESS           SHEN      66 HBC  +   4.6 K+P          10/66

R13     Q REGICN INTO K*(892) PI AND K RHO (OVERLAPPING BANDS)
R13                                                        (P1+P2)
R13     200   (1.0)                    BERLINGHI 67 HBC  +   12.7 K+ P         7/67

R14     Q REGION INTO (K PI) / TOTAL                       (P3)
R14           (0.02) OR LESS           BERLINGHI 67 HBC  +   12.7 K+ P        11/67
R14           (0.02) OR LESS  CL=.95   BARTSCH   68 HBC   - 10.0 K- P

R15     Q REGION INTO (K ETA) / TCTAL                      (P4)
R15           (0.02) OR LESS           BERLINGHI 67 HBC  +   12.7 K+ P        11/67

R16     Q REGION INTO (K CMEGA) / TCTAL                    (P5)
R16           (0.02) OR LESS           BERLINGHI 67 HBC  +   12.7 K+ P        11/67
R16      12    0.01      0.005         BARTSCH   68 HBC   -  10.0 K- P         9/68

R17     Q REGION INTO (K RHO) / (K*(892) PI)               (P2)/(P1)
R17            0.91      0.25          BERLINGHI 67 HBC  +   12.7 K+ P        11/67
R17     701    0.4       0.1           BARTSCH   68 HBC   - 10.0 K- P          9/68
R17          . . . . . . . . .
R17 AVG        0.47      0.18     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)
R17 STUDENT    0.46      0.11     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R18     Q REGION INTO (K PI) / (K*(892) PI)                (P3)/(P1)
R18           (0.21) OR LESS           DE BAERE  67 HBC  +   3.5 K+ P         11/66

R19     Q REGION INTO (K PI PI) / TOTAL                    (P6)
R19     201    0.22      0.08          BARTSCH   68 HBC   - 10.0 K- P          9/68
R19  S      POSSIBLY SEEN              ALEXANDER 69 HBC      9.0 K+ P          2/73
R19  S      POSSIBLY SEEN              DAVIS     72 HBC  +  12. K+ P           1/73
R19  S   WITH THE (PI PI) SYSTEM IN S-WAVE                                     1/73

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                      REFERENCES FOR Q REGICN

      PRODUCED BY BEAMS OTHER THAN K MESCNS

ARMENTER 64 DUBNA CONF 1 577  ARMENTEROS,EDWARDS,D-ANDLAU +   (CERN+CDEF)
    ALSO 64 DUBNA CONF 1 617  R ARMENTEROS (RAPPORTEUR)
    ALSO 66 PR  145  1095     BARASH,KIRSCH,MILLER,TAN            (COLUMBIA)
CRENNELL 67 PRL 19  44        +KALBFLEISCH,LAI,SCARR,SCHUMANN        (BNL)I
ASTIER   69 NP B 10 65        +MARECHAL,MONTANET,+  (CDEF+CERN+IPNP+LIVP)IJP
BETTINI  69 NC 62 A 1038      +CRESTI,LIMENTANI,BERTAUZA,BIGI+(PADO+PISA)I
CRENNELL 72 PR D 6 1220       +GORDON,KWAN-WU LAI,SCARR                (BNL)
DAVIDSON 74 PR D9 77          +CHAPMAN,GREEN,LYS,ROE                  (MICH)
DORE     75 LNC 13 265        +GUIDONI,LAAKSO,MARINI,CONFORTO+(ROMA+RHEL)

      PRODUCED BY K BEAMS

ALMEIDA  65 PL 16 184         ALMEIDA,ATHERTON,BYER,DORNAN,FORSON+ (CAVE)

SHEN     66 PRL  17  726      +BUTTERWORTH,FU,GOLDHABERS,TRILLING    (LRL)
    ALSO 66  (PRIVATE COMMUN)GERSCN GOLDHABER                        (LRL)

BASSOMPI 67 PL 26B 30         BASSOMPIERRE,GOLDSCHMIDT+  (CERN+BRUX+BIRM)IJP
BERLINGH 67 PRL 18 1087       BERLINGHIERI+FARBER+FERBEL+FORMAN     (ROCH)IJP
DE BAERE 67 NC 49A 374        +DEBAISIEUX+FAST+FILIPPAS+        (CERN+BRUX)
    ALSO PRIVATE COMMUNICATION BY B. JONGEJANS
GOLDHABE 67 PRL 19 976        G.GOLDHABER                             (LBL)

BARTSCH  68 NP B8 9           +COCCONI,+        (AACH+BERL+CERN+LOIC+VIEN)
BOMSE    68 PRL 20 1519       +BORENSTEIN,CALLAHAN,COLE,COX,+  (JOHNHOPK)  1+
DENEGRI  68 PRL 20 1194       +CALLAHAN+ETTLINGER+GILLESPIE+   (JCHNHOPK)  1+
    ALSO 70 ANTICH
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Data Card Listings

For notation, see key at front of Listings.

Mesons

Q, K*(1420)


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ALEXANDE 69 NP B 13 503          G.ALEXANDER,FIRESTONE,GOLDHABER,+      (LRL)
ANDREWS  69 PRL 22 731           +LACH,LUDLAM,SANDWEISS,BERGER,+  (YALE+LRL)
BARBARO  69 PRL 22 1207          BARBARO-GALTIERI,DAVIS,FLATTE,+        (LFL)
BISHOP   69 NP B 9 403           +GOSHAW,ERWIN,WALKER                  (WISC)
CHIEN    69 PL 29B 433           +MALAMUD,MELLEMA,RUDNICK,SCHLEIN+     (UCLA)
CHUNG    69 PR 182 1443          +EISNER+BALI+LUERS                     (BNL)
COLLEY   69 NC A 59 519          +EASTWOOD,+  (BIRM+GLAS+LCIC+MPIM+OXF+RHEL)
ERWIN    69 NP B 9 364           +WALKER,GOSHAW,WEINBERG     (WISC+PRIN+VAND)
FRIEDMAN 69  UCRL-18860          J.FRIEDMAN,PH.D. THESIS                (LRL)
WERNER   69 PR 188 2023          +AMMAR,DAVIS,KROPAC,YARGER,CHO,+ (NWES+ANL) 1+

ABRAMS   70 PR D 1 2433          +EISENSTEIN,KIM,MARSHALL,C-HALLCRAN,+ (ILL)
ANTICH   70 NP B 20 201          +CARSON,CHIEN,COX,DENEGRI,ETTLINGER,+ (JHU)  1+
BARNHAM  70 NP B 25 49           +COLLEY,GRIFFITHS,ALPER,+    (BIRM+GLAS+OXF)  1+
BOWLER   70 PL 31 B 318          M.G.BOWLER                          (OXFORD)
FARBER   70 PR D 1 78            +FERBEL,SLATTERY,YUTA                 (ROCH)  1+
FIRESTON 70 PHILAD.CONF.P.229 A. FIRESTONE REVIEW                       (LRL)

BARNHAM  71 NP B25 49            +COLLEY,GRIFFITHS,ALPER, +  (BIRM+GLAS+OXF)
BOWLER   71 BOLOGNA CONF.PROC M.G.BOWLER  INTRODUCTORY TALK         (OXFORD)
DENEGRI  71 NP B 28 13           +ANTICH,CALLAHAN,CARSON,CHIEN,COX,+   (JHU)  1+
FORMAN   71 PR D 3 2610          +GELFAND,LEARY,MOSER,SEIDL,WOLFSON    (EFI)
GARFINKE 71 PRL 26 1505          GARFINKEL,HOLLAND,CARMONY,LANDER+(PURD+UCD)  1+
SLATTERY 71  UR-875-332(PREP) P.SLATTERY,A REVIEW OF STRANGE MESONS(ROCH)

ANDERSON 72 PR D 6 1823          +FRANKLIN,GODDEN,KCPELMAN,LIBBY,TAN  (COLO)
BINGHAM  72 NP B 48 589          +EISENSTEIN,GRARD,HERQUET,+      (CERN+BRUX)
BRANDENB 72 NP B 45 397          BRANDENBURG,BRODY,JOHNSON,LEITH,LOOS+(SLAC)
BRANDENB 72 PRL 28 932           BRANDENBURG,JOHNSON,LEITH,LOOS,LUSTE+(SLAC)
DAVIS    72 PR D 5 2688          +ALSTON,BARBARO,FLATTE,FRIEDMAN,LYNCH+(LBL)
FIRESTON172 NP B 47 348          A.FIRESTONE                            (CIT)
FIRESTON 72 PR D 5 505           FIRESTONE,GOLDHABER,LISSAUER,TRILLING (LBL)
FRATI    72 PR D 6 2361          +HALPERN,HARGIS,SNAPE,CARNAHAN,+(PENN+CINC)
HAATUFT  72 NP B 48 78           +ARNOLD,HAGUENAUER,+  (BERG+STRB+EPOL+MADR)

BARLOUTA 73 NP B 59 374          +DREVILLON,SHAH,+           (SACL+EPOL+RHEL)  JP
BINGHAM  73 NP B 52 31           +FARWEL,+        (LBL+ORSAY+BNL+SACLAY+MILAN)  JP
DE JONGH 73 NP B 58 110          +CORNET,CHARRIERE,+   (BRUX+MONS+CERN+MPIM)
JONES    73 NP B 52 383          G.T.JONES                             (CERN)  JP
LEWIS    73 NP B 60 283          +ALLEN,JACOBS,DANYSZ,BORG,+(LOWC+LOIC+CDEF)
WERNER   73 PR D 7 1275          +SLATTERY,FERBEL                 (ROCHESTER)

ANGELOPO 74 NC 20A 49            ANGELOPOULOS,FILIPPAS+(ATHU+ATEN+LIVP+VIEN)  JP
BOWLER   74 NP B74 493           +DAINTON,KADDOURA,AITCHISCN            (OXF)
DEUTSCHM 74 PL 49B 388           CEUTSCHMANN,+     (AACH+BERL+CERN+LOIC+VIEN)  JP

ANTIPOV  75 NP B86 381           +ASCOLI,BUSNELLO,KIENZLE+    (SERP+CERN+ILL)  JP
BOWLER   75 NP B97 227           +GAME,AITCHISON,DAINTON            (OXF+DARE)
DREVILLO 75 PL 55 B 245          DREVILLCN,BORENSTEIN+        (EPOL+BOHR+COEF)  JP
DUNWOODI 75 NP B91 189           DUNMOODIE,GRANT+        (CERN+BELG+MONS+MPIM)  JP
OTTER1   75 NP B84 333           + (AACH+BERL+CERN+LOIC+VIEN+ATHU+ATEN+LIVP)  JP
OTTER2   75 NP B93 365           +RUDOLPH,RUMPF+  (AACH+BERL+CERN+LOIC+VIEN)  JP
OTTER3   75 NP B96 29            +RUDOLPH,SEYFERT+(AACH+BERL+CERN+LOIC+VIEN)I,JP
TOVEY    75 NP B95 109           +HANSEN,BORENSTEIN,BORG+    (RHEL+EPOL+SACL)I,JP

BRANDENB 76 PRL                  BRANDENBURG,CARNEGIE,CASHMCRE,DAVIER+(SLAC)  JP
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K*(1420)

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22  K*(1420,JP=2+) I=1/2

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                      22  K*(1420) MASS (MEV)

M   CHARGED ONLY, WITH FINAL STATE K PI
M    D  39 1423.      11.0              BASSANO    67 HBC   - 4.6-5.0K-P,KOPI-  12/75*
M   S   25(1440.)    (24.0)   (40.)     DE BAERE   67 HBC   + 3.5 K+P (K+ PIO)  12/75*
M   SD  13(1401.0)   (25.0)             SCHWEINGR  68 HBC   -  4.1 K- P (K PI)  12/75*
M   SD  63(1427.0)   (12.0)             SCHWEINGR  68 HBC   -  5.5 K- P (K PI)  12/75*
M   S  136(1420.0)    (20.0)            BISHOP     69 HBC   +  3.5 K+P(KO PI+)  12/75*
M      220 1416.0     10.0              CRENNELL   69 DBC   -  3.9 K-N (KOPI-)   7/69
M   SD  60(1414.)    (13.0)             LIND       69 HBC   +  9. K+ P(KO PI+)  12/75*
M     1400 1420.0      3.1              AGUILAR1   71 HBC   -  3.9,4.6 K- P     11/71
M  W D 225 1425.       8.0              BARNHAM    71 HBC   +  K+ P,KO PI+ P    12/75*
M   S  130(1418.)     (6.)              CLARK      73 HBC   -  3.3 K-P,P PI- KO 12/75*
M           . . . . . . . . . . .
M   AVG      1420.5     2.7     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT1420.4       2.9     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

M   CHARGED ONLY, WITH OTHER FINAL STATES
M       130(1400.0)   (20.0)            BADIER     65 HBC   -  3.  K- P (K*PI)  12/75*
M        20(1440.0)   (20.0)            DUBAL      68 MMS   -  11.5 K- P        12/75*
M  W D 240(1396.)     (6.)              BASSOMPIE  69 HBC   +  5 K+P (K 2PI)    12/75*
M          (1411.)    (7.)              FRIEDMAN   69 HBC   -  2.7 K-P (K 2PI)   2/72

M   CHARGED AND NEUTRAL
M       134(1404.0)   (15.0)            FOCARDI    65 HBC   -0 3.  K- P (K PI)  12/75*
M    D  55(1423.)     (24.0)            ADERHOLZ   68 HBC   -0 10 K- P (K PI)   12/75*

M   NEUTRAL ONLY
M   SD  46(1446.0)    (9.0)             DAHL       67 HBC    0 4.PI- P (KPI)    12/75*
M   S  160(1425.0)   (15.0)             KANG       68 HBC    0 4.6 K- P         12/75*
M   SD  81(1405.0)   (22.0)             SCHWEINGR  68 HBC    0 4.1 K- P (K PI)  12/75*
M   S   97(1397.0)   (19.0)             SCHWEINGR  68 HBC    0 5.5 K- P (K PI)  12/75*
M  WAD 210(1422.)     (8.0)             BASSOMPIE  69 HBC    0 5 K+P (K PI)     12/75*
M     2200 1421.1      2.6              DAVIS      69 HBC    0 12. K+ P(K+PI-)   9/69
M     1800 1419.1      3.7              AGUILAR1   71 HBC    0 3.9,4.6 K- P     11/71
M      600 1416.       6.               CORDS      71 DBC    0 9. K+ N,K+ PI- P  2/72
M     1100 1427.       3.               BUCHNER    72 DBC    0 4.6 K+ N,K+ PI-P 12/72
M    C         1420.1  4.3              LINGLIN    73 HBC    0 2-13 K+P,K+PI-    1/74
M      800 1421.6      4.2              MCCUBBIN   75 HBC    0 3.6 K-P,K-PI+N   12/75*
M           . . . . . . . . . . .
M   AVG      1421.8     1.5     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT1421.6       1.7     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

M    A    INCLUDED IN LINGLIN 73 WORLD K+P DST
M     C   FROM POLE EXTRAPOLATICN, USING WORLD K+P DST
M   D     ERRORS ENLARGED BY US TO  GAMMA/SQRT(N). SEE TYPED NCTE.
M     S   DATA WITH MASS ERROR OF 15 MEV OR MORE NOT AVERAGED
M  W      NUMBER OF EVENTS IN PEAK REEAVALUATED BY US

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                      22  K*(1420) WIDTH (MEV)

W   CHARGED ONLY, WITH FINAL STATE K PI
W    D  63    89.        45.                SCHWEINGR 68 HBC   - 5.5 K-P(KO PI-)  12/75*
W   SD 136 (110.0)      (42.0)              BISHOP    69 HBC   +  3.5 K+ P        12/75*
W   SD  60  (96.)       (50.0)              LIND      69 HBC   +  9. K+ P        .12/75*
W     1400   94.7        15.1        12.5   AGUILAR1  71 HBC   -  3.9,4.6 K- P    11/71
W  W D 225  115.         31.0               BARNHAM   71 HBC   + K+ P,KO PI+ P    12/75*
W   S  130  (42.)       (12.)               CLARK     73 HBC   -  3.3 K-P,P PI- KO 12/75*
W           . . . . . . . . . . .
W   AVG       97.4       12.1       AVERAGE (ERROR INCLUDES SCALE FACTOR CF 1.0)
W   STUDENT   97.3       13.2       AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

W   CHARGED ONLY, WITH CTHER FINAL STATES
W    D 130 (105.0)      (37.0)              BADIER    65 HBC   -  3.0 K-P         12/75*
W    D 120 (110.)       (40.0)              BASSOMPIE 69 HBC   +  5 K+P (K 2PI)   12/75*
W          (43.)        (13.)               FRIEDMAN  69 HBC   -  2.7 K-P (K 2PI)  2/72

W   CHARGED AND NEUTRAL
W      134  (92.0)      (32.0)              FOCARDI   65 HBC   -0 3.0 K- P (K PI) 12/75*
W    D  55 (175.)       (94.0)              ADERHOLZ  68 HBC   -0 10 K- P (K PI)  12/75*

W   NEUTRAL ONLY
W   SD  46  (61.0)      (36.0)              DAHL      67 HBC    0 3.8-4.2 PI- P   12/75*
W   SD 160 (116.0)      (37.0)              KANG      68 HBC    0 4.6 K- P        12/75*
W  WAD 210 (110.)       (30.0)              BASSOMPIE 69 HBC    0 5 K+P (K PI)    12/75*
W     2200  101.         10.                DAVIS     69 HBC    0 12. K+ P (K PI)  9/69
W     1800  116.6        10.3        15.5   AGUILAR1  71 HBC    0 3.9,4.6 K- P    11/71
W    D 600  144.         24.0               CORDS     71 CBC    0 9. K+ N,K+ PI- P 12/75*
W    D1100  109.         14.0               BUCHNER   72 DBC    0 4.6 K+ N,K+ PI-P 12/75*
W   C        (61.0)     (14.0)              LINGLIN   73 HBC    0 2-13 K+P,K+PI-    1/74
W      800  116.         18.                MCCUBBIN  75 HBC    0 3.6 K-P,K-PI+N  12/75*
W           . . . . . . . . . . .
W   AVG      110.9        6.2       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT 110.8         7.0       AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

W    A    INCLUDED IN LINGLIN 73 WORLD K+P DST
W    C    FROM POLE EXTRAPOLATION, USING WORLD K+P DST
W     D   ERRORS ENLARGEC BY US TO 4*GAMMA/SQRT(N). SEE K* TYPED NOTE.
W    S    DATA WITH MASS ERROR OF 15 MEV OR MORE NOT AVERAGED
W  W      NUMBER OF EVENTS IN PEAK REEAVALUATED BY US

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                      22  K*(1420) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      K*(1420) INTO K PI                               493+ 139
P2      K*(1420) INTO K*(892) PI                         892+ 139
P3      K*(1420) INTO K RHO                              493+ 773
P4      K*(1420) INTO K CMEGA                            493+ 783
P5      K*(1420) INTO K ETA                              493+ 548

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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

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        P 1          P 2          P 3          P 4          P 5
 P 1 .5613+-.0263
 P 2   -.3003    .3087+-.0214
 P 3   -.3784      -.1481    .C655+-.0167
 P 4   -.2841      -.3029      -.1163   .0448+-.0169
 P 5   -.4371      -.2957      -.0808      -.0499   .0197+-.0200

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                      22  K*(1420) BRANCHING RATIOS

R1       K*(1420) INTO (K PI)/TOTAL                         (P1)
R1  R         (0.37)    (0.19)          BADIER    65 HBC      3.0 K-P             6/66
R1  R         (0.39)    (0.11)          BASSANO   67 HBC   -  4.6, 5.0 K- P      10/67
R1  R          WE CANNOT USE THIS STATISTICALLY REDUNDANT RATIO. AUTHORS
R1  R          OBTAIN IT MERELY BY SUBTRACTING FROM UNITY THEIR
R1  R          MEASUREMENTS CF OTHER RATIOS.
R1          . . . . . . . . . . .
R1  FIT        0.561     0.026   FRCM FIT

R2       K*(1420) INTO (K*(892) PI) / TOTAL                 (P2)
R2  Q          (.41)    (0.14)          BADIER    65 HBC      3.0 K-P             6/66
R2  Q         (0.47)    (0.10)          BASSANO   67 HBC   -  4.6, 5.0 K- P      10/67
R2          . . . . . . . . . . .
R2  FIT        0.3C9     0.021   FRCM FIT

R3       K*(1420) INTO (K RHO)/TOTAL                        (P3)
R3  Q         (0.14)    (0.05)          BADIER    65 HBC      3.0 K-P             6/66
R3  Q         (0.14)    (0.10)          BASSANO   67 HBC    0 4.6, 5.0 K- P      10/67
R3          . . . . . . . . . . .
R3  FIT        0.065     0.017   FRCM FIT

R4       K*(1420) INTO (K CMEGA)/TOTAL                      (P4)
R4             0.07      0.04           BADIER    65 HBC      3.0 K-P             6/66
R4          . . . . . . . . . . .
R4  FIT        0.045     0.017   FRCM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R5       K*(1420) INTO (K ETA)/TOTAL                        (P5)
R5             0.02      0.02           BADIER    65 HBC      3.0 K-P             6/66
R5            (0.025)OR LESS            BASSCMPIE 69 HBC      5.0 K+ P            9/68
R5          . . . . . . . . . . .
R5  FIT        0.020     0.020   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R6       K*(1420) INTO (K*(892) PI) / (K PI)                (P2)/(P1)
R6        6    0.33      0.33           CHUNG     65 HBC  + 0  3.9-4.2 PI- P      8/66
R6             0.65      0.20           SHEN      66 HBC    0  N* PRODUCED       10/66
R6  Q         (0.63)    (0.20)          SHEN      66 HBC  +    NO N* PRODUCED    10/66
R6             0.52      0.12           SCHWEINGR 68 HBC    0 4.1+5.5 K- P       10/67
R6  Q   84    (0.93)    (0.11)          BISHOP    69 HBC      3.5 K+ P            9/69
R6             0.47      0.08           AGUILAR1  71 HBC      3.9,4.6 K- P       11/71
R6   G         0.91      0.20           CHARRIERE 73 HBC   0 5. K+ P,K P 3PI      1/73
R6   G  REVISED BY GOLDSCHMIDT 75
R6 AQ  150    (0.65)    (0.25)          ANTIPOV   75 ASPK  - 40 K-P,K*- P       .12/75*
R6 A    K* PI SIGNAL FRCM PARTIAL WAVE ANALYSIS OF (K-PI+PI-) SYSTEM
R6             0.54      0.16           DEHM      74 DBC   0 4.6 K+ N            12/75*
R6             0.62      0.19           LAUSCHER  75 HBC    010,16 K-P,K-PI+N   12/75*
R6          . . . . . . . . . . .
R6  AVG        0.540     0.053   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R6  STUDENT    0.535     0.060   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R6  FIT        0.550     0.052  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
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Mesons

$K^*(1420)$, $K_N(1700)$, $L(1770)$

Data Card Listings

For notation, see key at front of Listings.

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R7      K*(1420) INTO (K CMEGA) / K PI                          (P4)/(P1)
R7             (0.08) OR LESS           SHEN       66 HBC       4.6 K+P         8/66
R7             (0.2)  OR LESS           BASSOMPIE 69 HBC  +    5 K+ P          9/69
R7              0.13      0.07          BASSCMPIE 69 HBC    0 5 K+ P           9/69
R7              0.05      0.04          AGUILAR1  71 HBC      3.9-4.6 K- P    11/71
R7             (0.2)  OR LESS  CL=.95   CHUNG     74 HBC   - 7.3 K-P,K*- P   12/75*
R7              . . . . . . . . .
R7  AVG         0.070     0.035   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R7  STUDENT     0.069     0.039   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R7  FIT         0.080     0.031  FROM FIT (ERRCR INCLUDES SCALE FACTCR CF 1.0)

R8      K*(1420) INTO (K RHO) / (K PI)                          (P3)/(P1)
R8             (0.09) OR LESS           CHUNG     65 HBC  + 0  3.9-4.2 PI- P   8/66
R8              0.26      0.16          SCHWEINGR 68 HBC    0 4.1+5.5 K- P    10/67
R8             (0.2)  OR LESS           BASSOMPIE 69 HBC  +    5 K+ P          9/69
R8             (0.3)  OR LESS           BASSCMPIE 69 HBC    0 5 K+ P           9/69
R8  Q    15    (0.11)    (0.06)         BISHOP    69 HBC      3.5 K+ P         9/69
R8              0.16      0.05          AGUILAR1  71 HBC      3.9,4.6 K- P    11/71
R8              0.02      0.10     0.02 DEHM      74 DBC   0 4.6 K+ N         12/75*
R8              0.24      0.14          LAUSCHER  75 HBC    010,16 K-P,K-PI+N 12/75*
R8              . . . . . . . . . .
R8  AVG         0.120     0.046   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
R8  STUDENT     0.126     0.045   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R8  FIT         0.117     0.032  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R9      K*(1420) INTO (K RHC) / (K*(892) PI)                    (P3)/(P2)
R9             (0.39) OR LESS           BASSOMPIE 67 HBC  +   5. K+ P          9/67
R9             (0.40) OR LESS  CL=.90   FIELD     67 HBC   - 3.8 K- P          6/67
R9 P    130      .13       .09          OTTER     75 HBC    08,10,16 K-P,K* N 12/75*
R9 P     FROM PARTIAL WAVE ANALYSIS OF (KO PI+ PI-) SYSTEM
R9 AN          (0.03)    (0.03)         ANTIPOV   75 ASPK  - 40 K-P,K*- P     12/75*
R9  N    K RHO MODE NCT CBSERVED
R9 A     FROM PARTIAL WAVE ANALYSIS OF (K-PI+PI-) SYSTEM
R9              . . . . . . . . . .
R9  FIT         0.212     0.058  FRCM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R10     K*(1420) INTO (K OMEGA) / (K*(892) PI)                  (P4)/(P2)
R10 Q          (0.10)    (0.04)         FIELD     67 HBC   - 3.8 K- P          6/67
R10             . . . . . . . . . .
R10 FIT         0.145     0.059  FRCM FIT

R11     K*(1420) INTO (K ETA) / (K*(892) PI)                    (P5)/(P2)
R11 Q          (0.07)    (0.04)         FIELD     67 HBC   - 3.8 K- P          6/67
R11             . . . . . . . . . .
R11 FIT         0.064     0.066  FROM FIT

R12     K*(1420) INTO (K ETA) / (K PI)                          (P5)/(P1)
R12            (0.02) OR LESS           BISHOP    69 HBC      3.5 K+ P         9/69
R12            (0.04) OR LESS  CL=.95   AGUILAR1  71 HBC      3.9-4.6 K- P    11/71
R12             . . . . . . . . . .
R12 FIT         0.035     0.036  FROM FIT

R   Q   FOLLOWING SUGGESTION BY AGUILAR 70, WE DO NOT MAKE USE OF MEASURE-
R   Q   MENTS WHERE THE (K PI PI) BACKGROUND SUBTRACTION IS DIFFICULT DUE
R   Q   TO THE NEARBY Q REGION.
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REFERENCES FOR K*(1420)


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BADIER    65 PL 19 612          BADIER,DEMOULIN,GOLDBERG+(EPOL+SACL+ZEEMAN)
CHUNG     65 PRL  15  325       +DAHL,HARDY,HESS,JACOBS,KIRZ,MILLER    (LRL)
FOCARDI   65 PL 16 351          FCCARDI,MINGUZZI RANZI,SERRA+(BOLOGNA+SACL)

SHEN      66 PRL  17  726       +BUTTERWORTH,FU,GOLDHABERS,TRILLING    (LRL)
    ALSO 66  (PRIVATE COMMUN)GERSCN GOLDHABER                         (LRL)

BASSANO   67 PRL  19  968       +GOLCBERG,GOZ,BARNES,LEITNER+(BNL+SYRACUSE)
BASSOMPI  67 PL 26B 30          BASSCMPIERRE,GOLDSCHMIDT+  (CERN+BRUX+BIRM)IJP
CRENNELL  67 PRL 19  44         +KALBFLEISCH,LAI,SCARR,SCHUMANN        (BNL)
DAHL      67 PR 163 1377        +HARDY+HESS+KIRZ+MILLER                (LRL)
    ALSO 65 PRL 14 401          HARDY,CHUNG,DAHL,HESS,KIRZ,MILLER      (LRL)
DE BAERE  67 NC 51 A 401        +GOLDSCHMIDT-CLERMCNT,HENRI+     (BRUX+CERN)
FIELD     67 PL 24B 638         +HENDRICKS+PICCIONI+YAGER          (LAJOLLA)
GOLDHABE  67 PRL 19  972        G.GOLDHABER,FIRESTCNE,SHEN             (LRL)

ADERHOLZ  68 NP B 5  567        +DEUTSCHMANN+  (AACH+BERL+CERN+LOIC+VIENNA)
    ALSO 66 PL 22 357           BARTSCH,DEUTSCHMANN,MORRISCN+    (ABCL(IC)V)
ANTICH    68 PRL 21 1842       +CALLAHAN,CARSON,COX,DENEGRI,+          (JHU)
DUBAL     68 THESIS    1456     L.DUBAL                             (GENEVE)
KANG      68 PR 176 1587        Y.W.KANG                              (IOWA)
SCHWEING  68 PR 166 1317        SCHWEINGRUBER,DERRICK,FIELDS+     (ANL+NWES)
   ALSO  67  THESIS             F.L.SCHWEINGRUBER    (NORTHWESTERN,EVANSTCN)

BASSOMPI  69 NP  B13 189        BASSOMPIERE,GOLDSCHMIDT-CLERM.+ (CERN+BRUX) JP
BISHOP    69 NP B 9 403         +GOSHAW,ERWIN,WALKER                  (WISC)
CRENNELL  69 PRL 22  487        +KARSHON,LAI,ONEALL,SCARR              (BNL)
DAVIS     69 PRL 23 1071        +DERENZO,FLATTE,ALSTCN,LYNCH,SOLMITZ   (LRL)
DE BAERE  69 NC 61 A 397        +GOLDSCHMIDT-CLERMONT,HENRI,+    (BELG+CERN)
FRIEDMAN  69  UCRL-18860        J.FRIEDMAN,PH.D. THESIS                (LRL)
LIND      69 NP B 14 1          +ALEXANDER,FIRESTONE,FU,GOLDHABER      (LRL) JP

ABRAMS    70 PR D 1 2433        +EISENSTEIN,KIM,MARSHALL,C.HALLORAN,+ (ILL)
AGUILAR   70 PRL 25 1362        AGUILAR-BENITEZ,BASSANO,EISNER,+ (BNL+PURD)
BIRMINGH  70  KIEV CONF.        ASTIER RAPPORTEURS TALK      (BIRM+GLAS+OXF)

AGUILAR1  71 PR D 4 2583        +EISNER,KINSCN                         (BNL)
BARNHAM   71 NP B 28 171        +COLLEY,JOBES,GRIFFITHS,HUGHES,+(BIRM+GLAS)
CORDS     71 PR D 4 1974        +CARMONY,ERWIN,MEIERE,+       (PURD+UCD+IUPU)
SLATTERY  71  UR-875-332(PREP)  P.SLATTERY,A REVIEW OF STRANGE MESONS(ROCH)

BUCHNER   72 NP B 45 333        +DEHM,CHARRIERE,CORNET,+    (MPIM+CERN+BRUX)
CRENNELL  72 PR D 6 1220        +GORDON,KWAN-WU LAI,SCARR              (BNL)
DEUTSCHM  72 NP B 36 373        DEUTSCHMANN,+           (ABCLV COLLABORATION)
ENGELMAN  72 PR D 5 2162        ENGELMANN,MUSGRAVE,FORMAN,+        (ANL+EFI)
FRATI     72 PR D 6 2361        +HALPERN,HARGIS,SNAPE,CARNAHAN,+(PENN+CINC)
ROUGE     72 NP B 46 29         +VIDEAU,VOLTE,DE BRION,+         (EPCL+SACL)
TIECKE    72 NP B 39 596        +GRIJNS,HEINEN,DE GROOT,+        (NIJM+ZEEM)

CHARRIER  73 NP B 51 317        CHARRIERE,DRIJARD,DE BAERE,+     (CERN+BELG)
    ALSO 75  (PRIVATE COMMUNICATION) GOLDSCHMIDT-CLERMONT            (CERN)
CLARK     73 NP B 54 432        +LYONS,RADOJICIC                    (OXFORD)
DE JONGH  73 NP B 58 110        +CORNET,CHARRIERE,+   (BRUX+MONS+CERN+MPIM)
LINGLIN   73 NP B 55 408        D.LINGLIN                             (CERN)
WALUCH    73 PR D 8 2837        +FLATTE,FRIEDMAN                       (LBL)

DEHM      74 NP B75 47          +GOEBEL,WITTEK,WOLF,+ (MPIM+BRUX+MONS+CERN)
CHUNG     74 PL 51B 413         +EISNER,PROTOPOPESCU,SAMIOS,STRAND     (BNL)

ANTIPOV   75 NP B86 381         +ASCOLI,BUSNELLO,KIENZLE+    (SERP+CERN+ILL)
LAUSCHER  75 NP B86 189         +OTTER,WIECZOREK,+      (ABCLV COLLABORATION)  JP
MCCUBBIN  75 NP B86 13          N.A.MCCUBBIN,L.LYONS                   (CXF)
OTTER     75 NP B84 333         + (AACH+BERL+CERN+LOIC+VIEN+ATHU+ATEN+LIVP)

BRANDENB  76 PL                 BRANDENBURG,CARNEGIE,CASHMORE,DAVIER+(SLAC)  JP

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$K_N(1700)$

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27  KN(1700, JP=  ) I = 1/2
THIS ENTRY CONTAINS VARIOUS PEAKS IN STRANGE MESON
SYSTEMS REPORTED IN THE 1700 MEV REGION.
EVIDENCE NOT COMPELLING, OMITTED FROM TABLE.
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               27  KN(1700) MASS (MEV)

M        (1660.0)                      CARMONY   67 HBC  -  3.8 K-P,OMEGA K 11/67
M  J     (1660.0)    (10.0)            JOBES     67 HBC  +  5. K+ P        12/75*
M  J      CLAIMED BY JOBES IN (K PI), (K*(892) PI), AND (K*(1420) PI)
M  J      MODES. K PI BUMP INTERFERES MOSTLY WITH DELTA(1236).
M        (1660.)                       CHARRIERE 73 HBC  0 5. K+ P,K P 3PI   1/73
M      60(1710.)     (15.)             CHUNG     74 HBC  - 7.3K-P,K-CMEGA P 12/75*
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               27  KN(1700) WIDTH (MEV)

W         (60.0)     (20.0)            JOBES     67 HBC  +   5. K+ P        12/75*
W         (60.)                        CHARRIERE 73 HBC  0 5. K+ P,K P 3PI   1/73
W      60 (110.)     (50.)             CHUNG     74 HBC  - 7.3K-P,K-OMEGA P 12/75*
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               27  KN(1700) PARTIAL DECAY MODES

                                                 DECAY MASSES
P1     KN(1700) INTO K PI                        493+ 139
P2     KN(1700) INTO K PI PI                     493+ 139+ 139
P3     KN(1700) INTO K*(892) PI                  892+ 139
P4     KN(1700) INTO K RHO                       493+ 773
P5     KN(1700) INTO K*(1420) PI                1421+ 139
P6     KN(1700) INTO K OMEGA                     493+ 783
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               27  KN(1700) BRANCHING RATIOS

R1     KN(1700) INTO (K PI)/(K OMEGA)                 (P1)/(P6)
R1 N        (0.5)     (0.5)            CHUNG     74 HBC  - 7.3 K-P,KN- P    12/75*
R1 N   NO K PI SIGNAL SEEN IN THIS EXPERIMENT
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REFERENCES FOR KN(1700)


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CARMONY   67 PRL  18  615       D.CARMONY,T.HENDRICKS,L.LANDER    (LA JOLLA)
JOBES     67 PL 26B 49          +BASSOMPIERRE,DE BAERE +    (BIRM+CERN+BRUX)
CHARRIER  73 NP B 51 317        CHARRIERE,DRIJARD,DE BAERE,+     (CERN+BELG)
CHUNG     74 PL 51B 412         +EISNER,PROTOPOPESCU,SAMIOS,STRAND     (BNL)
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L(1770)

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23  L(1770, JP=  ) I = 1/2
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The L(1770) is seen as a bump in the diffractive-like process $KN \to (K\pi\pi)N$. BARBARO 69 and FIRESTONE 72 find the decay is consistent with being entirely $K^*(1420)\pi$, whereas AGUILAR 70, BARTSCH 70, COLLEY 71, and DENEGRI 71 present evidence for alternate decay modes. For a review see EISNER 74.

Recent partial-wave analyses (DEUTSCHMANN 74, ANTIPOV 75, OTTER 75) have shown that the situation in the L region is complicated, with many waves contributing. The $2^- K^*(1420)\pi$ S wave is important, but cannot explain the whole L enhancement (DEUTSCHMANN 74). The phase variation of the 2^- wave shows no evidence for any significant resonance contribution with $\Gamma < 300$ MeV (OTTER 75).

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               23  L MASS (MEV)

M        20(1780.)                     BERLINGHI 67 HBC  +    12.7 K+P       7/67
M          (1760.0)   (15.0)           JOBES     67 HBC  +   5. K+ P         1/73
M           1745.0     20.0            AGUILAR   70 HBC  -   4.6 K- P        6/70
M           1780.0     15.0            BARTSCH   70 HBC  -   10.1 K- P       1/71
M          (1760.0)   (15.0)           LUDLAM    70 HBC  -   12.6 K- P       1/73
M  X        1765.0     40.0            COLLEY    71 HBC  +  10.K+P,K 2PI     1/73
M  X     SYSTEMATIC ERRORS ADDED CORRESP. TO SPREAD OF DIFFERENT FITS.
M          (1740.0)                    DENEGRI   71 DBC  - 12.6 K-D,K 2PI D  5/71
M           1767.      6.              BLIEDEN   72 MMS  -  11.-16. K- P    12/72
M  P   306 1730.      20.              FIRESTONE 72 DBC  +  12. K+ D         1/73
M  P     PRODUCED IN CONJUNCTION WITH D*
M              . . . . . . . .
M   AVG     1764.6     6.7       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
M   STUDENT1765.0      5.8       AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
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Data Card Listings

For notation, see key at front of Listings.

Mesons

L(1770), K_N(1800), K^*(2200)

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                     23  L WIDTH (MEV)

W        20  (80.)                          BERLINGHI 67 HBC  +   12.7 K+P          7/67
W            (60.0)    (20.0)               JOBES     67 HBC  +   5. K+ P           1/73
W            100.0      50.0                AGUILAR   70 HBC  -   4.6 K- P          6/70
W            138.0      40.0                BARTSCH   70 HBC  -   10.1 K- P         1/71
W            (50.0)    (40.0)   (20.0)      LUDLAM    70 HBC  -   12.6 K- P         1/73
W   X         90.       70.                 COLLEY    71 HBC  +  10.K+P,K 2PI       1/73
W   X    SYSTEMATIC ERRORS ADDED CORRESP. TO SPREAD OF DIFFERENT FITS.
W           (130.0)                         DENEGRI   71 DBC  - 12.6 K-D,K 2PI D   5/71
W            100.       26.                 BLIEDEN   72 MMS  -  11.-16. K- P      12/72
W   P    306 210.       30.                 FIRESTONE 72 DBC  +  12. K+ D          12/72
W   P    PRODUCED IN CONJUNCTION WITH D*
W             . . . . . . . . . .
W    AVG     137.7      24.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
W    STUDENT 130.7      21.5     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                     23  L PARTIAL DECAY MODES

                                                                DECAY MASSES
P1      L INTO K PI PI                                        497+ 134+ 134
P2      L INTO K*(1420) PI                                    134+1421
P3      L INTO K PI PI PI                                     497+ 134+ 134+ 134
P4      L INTO K*(892) PI                                     892+ 134
P5      L INTO K*(892) RHO                                    892+ 773
P6      L INTO K*(892) OMEGA                                  892+ 783
P7      L INTO K*(892) PI PI                                  892+ 134+ 134

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                     23  L BRANCHING RATIOS

R1      L INTO (K*(1420) PI) / (K PI PI )                   (P2)/(P1)
R1          LARGE                          DENEGRI   68 DBC  -  12.6 K- D      1/71
R1            (1.0)                        BARBARO   69 HBC  +  12.0 K+ P      1/71
R1             0.2      0.2                AGUILAR   70 HBC  -  4.6 K- P       1/71
R1          LESS THAN   1.0                BARTSCH   70 HBC  -  10.1 K- P      1/71
R1          LESS THAN   1.0                COLLEY    71 HBC     10. K+ P      11/71
R1  P       CONSISTENT WITH 1.             FIRESTONE 72 DBC  +  12. K+ D      12/72
R1  P    PRODUCED IN CONJUNCTION WITH D*                                      12/72
R1   R   LESS THAN 1.0 SEEMS TO BE ESTABLISHED.
R1   R   FOR DISCUSSION OF THE EXPERIMENTAL EVIDENCE ON OTHER DECAY           11/71
R1   R   MODES SEE HUGHES 71,SLATTERY 71,EISNER 74.

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                        REFERENCES FOR L(1770)

BARTSCH  66 PL 22 357            +DEUTSCHMANN,+    (AACH+BERL+CERN+LOIC+VIEN)

BERLINGH 67 PRL 18 1087          BERLINGHIERI+FARBER+FERBEL+FORMAN+    (ROCH)I
JOBES    67 PL 26B 49            +BASSOMPIERRE,DE BAERE +   (BIRM+CERN+BRUX)

DENEGRI  68 PRL 20 1194          +CALLAHAN+ETTLINGER+GILLESPIE+          (JHU)
BARTSCH  68 NP B8 9              +COCCONI,+        (AACH+BERL+CERN+LOIC+VIEN)

ANDREWS  69 PRL 22 731           +LACH,LUDLAM,SANDWEISS,BERGER,+  (YALE+LRL)
BARBARO  69 PRL 22 1207          BARBARO-GALTIERI,DAVIS,FLATTE,+        (LRL)
COLLEY   69 NC A 59 519          +EASTWOOD,+  (BIRM+GLAS+LOIC+MPIM+OXF+RHEL)

AGUILAR  70 PRL 25 54            AGUILAR-BENITEZ,BARNES,BASSANO,CHUNG,+(BNL)
BARTSCH  70 PL 33 B 186          +DEUTSCHMANN,+    (AACH+BERL+CERN+LOIC+VIEN)
LUDLAM   70 PR D 2 1234          +SANDWEISS,SLAUGHTER                  (YALE)

COLLEY   71 NP B 26 71           +JOBES,KENYON,PATHAK,HUGHES,+   (BIRM+GLAS)
DENEGRI  71 NP B 28 13           +ANTICH,CALLAHAN,CARSON,CHIEN,COX,+   (JHU)  JP
HUGHES   71 BOLOGNA CONF.PROC I.S.HUGHES,TALK AT BOLOGNA CONF.  (GLASGOW)
SLATTERY 71  UR-875-332(PREP) P.SLATTERY,A REVIEW OF STRANGE MESONS(ROCH)

ANDERSON 72 PR D 6 1823          +FRANKLIN,GODDEN,KOPELMAN,LIBBY,TAN  (COLO)
BLIEDEN  72 PL 39 B 668          +FINOCCHIARO,BOWEN,EARLES,+     (STON+NEAS)
FIRESTON 72 PR D 5 505           FIRESTONE,GOLDHABER,LISSAUER,TRILLING (LBL)

BARLOUTA 73 NP B 59 374          +DREVILLON,SHAH,+          (SACL+EPCL+RHEL)
BINGHAM  73 NP B 52 31           +FARWEL,+     (LBL+ORSAY+BNL+SACLAY+MILAN)
CHARRIER 73 NP B 51 317          CHARRIERE,DRIJARD,DE BAERE,+   (CERN+BELG)

DEUTSCHM 74 PL 49B 388           DEUTSCHMANN,+     (AACH+BERL+CERN+LOIC+VIEN)  JP
EISNER   74  BOSTON              R.L.EISNER  REVIEW TALK                (BNL)

ANTIPOV  75 NP B86 381           +ASCOLI,BUSNELLO,KIENZLE+   (SERP+CERN+ILL)  JP
OTTER    75 NP B93 365           +RUDOLPH,RUMPF+  (AACH+BERL+CERN+LOIC+VIEN)  JP

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K_N(1800) → 60 KN(1800,JP=3-)

This entry includes peaks of low statistical significance seen in the $K\pi$ and $K\pi\pi$ spectra in the region of 1800 MeV (CARMONY 71, AGUILAR 73, SPIRO 76). FIRESTONE 71 and BRANDENBURG 76 observe structure in the $K\pi$ angular distribution, the simplest explanation for which is a rapid rise of the F-wave amplitude around 1800 MeV, interfering strongly with other waves. BRANDENBURG 76 propose the existence of a $J^P=3^-$ resonance, but we prefer to wait for further confirmation before including this entry in the Table.

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                     60  KN(1800) MASS (MEV)

M   C    76(1753.)    (12.)             CARMONY   71 DBC    09 K+N,K+PI-P       11/71
M   C  DISAGREEMENT BETWEEN THE FIT AND DATA ON BOTH SIDES OF THE SIGNAL      11/71
M   I       (1850.)   APPROX.           FIRESTONE 71 DBC    0 12.K+ N,K+ PI-P 11/71
M   I       APPARENT INTERFERENCE WITH OTHER AMPLITUDES PRECLUDES            11/71
M   I       PRECISE DETERMINATION .                                          11/71
M        65(1760.)                      AGUILAR   73 HBC    07.3 K-P,K-PI+N     1/74
M  A        (1776.)    (26.)            BRANDENB  76 ASPK   013 K+-P,K+-PI-+  12/75*
M  A     APPROXIMATE VALUE ONLY, BUT ERROR INCLUDES SOME UNCERTAINTIES
M  A     FROM BACKGROUND ETC.
M        40(1780.)     (30.)            SPIRO     76 HBC   - 14.3 K-P,K0PI-P  12/75*
M        80(1840.)     (30.)            SPIRO     76 HBC    014.3 K-P,K-PI+N  12/75*

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                     60  KN(1800) WIDTH (MEV)

W   C    76  (60.)     (20.)            CARMONY   71 DBC    09 K+N,K+PI-P       11/71
W   C  DISAGREEMENT BETWEEN THE FIT AND DATA ON BOTH SIDES OF THE SIGNAL      11/71
W   I       (300.)    APPROX.           FIRESTONE 71 DBC    0 12.K+ N,K+ PI-P 11/71
W   I    SEE NOTE I ABOVE
W        65  (80.)    OR LESS           AGUILAR   73 HBC    07.3 K-P,K-PI+N     1/74
W  A        (270.)     (70.)            BRANDENB  76 ASPK   013 K+-P,K+-PI-+  12/75*
W  A     SEE NOTE A ABOVE
W        40 (120.)     (40.)            SPIRO     76 HBC   - 14.3 K-P,K0PI-P  12/75*
W        80 (100.)     (40.)            SPIRO     76 HBC    014.3 K-P,K-PI+N  12/75*

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                     60  KN(1800) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      KN(1800) INTO K PI                                  493+ 139
P2      KN(1800) INTO K*(892) PI                            892+ 139
P3      KN(1800) INTO K RHO                                 493+ 773
P4      KN(1800) INTO K*(1420) PI                          1421+ 139
P5      KN(1800) INTO K PI PI                               493+ 139+ 139

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                     60  KN(1800) BRANCHING RATIOS

R1      KN(1800) INTO (K PI)/(K*(892) PI + K RHO)         (P1)/(P2+P3)
R1  ES        (0.40)    (0.10)         CARMONY   71 DBC    0 9. K+ N           11/71
R1   S   STATIST. COMPATIBLE WITH THE WEAK K PI PI SIGNAL OF AGUILAR 73.        1/74

R2      KN(1800) INTO (K*(892) PI)/(K PI PI)               (P2)/(P5)
R2  E         (0.40)    (0.15)         CARMONY   71 DBC    0 9. K+ N           11/71

R3      KN(1800) INTO (K RHO)/(K PI PI)                    (P3)/(P5)
R3  E         (0.60)    (0.25)         CARMONY   71 DBC    0 9. K+ N           11/71

R4      KN(1800) INTO (K*(892) PI + K RHO)/(K PI PI)      (P2+P3)/(P5)
R4  E         (1.)      (0.12)         CARMONY   71 DBC    0 9. K+ N           11/71

R5      KN(1800) INTO (K*(1420) PI)/(K PI PI)              (P4)/(P5)
R5  E         (0.06) OR LESS           CARMONY   71 DBC    0 9. K+ N           11/71
R5  E   DIFFICULT BACKGROUND SUBTRACTION . ERRORS STATISTICAL ONLY .           11/71

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                        REFERENCES FOR KN(1800)

CARMONY  71 PRL 27 1160          +CORDS,CLOPP,ERWIN,MEIERE,+ (PURD+UCD+IUPU)
FIRESTON 71 PL 36 B 513          FIRESTONE,GOLDHABER,LISSAUER,TRILLING (LBL)
AGUILAR  73 PRL 30 672           +CHUNG,EISNER,PROTOPOPESCU,SAMIOS,+   (BNL)
WALUCH   73 PR D 8 2837          +FLATTE,FRIEDMAN                      (LBL)
BRANDENB 76 PL                   BRANDENBURG,CARNEGIE,CASHMORE,DAVIER+(SLAC)  JP
SPIRO    76 PL                   +BARLOUTAUD,PALER,CHAURAND+(SACL+RHEL+EPOL)  JP

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K^*(2200) → 40 K*(2200,JP=)

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ENHANCEMENT SEEN IN (ANTIHYPERON-NUCLEON) MASS
NEAR THRESHOLD.INTERPRETATION UNCERTAIN.
OMITTED FROM TABLE.

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                     40  K*(2200) MASS (MEV)

M        20 2240.      20.              LISSAUER  70 HBC      9. K+ P          11/71
M   C      (2200.)   APPROX.            SLATTERY  71 RVUE     8-13 K+ P        11/71
M   C   COMPILATION OF (ANTIHYP.-NUCLEON) MASS IN K+ P 8.-13.  GEV/C          11/71

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                     40  K*(2200) WIDTH (MEV)

W        20   80.      20.              LISSAUER  70 HBC      9. K+ P          11/71
W   C       (200.)   APPROX.            SLATTERY  71 RVUE     8-13 K+ P        11/71
W   C   COMPILATION OF (ANTIHYP.-NUCLEON) MASS IN K+ P 8.-13.  GEV/C          11/71

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                        REFERENCES FOR K*(2200)

ALEXANDE 68 PRL 20 755           ALEXANDER,FIRESTONE,GOLDHABER,SHEN     (LRL)
LISSAUER 70 NP B 18 491          +ALEXANDER,FIRESTONE,GOLDHABER         (LBL)

CARMONY  71 PRL 27 1160          +CORDS,CLOPP,ERWIN,MEIERE,+  (PURD+UCD+IND)
SLATTERY 71  UR-875-332(PREP) P.SLATTERY,A REVIEW OF STRANGE MESONS(ROCH)

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Mesons

EXOTICS, NEW HEAVY MESONS

EXOTIC MESONS

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EXOTICS 70 EXOTICS

THE PURPOSE OF THIS ENTRY IS TO PROVIDE A LIST OF REFERENCES FOR EXOTIC MESON SEARCHES (SEE MAIN TEXT, SEC. III AND TABLE I), AS WELL AS THEORETICALLY BASED SUGGESTIONS FOR EXPERIMENTS. NOTE THAT LIPKIN 73 PROPOSES EXPERIMENTS WHICH ARE CONCLUSIVE EVEN IF NEGATIVE RESULTS ARE OBTAINED.

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REFERENCES FOR EXOTICS

REPORTS ON SEARCHES

ROSENFEL 68 PHILA.CONF.P.455 A.H.ROSENFELD (LRL)
DODD 69 PR 177 1991 +JOLDERSMA, PALMER, SAMIOS (BNL)
CHO 70 PL 32 B 409 +DERRICK,JOHNSON,MUSGRAVE,+ (ANL+NWES+KANS)
GIACOMEL 70 PL 33 B 373 G.GIACOMELLI + (BGNA+SACL+ZEEM+REHO+EPOL)
LYS 70 PR D 2 2525 J.LYS+ (MICH)
ROSNER 70 EXP.MESON SPECTROSCOPY,ED. C.BALTAY AND A.H.ROSENFELD,P.499
BUHL 72 NP B 37 421 +CLINE,TERRELL (WISCONSIN)
COHEN 73 NP B 53 1 +FERBEL,SLATTERY,WERNER (ROCHESTER)
ALAM 74 PL 53B 207 +BRABSON,GALLOWAY,+ (IND+PURD+SLAC+VAND)
COHEN 74 BOSTON D.COHEN REVIEW TALK (COLU)
OREN 74 NP B71 189 +COOPER,FIELDS,RHINES,WHITMORE,+ (ANL+OXF)
BALTAY 75 PL 57B 293 +CAUTIS,COHEN,KALELKAR,PISELLO,+(COLU+BING)
DAVIS 75 NP B96 426 +AMMAR,KROPAC,YARGER,+ (KANS+CCAC+ANL)

SUGGESTIONS FOR SEARCHES

ROSNER 68 PRL 21 950,1468 J.L.ROSNER (TEL-AVIV)
ROSNER 70 EXP.MESON SPECTROSCOPY,ED. C.BALTAY AND A.H.ROSENFELD,P.499
FAIMAN 73 PL 43 B 307 D.FAIMAN,G.GOLDHABER,Y.ZARMI (CERN)
LIPKIN 73 PR D 7 2262 H.J.LIPKIN (ARGONNE+FNAL)

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NEW HEAVY MESONS

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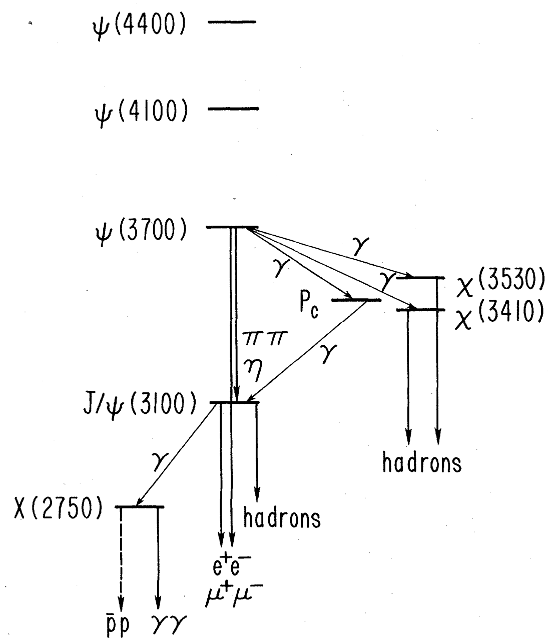
The New Heavy Mesons

Since the discovery of the J/ψ(3100) particle in p-Be collisions at the AGS (AUBERT 74), and in e^+e^- collisions at SPEAR (AUGUSTIN 74), the size of the family of "new particles" has increased to at least 8 members, with a complex set of decay modes and mutual transitions; the main features of the experimental situation are illustrated in the figure below.

In the following entries we compile the experimental data as of January 1976, with only a minimum of mini-reviews and footnotes. For detailed discussions of the implications and possible interpretations of the properties of the new particles, see, e.g., the Proceedings of the 1975 International Symposium on Lepton and Photon Interactions at High Energies, Stanford, 1975 [W. T. Kirk (SLAC), editor].



XBL 763 2361

The New Heavy Mesons

Extracting Resonance Widths from e^+e^- Colliding Beam Formation Experiments

In an e^+e^- colliding beam formation experiment, the true shape of an observed resonance is distorted primarily by the effects of (1) soft-photon processes, and (2) beam energy spread due to processes such as quantum fluctuations in emission of synchrotron radiation. The spread in energy due to (2) may usually be approximated by a Gaussian distribution, the effect of which vanishes rapidly at energies sufficiently removed from resonance. The major effect of (1) is a decrease in the effective c.m. energy for some fraction of the collisions, because of the emission of bremsstrahlung by the electron or positron before annihilation. Hence, though the nominal beam energy may be well above the resonance region, a certain fraction of the collisions occur at or near resonance. This gives rise to the well-known high-mass radiative tails of the J/ψ(3100) and ψ(3700) resonances.

Data Card Listings

For notation, see key at front of Listings.

Mesons

NEW HEAVY MESONS, $J/\psi(3100)$

Because of these effects, the most reliable means for determining resonance widths is to use a method based on the area under the line shape [see, e.g., "Notes from the SLAC Theory Workshop on the ψ", ed. R. Pearson, SLAC-PUB-1515 (1974)] . This method, familiar in nuclear physics, minimizes the sensitivity to the details of the beam energy spread. Corrections for the radiative processes, which depend on the limits of integration of the areas, still need to be made. This discussion assumes the resolution is adequate to allow a reasonable separation of signal from background (which itself is subject to radiative processes).

For formation of a resonance of mass M in e^+e^- collisions, with subsequent decay via channel i,

$$\sigma_i(W) = \sigma_0 \frac{\Gamma_e\Gamma_i/4}{(M-W)^2 + \Gamma^2/4} ,$$

where W is the total center of mass energy; Γ, Γ_e, and Γ_i are the total width and partial widths for coupling to e^+e^- and channel i, respectively; and a Breit-Wigner line shape with energy-independent partial widths is assumed. The quantity σ_0 is given by

$$\sigma_0(W) = \frac{4\pi(2J + 1)}{W^2} ,$$

where J is the spin of the resonance. For a narrow resonance, the area under the resonant line is given by

$$A_i = \frac{\pi}{2} \frac{\Gamma_e\Gamma_i}{\Gamma} \sigma_0(M) ,$$

independent of the energy resolution of the apparatus. Determination of the mass, spin, and integrated channel cross sections, A_i, allows, then, determination of the quantities $\Gamma_e\Gamma_i/\Gamma$, and, assuming there are no undetected decay modes (i.e., in our case $\Gamma = \Gamma_{e^+e^-} + \Gamma_{\mu^+\mu^-} + \Gamma_{hadrons}$), determination of the total and partial widths.

In the Data Card Listings, we tabulate and average the quantity $\Gamma_e\Gamma_i/\Gamma$ only when it was not used to determine the partial widths and/or branching ratios.

$J/\psi(3100)$

70 J/PSI(3100,JPG=1--) I=0

The $J/\psi(3100)$ was discovered in p-Be collisions at the AGS (AUBERT 74), and in e^+e^- collisions at SPEAR (AUGUSTIN 74), and since then has been extensively investigated in e^+e^- collisions at SPEAR, DORIS, and ADONE, as well as at conventional accelerators with photon and hadron beams.

Evidence bearing on the hadronic nature of the $J/\psi(3100)$ comes from the observation of a large forward photoproduction cross section. Using vector dominance arguments one derives a total cross section for $J/\psi(3100)$ on nucleons over a large energy range of the order of 1 mb (ANDREWS 75, DAKIN 75, KNAPP1 75, MARTIN 75). Although this cross section is an order of magnitude smaller than the corresponding cross sections of the well known vector mesons, it is large enough to suggest that the $J/\psi(3100)$ is probably a hadron. The hadronic interpretation of the $J/\psi(3100)$ is also supported by the apparent conservation of isospin and G-parity in direct hadronic decays (JEAN-MARIE 75). For a detailed discussion of the hadronic nature of $J/\psi(3100)$, see HARARI 75.

The $J^{PC} = 1^{--}$ assignment, suggested by production in s-channel e^+e^- collisions, is confirmed by the observation of an interference between the resonant and QED amplitudes, and by the angular distribution of the lepton pairs in the final state (BOYARSKI 75). The $I^G = 0^-$ assignment was determined by a study of multipion decays (JEAN-MARIE 75). These quantum numbers are compatible with all the data on partial decay widths (non-observation of the $\gamma\gamma$ mode, observation of the $\Lambda\bar{\Lambda}$ mode, etc.).

70 J/PSI(3100) MASS (MEV)

M		(3100.)		AUBERT	74	SPEC	28.	PP(E+E-)	2/75*
M	L	(3105.)	(3.)	AUGUSTIN	74	SPEAR		E+E-	2/75*
M	O	3095.	4.	BOYARSKI	75	SPEAR		E+E-	3/75*
M	S	(3089.5)		CRIEGEE	75	DORIS		E+E-	2/75*
M		3098.	6.	PREPOST	75	SPEC	13.-21.	GAMMA D	1/76*
M		3103.	6.	BEMPORAD	75	ADONE		E+E-	1/76*

M L BOYARSKI 75 IS A REEVALUATION OF AUGUSTIN 74 BASED
M L ON A RECALIBRATION OF THE SPEAR BEAM ENERGY.

M O MASS, WIDTH, PARTIAL WIDTHS, AND BRANCHING RATIOS ALL OBTAINED 3/75*
M O FROM ONE OVERALL FIT TO DATA OF THIS EXPERIMENT. 3/75*

M S ERROR OF ABOUT 1 PER CENT FROM THE UNCERTAINTY IN CALIBRATION OF 2/75*
M S THE BEAM ENERGY. 2/75*

M	AVG	3097.6	2.9	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M	STUDENT	3097.6	3.3	AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

70 J/PSI(3100) WIDTH (KEV)

SEE THE MINI-REVIEW ON EXTRACTING RESONANCE WIDTHS.

W		69.	15.	BOYARSKI	75	SMAG	E+E-	3/75*
W		68.	26.	BALDINI1	75	FRAG	E+E-	1/76*
W		60.	25.	ESPOSITO	75	FRAM	E+E-	1/76*

W	AVG	66.9	11.5	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W	STUDENT	66.9	12.4	AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

Mesons

J/ψ(3100)

Data Card Listings

For notation, see key at front of Listings.

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                   70  J/PSI(3100) PARTIAL DECAY MODES

                                                                DECAY MASSES
P1        J/PSI(3100) INTO E+ E-                                 .5+  .5
P2        J/PSI(3100) INTO MU+ MU-                               105+ 105
P3        J/PSI(3100) INTO HADRONS
P4        J/PSI(3100) INTO GAMMA INTO HADRONS

P         HADRONIC DECAYS
P         ---------------
P11       J/PSI(3100) INTO PI+ PI-
P12       J/PSI(3100) INTO PI+ PI- PI0
P13       J/PSI(3100) INTO 2(PI+ PI-)
P14       J/PSI(3100) INTO 2(PI+ PI-) PI0
P15       J/PSI(3100) INTO 3(PI+ PI-)
P16       J/PSI(3100) INTO 3(PI+ PI-) PI0
P17       J/PSI(3100) INTO 4(PI+ PI-)
P18       J/PSI(3100) INTO 4(PI+ PI-) PI0
P19       J/PSI(3100) INTO KOS KOL
P20       J/PSI(3100) INTO K+ K-
P21       J/PSI(3100) INTO PI+ PI- K+ K-
P22       J/PSI(3100) INTO 2(PI+ PI-) K+ K-
P23       J/PSI(3100) INTO RHO PI
P24       J/PSI(3100) INTO RHO PI PI PI
P25       J/PSI(3100) INTO OMEGA PI PI
P26       J/PSI(3100) INTO PHI PI PI
P27       J/PSI(3100) INTO K K*(892)
P28       J/PSI(3100) INTO K K*(1420)
P29       J/PSI(3100) INTO K*(892) K*(892)
P30       J/PSI(3100) INTO K*(1420) K*(1420)
P31       J/PSI(3100) INTO K*(892) K*(1420)
P32       J/PSI(3100) INTO PBAR P
P33       J/PSI(3100) INTO LAMBDA ANTILAMBDA
P34       J/PSI(3100) INTO NUCLEON ANTINUCLEON PI
P35       J/PSI(3100) INTO P PBAR PI+ PI-
P36       J/PSI(3100) INTO P PBAR PI+ PI- NEUTRALS

P         RADIATIVE DECAYS
P         ----------------
P51       J/PSI(3100) INTO GAMMA GAMMA
P52       J/PSI(3100) INTO PI0 GAMMA
P53       J/PSI(3100) INTO ETA GAMMA
P54       J/PSI(3100) INTO ETA PRIME GAMMA
P55       J/PSI(3100) INTO X(2750) GAMMA                         2750+   0
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                   70  J/PSI(3100) PARTIAL WIDTHS (KEV)

          SEE THE MINI-REVIEW ON EXTRACTING RESONANCE WIDTHS.

W1        J/PSI(3100) INTO E+ E-                           (G1)               2/75*
W1              4.8        0.6            BOYARSKI  75 SMAG          E+E-     3/75*
W1  B          (4.6)      (.8)            BALDINI1  75 FRAG          E+E-     1/76*
W1  B     ASSUMING EQUAL PARTIAL WIDTHS FOR (E+E-) AND (MU+MU-)
W1              4.6        1.0            ESPOSITO  75 FRAM          E+E-     1/76*
W1           . . . . . . . . .
W1  AVG         4.75       0.51    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W1  STUDENT     4.75       0.55    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

W2        J/PSI(3100) INTO MU+ MU-                         (G2)               2/75*
W2              4.8        0.6            BOYARSKI  75 SMAG          E+E-     3/75*
W2              5.0        1.0            ESPOSITO  75 FRAM          E+E-     1/76*
W2           . . . . . . . . .
W2  AVG         4.85       0.51    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W2  STUDENT     4.85       0.55    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

W3        J/PSI(3100) INTO HADRONS                         (G3)               2/75*
W3              59.        14.            BOYARSKI  75 SMAG          E+E-     3/75*
W3              59.        24.            BALDINI1  75 FRAG          E+E-     1/76*
W3              50.        25.            ESPOSITO  75 FRAM          E+E-     1/76*
W3           . . . . . . . . .
W3  AVG         57.3       10.9    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W3  STUDENT     57.3       11.7    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

W4        J/PSI(3100) INTO GAMMA INTO HADRONS
W4              12.        2.             BOYARSKI  75 SMAG          E+E-     1/76*
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                   70  J/PSI(3100) BRANCHING RATIOS

          FOR THE BRANCHING RATIOS R1 - R4, SEE ALSO THE PARTIAL
          WIDTHS ABOVE, AND (PARTIAL WIDTHS)*R1 BELOW.

R1        J/PSI(3100) INTO (E+ E-)/TOTAL                   (P1)               3/75*
R1              0.069      0.009          BOYARSKI  75 SMAG          E+E-     3/75*

R2        J/PSI(3100) INTO (MU+ MU-)/TOTAL                 (P2)               3/75*
R2              0.069      0.009          BOYARSKI  75 SMAG          E+E-     3/75*

R3        J/PSI(3100) INTO (HADRONS)/TOTAL                 (P3)               3/75*
R3              0.86       0.02           BOYARSKI  75 SMAG          E+E-     3/75*

R4        J/PSI(3100) INTO (E+ E-)/(MU+ MU-)               (P1)/(P2)          2/75*
R4              1.00       0.05           BOYARSKI  75 SMAG          E+E-     3/75*
R4              0.93       0.10           FORD      75 SPEC          E+E-     2/75*
R4              .91        .15            ESPOSITO  75 FRAM          E+E-     1/76*
R4           . . . . . . . . .
R4  AVG         0.980      0.043   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R4  STUDENT     0.980      0.047   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R5        J/PSI(3100) INTO (GAMMA INTO HADRONS)/TOTAL
R5              .17        .02            BOYARSKI  75 SMAG          E+E-     1/76*

R         HADRONIC DECAYS
R         ---------------

R8        J/PSI(3100) INTO (PI+ PI-)/TOTAL
R8              (.0003)OR LESS CL=.90     WIIK      75 DASP          E+E-     1/76*

R9        J/PSI(3100) INTO (2(PI+ PI-))/TOTAL
R9        76        .004       .001       JEAN-MARI 75 SMAG          E+E-     1/76*

R10       J/PSI(3100) INTO (2(PI+ PI-) PI0)/TOTAL
R10       675       .04        .01        JEAN-MARI 75 SMAG          E+E-     1/76*

R11       J/PSI(3100) INTO (3(PI+ PI-))/TOTAL
R11       32        .004       .002       JEAN-MARI 75 SMAG          E+E-     1/76*

R12       J/PSI(3100) INTO (3(PI+ PI-) PI0)/TOTAL
R12       181       .029       .007       JEAN-MARI 75 SMAG          E+E-     1/76*

R13       J/PSI(3100) INTO (4(PI+ PI-) PI0)/TOTAL
R13       13        .009       .003       JEAN-MARI 75 SMAG          E+E-     1/76*

R14       J/PSI(3100) INTO (PI+ PI- K+ K-)/TOTAL
R14 A     83        .005       .002       ABRAMS4   75 SMAG          E+E-     1/76*
R14 A     INCLUDING CONTRIBUTION FROM K*(892)K*(1420)

R15       J/PSI(3100) INTO (2(PI+ PI-) K+ K-)/TOTAL
R15                 .003       .001       ABRAMS4   75 SMAG          E+E-     1/76*

R16       J/PSI(3100) INTO (RHO PI)/(PI+ PI- PI0)
R16                 (.7)    OR MORE       JEAN-MARI 75 SMAG          E+E-     1/76*

R17       J/PSI(3100) INTO (RHO0 PI0)/(RHO+- PI-+)
R17                 .59        .17        JEAN-MARI 75 SMAG          E+E-     1/76*

R18       J/PSI(3100) INTO (RHO PI)/TOTAL
R18       153       .013       .003       JEAN-MARI 75 SMAG          E+E-     1/76*

R19       J/PSI(3100) INTO (OMEGA PI PI)/(2(PI+ PI-) PI0)
R19 J               (.2)                  JEAN-MARI 75 SMAG          E+E-     1/76*

R20       J/PSI(3100) INTO (RHO PI PI PI)/(2 (PI+ PI-) PI0)
R20 J               (.3)                  JEAN-MARI 75 SMAG          E+E-     1/76*
R20 J     FINAL STATE  2(PI+PI-)PI0

R21       J/PSI(3100) INTO (PHI PI+ PI-)/(OMEGA PI+ PI-)
R21                 .2         .1         ABRAMS4   75 SMAG          E+E-     1/76*

R22       J/PSI(3100) INTO (KOS KOL)/TOTAL
R22               (.0002)OR LESS CL=.90   ABRAMS4   75 SMAG          E+E-     1/76*

R23       J/PSI(3100) INTO (K+ K-)/TOTAL
R23               (.0006)OR LESS CL=.90   WIIK      75 DASP          E+E-     1/76*

R24       J/PSI(3100) INTO (K0 K*(892)0)/TOTAL
R24       57        .0024      .0005      ABRAMS4   75 SMAG          E+E-     1/76*

R25       J/PSI(3100) INTO (K+- K*(892)-+)/TOTAL
R25       87        .0031      .0007      ABRAMS4   75 SMAG          E+E-     1/76*
R25          POSSIBLY SEEN                WIIK      75 DASP          E+E-     1/76*

R26       J/PSI(3100) INTO (K0 K*(1420)0)/TOTAL
R26               (.0019)OR LESS CL=.90   ABRAMS4   75 SMAG          E+E-     1/76*

R27       J/PSI(3100) INTO (K+- K*(1420-+)/TOTAL
R27               (.0019)OR LESS CL=.90   ABRAMS4   75 SMAG          E+E-     1/76*

R28       J/PSI(3100) INTO (K*(892)0 K*(892)0)/TOTAL
R28               (.0006)OR LESS CL=.90   ABRAMS4   75 SMAG          E+E-     1/76*

R29       J/PSI(3100) INTO (K*(1420)0 K*(1420)0)/TOTAL
R29               (.0018)OR LESS CL=.90   ABRAMS4   75 SMAG          E+E-     1/76*

R30       J/PSI(3100) INTO (K*(892)0 K*(1420)0)/TOTAL
R30       30        .0037      .0010      ABRAMS4   75 SMAG          E+E-     1/76*

R31       J/PSI(3100) INTO (PBAR P)/TOTAL
R31 A     105       .0021      .0004      ABRAMS4   75 SMAG          E+ E-    1/76*
R31 A     40        .0023      .0006      WIIK      75 DASP          E+ E-    1/76*
R31 A     ASSUMING ANGULAR DISTRIBUTION (1.+COS(THETA)**2)
R31          . . . . . . . . .
R31 AVG         0.00216    0.00033  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R31 STUDENT     0.00216    0.00036  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R32       J/PSI(3100) INTO (PBAR P)/(MU+ MU-)
R32 A     20        .051       .02        CRIEGEE   75 PLUT          E+ E-    1/76*
R32 A     ASSUMING ANGULAR DISTRIBUTION (1.+COS(THETA)**2)

R33       J/PSI(3100) INTO (LAMBDA ANTILAMBDA)/TOTAL
R33       19        .0016      .0008      ABRAMS4   75 SMAG          E+ E-    1/76*

R34       J/PSI(3100) INTO (NUCLEON ANTINUCLEON PI)/TOTAL
R34 A     87        .0037      .0019      ABRAMS4   75 SMAG          E+ E-    1/76*
R34 A     INCLUDES P PBAR PI0, NBAR P PI- AND N PBAR PI+

R35       J/PSI(3100) INTO (P PBAR PI+PI-)/TOTAL
R35 G     125 SEEN                        GOLDHABER 75 SMAG          E+E-     2/76*
R35 G     INCLUDES LAMBDA ANTILAMBDA

R36       J/PSI(3100) INTO (P PBAR PI+ PI- NEUTRALS)/TOTAL
R36 I     91 SEEN                         GOLDHABER 75 SMAG          E+E-     2/76*
R36 I     INCLUDES SIGMA ANTISIGMA ETC.

R37       J/PSI(3100) INTO (LAMBDA ANTISIGMA)/(LAMBDA ANTILAMBDA)
R37               (.22) OR LESS           GOLDHABER 75 SMAG          E+E-     2/76*


R         RADIATIVE DECAYS
R         ----------------

R51       J/PSI(3100) INTO (2 GAMMA)/(E+ E-)                    (P4)/(P1)     2/75*
R51             (0.050)OR LESS  CL=.90    BRAUNSCH  75 DASP          E+E-     2/75*

R52       J/PSI(3100) INTO (PI0 GAMMA)/(E+ E-)                  (P5)/(P1)     2/75*
R52             (0.13) OR LESS  CL=.90    BRAUNSCH  75 DASP          E+E-     2/75*
R52 B           (.06) OR LESS   CL=.90    BACCI     75 FRAG          E+E-     1/76*
R52 B     RE-STATED BY US USING (E+E-)/HADRONS = .08

R53       J/PSI(3100) INTO (ETA GAMMA)/TOTAL
R53 U             .0014      .0005        WIIK      75 DASP          E+ E-    1/76*
R53 U     USING TOTAL WIDTH (69+-15) KEV
R53               (.016)OR LESS  CL=.90   BACCI     75 FRAG          E+E-     1/76*

R54       J/PSI(3100) INTO (ETA PRIME GAMMA)/(ETA GAMMA)
R54             (5.)    OR LESS  CL=.90   WIIK      75 DASP          E+E-     1/76*
R54             4.0        2.5            HEINTZE   75 DESY          E+E-     1/76*
R54 B           (10.)   OR LESS  CL=.90   BALDINI2  75 FRAG          E+E-     1/76*
R54 B     RE-STATED BY US USING (ETA GAMMA)/TOTAL = .0014

R56       J/PSI(3100) INTO (X(2750) GAMMA)/(ETA GAMMA) FINAL STATE (3 GAMMA)
R56       16        (1.)                  HEINTZE   75 DESY          E+E-     1/76*
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Data Card Listings

For notation, see key at front of Listings.

Mesons

$J/\psi(3100)$, $\psi(3700)$

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                70  J/PSI(3100)   G(I)*G(E+E-)/G(TOTAL)  (KEV)

        THIS COMBINATION OF A PARTIAL WIDTH WITH THE PARTIAL WIDTH
        INTO E+E- AND WITH THE TOTAL WIDTH IS OBTAINED FROM THE INTEGRATED
        CROSS-SECTION INTO CHANNEL(I) IN THE E+E- ANNIHILATICN.
        SEE THE MINI-REVIEW ON EXTRACTING RESONANCE WIDTHS.

G1      G(E+E-)*G(E+E-)/G(TOTAL)
G1  S         (.32)     (.07)          BALDINI1  75 FRAG        E+E-          1/76*
G1             .41       .06           DASP1     75 DASP        E+E-          1/76*
G1  S         (.36)     (.10)          FORD      75 SPEC        E+E-
G1             .34       .14           BEMPORAD  75 FRAB        E+E-          1/76*
G1  S         (.34)     (.09)          ESPOSITC  75 FRAM        E+E-          1/76*
G1          . . . . . . . . .
G1  AVG       0.399     0.055    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
G1  STUDENT   0.399     0.060    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

G2      G(MU+MU-)*G(E+E-)/G(TOTAL)
G2             .51       .09           DASP1     75 DASP        E+E-          1/76*
G2             .31       .09           BEMPORAD  75 FRAB        E+E-          1/76*
G2             .32       .08           CRIEGEE   75 PLUT        E+E-          1/76*
G2  S         (.38)     (.05)          ESPOSITO  75 FRAM        E+E-          1/76*
G2  S         (.46)     (.10)          LIBERMAN  75 SPEC        E+E-          1/76*
G2          . . . . . . . . .
G2  AVG       0.375     0.063    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
G2  STUDENT   0.369     0.059    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

G3      G(HADRONIC)*G(E+E-)/G(TCTAL)
G3  S         (4.)      (.8)           BALDINI1  75 FRAG        E+E-          1/76*
G3  S         (3.9)     (.8)           ESPOSITO  75 FRAM        E+E-          1/76*

G   S   SEE THE BRANCHING RATIOS AND PARTIAL WIDTHS ABOVE.

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                         REFERENCES FOR J/PSI(3100)

CHRISTEN 70 PRL 25 1523      CHRISTENSON,HICKS,LEDERMAN+ (COLU+BNL+CERN)    V70

ABRAMS   74 PRL 33 1453      +BRIGGS,AUGUSTIN,BOYARSKI+         (LBL+SLAC)  V70
ASH      74 NCL 11 705       +ZORN,BARTOLI+     (FRAS+UMD+NAPL+PADO+RCMA)   V70
AUBERT   74 PRL 33 1404      +BECKER,BIGGS,BURGER,CHEN,EVERHART(MIT+BNL)    V70
   ALSO  75  COO-3069-285    AUBERT,BECKER,BIGGS,BURGER,GLENN+ (MIT+BNL)    V7C
AUGUSTIN 74 PRL 33 1406      +BOYARSKI,ABRAMS,BRIGGS+           (SLAC+LBL)  V70
BACCI    74 PRL 33 1408      +BARTOLI,BARBARINO,BARBIELLINI+    (FRASCATI)  V70
   ALSO  74 PRL 33 1649      FCR ERRATA                                     V70
BALDINI- 74 NCL 11 711       BALDINI-CELIO,BACCI+          (FRASCATI+ROMA)  V70
BARBIELL 74 NCL 11 718       BARBIELLINI,BEMPORAD+ (FRAS+NAPO+PISA+ROMA)    V70
BRAUNSCH 74 PL 53B 393       BRAUNSCHWEIG+     (AACHEN+HAMB+MUNICH+TOKYO)   V7C

ABRAMS4  75  STANFORD SYMP.  G.S.ABRAMS                              (LBL)  V70
ANDREWS  75 PRL 34 231       +HARVEY,LOBKOWICZ,MAY,NORDBERG  (ROCH+CORN)    V70
   ALSO  75  UR-518          ANDREWS,HARVEY,LOBKCWICZ,MAY+   (ROCH+CORN)    V70
ANTIPOV  75  IHEP PREP 75-125 +BESSUBOV,BUDANOV,BUSHNIN,DENISOV,+  (IHEP)   V70
AUBERT   75 NP B 89 1                                                       V70
BACCI    75 NCL 12 269       +PENSO,STELLA,BALDINI-CELIC,+   (ROMA+FRAS)    V70
BALDINI1 75 PL 58B 471       BALDINI-CELIO,BOZZO,CAPON,BACCI+(FRAS+ROMA)    V70
BALDINI2 75 PL 58B 475       BALDINI-CELIO,CAPON,DEL FABBRO+ (FRAS+RCMA)    V70
BEMPORAD 75  STANFORD SYMP.  C.BEMPORAD                  (PISA+FRASCATI)    V70
BLANAR   75 PRL 35 346       +BOYER,FAISSLER,GARELICK,GETTNER,+)       )
BOYARSKI 75 PRL 34 1357      +BREIDENBACH,BULOS,FELDMAN,+     (SLAC+LBL)JPC V70
BRAUNSCH 75 PL 53B 491       BRAUNSCHWEIG+     (AACHEN+HAMB+MUNICH+TOKYO)   V70
CAMERINI 75 PRL 35 483       +LEARNED,PREPOST,ASH,ANDERSON,+ (WISC+SLAC)    V70
CRIEGEE  75 PL 53B 489       +DEHNE,FRANKE,HORLITZ,KRECHLOCK+     (DESY)    V70
CRIEGEE  75  DESY PREP.75/32 +DEHNE,FOX,FRANKE,HORLITZ,KNIES,+    (DESY)    V70
DAKIN    75 PL 56 B 405      +KREISLER,BOLON,HEILE+      (MASA+MIT+SLAC)    V70
DASP1    75 PL 56B 491       BRAUNSCHWEIG,KONIGS,+ (AACH+DESY+MPIM+TOKY)    V70
DASP2    75 PL 57B 297       BRAUNSCHWEIG,KONIGS,+ (AACH+DESY+MPIM+TOKY)    V70
ESPOSITO 75 NCL 14 73        +BARTOLI,BISELLC,+    (FRAS+NAPO+PADO+RCMA)    V70
FORD     75 PRL 34 604       +BERON,HILGER,HOFSTADTER+       (SLAC+PENN)    V70
GITTELMA 75 PRL 35 1616      GITTELMAN+HANSON+LARSCN+LCH+         (CORN)    V70
GOLDHABE 75  LBL-4224        GOLDHABER,JOHNSON,KADYK,+       (LBL+SLAC)     V70
GRECO    75 PL 56B 367       +PANCHERI-SRIVASTAVA,SRIVASTAVA      (FRAS)    V70
HEINTZE  75  STANFORD SYMP.  J.HEINTZE                      (HEIDELBERG)    V70
JACKSON  75 NIM 128 13       J.D.JACKSON,D.SCHARRE                 (LBL)    V70
JEAN-MAR 75 PRL (SLAC-PUB-1681+ABRAMS,BOYARSKI,BREIDENBACH,+ (SLAC+LBL)IG   V70
KNAPP1   75 PRL 34 1040      +LEE,BRONSTEIN+   (COLU+HAWA+CORN+ILL+FNAL)    V70
KNAPP2   75 PRL 34 1044      +LEE,BRONSTEIN+   (COLU+HAWA+CORN+ILL+FNAL)    V70
LIBERMAN 75  STANFORD SYMP.  A.D.LIBERMAN                     (STANFORD)    V70
MARTIN   75 PRL 34 288       +BOLON,DAKIN,FELDMAN,HANSON+(MIT+MASA+SLAC)    V70
PREPOST  75  STANFORD SYMP.  R.PREPCST                       (WISCONSIN)    V70
SIMPSON  75 PRL 35 699       +BERON,FORD,HILGER,HOFSTADTER,+ (STAN+PENN)    V70
WIIK     75  STANFORD SYMP.  B.H.WIIK                             (DESY)    V70
YENNIE   75 PRL 34 239       D.R.YENNIE                        (CORNELL)    V70

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$\psi(3700)$

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71  PSI(3700,JPG=1--) I=0
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The $\psi(3700)$ was discovered in e^+e^- collisions at SPEAR (ABRAMS 74), and since then has been extensively investigated in e^+e^- collisions at SPEAR and DORIS, as well as at conventional accelerators.

The hadronic interpretation of the $\psi(3700)$ is closely related to that of $J/\psi(3100)$, due to the decays $\psi(3700) \rightarrow J/\psi(3100)\pi\pi$ and $\psi(3700) \rightarrow J/\psi(3100)\eta$. These decays also determine the $I^G = 0^-$ assignment for the $\psi(3700)$ (TANENBAUM 75).

The J^{PC} assignment, suggested by production in s-channel e^+e^- collisions, is confirmed by the observation of an interference between the resonant and QED amplitudes, and by the angular distribution of the lepton pairs in the final state (LÜTH 75). These quantum numbers are compatible with all the data on partial decay widths (the multipion decays mentioned above, the non-observation of $J/\psi(3100)\pi^0$ and $\gamma\gamma$ modes, etc.).

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                      71  PSI(3700) MASS (MEV)

M   L     (3695.)     (4.)           ABRAMS    74 SPEAR       E+E-       2/75*
M  S      (3680.3)                   CRIEGEE   75 DORIS       E+E-       2/75*
M          3684.       5.            LUTH      75 SPEAR       E+E-       1/76*
M          3684.       9.            PREPOST   75 SPEC   21. GAMMA D     1/76*
M
M   L   LUTH  75 IS A REEVALUATION OF ABRAMS 74 BASED ON A RECALIBRATION 2/75*
M   L   OF THE SPEAR BEAM ENERGY.                                        2/75*
M  S    ERROR OF ABOUT 1 PER CENT FROM THE UNCERTAINTY IN CALIBRATION OF 2/75*
M  S    THE BEAM ENERGY.                                                 2/75*
M          . . . . . . . . .
M  AVG     3684.0      4.4     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M  STUDENT3684.0       4.7     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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DM                    PSI(3700) - J/PSI(3100) MASS CIFFERENCE (MEV)

DM          588.7      .8            LUTH      75 SMAG

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                      71  PSI(3700) WIDTH (KEV)

W           228.       56.           LUTH      75 SMAG

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                      71  PSI(3700) PARTIAL DECAY MODES

                                                            DECAY MASSES
P1      PSI(3700) INTO E+ E-                                 .5+  .5
P2      PSI(3700) INTO MU+ MU-                              105+ 105
P3      PSI(3700) INTO HADRCNS
P4      PSI(3700) INTO GAMMA INTO HADRCNS

P       DECAYS INTO J/PSI(3100) + ANYTHING
P       ------------------------------
P11     PSI(3700) INTO J/PSI(3100) + ANYTHING
P12     PSI(3700) INTO J/PSI(3100) + NEUTRALS
P13     PSI(3700) INTO J/PSI(3100) PI+ PI-                  3098+ 139+ 139
P14     PSI(3700) INTO J/PSI(3100) PIO PIO                  3098+ 134+ 134
P15     PSI(3700) INTO J/PSI(3100) ETA                      3098+ 548
P54     PSI(3700) INTO J/PSI(3100) GAMMA GAMMA

P       HADRONIC DECAYS
P       ---------------
P21     PSI(3700) INTO PI+ PI-
P22     PSI(3700) INTO RHO0 PIO
P23     PSI(3700) INTO K+ K-
P24     PSI(3700) INTO 2(PI+ PI-) PIO
P25     PSI(3700) INTO PI+ PI- K+ K-
P26     PSI(3700) INTO PBAR P

P       RADIATIVE DECAYS
P       ----------------
P51     PSI(3700) INTO GAMMA GAMMA
P52     PSI(3700) INTO PIO GAMMA
P53     PSI(3700) INTO ETA GAMMA
P55     PSI(3700) INTO ETA PRIME GAMMA
P56     PSI(3700) INTO CHI(3410) GAMMA                      3410+   0
P57     PSI(3700) INTO CHI(3530) GAMMA                      3530+   0
P58     PSI(3700) INTO PC GAMMA
P59     PSI(3700) INTO X(2750) GAMMA

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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

	P13	P14	P15	P58	P_{OTHER}
P13	.3307+-.0266				
P14	.5922	.1724+-.0242			
P15	-.0079	-.1453	.0416+-.0070		
P58	.0264	-.2301	-.0065	.0363+-.0066	
P_{OTHER}	-.9108	-.8301	-.0727	-.0370	.4190+-.0450

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                      71  PSI(3700) PARTIAL WIDTHS (KEV)

W1      PSI(3700) INTO E+ E-                          (G1)                2/75*
W1           2.1        .3           LUTH      75 SMAG           E+E-     1/76*

W3      PSI(3700) INTO HACRCNS                        (G3)
W3           224.       56.          LUTH      75 SMAG           E+E-     1/76*

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                      71  PSI(3700) BRANCHING RATIOS

R1      PSI(3700) INTO (E+ E-)/TOTAL
R1 L          .0093      .0016       LUTH      75 SMAG           E+E-     1/76*
R1 L     FROM AN OVERALL FIT ASSUMING EQUAL PARTIAL WIDTHS FOR (E+E-)
R1 L     AND (MU+MU-). FOR A MEASUREMENT OF THE RATIO SEE THE ENTRY R4 BELOW
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Mesons

ψ(3700)

Data Card Listings

For notation, see key at front of Listings.

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R2       PSI(3700) INTO (MU+ MU-)/TOTAL
R2 H           .0084     .0018             HILGER     75 SPEC          E+E-           1/76*
R2 H      RE-STATED BY US USING (J/PSI(3100)+ANYTHING)/TOTAL = .6

R3       PSI(3700) INTO (HADRONS)/TOTAL
R3             .981      .003              LUTH       75 SMAG          E+E-           1/76*

R4       PSI(3700) INTO (MU+ MU-)/(E+ E-)
R4             .89       .16               LUTH1      75 SMAG          E+E-           1/76*

R5       PSI(3700) INTO (GAMMA INTO HADRONS)/TOTAL
R5             .029      .004              LUTH       75 SMAG          E+E-           1/76*


R        DECAYS INTO J/PSI(3100) + ANYTHING
R        --------------------------------

R10      PSI(3700) INTO (J/PSI(3100) + ANYTHING)/TOTAL
R10            .57       .08               ABRAMS4    75 SMAG          E+E-           1/76*
R10         . . . . . . . . .
R10 FIT        0.581     0.045   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R11      PSI(3700) INTO (J/PSI(3100) + NEUTRALS)/(J/PSI(3100) + ANYTHING)
R11  S         (.44)     (.03)             ABRAMS1    75 SMAG          E+E-           1/76*
R11  S    SUPERSEDED BY TANENBAUM 76 (FOOTNOTE 13 OF TANENBA1 75,AND
R11  S    PRIV. COMMUNICATION).
R11            .41       .02               TANENBAUM 76 SMAG           E+E-           2/76*
R11         . . . . . . . . .
R11 FIT        0.410     0.019   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R12      PSI(3700) INTO (J/PSI(3100) PI+ PI-)/TOTAL
R12            .32       .04               ABRAMS1    75 SMAG          E+E-           1/76*
R12            .36       .06               WIIK       75 DASP          E+E-           1/76*
R12         . . . . . . . . .
R12 AVG        0.332     0.033    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R12 STUDENT    0.332     0.036    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R12 FIT        0.331     0.027   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R13      PSI(3700) INTO (J/PSI(3100) PIO PIO)/TOTAL
R13            .18       .06               WIIK       75 DASP          E+E-           1/76*
R13         . . . . . . . . .
R13 FIT        0.172     0.024   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R14      PSI(3700) INTO (J/PSI(3100) PIO PIO)/(J/PSI(3100) PI+ PI-)
R14 H          (.64)     (.15)             HILGER     75 SPEC          E+E-           1/76*
R14 H     IGNORING THE (J/PSI ETA) AND (J/PSI GAMMA GAMMA) DECAYS

R15      PSI(3700) INTO (J/PSI(3100) ETA)/TOTAL
R15            .043      .008              TANENBA1   75 SMAG          E+E-           1/76*
R15            .037      .015              WIIK       75 DASP          E+E-           1/76*
R15         . . . . . . . . .
R15 AVG        0.0417    0.0071   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R15 STUDENT    0.0417    0.0076   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R15 FIT        0.0416    0.0070 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R16      PSI(3700) INTO (J/PSI(3100) GAMMA OR J/PSI(3100) PIO)/TOTAL
R16            (.0015)OR LESS CL=.90     TANENBA1   75 SMAG          E+E-           2/76*

R50      PSI(3700) INTO (J/PSI(3100) GAMMA GAMMA)/TOTAL
R50  A   10 SEEN                           DASP3      75 DASP          E+E-           1/76*
R50  B    5 SEEN                           DASP3      75 DASP          E+E-           1/76*
R50  A   15 SEEN                           HEINTZE    75 SPEC          E+E-           1/76*
R50  B  150 SEEN                           TANENBAUM 75 SMAG           E+E-           1/76*
R50 AB   DECAY PROCEEDS VIA INTERMEDIATE STATE PC  (SEE R51) .
R50  A   WITH J/PSI(3100) INTO (E+ E-)
R50  B   WITH J/PSI(3100) INTO (MU+ MU-)

R        HADRONIC DECAYS
R        ---------------

R20      PSI(3700) INTO (PI+ PI-)/TOTAL
R20            (.0009)OR LESS CL=.90     WIIK       75 DASP          E+E-           1/76*
R20           (.00019)OR LESS CL=.90     FELDMAN    75 SMAG          E+E-           1/76*

R21      PSI(3700) INTO (RHOO PIO)/TOTAL
R21            (.001)OR LESS  CL=.90     ABRAMS4    75 SMAG          E+E-           1/76*

R22      PSI(3700) INTO (2(PI+ PI-) PIO)/TOTAL
R22            .0035     .0015             ABRAMS4    75 SMAG          E+E-           1/76*

R23      PSI(3700) INTO (K+ K-)/TOTAL
R23            (.0016)OR LESS CL=.90     WIIK       75 DASP          E+E-           1/76*
R23           (.00023)OR LESS CL=.90     FELDMAN    75 SMAG          E+E-           1/76*

R24      PSI(3700) INTO (PI+ PI- K+ K-)/TOTAL
R24            (.0005)                     ABRAMS4    75 SMAG          E+E-           1/76*

R25      PSI(3700) INTO (PBAR P)/TOTAL
R25            (.001)OR LESS  CL=.90     WIIK       75 DASP          E+E-           1/76*
R25             .0004     .0002            ABRAMS4    75 SMAG          E+E-           1/76*

R        RADIATIVE DECAYS
R        ----------------

R41      PSI(3700) INTO (GAMMA GAMMA)/TOTAL
R41            (.008)OR LESS  CL=.90     WIIK       75 DASP          E+E-           1/76*
R41  U         (.005)OR LESS  CL=.95     HUGHES     75 SPEC          E+E-           1/76*

R42      PSI(3700) INTO (PIO GAMMA)/TOTAL
R42            (.01) OR LESS  CL=.90     WIIK       75 DASP          E+E-           1/76*
R42  U         (.007)OR LESS  CL=.95     HUGHES     75 SPEC          E+E-           1/76*

R43      PSI(3700) INTO (ETA GAMMA)/TOTAL
R43            (.0013)OR LESS CL=.90     WIIK       75 DASP          E+E-           1/76*
R43  U         (.024)OR LESS  CL=.95     HUGHES     75 SPEC          E+E-           1/76*
R43  U   RE-STATED BY US USING (MU+MU-)/TOTAL = .01

R44      PSI(3700) INTO (ETA PRIME GAMMA)/TOTAL
R44            (.014)OR LESS  CL=.90     WIIK       75 DASP          E+E-           1/76*

R51      PSI(3700) INTO (PC GAMMA)/TOTAL, PC INTO (J/PSI(3100) GAMMA)
R51            .04       .02               WIIK       75 DASP          E+E-           1/76*
R51            .036      .007              TANENBAUM 75 SMAG           E+E-           1/76*
R51         . . . . . . . . .
R51 AVG        0.0364    0.0066   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R51 STUDENT    0.0364    0.0071   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R51 FIT        0.0363    0.0066 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R52      PSI(3700) INTO (PC GAMMA)/TOTAL, PC INTO (GAMMA GAMMA)
R52          (.000013)OR LESS CL=.90     WIIK       75 DASP          E+E-           1/76*

R53      PSI(3700) INTO (X(2750) GAMMA)/TOTAL,  X(2750) INTO (GAMMA GAMMA)
R53           (.00037)OR LESS CL=.90     WIIK       75 DASP          E+E-           1/76*
R53            (.003)OR LESS  CL=.95     HUGHES     75 SPEC          E+E-           1/76*

R54      PSI(3700) INTO (CHI(3410) GAMMA)/TOTAL  *10**2
R54
R54 F     FOR DECAY MODES OF THE CHI INDICATED        **********************
R54 F          (.13)     (.05)             FELDMAN    75  CHI INTO (PI+PI-)OR(K+K
R54 F          (.07)                       FELDMAN1   75  CHI INTO (PI+PI-K+K-)
R54 F          (.14)     (.07)             FELDMAN1   75  CHI INTO (2(PI+PI-))
R54 F          (.1)                        FELDMAN1   75  CHI INTO (3(PI+PI-))
R54 F          (.5)  OR LESS  CL=.90     FELDMAN1   75  CHI INTO (J/PSI GAMMA)
R54 F     FOR DECAY MODES OF THE CHI INDICATED        **********************

R55      PSI(3700) INTO (CHI(3530) GAMMA)/TOTAL  *10**2
R55
R55 F     FOR DECAY MODES OF THE CHI INDICATED        **********************
R55 F          (.027)OR LESS  CL=.90     FELDMAN    75  CHI INTO (PI+PI-)OR(K+K
R55 F          (.05)                       FELDMAN1   75  CHI INTO (PI+PI-K+K-)
R55 F          (.2)      (.1)              FELDMAN1   75  CHI INTO (2(PI+PI-))
R55 F          (.2)                        FELDMAN1   75  CHI INTO (3(PI+PI-))
R55 F     FOR DECAY MODES OF THE CHI INDICATED        **********************

R56      PSI(3700) INTO (PC GAMMA)/TOTAL, PC INTO (PI+PI-) OR (K+K-)
R56           (.00027)OR LESS CL=.90     FELDMAN1   75 SMAG          E+E-           1/76*


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                         71   PSI(3700)      G(I)*G(E+E-)/G(TOTAL)   (KEV)


          THIS COMBINATION OF A PARTIAL WIDTH WITH THE PARTIAL WIDTH
          INTO E+E- AND WITH THE TOTAL WIDTH IS OBTAINED FROM THE INTEGRATED
          CROSS-SECTION INTO CHANNEL(I) IN THE E+E- ANNIHILATION.
          SEE THE MINI-REVIEW ON EXTRACTING RESONANCE WIDTHS.


G3       G(HADRONIC)*G(E+E-)/G(TOTAL)
G3             2.2       .4                ABRAMS4    75 SMAG          E+E-           1/76*


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                                 REFERENCES FOR PSI(3700)
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ABRAMS    74 PRL 33 1453            +BRIGGS,AUGUSTIN,BOYARSKI+        (LBL+SLAC)     V71

ABRAMS1   75 PRL 34 1181            +BRIGGS,CHINOWSKY,FRIEDBERG,+     (LBL+SLAC)     V71
ABRAMS4   75  STANFORD SYMP.        G.S.ABRAMS                             (LBL)     V71
AUBERT    75 PRL 33 1624            +BECKER,BIGGS,BURGER,GLENN+        (MIT+BNL)     V71
CAMERINI  75 PRL 35 483             +LEARNED,PREPOST,ASH,ANDERSON,+ (WISC+SLAC)     V71
CRIEGEE   75 PL 53B 489             +DEHNE,FRANKE,HORLITZ,KRECHLOCK+      (DESY)     V71
DASP3     75 PL 57B 407             BRAUNSCHWEIG,KONIGS,+ (AACH+DESY+MPIM+TOKY)     V71
FELDMAN   75 PRL 35 821             +JEAN-MARIE,SADOULET,VANNUCCI,+  (LBL+SLAC)     V71
FELDMAN1  75  STANFORD SYMP.        G.J.FELDMAN                           (SLAC)     V71
GRECO     75 PL 56B 367             +PANCHERI-SRIVASTAVA,SRIVASTAVA       (FRAS)     V71
HEINTZE   75  STANFORD SYMP.        J.HEINTZE                       (HEIDELBERG)     V71
JACKSON   75 NIM 128 13             J.D.JACKSON,D.SCHARRE                  (LBL)     V71
HILGER    75 PRL 35 625             +BERON,FORD,HOFSTADTER,HOWELL,+ (STAN+PENN)     V71
HUGHES    75  PREP.HEPL 765         +BERON,CARRINGTON,FORD,HILGER,+ (STAN+PENN)     V71
LUTH      75 PRL 35 1124            +BOYARSKI,LYNCH,BREIDENBACH,+     (SLAC+LBL)JPC V71
LUTH1     75  SLAC-PUB-1599         V.LUTH , PALERMO CONF.PROC.+      (SLAC+LBL)     V71
LIBERMAN  75  STANFORD SYMP.        A.D.LIBERMAN                      (STANFORD)     V71
PREPOST   75  STANFORD SYMP.        R.PREPOST                        (WISCONSIN)     V71
SIMPSON   75 PRL 35 699             +BERON,FORD,HILGER,HOFSTADTER,+ (STAN+PENN)     V71
TANENBAU  75 PRL 35 1323            TANENBAUM,WHITAKER,ABRAMS,+       (LBL+SLAC)     V71
TANENBA1  75 PRL  SLAC-PUB1696      TANENBAUM,ABRAMS,BOYARSKI,+       (SLAC+LBL)     V71
WIIK      75  STANFORD SYMP.        B.H.WIIK                              (DESY)     V71

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Additional States in S-channel e^+e^- Collisions

No evidence for narrow states has been found in the mass intervals 1910-2545 MeV and 2970-3090 MeV (BACCI 75, ESPOSITO 75). Except for the ψ(3700), no additional narrow states have been found in the mass interval 3200-7600 MeV (BOYARSKI 75, SCHWITTERS 75).

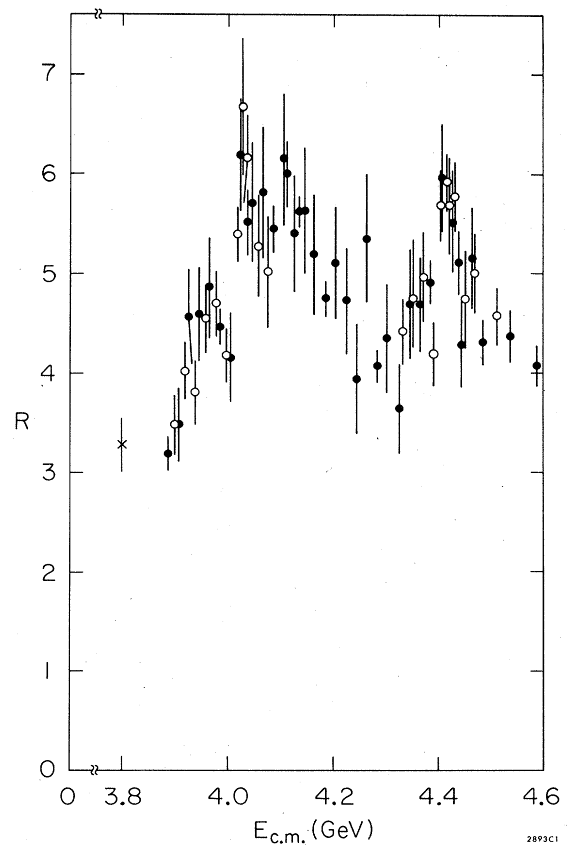
The broad enhancement observed in the e^+e^- total cross section at SPEAR (AUGUSTIN 75) is now resolved into two distinct objects at 4100 and 4400 MeV (SIEGRIST 76), with indications of even more detailed substructure especially at 4100 MeV (see figure). Due to there being very limited information available on the properties of ψ(4100) and ψ(4400), their resonant interpretation is not yet established. If in fact they are resonances, then their relatively large widths suggest that they are hadronic, with $J^{PC} = 1^{--}$.

Data Card Listings

For notation, see key at front of Listings.

Mesons

ψ(4100), ψ(4400), X(2750)



The ratio of cross sections $\frac{\sigma(e^+e^- \to \text{hadrons})}{\sigma(e^+e^- \to \mu^+\mu^-)}$ in the ψ(4100)-ψ(4400) region (from SIEGRIST 76).

ψ(4100)

```
ψ(4100)   72  PSI(4100,JPG=    ) I=
------ --------- --------- --------- --------- --------- --------- --------

                 72  PSI(4100) MASS (MEV)

M          (4150.)                  AUGUSTIN  75 SPEAR   2.4-5.0 E+E-      2/75*
M          (4100.)                  SCHWITTER 75 SMAG            E+E-      1/76*

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                        REFERENCES FOR PSI(4100)

AUGUSTIN 75 PRL 34 764        +BOYARSKI,ABRAMS,BRIGGS+           (SLAC+LBL)    V72
BACCI    75 PL 58B 481        +BIDOLI,PENSO,STELLA,+            (ROMA+FRAS)    V72
BOYARSKI 75 PRL 34 762        +BREIDENBACH,ABRAMS,BRIGGS,+       (SLAC+LBL)    V72
ESPOSITO 75 PL 58B 478        +FELICETTI,PERUZZI,+  (FRAS+NAPO+PADO+ROMA)    V72
SCHWITTE 75  STANFCRD SYMP.   R.F.SCHWITTERS                         (SLAC)    V72
SIEGRIST 76  SUBM. TO PRL     +ABRAMS,BOYARSKI,BREIDENBACH,+     (LBL+SLAC)    V72

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ψ(4400)

```
ψ(4400)   73  PSI(4400,JPG=    ) I=
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                 73  PSI(4400) MASS (MEV)

M        4414.       7.             SIEGRIST  76 SMAG            E+E-      2/76*

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                 73  PSI(4400) WIDTH (MEV)

W          33.      10.             SIEGRIST  76 SMAG            E+E-      2/76*

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                 73  PSI(4400) BRANCHING RATIOS

R1     PSI(4400) INTO (E+ E-)/TCTAL *10**5
R1            1.3      .3           SIEGRIST  76 SMAG            E+E-      2/76*
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                        REFERENCES FOR PSI(4400)

SCHWITTE 75  STANFCRD SYMP.   R.F.SCHWITTERS                         (SLAC)    V73
SIEGRIST 76  SUBM. TO PRL     +ABRAMS,BOYARSKI,BREIDENBACH,+     (LBL+SLAC)    V73

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X(2750)

```
X(2750)   54  X(2750,JPG=    ) I=
---->
                     OBSERVEC IN THE SEQUENTIAL RADIATIVE CECAY OF THE
       J/PSI(3100) INTO X(2750) GAMMA, X(2750) INTO GAMMA GAMMA,AND POSSIBLY
       PBAR P (HEINTZE 75). THIS SUGGESTS QUANTUM NUMBER ASSIGNMENTS
       C=+, IG=0+ OR 1-.
       NEEDS CONFIRMATICN. CMITTED FROM TABLE.

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                 54  X(2750) MASS (MEV)

M          (2750.)                  HEINTZE   75 DESY            E+E-      1/76*
------ --------- --------- --------- --------- --------- --------- --------

                 54  X(2750) PARTIAL DECAY MODES

                                                            DECAY MASSES
P1     X(2750) INTO GAMMA GAMMA
P2     X(2750) INTO PBAR P

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                 54  X(2750) BRANCHING RATIOS

R1     X(2750) INTO (PBAR P)/TOTAL
R1        2 POSSIBLY SEEN           WIIK      75 DASP            E+E-      1/76*
****** ********* ********* ********* ********* ********* ********* ********

                        REFERENCES FOR X(2750)

HEINTZE  75  STANFORD SYMP.   J.HEINTZE                       (HEIDELBERG)    V54
WIIK     75  STANFORD SYMP.   B.H.WIIK                              (DESY)    V54

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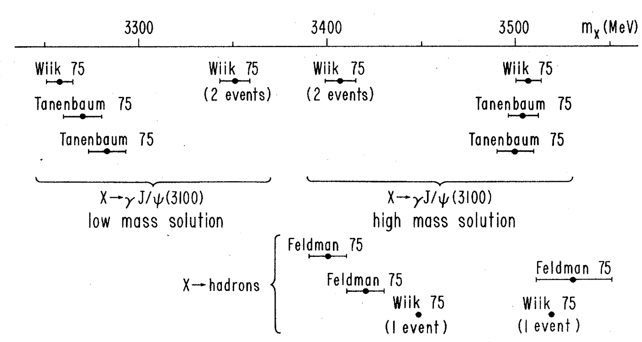
States Observed in Radiative Decays of ψ(3700)

The properties, and even the number, of intermediate states in radiative decay of ψ(3700) are not well known. The main problems are:

1) small statistics in most experiments;
2) ambiguity in the determination of the mass of P_c;
3) it is not known whether the χ(3530) is a single state, or whether the relatively large observed width is due to a superposition of several narrow states.

The data seem to require the presence of at least 3 states in the mass interval 3250-3550 MeV; the figure summarizes all the present claims.



Claims for intermediate states X in the radiative decay ψ(3700) → γX.

Mesons

P_c(3300 or 3500), χ(3410), χ(3530)

Data Card Listings

For notation, see key at front of Listings.

P_c(3300 or 3500)

```
                    55   PC(3300 OR 3500,JPG=    ) I=

          OBSERVED IN THE RADIATIVE SEQUENTIAL DECAY OF THE
PSI(3700) INTO PC GAMMA, PC INTO J/PSI(3100) GAMMA (BRAUNSWEIG 75,
CONFIRMED BY TANENBAUM 75), THEREFORE C=+. MASS DETERMINATION
AMBIGUOUS DUE TO TWO POSSIBLE (GAMMA J/PSI) COMBINATIONS IN THE
FINAL STATE (J/PSI GAMMA GAMMA).
NEEDS CLARIFICATION (SEE THE MINIREVIEW ON STATES OBSERVED IN
RADIATIVE DECAYS OF PSI(3700). OMITTED FROM TABLE.

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                    55   PC MASS (MEV)

M1 L      LOW MASS SOLUTION
M1 L W    4(3260.)     (50.)             DASP3      75 DASP         E+E-        1/76*
M1 L     40 3270.       10.              TANENBAUM  75 SMAG         E+E-        1/76*
M1 L      7 3283.       10.              TANENBAUM  75 SMAG         E+E-        1/76*
M1 L W    7 3258.        7.              WIIK       75 DASP         E+E-        1/76*
M1 L W    2(3351.)      (8.)             WIIK       75 DASP         E+E-        1/76*
M1           . . . . . . . . .
M1  AVG     3267.2       7.3     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
M1  STUDENT3267.0        6.2     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

M2 H      HIGH MASS SOLUTION
M2 H W    4(3520.)     (50.)             DASP3      75 DASP         E+E-        1/76*
M2 H     40 3500.       10.              TANENBAUM  75 SMAG         E+E-        1/76*
M2 H      7 3504.        8.              TANENBAUM  75 SMAG         E+E-        1/76*
M2 H W    7 3507.        7.              WIIK       75 DASP         E+E-        1/76*
M2 H W    2(3407.)      (8.)             WIIK       75 DASP         E+E-        1/76*
M2 H W   WIIK 75 SUPERSEDES CASP3  75, WITH 3 ADDITIONAL EVENTS FOR THE PC,
M2 H W   AND 2 EVENTS INDICATING POSSIBLE EXISTENCE OF A PC PRIME.
M2           . . . . . . . . .
M2  AVG     3504.5       4.7     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M2  STUDENT3504.5        5.0     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    55   PC PARTIAL DECAY MODES

                                                             DECAY MASSES
P1       PC INTO J/PSI(3100) GAMMA
P2       PC INTO PI+ PI-
P3       PC INTO K+ K-
P4       PC INTO GAMMA GAMMA

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                    55   PC BRANCHING RATIOS

R1       PC INTO (J/PSI(3100) GAMMA)/TOTAL
R1  D        DOMINANT                    DASP3     75 CASP          E+E-        1/76*
R1  D    USING THE UPPER LIMITS OF SIMPSON 75

R2       PC INTO (PI+PI- OR K+K-)/TOTAL
R2  F        NOT SEEN                    FELDMAN1  75 SMAG          E+E-        1/76*
R2  F    SEE BRANCHING RATIO R56 OF PSI(3700).

R3       PC INTO (GAMMA GAMMA)/TOTAL
R3           (.0032)OR LESS CL=.90   WIIK      75 CASP          E+E-        1/76*

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                         REFERENCES FOR PC
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DASP3     75 PL 57B 407          BRAUNSCHWEIG,KONIGS,+ (AACH+DESY+MPIM+TOKY)   V55
FELDMAN1  75  STANFORD SYMP.     G.J.FELDMAN                          (SLAC)   V55
HEINTZE   75  STANFORD SYMP.     J.HEINTZE                      (HEIDELBERG)   V55
SIMPSON   75 PRL 35 699          +BERON,FORD,HILGER,HOFSTADTER,+ (STAN+PENN)   V55
TANENBAU  75 PRL 35 1323         TANENBAUM,WHITAKER,ABRAMS,+      (LBL+SLAC)   V55
WIIK      75  STANFORD SYMP.     B.H.WIIK                             (DESY)   V55

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χ(3410)

```
               56   CHI(3410,JPG=    ) I=

          OBSERVED IN THE RADIATIVE DECAY OF PSI(3700) INTO
CHI(3410) GAMMA (FELDMAN 75), THEREFORE C=+. THE OBSERVED DECAY
INTO (PI+PI-) OR(K+K-) IMPLIES G=+, JP=0+,2+,... . CONFIRMATION
OF BOTH (PI+PI-) AND (K+K-) MODES WOULD ESTABLISH I=0.
NEEDS CLARIFICATION (SEE THE MINIREVIEW ON STATES OBSERVED IN
RADIATIVE DECAYS OF PSI(3700). OMITTED FROM TABLE.

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                    56   CHI(3410) MASS (MEV)

M        11 3400.       10.              FELDMAN    75 SMAG         E+E-        1/76*
M        50 3410.       10.              FELDMAN    75 SMAG         E+E-        1/76*
M            . . . . . . . . .
M   AVG     3405.0       7.1     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT3405.0        7.8     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    56   CHI(3410) PARTIAL DECAY MODES

                                                             DECAY MASSES
P1       CHI(3410) INTO PI+ PI-
P2       CHI(3410) INTO K+ K-
P3       CHI(3410) INTO 2(PI+ PI-)
P4       CHI(3410) INTO 3(PI+ PI-)
P5       CHI(3410) INTO PI+ PI- K+ K-
P6       CHI(3410) INTO J/PSI(3100) GAMMA

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                    56   CHI(3410) BRANCHING RATIOS

R        SEE BRANCHING RATIOS R54 OF PSI(3700)

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                         REFERENCES FOR CHI(3410)
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```
FELDMAN   75 PRL 35 821          +JEAN-MARIE,SADOULET,VANNUCCI,+  (LBL+SLAC)   V56
    ALSO  75 PRL 35 1189   (ERRATA)
TANENBAU  75 PRL 35 1323         TANENBAUM,WHITAKER,ABRAMS,+      (LBL+SLAC)   V56

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χ(3530)

```
               57   CHI(3530,JPG=    ) I=

          OBSERVED IN RADIATIVE DECAY OF PSI(3700) INTO
CHI(3530) GAMMA (FELDMAN 75), THEREFORE C=+. CAN BE INTERPRETED
AS A SINGLE (BROAD) STATE, OR AS A SUPERPOSITION OF SEVERAL
NARROW STATES.
NEEDS CLARIFICATION (SEE THE MINIREVIEW ON STATES OBSERVED IN
RADIATIVE DECAYS OF PSI(3700). OMITTED FROM TABLE.

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                    57   CHI(3530) MASS (MEV)

M        60 3530.       20.              FELDMAN    75 SMAG         E+E-        1/76*

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                    57   CHI(3530) PARTIAL DECAY MODES

                                                             DECAY MASSES
P1       CHI(3530) INTO PI+ PI-
P2       CHI(3530) INTO K+ K-
P3       CHI(3530) INTO 2(PI+ PI-)
P4       CHI(3530) INTO 3(PI+ PI-)
P5       CHI(3530) INTO PI+ PI- K+ K-
P6       CHI(3530) INTO J/PSI(3100) GAMMA

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                    57   CHI(3530) BRANCHING RATIOS

R        SEE BRANCHING RATIOS R55 OF PSI(3700)

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                         REFERENCES FOR CHI(3530)
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```
FELDMAN   75 PRL 35 821          +JEAN-MARIE,SADOULET,VANNUCCI,+  (LBL+SLAC)   V57
    ALSO  75 PRL 35 1189   (ERRATA)
TANENBAU  75 PRL 35 1323         TANENBAUM,WHITAKER,ABRAMS,+      (LBL+SLAC)   V57

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Data Card Listings

For notation, see key at front of Listings.

Baryons

N's and Δ's

Note on N's and Δ's

I. Determination of Resonance Parameters

Values of masses, widths, and branching ratios are obtained mainly from phase-shift analyses. In production experiments, in fact, it is seldom clear which of the many states at similar masses is being observed. In addition to a few complete phase-shift analyses, we have other analyses, done by using somewhat incomplete data, by various different groups, but we are quite far from having reliable masses and widths derived therefrom.

There are essentially two problems in obtaining reliable resonance parameters. First there is often disagreement as to just what the values of the partial-wave amplitudes are. This problem is obviously related to the quality and quantity of the data and to the procedures used to determine the amplitudes. Secondly, even if smooth curves were available for the amplitudes, there would still be some parametrization-dependent ambiguity in deciding what the resonance parameters should be. From a theoretical standpoint the most unambiguously defined resonance parameters are the pole position and residue, and it has been found in practice that, given sufficiently precise partial-wave amplitudes, these quantities can be extracted in a stable and parametrization-independent way, in spite of the fact that they require an extrapolation away from the physical region. This point has been discussed in detail with regard to the Δ(1232) in previous editions of this review[1,2]. We list available pole parameter determinations in the Data Card Listings, and many further discussions can be found in the corresponding references, e.g., NOGOVA 73, SPEARMAN 74, BALL 75, LICHTENBERG 75, LONGACRE 75, and VASAN 75.

At the beginning of the Data Card Listings for N's and Δ's, we present a table giving our evaluation of the N and Δ resonances based on information contained in the Listings. In the Table of Particle Properties, we do not quote values and errors for most parameters, but give only ranges for masses and widths in order to emphasize that in some cases these parameters are quite poorly determined.

References for Section I

1. Particle Data Group, Rev. Mod. Phys. 43, S114 (1971).
2. Particle Data Group, Phys. Lett. 39B, 103 (1972).

For other references see the Data Card Listings.

II. $\pi N \to \pi N$, ηN, $K\Sigma$, $K\Lambda$

The most recent available $\pi N \to \pi N$ amplitudes are from the analysis of the Saclay group, AYED 74. Preliminary results of more recent analyses have been discussed at meetings[1,2], but resonance parameters are not yet available. The results of AYED 74 are shown in Figs. II.1-II.6. The figure captions summarize the known resonances in the various partial waves. We restrict our discussion here to mentioning the possible new effects seen in recent analyses. All resonance parameters quoted under AYED 74 derive from energy-dependent fits (Breit-Wigner with background) to the partial-wave amplitudes which were determined in an energy-independent shortest-path analysis.

S''_{31}: In Fig. II.1, the energy-dependent fit of AYED 74 suggests that the broad structure around 2000 MeV is associated with a second resonance with

$$M = 2001 \text{ MeV},\ \Gamma_{tot} = 307 \text{ MeV},\ x_{el} = 0.08 \ .$$

There is some additional evidence for such an effect from LANGBEIN 73 and DEANS 75, which are energy-independent and energy-dependent analyses, respectively, of $K\Sigma$ associated production.

P''_{33}: The small dip in the imaginary part of P_{33} and the zero in the real part around 1900 MeV are interpreted in the energy-dependent fit of AYED 74 as a second P_{33} resonance,

$$M = 1904 \text{ MeV},\ \Gamma_{tot} = 204 \text{ MeV},\ x_{el} = 0.19$$

ALMEHED 72 found two effects, one at ∿1680 MeV and another at ∿2150 MeV, as did DEANS 75. However, LANGBEIN 73 found evidence for the higher mass effect only. The existence of some sort of effect at ∿2200 MeV seems definitely established

Baryons

N's and Δ's

Data Card Listings

For notation, see key at front of Listings.

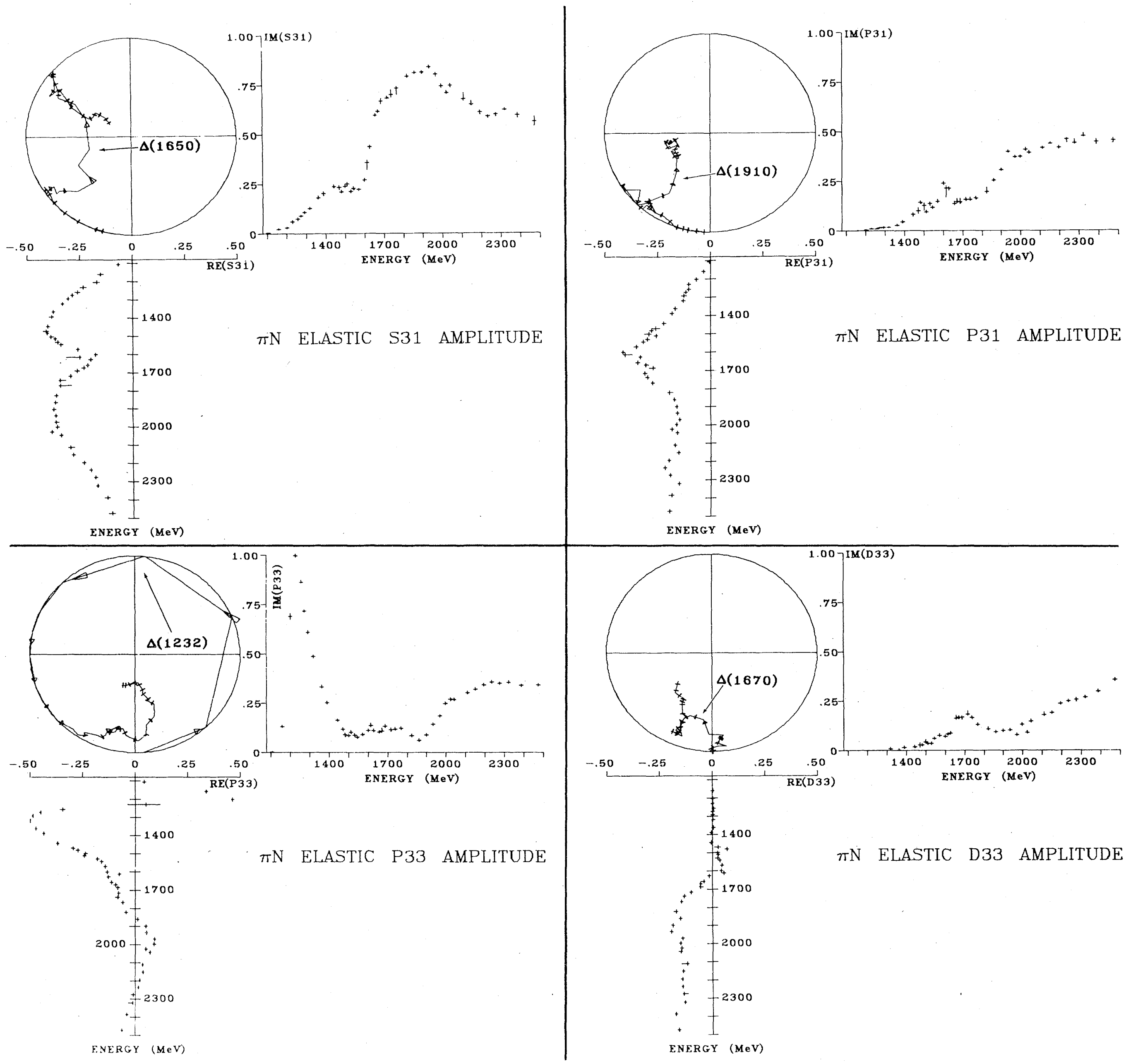

Fig. II.1. Amplitudes for I = 3/2 πN elastic scattering in the J = 1/2 and J = 3/2 waves from AYED 74. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts vs. energy, in alignment with the corresponding Argand plot. In addition, arrows are plotted on the Argand plots with bases positioned at integer multiples of 50 MeV and a base-to-tip length of 5 MeV. All the energy axes run from elastic threshold to 2500 MeV. Established resonances in these waves are the Δ(1650), Δ(1910), Δ(1232), and Δ(1670) in the S_{31}, P_{31}, P_{33}, and D_{33} waves, respectively; these are indicated on the above Argand plots. See the Data Card Listings and the accompanying mini-review for other possible resonances in the S_{31} and P_{33} waves.

Data Card Listings

For notation, see key at front of Listings.

Baryons

N's and Δ's

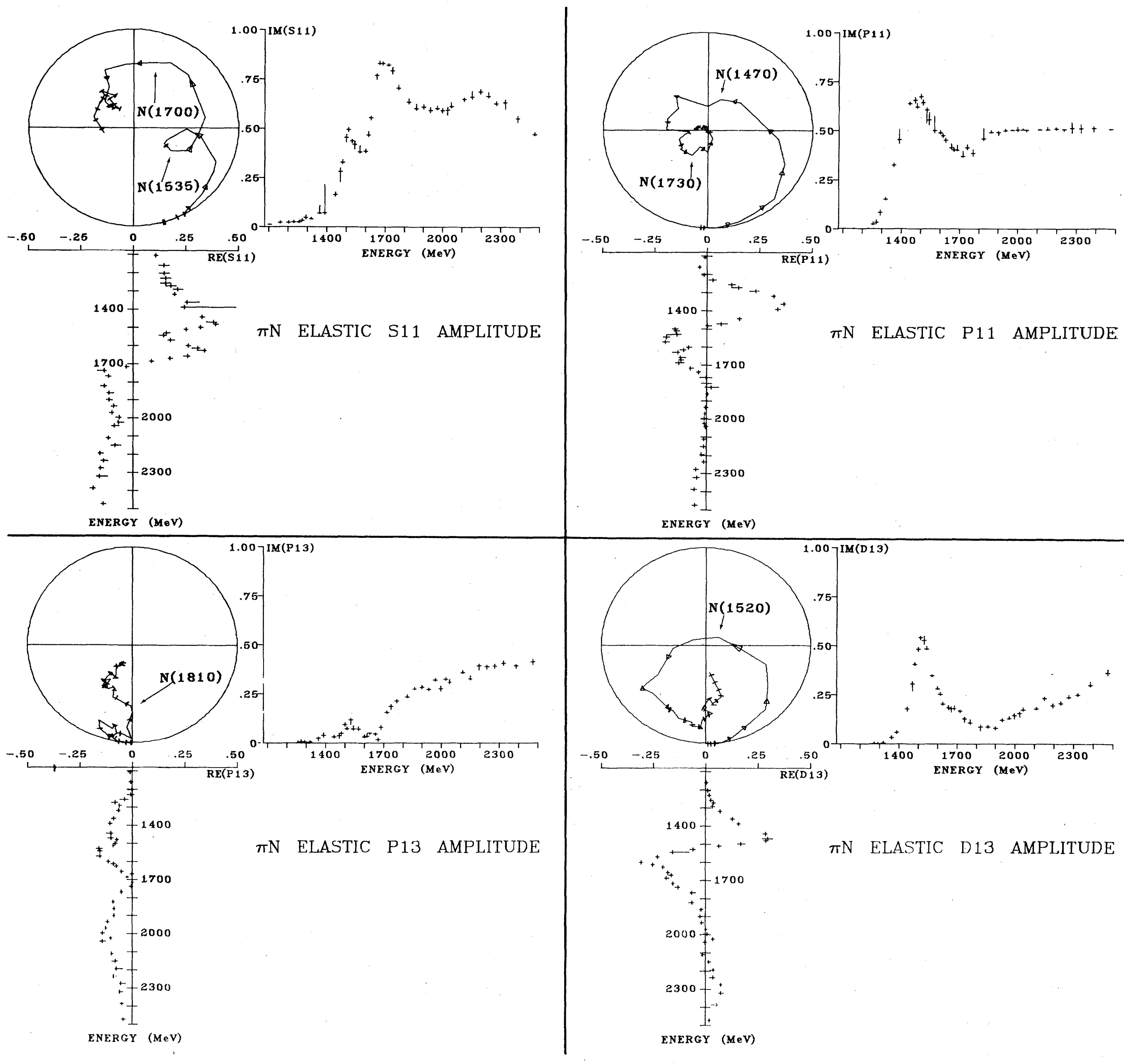

Fig. II.2. Amplitudes for I = 1/2 πN elastic scattering in the J = 1/2 and J = 3/2 waves from AYED 74. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts vs. energy, in alignment with the corresponding Argand plot. In addition, arrows are plotted on the Argand plots with bases positioned at integer multiples of 50 MeV and a base-to-tip length of 5 MeV. All the energy axes run from elastic threshold to 2500 MeV. Established resonances in these waves are the N(1535) and N(1700) in the S_{11} wave, the N(1470) and N(1780) in the P_{11} wave, the N(1810) in the P_{13} wave, and the N(1520) in the D_{13} wave; these are indicated on the above Argand plots. The P_{11} wave also contains the nucleon pole, 138 MeV below threshold. See the Data Card Listings and the accompanying mini-review for other possible resonances in these waves.

Baryons

N's and Δ's

Data Card Listings

For notation, see key at front of Listings.

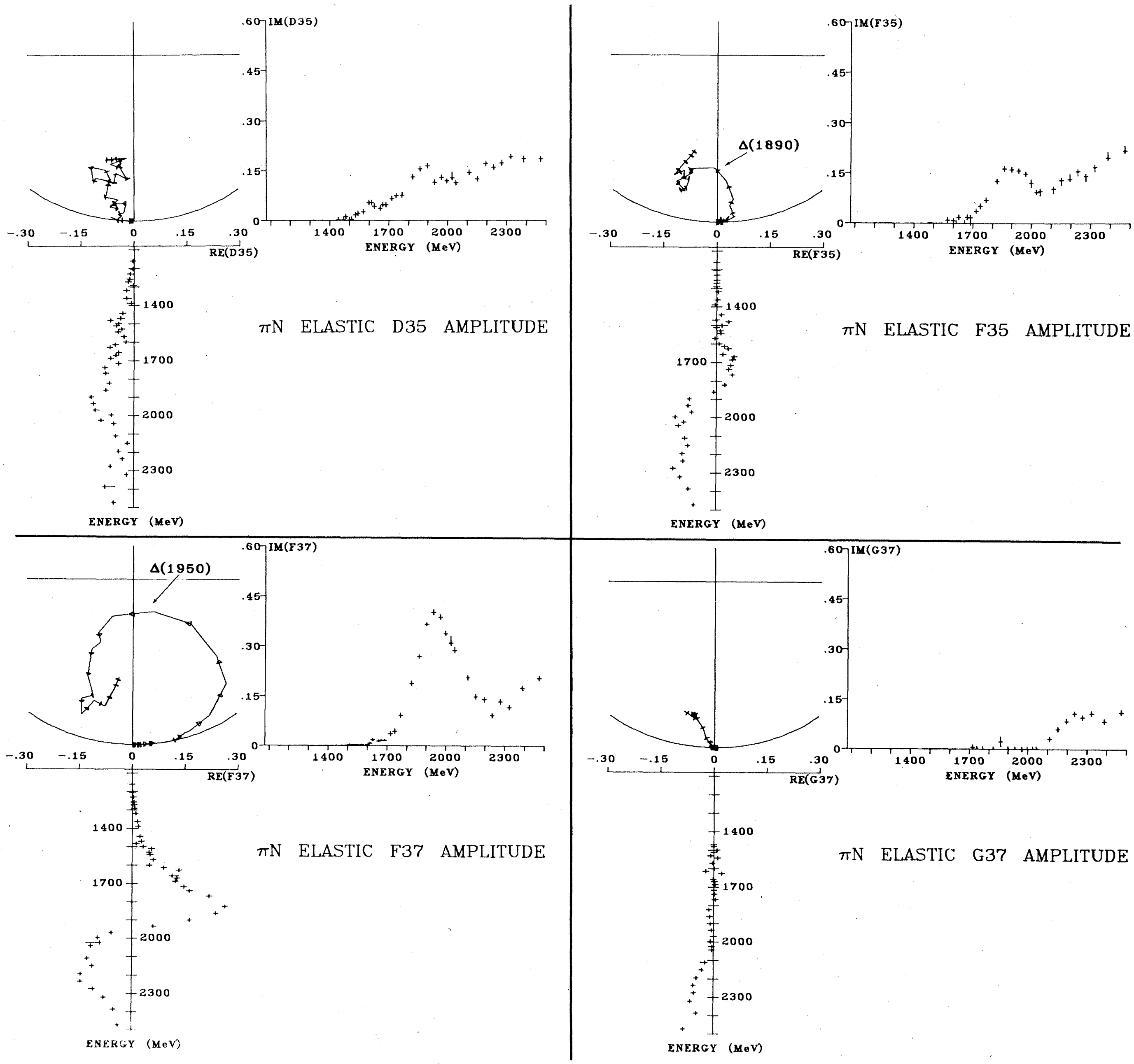

Fig. II.3. Amplitudes for I = 3/2 πN elastic scattering in the J = 5/2 and J = 7/2 waves from AYED 74. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts vs. energy, in alignment with the corresponding Argand plot. In addition, arrows are plotted on the Argand plots with bases positioned at integer multiples of 50 MeV and a base-to-tip length of 5 Mev. All the energy axes run from elastic threshold to 2500 MeV. Established resonances in these waves are the Δ(1890) and Δ(1950) in the F_{35} and F_{37} waves, respectively; these are indicated on the above Argand plots. See the Data Card Listings and the accompanying mini-review for another possible resonance in the D_{35} wave.

Data Card Listings

For notation, see key at front of Listings.

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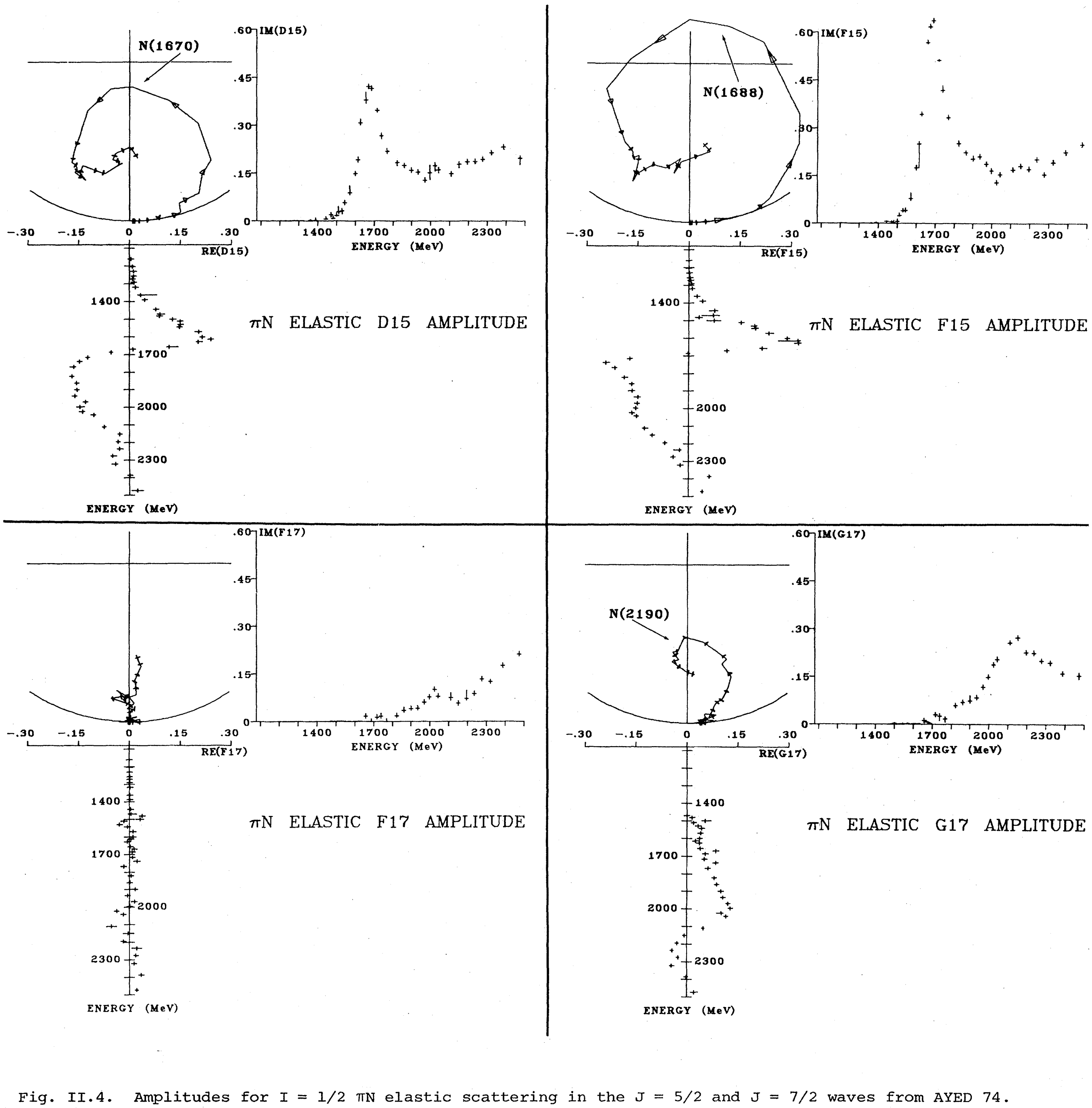

Fig. II.4. Amplitudes for I = 1/2 πN elastic scattering in the J = 5/2 and J = 7/2 waves from AYED 74. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts vs. energy, in alignment with the corresponding Argand plot. In addition, arrows are plotted on the Argand plots with bases positioned at integer multiples of 50 MeV and a base-to-tip length of 5 MeV. All the energy axes run from elastic threshold to 2500 MeV. Established resonances in these waves are the N(1670), N(1688), and N(2190) in the D_{15}, F_{15}, and G_{17} waves, respectively; these are indicated on the above Argand plots. See the Data Card Listings and the accompanying mini-review for other possible resonances in the D_{15}, F_{15}, and F_{17} waves.

Baryons
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For notation, see key at front of Listings.

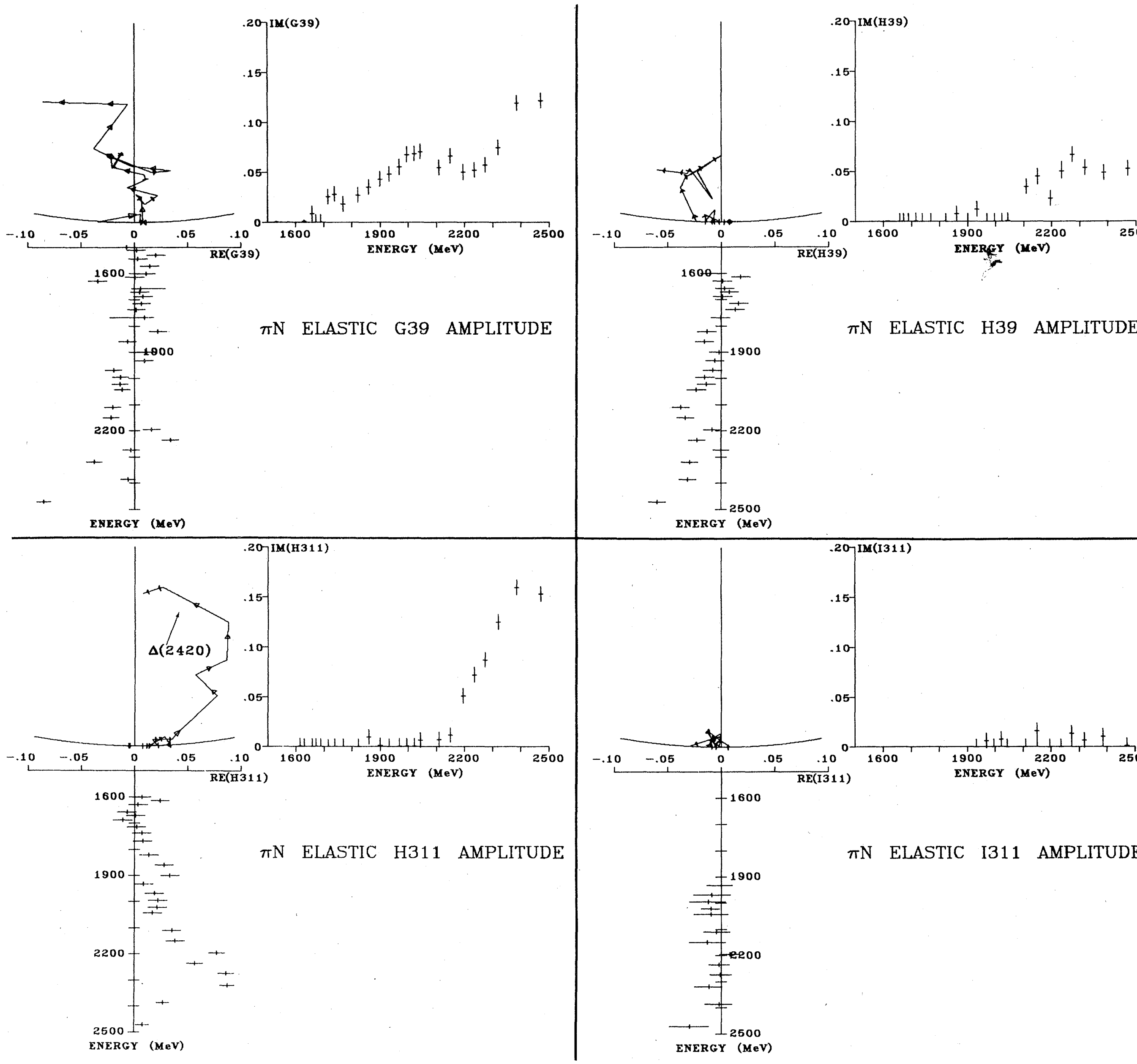

Fig. II.5. Amplitudes for I = 3/2 πN elastic scattering in the J = 9/2 and J = 11/2 waves from AYED 74. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts vs. energy, in alignment with the corresponding Argand plot. In addition, arrows are plotted on the Argand plots with bases positioned at integer multiples of 50 MeV and a base-to-tip length of 5 MeV. All energy axes run from 1500 to 2500 MeV. The only established resonance in these waves is the Δ(2420) in the $H_{3\,11}$ wave; it is indicated on the above $H_{3\,11}$ Argand plot. See the Data Card Listings and the accompanying mini-review for another possible resonance in the G_{39} wave.

Data Card Listings

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Baryons

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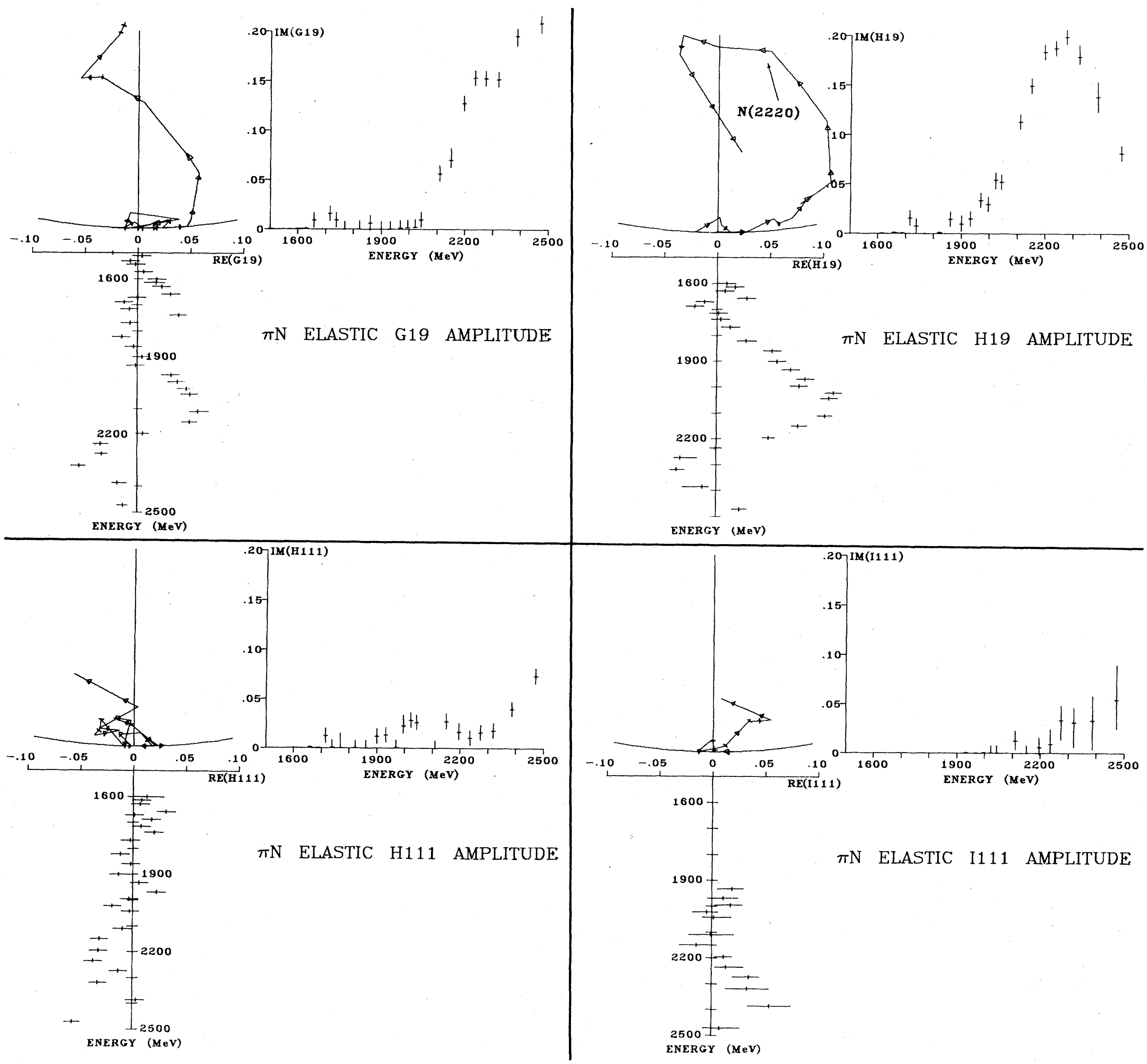

Fig. II.6. Amplitudes for I = 1/2 πN elastic scattering in the J = 9/2 and J = 11/2 waves from AYED 74. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts vs. energy, in alignment with the corresponding Argand plot. In addition, arrows are plotted on the Argand plots with bases positioned at integer multiples of 50 MeV and a base-to-tip length of 5 MeV. All the energy axes run from 1500 to 2500 MeV. The only established resonance in these waves is the N(2220) in the H_{19} wave; it is indicated on the above H_{19} Argand plot. See the Data Card Listings and the accompanying mini-review for another possible resonance in the G_{19} wave.

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by the backward π^+p scattering experiment of REY 74, but the quantum numbers are not yet established [see the Listings for Δ(2160)].

$\underline{P_{31}}$: The P_{31} resonance mass quoted by AYED 74 (M = 1786 MeV) is considerably lower than in previous analyses (except AYED 70) which find M in the region 1900 to 1950 MeV.

$\underline{D_{35}}$: AYED 74, LANGBEIN 73, and DEANS 75 all find evidence for a D_{35} state somewhere in the mass range 1900-2000 MeV, ALMEHED 72 found an effect at 2200 MeV, but with such a large width, 600 MeV, that a resonance interpretation is questionable.

$\underline{S_{11}'''}$: In Fig. II.2 are shown the low spin I = 1/2 waves of AYED 74. They associate the broad effect at ∿2300 MeV with a third S_{11} resonance:

$$M = 2283 \text{ MeV}, \ \Gamma_{tot} = 310 \text{ MeV}, \ x_{el} = 0.14 \quad .$$

ALMEHED 72 find a similar effect at 2100 MeV.

$\underline{P_{11}'}$: AYED 74 claim the "Roper" to be split:

$$M_{low} = 1413 \text{ MeV}, \ \Gamma_{tot} = 187 \text{ MeV}, \ x_{el} = 0.55 \ ;$$

$$M_{high} = 1532 \text{ MeV}, \ \Gamma_{tot} = 89 \text{ MeV}, \ x_{el} = 0.12 \quad .$$

While such a splitting might be a natural explanation for the relatively low mass and broad width of the "Roper" as seen in production experiments, the evidence in Fig. II.2, especially the projections, seems only tentative. The new Saclay ηn data and partial-wave analysis of FELTESSE 75 are not inconsistent with the parameters of the high mass state. However, an equally acceptable fit to their data is obtained by introducing a new P_{13} resonance with M = 1530 MeV, Γ = 79 MeV, and $\sqrt{xx'}$ = 0.33.

$\underline{D_{13}''}$: A somewhat larger effect in this wave at ∿1700 MeV is identified by AYED 74 as a second D_{13} resonance:

$$M = 1710 \text{ MeV}, \ \Gamma_{tot} = 100 \text{ MeV}, \ x_{el} = 0.09 \quad .$$

The projections reveal a shoulder in the imaginary part and a small dip in the real part. A similar effect exists in ALMEHED 72, but was not claimed as a resonance. Further evidence for this state is found by LANGBEIN 73, DEANS 75, and KNASEL 75 (KΛ associated production), as well as recent pion photoproduction analyses and the LBL-SLAC ππN analysis (see III and IV below).

$\underline{D_{13}'''}$: Along with ALMEHED 72, AYED 74 find evidence for a D_{13} state at ∿2000 MeV:

$$M = 2029 \text{ MeV}, \ \Gamma_{tot} = 116 \text{ MeV}, \ x_{el} = 0.10 \quad .$$

The evidence in the projections seems less than for the effect at 1700 MeV. Evidence for coupling of this state to the KΣ channel is found by DEANS 75, but not by LANGBEIN 73.

$\underline{D_{15}''}$: The rapid decrease in the real part of this amplitude around 2100 MeV (see Fig. II.4) is associated with a second D_{15} resonance by AYED 74:

$$M = 2100 \text{ MeV}, \ \Gamma_{tot} = 220 \text{ MeV}, \ x_{el} = 0.08 \quad .$$

These parameters are in reasonable agreement with those of ALMEHED 72.

$\underline{F_{15}''}$: The broad shoulder in the real part and dip in the imaginary part are identified with a second F_{15} resonance by AYED 74:

$$M = 1989 \text{ MeV}, \ \Gamma_{tot} = 179 \text{ MeV}, \ x_{el} = 0.08 \quad .$$

ALMEHED 72 find an effect at ∿2200 MeV, and LANGBEIN 73 and DEANS 75 find some evidence for coupling to the KΣ channel at ∿2000 MeV.

<u>Higher Waves</u>. Besides confirming the already accepted $H_{3,11}$ and H_{19}, AYED 74 present evidence for two additional states in the 2200 MeV region:

$$G_{39}: \ M = 2174 \text{ MeV}, \ \Gamma_{tot} = 205 \text{ MeV}, \ x_{el} = 0.04 \ ;$$

$$G_{19}: \ M = 2133 \text{ MeV}, \ \Gamma_{tot} = 193 \text{ MeV}, \ x_{el} = 0.10 \ .$$

The G_{39} effect in Fig. II.5 is not too convincing. Notice that ALMEHED 72 claimed a P_{33} resonance in this same region; see Δ(2160) for further possibilities in this mass region. In contrast, the evidence for G_{19}, Fig. II.6, looks quite good; note, in particular, the behavior of the real part projection in the region 1900-2500 MeV.

<u>References for Section II</u>

1. R. L. Kelly, in <u>New Directions in Hadron Spectroscopy</u> (ANL-HEP-CP-75-58), eds. S. L. Kramer and E. L. Berger, 1975.
2. E. Pietarinen, Universität Karlsruhe Reports TKP 4/75 and TKP 15/75.

For other references see the Data Card Listings.

III. The $N\pi\pi$ Channel

In the isobar model, the amplitude for the reaction $\pi N \rightarrow N\pi\pi$ is written

$$T = \sum \Big\{ T^{JILL'}_{\Delta\pi}(E)\ BW_{\Delta}(E_{\pi N})\ X^{JILL'}_{\Delta\pi} + T^{JILL'}_{\rho N}(E)\ BW_{\rho}(E_{\pi\pi})\ X^{JILL'}_{\rho N} + T^{JILL'}_{\varepsilon N}(E)\ BW_{\varepsilon}(E_{\pi\pi})\ X^{JILL'}_{\varepsilon N} \Big\} .$$

In this expression the BW's denote either appropriate Breit-Wigner's or the corresponding two-body amplitude. The functions X contain all the angular information; these are well-defined functions depending only on which isobars are used in the model. The partial-wave amplitudes, $T^{JILL'}_{\Delta\pi}$, etc., may be indicated by

$$\Delta\pi, LL'_{2I2J} \qquad \rho N, LL'_{2I2J} \qquad \varepsilon N, LL'_{2I2J}$$

where L is the incoming (πN) angular momentum, and L' is the outgoing angular momentum between the isobar [$\rho, \varepsilon (= \pi\pi$ I = 0, S wave$), \Delta$] and the remaining hadron (N or π); as usual I and J are the isospin and total spin ($\vec{J} = \vec{L} + \vec{S} = \vec{L}' + \vec{S}'$), respectively. Often the ρ has a subscript 1 or 3 which denotes twice the ρN total spin. The generalization of the model to include more two-body final-state interactions is obvious, but only the three included above, Δ, ρ, and ε, have actually been used in presently published analyses. It should be noted that one assumes the partial-wave amplitudes depend only on the c.m. energy E and not on the diparticle subenergies, $E_{\pi\pi}$ and $E_{\pi N}$.

The largest isobar analysis to date is that of the LBL-SLAC collaboration, LONGACRE 75 and Ref. 1, which analyzes 200K events of $\pi^- p \rightarrow \pi^-\pi^0 p$, $\pi^+\pi^- n$ and $\pi^+ p \rightarrow \pi^+\pi^0 p$, $\pi^+\pi^+ n$ in the c.m. energy range 1300-2000 MeV. Details of this analysis, particularly the evolution of the preferred solution B, have been discussed in the previous edition of this review[2]. Results from this solution are shown in Fig. III.1. In this edition we list resonance parameters, including pole positions, from LONGACRE 75 in the Data Card Listings. Breit-Wigner masses, widths, and resonance couplings were extracted in two ways by LONGACRE 75, and we list the results of both methods, in addition to the pole positions. Method 1 used Breit-Wigner fitting to individual partial waves, and method 2 used a coupled-channel K-matrix fit to all waves with the same IJP. Among the most interesting results are further evidence for the existence of the $D_{13}(1700)$ and the $P_{33}(1690)$, further evidence for dominantly F-wave decay of the $F_{37}(1950)$ into $\Delta\pi$, and good agreement with quark-model predictions[3].

Some information on isobar couplings is also available from earlier analysis. CHAVANON 74[4] analyzed $\pi^+ p \rightarrow \pi^+\pi^0 p$ in the range 1580-1970 MeV and obtained information on Δ-resonance decays to $\Delta\pi$ and $N\rho$. MEHTANI 72 analyzed the $\Delta\pi$ channel in the region 1820-2090 MeV and found the first evidence for strong F-wave decay of the $F_{37}(1950)$. The analysis of DIEM 70 covered the region 1550-1650 MeV.

In connection with all of these analyses it should be kept in mind that the isobar model is really a model and is not an exact representation of the $\pi N \rightarrow \pi\pi N$ amplitude. There are a number of ways in which the model could seriously fail to represent the physical amplitude. The problem that has received the most attention recently is the assumption that the isobar partial-wave amplitudes do not depend on the diparticle sub-energies, an assumption which is inconsistent with unitarity. For discussion of this problem see Refs. 2, 5, 6, and other references quoted therein.

References for Section III

1. D. J. Herndon et al., Phys. Rev. D11, 3183 (1975).
2. Particle Data Group, Phys. Lett. 50B, No. 1 (1974).
3. R. J. Cashmore et al., Nucl. Phys. B92, 37 (1975).
4. P. Chavanon et al., Nucl. Phys. B76, 157 (1974).
5. R. Aaron et al., Phys. Rev. D12, 1984 (1975).
6. Y. Goradia and T. A. Lasinski, LBL-3626 (1975); submitted to Phys. Rev. D.

For other references see the Data Card Listings.

Baryons

N's and Δ's

Data Card Listings

For notation, see key at front of Listings.

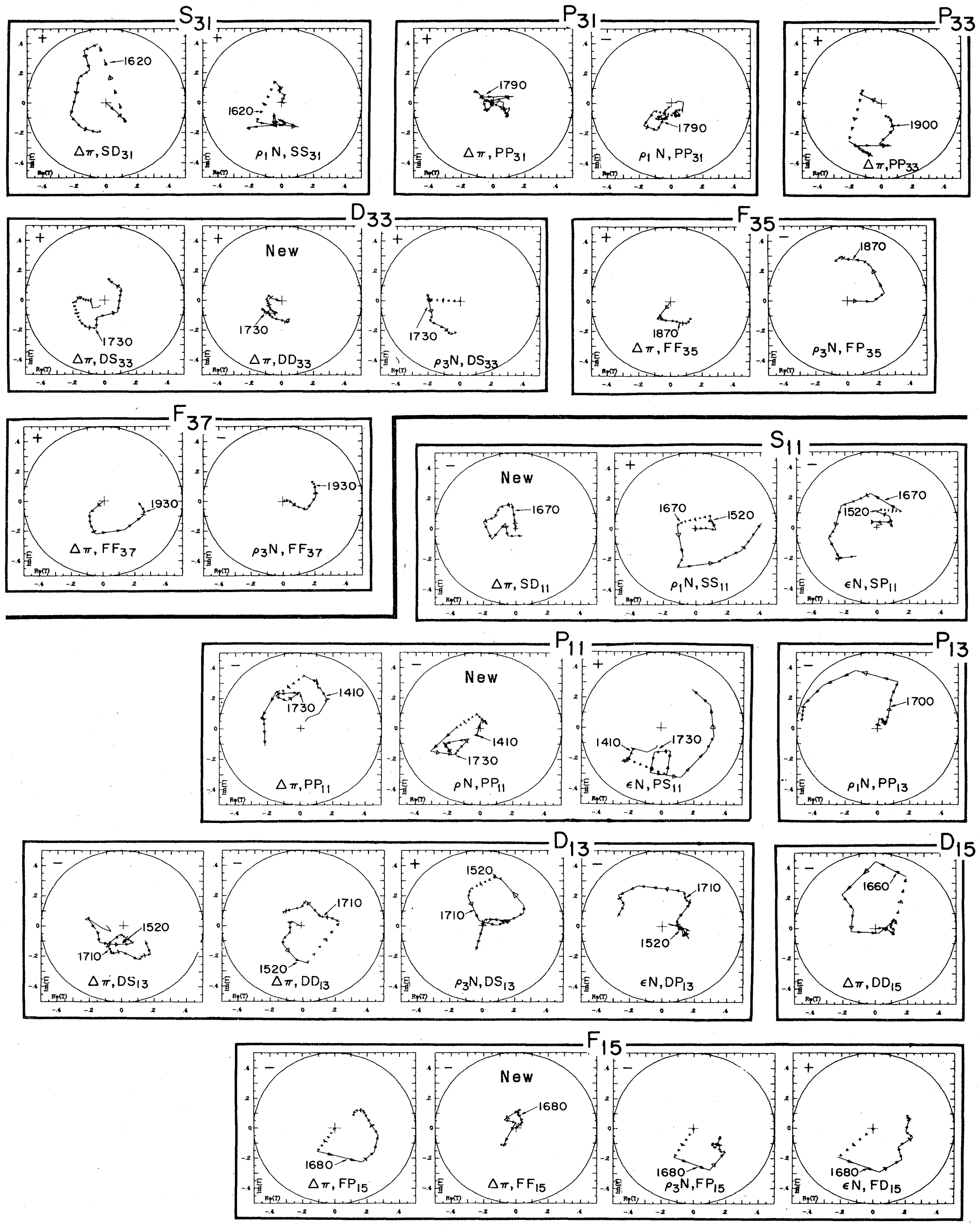

Fig. III.1. Solution B of the LBL-SLAC isobar analysis of $\pi N \to N\pi\pi$. See mini-review for notation. The four waves labeled "New" were not used in earlier solutions. The sign in the upper left-hand corner of each plot indicates how to transform from the sign conventions of this group to that of the "baryon-first" convention. (See main text, Sec. IV B.)

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IV. Photon Couplings

(R. L. Crawford and R. G. Moorhouse, Glasgow Univ.)

Photon couplings can be studied in formation reactions like

$$\gamma N \to N^* \to \pi N \ , \ \eta N \ , \ K\Lambda \ , \ \pi\Delta, \ \ldots .$$

A partial-wave analysis of these processes is the standard technique to determine the coupling strengths $g(N^*N\gamma)$. Up to now, almost all results are derived from the analysis of single-pion photoproduction. In the following we, therefore, define the conventions of pion photoproduction in which the results will be quoted.

The process $\gamma N \to N^* \to \pi N$ for a specific intermediate resonance can be symbolically described as

$$\langle \pi N | H_\pi | N^* \rangle \langle N^* | H_\gamma | \gamma N \rangle \quad .$$

The first term is measured in strong interactions, e.g., by partial-wave analysis of elastic πN scattering. A common feature of almost all analyses of pion photoproduction is a strong reliance on the knowledge of resonance parameters from πN partial-wave analyses. Pion photoproduction does not give a particularly accurate method of determining the resonance masses and widths, due partly to a lack of sufficiently precise data at many energies and partly because photoproduction is complicated by the fact that the photon has helicity states ±1 and can react as an isoscalar and isovector particle. Consequently, several couplings for $N^* \to \gamma N$ have to be determined (2 for Δ and 4 for N).

Isospin Decomposition. Ignoring possible isotensor components, the reactions leading to the four possible final charge states are described by three isospin amplitudes. One set of these consists of the amplitudes A^Δ, A^p, and A^n which are respectively the amplitudes for the reaction to proceed by an I = 3/2 state, an I = 1/2 state with charge = +1, and an I = 1/2 state with charge = 0:

$$\begin{aligned} A(\gamma p \to \pi N) &= C^{3/2}_{\pi N} A^\Delta + C^{1/2}_{\pi N} A^p \quad , \\ A(\gamma n \to \pi N) &= C^{3/2}_{\pi N} A^\Delta + C^{1/2}_{\pi N} A^n \quad . \end{aligned} \tag{1}$$

The C-G coefficients, $C^I_{\pi N}$, for the coupling to a specific πN state are given explicitly by

$$\begin{aligned} A(\gamma p \to \pi^+ n) &= -\sqrt{1/3}\, A^\Delta - \sqrt{2/3}\, A^p \quad , \\ A(\gamma p \to \pi^0 p) &= \sqrt{2/3}\, A^\Delta - \sqrt{1/3}\, A^p \quad , \\ A(\gamma n \to \pi^- p) &= \sqrt{1/3}\, A^\Delta - \sqrt{2/3}\, A^n \quad , \\ A(\gamma n \to \pi^0 n) &= \sqrt{2/3}\, A^\Delta + \sqrt{1/3}\, A^n \quad . \end{aligned} \tag{2}$$

Walker's[1] amplitudes, A^{V3}, A^{V1}, and A^S for the production of an isospin eigenstate by the isovector and isoscalar parts of the electromagnetic current and the corresponding CGLN[2] amplitudes $A^{(3)}$, $A^{(1)}$, and $A^{(0)}$ are given by

$$\begin{aligned} A^{V3} &= A^\Delta = \sqrt{3}\, A^{(3)} \quad , \\ A^{V1} &= 1/2(A^n - A^p) = \sqrt{1/3}\, A^{(1)} \quad , \\ A^S &= 1/2(A^n + A^p) = \sqrt{2/3}\, A^{(0)} \quad . \end{aligned} \tag{3}$$

Resonance Couplings. Since we are interested in intermediate resonances, we can approximate the energy dependence of the photoproduction partial waves by a Breit-Wigner form with added background. Using the helicity and parity eigenstates,[3] $C^{\ell\pm}_\lambda(W)$, this gives

$$C^{\ell\pm}_\lambda(W) = \varepsilon \left\{ \frac{\Gamma^\lambda(N^*\to\gamma N)\,\Gamma(N^*\to\pi N)}{kq} \right\}^{1/2} \frac{W}{W^2 - m_R^2 - iW\Gamma} + \text{background} \tag{4}$$

where ε is the sign of the amplitude and k, q are the c.m. momenta of the initial, final states. The resonance energy is m_R and Γ is its total width. In the following discussion of resonance couplings, we use the notation $\tilde{A}$ for the imaginary part of the resonance coupling to an amplitude A(W) evaluated at resonance ($W = m_R$). Thus

$$\tilde{C}^{\ell\pm}_\lambda = \varepsilon \left\{ \frac{\Gamma^\lambda_\gamma \Gamma_\pi}{kq\Gamma^2} \right\}^{1/2} \tag{5}$$

A dominant feature in pion photoproduction is the Born approximation which contains the nucleon pole in the s- and u-channels and the pion pole in the t-channel. It reproduces, for example, the experimentally observed forward peak in charged-pion photoproduction. In partial-wave analyses, the sign factor ε is well determined relative to the Born terms.

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Introducing helicity amplitudes $A_\lambda^{j^P}$ for the decay $N^*(j^P) \to (\gamma N)_\lambda$, where j^P labels the spin and parity of the N^*, we can calculate the radiative width[4], Γ_γ^λ,

$$\Gamma_\gamma^\lambda = \frac{k^2}{\pi}\frac{m_N}{m_R}\frac{1}{2j+1}\left(\tilde{A}_\lambda^{j^P}\right)^2 , \qquad (6)$$

where m_N is the nucleon mass. Introducing this expression into Eq. (5) we find

$$\tilde{C}_\lambda^{\ell\pm} = \left\{\frac{1}{(2j+1)\pi}\frac{k}{q}\frac{m_N}{m_R}\frac{\Gamma_\pi}{\Gamma^2}\right\}^{1/2}\tilde{A}_\lambda^{j^P} . \qquad (7)$$

We quote the results of partial-wave analyses in terms of the amplitudes $\tilde{A}_\lambda^{j^P}$ in units of $GeV^{-1/2}$.

The total radiative width Γ_γ and the corresponding contribution $\sigma_T^{j^P}$ of the partial waves $C_\lambda^{\ell\pm}$ to the total cross section are given by

$$\Gamma_\gamma = \sum_{\lambda=-3/2}^{3/2}\Gamma_\gamma^\lambda = \frac{k^2}{\pi}\frac{m_N}{m_R}\frac{2}{2j+1}\left\{\left(\tilde{A}_{1/2}^{j^P}\right)^2 + \left(\tilde{A}_{3/2}^{j^P}\right)^2\right\}, \qquad (8)$$

$$\sigma_T^{j^P} = 2\left(C_{\pi N}^I\right)^2\frac{m_N}{m_R}\frac{\Gamma_\pi}{\Gamma^2}\left\{\left(\tilde{A}_{1/2}^{j^P}\right)^2 + \left(\tilde{A}_{3/2}^{j^P}\right)^2\right\} . \qquad (9)$$

The Hebb-Walker amplitudes[1], $\tilde{A}_{\ell\pm}$, $\tilde{B}_{\ell\pm}$, are related to the $\tilde{A}_\lambda^{j^P}$ by

$$\tilde{A}_{\ell\pm} = \mp\left\{\frac{1}{(2j+1)\pi}\frac{k}{q}\frac{m_N}{m_R}\frac{\Gamma_\pi}{\Gamma^2}\right\}^{1/2} C_{\pi N}^I\tilde{A}_{1/2}^{j^P} , \qquad (10)$$

$$\tilde{B}_{\ell\pm} = \pm\left\{\frac{1}{(2j+1)\pi}\frac{k}{q}\frac{m_N}{m_R}\frac{\Gamma_\pi}{\Gamma^2}\right\}^{1/2} \times \left\{\frac{16}{(2j-1)(2j+3)}\right\}^{1/2} C_{\pi N}^I\tilde{A}_{3/2}^{j^P} . \qquad (11)$$

We see from (2), (4), (5) and (7) that, apart from the factor $[16/(2j-1)(2j+3)]^{1/2}$, these are just the imaginary part of the resonance part of the amplitude (2) at resonance. Consequently, they are more directly related to experiment than the $\tilde{A}_\lambda^{j^P}$, which incorporate an additional uncertainty in the partial width $\Gamma(N^* \to \pi N)$.

Methods of Partial-Wave Analysis. (a) Simple Isobar Model: In this method, the partial-wave amplitudes are formulated as in (4) (or similarly), with the resonance or resonances built partly using knowledge of m_R, Γ, and $\Gamma(N^* \to \pi N)$ from πN elastic partial-wave analysis. The parametrization of the background is generally author-dependent, as is the detailed form of the resonance term, but the background is generally assumed to vary more slowly than the resonances. When the partial waves of Eq. (4) have been summed to form the angular-dependent helicity amplitudes, the Born amplitudes given by the Feynman diagrams of Fig. IV.1 must be added. [Alternatively, these Born amplitudes may previously have been projected into partial waves and included in the background terms of Eq. (4).]

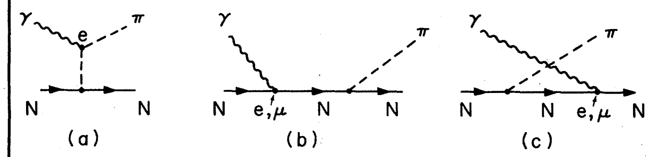

Fig. IV.1. Feynman diagrams for the Born terms in pion photoproduction. The couplings of the photon to the pion and nucleon are indicated by an e to represent a coupling via charge and by a μ for a coupling via anomalous magnetic moment.

As indicated in Fig. IV.1, the photon couples to the nucleon through both the electric charge, e, and the anomalous magnetic moment, μ. The minimum gauge invariant form, which includes the pion pole, is given by the pion pole plus the nucleon pole terms with the electric charge interaction only. Generally, only these terms, which we can refer to as the electric Born terms, are included explicitly because they reproduce the forward peak in charged-pion production. The magnetic terms can be assumed to be included in the real parts of the background and resonance terms in Eq. (4). However, this certainly raises problems of principle since some of the electric Born terms might also be subsumed in the background and resonances.

The best values of the resonance couplings, $\Gamma(N^* \to \pi N)$, and background parameters are found as those which give minimum χ^2 for all data within the energy range, in the usual manner for DPWA.

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(b) Fixed-t Dispersion Relations (FTDR): The difficulties of principle with the Born approximation in the simple isobar model are among the reasons which have led to the use of FTDR:

$$\mathrm{Re}A_i^{(\pm,0)}(s,t) = B_i^{(\pm,0)}(s,t) + \frac{1}{\pi} P\int_{(m_N+m_\pi)^2}^{\infty} ds' \times \left\{ \frac{\mathrm{Im}A_i^{(\pm,0)}(s',t)}{s'-s} + \xi_i \frac{\mathrm{Im}A_i^{(\mp,0)}(s',t)}{s'-u} \right\} \quad (12)$$

for the invariant amplitudes $A_i^{(\pm,0)}(s,t)$ ($i=1, 2, 3, 4$), where $B_i^{(\pm,0)}(s,t)$ are the Born amplitudes[5] of Fig. IV.1, $\xi_1 = \xi_2 = \xi_4 = 1$, $\xi_3 = -1$ and $\pm,0$ denote $\gamma p \to \pi^+ n$, $\gamma n \to \pi^- p$, $\gamma p \to \pi^0 p$ respectively. $A_i^{(\pm,0)}(s,t)$ can be expressed in terms of the helicity amplitudes, and vice versa, by standard formulae[5]. $B_i^{(\pm,0)}(s,t)$ includes both the electric Born and anomalous magnetic moment terms, and thus no ambiguity arises as in the simple isobar model because all the real part (including the "resonant" real part) is manufactured by the unique prescription in Eq. (12).

The $\mathrm{Im}A_i^{(\pm,0)}(s,t)$ are constructed using only the imaginary part of Eq. (4), or alternative formulae[5]. The $\mathrm{Re}A_i^{(\pm,0)}(s,t)$ are obtained from Eq. (12) and minimization of χ^2 in fitting to experimental data to find the unknown parameters of Eq. (4) as is usual in DPWA.

A second advantage of FTDR over the simple isobar model is that the imaginary parts appear to be resonance-dominated[1,5] (but not resonance-saturated), and this is not true of the real parts. The FTDR method only parametrizes the imaginary parts, and the smaller influence therein of background terms, relative to the size of the background in the real parts, is helpful. This advantage is diminished by the need, apparent from Eq. (12), to parametrize $\mathrm{Im}A_i^{(\pm,0)}(s,t)$ outside the energy region of fitting for many analyses, thus effectively adding extra parameters to describe the resulting real background in the energy region being studied. This has been treated in two recent analyses[6,7] by fitting data simultaneously in the resonance region and in the high energy (Regge) region.

Another, and in principle serious, disadvantage is that $\mathrm{Im}A_i^{(\pm,0)}(s,t)$ in Eq. (12) is required for values of t outside the physical range corresponding to s'. Formally, $\mathrm{Im}A_i^{(\pm,0)}(s',t)$ is given by the partial-wave expansion in $\cos\theta$ (θ is the production angle in the center-of-mass system), and this is the method used in practice to calculate the dispersion integrals. While the convergence of this expansion has not been proved for important parts of the unphysical region, Devenish, Lyth, and Rankin[8] have surmised on the basis of the Mandelstam representation that the method is good up to $-t \leqslant 1\ (\mathrm{GeV}/c)^2$ in $\pi^\pm$ production and to $-t \leqslant 1.5\ (\mathrm{GeV}/c)^2$ in π^0 production.

At low energies, the unitarity of the S-matrix imposes a phase condition on the partial-wave amplitudes known as Watson's theorem. It states that in the elastic region the complex phase of each $C_\lambda^{\ell\pm}(W)$ is equal to the scattering phase of the corresponding πN partial wave. This is important across the first resonance region in photoproduction since it imposes a strict phase condition on the two P_{33} partial waves and results in important non-resonant S-wave background in the imaginary parts contributing to the dispersion integrals. However, while the effects of Watson's theorem are significant in the first resonance region, the consequences in a FTDR calculation of ignoring it appear to be slight at higher energies.

The use of FTDR in pion photoproduction has a long history in the first resonance region[9] where their role was envisaged as largely predictive or synthetic. The independently motivated extension by the Berkeley[5,10,11,12], Lancaster[6,13], and Glasgow[7,14] based groups to a larger energy region has changed their role to one that is almost purely analytic.

(c) Energy-Independent Partial-Wave Analyses: Recent improvements in experimental data have allowed Berends and Donnachie[15] to extend the energy-independent analysis of pion photoproduction to beyond the second resonance region. Previous analyses[16] were restricted by the data then available to the first resonance region where Watson's theorem can be used to get a unique

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solution for the partial waves. In general, the energy-independent analyses are in good qualitative agreement with the energy-dependent analyses but there are some qualitative discrepancies. The significance of these is not yet clear.

Definitions of Resonance Parameters and Errors: From analyses which use a form like that of Eq. (4) there are reported in the Data Card Listings and Table IV.1, photonic resonance couplings which are obtained through Eq. (4) from a Breit-Wigner partial width. The FTDR method fits only the imaginary part of Eq. (4) to experimental data. The FTDR method of the Berkeley group[5,10,11,12] uses a K-matrix ansatz for the imaginary part and in these cases it is the corresponding K-matrix pole quantity that is reported. (Regretably, no authors give also partial widths corresponding to T-matrix residues.)

If no errors are assigned, the authors have given a unique result without quoting an error. The Berkeley[5,10,11,12] and Glasgow[7] analyses quote as an error the spread around a central value of a number of solutions. The Lancaster group[6,13] estimate a "real error" for each parameter of a given solution that corresponds to the change in value required to increase "the best possible χ^2" by 1%.

The variation between the central values of the various papers are generally about the same size as or greater than the quoted uncertainties in individual papers. This indicates that the systematic effects of different parametrizations and choices of experimental data are at least as important as statistical effects when estimating the uncertainty in the couplings. This is reflected in the errors given in Table IV.1.

Recent Partial-Wave Analyses: We describe only the most recent analyses by the various groups involved. A description of earlier analyses may be found in the previous edition of this Review.[3]

(a) Simple Isobar Model: The most important of these is still METCALF 74[17] which uses the methods of Walker[1] to analyze data for $\gamma p \to \pi^+ n$, $\pi^0 p$ and $\gamma n \to \pi^- p$ from the first through the fourth resonance regions. The partial waves are parametrized as in Eq. (4) with the background taken to be an independent number at each energy fitted. The electric Born terms are added explicitly.

TABLE IV.1. Photon resonance couplings.

		Helicity Couplings $(\mathrm{GeV})^{-1/2}\ 10^{-3}$ Analyses Average (1)		Helicity Couplings $(\mathrm{GeV})^{-1/2}\ 10^{-3}$ Quarks (2)	
State	λ	$\tilde{A}^p_\lambda$	$\tilde{A}^n_\lambda$	$\tilde{A}^p_\lambda$	$\tilde{A}^n_\lambda$
$P'_{11}(1470)$	1/2	-74±15	34±35	27	-18
$D'_{13}(1520)$	1/2	-10±15	-75±15	-34	-31
	3/2	171±15	-129±10	109	-109
$S'_{11}(1535)$	1/2	63±25	-49±35	156	-108
$D'_{15}(1670)$	1/2	16±10	-32±36	0	-38
	3/2	21±12	-62±40	0	-53
$F'_{15}(1688)$	1/2	-5±30	25±10	-10	30
	3/2	127±35	-16±20	60	0
$S''_{11}(1700)$	1/2	43±30	-37±40	0	30
$D''_{13}(1700)$	1/2	-20±45	18±55	0	-10
	3/2	19±45	18±80	0	-40
$P''_{11}(1780)$	1/2	18±40	18±50	-40	10
$P_{13}(1810)$	1/2	-25±50	24±70	100	-30
	3/2	-31±50	-4±60	-30	0
		$\tilde{A}^\Delta_\lambda = \tilde{A}^{V3}_\lambda$		$\tilde{A}^\Delta_\lambda = \tilde{A}^{V3}_\lambda$	
$P'_{33}(1232)$	1/2	-139±5		-108	
	3/2	-256±5		-187	
$S'_{31}(1650)$	1/2	46±36		47	
$D_{33}(1670)$	1/2	72±26		88	
	3/2	72±45		84	
$P''_{33}(1690)$	1/2	-2±40		23	
	3/2	-12±50		39	
$F_{35}(1890)$	1/2	21±30		-20	
	3/2	-10±60		-90	
$P_{31}(1910)$	1/2	-11±20		-30	
$F_{37}(1950)$	1/2	-69±16		-50	
	3/2	-76±20		-70	

(1) Average of the couplings from MOORHOUSE 73, DEVENISH 73, MOORHOUSE 74, METCALF 74, KNIES 74, DEVENISH2 74, CRAWFORD 75, BARBOUR 76, and Ref. 12. The errors given are an estimate that takes into account the errors quoted in these analyses and the differences between the analyses.

(2) The naive, ℓ-excitation, quark model is used in the 4-dimensional oscillator form of Feynman, Kislinger, and Ravndal. The non-relativistic quark model with recoil gives generally very similar results.

Other recent isobar analyses have been on a much smaller scale. KRIVETS 74[18] is an analysis of $\gamma p \to \pi^+ n$, $\pi^0 p$ and $\gamma n \to \pi^- p$ across the first, second, and third resonance regions using a rather small data set consisting only of differential cross-section measurements. Several solutions are given with a large spread in the values of the couplings and those for the resonance couplings to γn are stated to be preliminary. HEMMI1 73[19] is a fit to forward $\gamma p \to \pi^0 p$ differential cross-section data across the second and third resonance regions and evaluates the $\lambda = 1/2$ couplings in this region. HEMMI2 73[20] is an isobar analysis of $\gamma n \to \pi^0 n$ across the second resonance region. ROSSI 73[21] and BENEVENTANO 73[22] are analyses of data for $\gamma n \to \pi^- p$ across the second resonance region. Earlier analyses[1,23] are not included in the Data Card Listings.

(b) Fixed-t Dispersion Relations: MOORHOUSE 73[10] and MOORHOUSE 74[5] are FTDR analyses from threshold through the third resonance region ($1160 < W < 1780$ MeV) using data for $\gamma p \to \pi^+ n$, $\pi^0 p$ and $\gamma n \to \pi^- p$. The first uses the results of seven fits with a χ^2 per data point ranging from 9.7 with 52 variables to 5.7 with 74. The second uses the average of three solutions with a χ^2 per data point ranging from 4.0 (56 variables) to 3.0 (74 variables). KNIES 74[11] and Ref. 12 extend the energy range of the Berkeley analyses up to a center-of-mass total energy of 2 GeV, and thus include the energy region of the $\Delta(1950)F_{37}$. Several solutions are described with typical values of the χ^2 per data point of between 3.5 and 4.5. In all these analyses, the imaginary parts of the partial waves are parametrized using a K-matrix formalism.

DEVENISH 73[13] analyze data from the first through the third resonance regions and parametrize the imaginary parts of the partial waves as Breit-Wigner forms without background except for the π^0-production S wave. The dispersion integral is cut off at $W = 1.9$ GeV, but parametrized real background is added to allow for the integrals above 2 GeV. Three solutions are given with χ^2 per data point of 10.5, 3.0, and 4.7 for 37, 68, and 68 free parameters, respectively. DEVENISH2 74[6] treats the problem of the high energy contributions to the dispersion integral by simultaneously fitting data in the resonance region and at high energies and evaluates the couplings for all resonances for $W \leq 2$ GeV. It uses data for $\gamma p \to \pi^+ n$, $\pi^0 p$ and $\gamma n \to \pi^- p$ at all available energies and for $|t| < 1$ $(\mathrm{GeV}/c)^2$. A χ^2 per data point of 4.8 is obtained with 48 resonance parameters and 50 high energy parameters.

CRAWFORD 75[14] is an FTDR analysis from the first through the fourth resonance regions of $\gamma p \to \pi^+ n$, $\pi^0 p$ and $\gamma n \to \pi^- p$. Data are fitted for $W \leq 2$ GeV and $|t| \leq 1.5$ $(\mathrm{GeV}/c)^2$. Three solutions are given with a best χ^2 per data point of 3.1 with 58 free parameters. The masses and widths of all resonances below 1.7 GeV are evaluated. Stable values are obtained that agree well with the values from elastic πN partial-wave analyses. BARBOUR 76[7] is an extension of the previous analysis to include the fitting of high energy data for $W > 2.6$ GeV. One fit is presented with a χ^2 per data point of 2.6 for the resonance region data and 1.8 for the high energy data. No data are fitted for $2\ \mathrm{GeV} < W < 2.6$ GeV, thus omitting the region of the $H_{3,11}$.

(c) Energy-Independent Analyses: These have now been extended to the second resonance region by Berends and Donnachie[15] as described above. Earlier analyses[16] fitted only in the first resonance region. Resonance couplings have not been quoted in these analyses.

Electroproduction in the Resonance Region: Although single-pion electroproduction can be considered in many ways to be similar to photoproduction[24], a partial-wave analysis of the process is considerably more difficult than in photoproduction. This is due to the less accurate and complete experimental data that are available and because the scalar part of the virtual photon in electroproduction contributes an extra (scalar) coupling for each resonance. The scalar amplitudes uncouple from the T-matrix in the photoproduction limit. Also, it is necessary, in principle, to make an analysis at each value of λ^2, the (virtual photon mass)^2, at which there are

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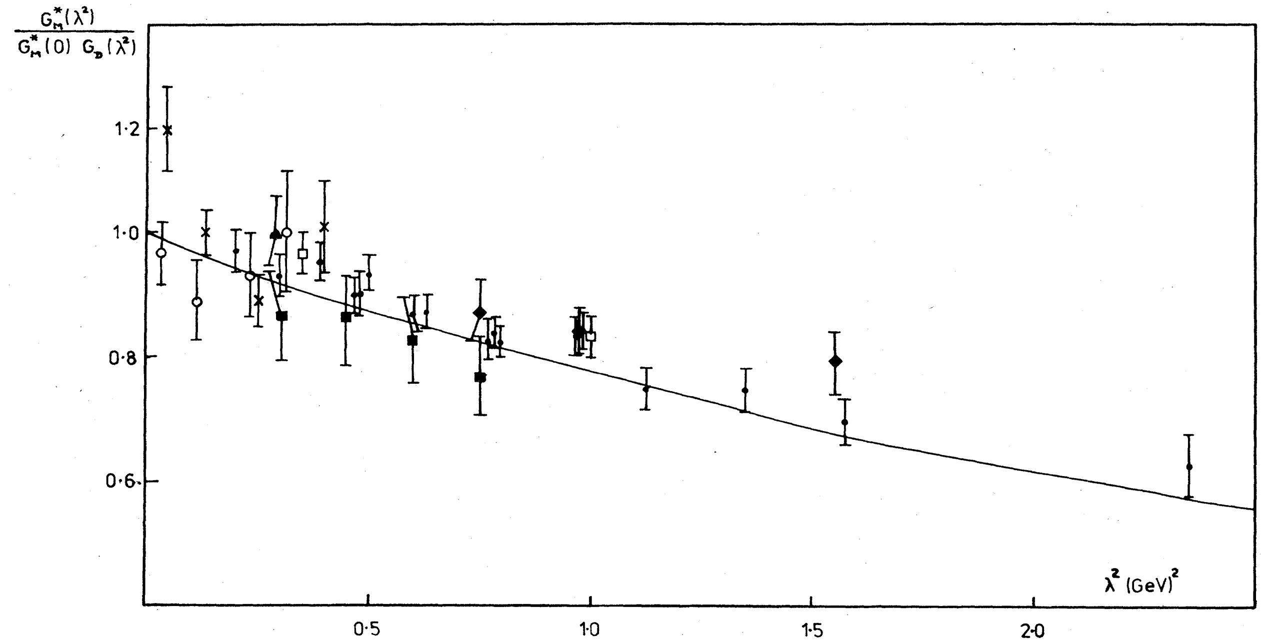

Fig. IV.2. The Δ(1232) magnetic moment form factor, $G_M^*(\lambda^2)$, normalized to $G_M^*(0) = 3$, compared to the nucleon dipole form factor, $G_D(\lambda^2) = (1 + \lambda^2/0.71)^{-2}$. The sources of the data points are ● ref. 25, ○ ref. 27, × ref. 28, ■ ref. 29, □ ref. 30, ◆ ref. 31, ▲ ref. 32, and ◇ ref. 33. The solid line is from Devenish and Lyth[34].

data. The information to be obtained from such an analysis is the size of the scalar couplings to the resonance and the form factors of the scalar transverse couplings, i.e., their λ^2 dependence. This information has been extracted in a number of ways, depending on the experimental data available and the energy range being studied.

(a) Total Cross Sections: In a single-arm experiment, in which only the final electron is detected, it is possible to measure only σ_T and σ_S, the total cross sections for the absorption of transverse and scalar photons. In the first resonance region, due to the dominance of the $M_{1+}^{(3)}$ multipole, σ_T can give the form factor for the magnetic coupling to the $P_{33}(1232)$. There have been many analyses of this type, both the form factors for γp and γn coupling to the $P_{33}(1232)$ having been measured. We quote as examples of these, the analyses of Bartel et al.[25] and of Köbberling et al.[26] Due to the unknown non-resonant scalar background and because the scalar coupling is relatively small, σ_S gives only qualitative information about the scalar coupling to this resonance. Above the second resonance region, due to the large number of resonances, the total cross sections again give little more than qualitative information.

(b) Energy-Independent Analyses: Differential cross-section measurements have been made for π^0 and π^+ electroproduction in a number of coincidence experiments. Although the data are not good enough for a full partial-wave analysis, it is possible, due to the small number of partial waves involved, to use the dominance of the $M_{1+}^{(3)}$ multipole to measure $|M_{1+}|$, Re $E_{1+}^* M_{1+}/|M_{1+}|^2$, and Re $S_{1+}^* M_{1+}/|M_{1+}|^2$ for π^0 production across the first resonance region. This has been done by a number of groups[27–32]. Because $M_{1+}^{(3)}$ is so large and is purely imaginary at the P_{33} mass, these terms can be taken to be respectively Im$M_{1+}^{(3)}$, $E_{1+}^{(3)}/M_{1+}^{(3)}$, and $S_{1+}^{(3)}/M_{1+}^{(3)}$ at the resonance.

(c) Energy-Dependent Analyses: Energy-dependent partial-wave analyses using FTDR have been made for pion electroproduction by Crawford[33]

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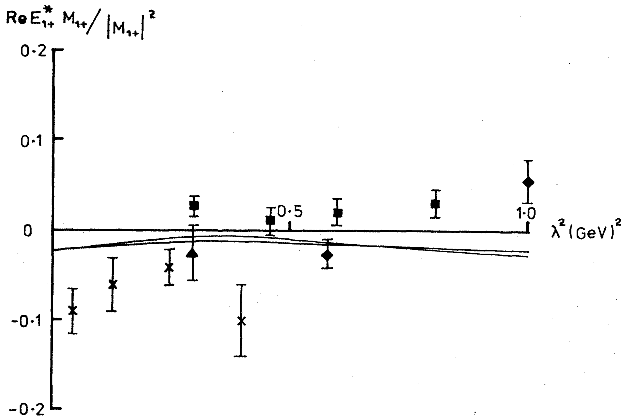

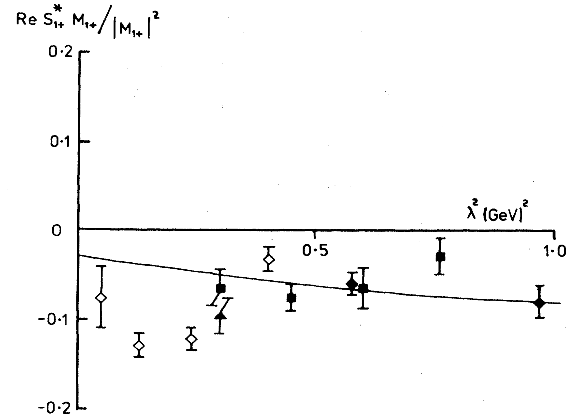

Fig. IV.3. The ratios $\mathrm{Re}(E_{1+}M^*_{1+}/|M_{1+}|^2)$ and $\mathrm{Re}(S_{1+}M^*_{1+}/|M_{1+}|^2)$ for π^0 electroproduction at the Δ(1232). The data points and curves are indicated as in Fig. IV.2. Crawford[33] and Devenish and Lyth[34] give the ratios $E^{(3)}_{1+}/M^{(3)}_{1+}$ and $S^{(3)}_{1+}/M^{(3)}_{1+}$.

and by Devenish and Lyth[34]. The first fitted only in the first resonance region and over a relatively small range of λ^2. The second is an extensive analysis from the first to the fourth resonance regions. Using the results of photoproduction analyses to give a starting point, the form factors for the resonance couplings are given algebraic forms that reflect their analytic structure in the complex λ^2 plane. Data for π^0 and π^+ production and for a range of values of λ^2 are fitted simultaneously and the results of a number of fits are presented. The analysis evaluates the couplings for the $P_{33}(1232)$, $P_{11}(1470)$, $D_{13}(1520)$, $S_{11}(1535)$, $D_{33}(1670)$, $F_{15}(1688)$, $S_{11}(1700)$, $D_{13}(1700)$, $P_{13}(1780)$, $F_{37}(1950)$, and $D_{13}(2040)$ resonances. The results are discussed below.

The couplings and form factors for the $P_{33}(1232)$ are now established for $\lambda^2 < 1$ (GeV)^2 and there is agreement on all general features between the basic methods of analysis (Figs. IV.2 and IV.3). The λ^2 dependence of $M^{(3)}_{1+}$ is usually expressed in terms of the form factor $G^*_M(\lambda^2)$,[27]

$$G^*_M(\lambda^2) = 2M\left(\frac{3}{2\alpha}\,\frac{|\vec{k}|}{\sin^2\delta_{33}}\,\frac{\Gamma|M_{1+}|^2}{\vec{q}^{\,2}}\right)^{1/2} ,$$

where $\vec{k}$ and $\vec{q}$ are respectively the center-of-mass three-momenta of the pion and the virtual photon.

The behavior of G^*_M for the charge = +1 state, normalized to $G^*_M(0) = 3$, is compared with the nucleon dipole form, $G_D(\lambda^2) = (1 + \lambda^2/0.71)^{-2}$, in Fig. IV.2. It is clearly seen that G^*_M falls off significantly faster with λ^2 than the nucleon dipole. Measurements of G^*_M for the charge = 0 state[26,35] show that it has the same form as for the charge = +1 state. The measurements of the ratios of $E^{(3)}_{1+}$ and $S^{(3)}_{1+}$ to $M^{(3)}_{1+}$ are all consistent with these being small, although the $S^{(3)}_{1+}$ is clearly established as being non-zero with a value of about $-0.06\ M^{(3)}_{1+}$. This is a small violation of the quark model selection rule that predicts that there should be no scalar excitation of the $P_{33}(1232)$[36].

In the second to the fourth resonance regions, Devenish and Lyth obtain definite results for the couplings to the charge = +1 states of the $P_{11}(1470)$, $D_{13}(1520)$, $S_{11}(1535)$, $F_{15}(1688)$, and $F_{37}(1950)$ resonances. These are expressed in terms of the multipole partial waves:

$\underline{P_{11}(1470)}$ The form factor for the magnetic multipole rapidly vanishes and there is no evidence for a scalar coupling.

$\underline{D_{13}(1520)}$ The electric multipole decreases rapidly with λ^2 in an approximate dipole form, but the electric dipole decreases significantly less quickly. There is therefore a rapid change in

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the ratio of the transverse helicity partial waves. The scalar coupling is non-zero at $\lambda^2 = 0$ but decreases rapidly.

$S_{11}(1535)$ The electric multipole decreases slowly with λ^2. The scalar coupling is comparable to the electric one at $\lambda^2 = 0$ but may decrease in an approximately dipole form.

$F_{15}(1688)$ The form factors for the transverse multipoles are similar to those for $D_{13}(1520)$. The scalar coupling decreases rapidly.

$F_{37}(1950)$ The magnetic multipole probably decreases more slowly than the dipole form. The electric multipole is small and its λ^2 behavior is not clearly determined. The scalar multipole is small and decreases rapidly.

The form factors for the $S_{11}(1535)$ can be checked in η electroproduction. This process proceeds mainly through S-wave excitation in the second resonance region and is thus dominated by the $S_{11}(1535)$. The results for the cross section of this process[37] again require that at least one of the form factors should fall off slowly with λ^2.

The rapid change in the ratio of the transverse helicity amplitudes of the $D_{13}(1520)$ and the $F_{15}(1688)$, along with the almost constant value of the ratio for the $P_{33}(1232)$, gives qualitative agreement with quark model calculations[4,38]. However, some quark models find that the form factor for the $S_{11}(1535)$ should decrease rapidly and that the one for the $P_{11}(1470)$ should stay up, and are therefore in conflict with the results above.

Information in this Edition: The Baryon Table contains the branching fractions, Γ_γ/Γ for 14 resonances.

The Data Card Listings contain the photon resonance couplings ($\tilde{A}_\lambda^{jP}$ for p, n, and Δ) from the analyses of Moorhouse and Oberlack[10] (MOORHOUSE 73), Moorhouse, Oberlack, and Rosenfeld[5] (MOORHOUSE 74), Knies, Moorhouse, and Oberlack[11] (KNIES 74), Devenish, Lyth, and Rankin[13,6] (DEVENISH 73 and DEVENISH2 74), Crawford[14] (CRAWFORD 75), Barbour and Crawford[7] (BARBOUR 76), Metcalf and Walker[17] (METCALF 74), Hemmi et al.[19] (HEMMI1 73), Hemmi et al.[20] (HEMMI2 73), Rossi et al.[21] (ROSSI 73), and Beneventano et al.[22] (BENEVENTANO 73).

The average of the listed results along with an estimate of the uncertainty in each from the spread of results is given in Table IV.1. We give results from a naive (ℓ-excitation) quark model for comparison.

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STATUS OF N* RESONANCES

THOSE WITH AN OVERALL STATUS OF *** OR **** ARE INCLUDED IN THE MAIN BARYON TABLE. THE OTHERS AWAIT CONFIRMATION.

				STATUS AS SEEN IN --						
PARTICLE	LIJ	OVERALL STATUS	TOTAL≠ CR.S.	PI N	ETA N	K LAM	K SIG	PI DE	GAM N	OTHER CHANN.
N(940)	P11	****								
N*(1470)	P11	****		****				***	**	EPS N
N*(1520)	D13	****	****	****	*			***	***	RHO N
N*(1535)	S11	****		****	***				***	RHO N
N*(1670)	D15	****	***	****	*	*		***	*	
N*(1688)	F15	****	***	****	*	*		***	**	RHO N
N*(1700)	S11	****		****	*	***			**	EPS N
N*(1700)	D13	**		**		*	*	*	*	EPS N
N*(1780)	P11	***		***	*	**		***	*	EPS N
N*(1810)	P13	***		***	*	**			*	RHO N
N*(1990)	F17	**		**	*	*	*		*	
N*(2000)	F15	*		*		*	*		*	
N*(2040)	D13	**		**	*	*			*	
N*(2100)	S11	*		*						
N*(2100)	D15	*		*						
N*(2190)	G17	***	***	***		*			*	
N*(2220)	H19	***	***	***						
N*(2650)		***	***	*						
N*(3030)		***	***	*						
N*(3245)		*	*							
N*(3690)		*	*							
N*(3755)		*	*							
DE(1232)	P33	****	****	****	F				****	
DE(1650)	S31	****	**	****	O			**	**	RHO N
DE(1670)	D33	***	***	***	R			**	*	
DE(1690)	P33	*		*	B			**	*	
DE(1890)	F35	***	*	***		I	*	*	*	RHO N
DE(1900)	S31	*	*	*			*			
DE(1910)	P31	***	*	***		D	*	*	*	RHO N
DE(1950)	F37	****	***	****		D	*	**	*	RHO N
DE(1960)	D35	**	*	*		E	*	*		
DE(2160)		**		***		N	*			
DE(2420)	H311	***	***	***	F					
DE(2850)		***	***	**	O					
DE(3230)		***	***	*	R					

**** GOOD, CLEAR, AND UNMISTAKABLE.
*** GOOD, BUT IN NEED OF CLARIFICATION OR NOT ABSOLUTELY CERTAIN.
** NEEDS CONFIRMATION.
* WEAK.
≠ ATTRIBUTED TO THE STATE CLOSEST TO WHERE THE CROSS SECTION PEAKS.

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S=0 I=1/2 NUCLEON STATES (N)

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p 16 PROTON(938, J=1/2) I=1/2

SEE STABLE PARTICLE DATA CARD LISTINGS

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n 17 NEUTRON(939, J=1/2) I=1/2

SEE STABLE PARTICLE DATA CARD LISTINGS

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Baryons
N(1470)

Data Card Listings
For notation, see key at front of Listings.

N(1470) P'_{11}

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61  N*1/2(1470, JP=1/2+) I=1/2

MASS AND WIDTH ARE BEST DETERMINED FROM PARTIAL WAVE
ANALYSES.  WE LIST PRODUCTION EXPERIMENTS SEPARATELY --
SEE BELOW.

AYED 74 CLAIM TWO P11 STATES IN THE 1500 MEV REGION.
WE TENTATIVELY LIST BOTH HERE.

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                 61  N*1/2(1470) MASS (MEV)

M        (1370.0)                  BRANDSEN  65 RVUE   PHASE-SHIFT ANAL  9/66
M        (1380.0)                  ROPER     65 RVUE   PHASE-SHIFT ANAL  9/66
M   1    (1470.0)                  BAREYRE   68 RVUE   PHASE-SHIFT ANAL 11/67
M   1          WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M   3    (1466.0)                  DONNACH1  68 RVUE   PHASE-SHIFT ANAL  6/68
M   6    (1461.0)                  AYED      70 IPWA                     1/71
M   6  FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M   4    (1462.0)                  DAVIES    70 RVUE   P-S ANAL  SCL A   8/69
M   7    (1470.)                   ALMEHED   72 IPWA                     2/72
M   2    (1413.)                   AYED      74 IPWA                     2/74
M   2    (1532.)                   AYED      74 IPWA                     2/74
M   2  AYED 74 FIND 2 DIFFERENT P11 RESONANCES IN THIS REGION IN CONTRAST 2/74
M   2  TO ALL PREVIOUS PWAS. WE LIST BOTH TOGETHER HERE UNTIL THE         2/74
M   2  SITUATION IS FURTHER CLARIFIED.                                    2/74
M          1405. TO 1420.          CRAWFORD  75 DPWA   PI N PHOTO-PROD  1/76*
M     L    1415. OR 1390.          LONGACRE  75 IPWA   PI N TO 2PI N   11/75*
M     L  THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75. 11/75*
M        (1404.)                   BARBOUR   76 DPWA   PI N PHOTO-PROD  1/76*

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                 61  N*1/2(1470) WIDTH (MEV)

W   1    (255.0)                   BAREYRE   68 RVUE                    11/67
W   3    (211.0)                   DONNACH1  68 RVUE                     6/68
W   6    (164.0)                   AYED      70 IPWA                     1/71
W   4    (391.)                    DAVIES    70 RVUE   P-S ANAL  SOL A   8/69
W   7    (220.)                    ALMEHED   72 IPWA                     2/72
W   2    (187.)   (SMALLER MASS)   AYED      74 IPWA                     2/74
W   2     (89.)   (LARGER MASS)    AYED      74 IPWA                     2/74
W         255. TO  396.            CRAWFORD  75 DPWA   PI N PHOTO-PROD  1/76*
W     L   180. OR  200.            LONGACRE  75 IPWA   PI N TO 2PI N   11/75*
W        (330.)                    BARBOUR   76 DPWA   PI N PHOTO-PROD  1/76*
      SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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                 61  N*1/2(1470) REAL PART OF POLE POSITION (MEV)        1/74
RE       (1375.)    (5.)           LEE       73        FIT TO ALMEHED72  1/74
RE       (1381.)                   LONGACRE  75 IPWA   PI N TO 2PI N    11/75*

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                 61  N*1/2(1470) 2*IMAG PART OF POLE POSITION (MEV)      1/74
IM       (216.)    (10.)           LEE       73        FIT TO ALMEHED72  1/74
IM       (209.)                    LONGACRE  75 IPWA   PI N TO 2PI N    11/75*

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                 61  N*1/2(1470) ABSOLUTE VALUE OF POLE RESIDUE (MEV)    1/74
ABS       (74.)     (5.)           LEE       73        FIT TO ALMEHED72  1/74

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                 61  N*1/2(1470) PHASE OF POLE RESIDUE (RADIANS)         1/74
PH        (-1.4)                   LEE       73        FIT TO ALMEHED72  1/74

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                 61  N*1/2(1470) PARTIAL DECAY MODES

                                                   DECAY MASSES
P1     N*1/2(1470) INTO PI N                       139+ 938
P2     N*1/2(1470) INTO N EPSILON                  938+1200
P3     N*1/2(1470) INTO N*3/2(1232) PI            1232+ 139
P4     N*1/2(1470) INTO N PI PI                    938+ 139+ 139
P5     N*1/2(1470) INTO GAMMA N                      0+ 938
P6     N*1/2(1470) INTO N RHO                      938+ 773
P7     N*1/2(1470) INTO GAM P, HELICITY=1/2          0+ 938
P8     N*1/2(1470) INTO GAM N, HELICITY=1/2          0+ 939
P9     N*1/2(1470) INTO ETA N                      939+ 548
P10    N*1/2(1470) INTO K LAMBDA                   497+1115
P11    N*1/2(1470) INTO N RHO,S=1/2,P-WAVE         938+ 773

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                 61  N*1/2(1470) BRANCHING RATIOS

R1     N*1/2(1470) INTO (PI N)/TOTAL                    (P1)
R1  1        (0.68)                BAREYRE   68 RVUE                    11/67
R1  3        (0.658)               DONNACH1  68 RVUE                     6/68
R1  6        (0.564)               AYED      70 IPWA                     1/71
R1  4        (0.49)                DAVIES    70 RVUE   P-S ANAL  SOL A   8/69
R1  A        (0.67)    (0.18)      SAXON     70 HBC    AT 1400 MEV       6/70
R1  B        (0.58)    (0.09)      SAXON     70 HBC                      6/70
R1  7        (0.65)                ALMEHED   72 IPWA                     2/72
R1  2         (.549)(SMALLER MASS) AYED      74 IPWA                     2/74
R1  2         (.123)(LARGER MASS)  AYED      74 IPWA                     2/74
R1  A A AND B CORRESPOND TO THE 2 BEST SOLUTIONS.  ANALYSIS IS DONE ON THRE
R1  B BODY DECAYS, ASSUMING ONLY P1, P2 AND P3 DECAYS PRESENT.
       SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

R2     N*1/2(1470) INTO (N EPSILON)/TOTAL               (P2)
R2          DOMINANT INELASTIC DECAY  THURNAUER 65 RVUE -               11/67
R2          DOMINANT INELASTIC DECAY  NAMYSLOWS 66 RVUE -               11/67
R2          DOMINANT INELASTIC DECAY  ROSENFELD 67 RVUE -               11/67
R2          DOMINANT INELASTIC DECAY  MORGAN    68 RVUE   ISOBAR MODEL    6/68
R2  D        (0.16)                DIEM      70 IPWA   3 BODY ANALYSIS   1/71
R2  D       ASSUMING  R1= 0.61
R2  A        (0.30)    (0.20)      SAXON     70 HBC                      6/70
R2  B        (0.20)    (0.12)      SAXON     70 HBC                      6/70
R2  A AND B CORRESPOND TO THE 2 BEST SOLUTIONS, SEE NOTE IN R1.

R3     N*1/2(1470) INTO (N*3/2(1232) PI)/TOTAL          (P3)
R3  D        (0.17)                DIEM      70 IPWA   3 BODY ANALYSIS   1/71
R3  D       ASSUMING  R1= 0.61
R3  A        (0.03)    (0.20)      SAXON     70 HBC                      6/70
R3  B        (0.22)    (0.12)      SAXON     70 HBC                      6/70
R3  A AND B CORRESPOND TO THE 2 BEST SOLUTIONS, SEE NOTE IN R1.
R3  R        (0.20)                MAKAROV   71 IPWA  0 PI- P TO PI PI N 3/72
R3  R   ASSUMES R1=0.6. MAXIMUM CM ENERGY ANALYZED WAS 1435 MEV.

R4     N*1/2(1470) INTO (GAMMA N)/(PI N)                (P5)/(P1)
R4   F      STRONG INDICATION         ROSSI     73 DBC   0 GAM N TO PI-P  . 2/73
R4   F  DISAGREES WITH OTHER DATA                                         2/73

R5     N*1/2(1470) INTO (N RHO )/TOTAL                  (P6)
R5  D        (0.07)                DIEM      70 IPWA   3 BODY ANALYSIS   1/71
R5  D       ASSUMING  R1= 0.61

R6     N*1/2(1470) INTO (GAMMA N)/TOTAL                 (P5)
R6  E        (.0006)               MICKENS   71           THEORETICAL EST. 10/71
R6  E   TOTAL WIDTH TAKEN AS 250 MEV.

R7     N*1/2(1470) FROM PI N INTO ETA N                 SQRT(P1*P9)       2/74
R7           (+.23)                LEMOIGNE  73 DPWA    1488 TO 1685 MEV  2/74
R7  9        (+.328)               FELTESSE  75 DPWA  0 1488 TO 1745 MEV 11/75*
R7  9   SUPERCEDES LEMOIGNE 73, USES M AND W OF AYED 74 (LARGER MASS).   11/75*
R7  9   AN ALTERNATIVE WHICH CAN NOT BE DISTINGUISHED FROM THIS IS TO HAVE 11/75*
R7  9   A P13 RESONANCE WITH M=1530, W=79, AND COUPLING=+.271            11/75*

R8     N*1/2(1470) FROM PI N TO K LAMBDA                SQRT(P1*P10)      4/75*
R8 C        -.296      .068        DEVENISH  74         0 FIXED T DISP REL 4/75*
R8 C    EXTRAPOLATION OF PARAMETRIZED AMPLITUDE BELOW THRESHOLD.          4/75*

R9     N*1/2(1470) FROM PI N TO N*3/2(1232) PI          SQRT(P1*P3)      11/75*
R9   L       (-.30)OR  -.37        LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

R10    N*1/2(1470) FROM PI N TO N RHO,S=1/2,P-WAVE      SQRT(P1*P11)     11/75*
R10  L       (0.0) OR  -.23        LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

R11    N*1/2(1470) FROM PI N TO N EPSILON               SQRT(P1*P2)      11/75*
R11  L       (.18)OR  +.23         LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

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                 61  N*1/2(1470) PHOTON DECAY AMPL(GEV**-1/2)

    FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
  REVIEW PRECEDING THE BARYON LISTINGS.

A1     N*1/2(1470) INTO GAM P, HELICITY=1/2 (GEV**-1/2)
A1          -.096      .022        DEVENISH  73 DPWA    PI N PHOTO PROD   2/74
A1         (-.080)                 HEMMI1    73       + FWD PIO PHTOPROD  2/74
A1          -.055      .028        MOORHOUS  73 DPWA    PI N PHOTO-PROD   2/73
A1          -.079      .012        DEVENIS2  74 DPWA    PI N PHOTO-PROD   4/75*
A1          -.066      .013        KNIES     74 DPWA    PI N PHOTO PROD   2/74
A1          -.070      .023        METCALF   74 DPWA    PI N PHOTO-PROD   2/74
A1          -.087      .002        MOORHOUS  74 DPWA    PI N PHOTO-PROD   2/74
A1          -.070      .040        CRAWFORD  75 DPWA    PI N PHOTO-PROD   1/76*
A1         (-.053)                 BARBOUR   76 DPWA    PI N PHOTO-PROD   1/76*
A1        . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.2)

A2     N*1/2(1470) INTO GAM N, HELICITY=1/2 (GEV**-1/2)
A2           .089      .056        DEVENISH  73 DPWA    PI N PHOTO PROD   2/74
A2 8       (-.001)                 HEMMI2    73       0 GAM N TO PIO N    4/75*
A2 8  CONVERTED TO OUR CONVENTIONS USING M AND W FROM WALKER69 AND X=.55  4/75*
A2          +.002      .025        MOORHOUS  73 DPWA    PI N PHOTO-PROD   2/73
A2 F         .117      .011        ROSSI     73 DPWA  0 GAM N TO PI- P    4/75*
A2 F  CONVERTED TO OUR CONVENTIONS USING M AND W FROM ROSSI73 AND X=.55   4/75*
A2 5        (.083)                 BENEVENT  74 DPWA  0 GAM N TO PI- P    4/75*
A2 5  CONVERTED TO OUR CONVENTIONS USING M=1470 MEV, W=230 MEV, X=.55     4/75*
A2           .041      .025        DEVENIS2  74 DPWA    PI N PHOTO-PROD   4/75*
A2           .000      .013        KNIES     74 DPWA    PI N PHOTO PROD   2/74
A2           .043      .035        METCALF   74 DPWA    PI N PHOTO-PROD   2/74
A2           .033      .013        MOORHOUS  74 DPWA    PI N PHOTO-PROD   2/74
A2          +.044      .007        CRAWFORD  75 DPWA    PI N PHOTO-PROD   1/76*
A2         (+.058)                 BARBOUR   76 DPWA    PI N PHOTO-PROD   1/76*
A2        . . . . . . . . .
A2  AVERAGE MEANINGLESS (SCALE FACTOR = 3.1)

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                        REFERENCES FOR N*1/2(1470)

BRANDSEN 65 PR 139 B1566      +ODONNELL, MOORHOUSE          (DURHAM, RHEL)IJP
ROPER    65 PR 138 B190       LD ROPER,RM WRIGHT,BT FELD    (LRL-LVMR,MIT)IJP
THURNAUE 65 PRL 14 985        P G THURNAUER                          (ROCH)

NAMYSLOW 66 PR 157 1328       NAMYSLOWSKI,RAZMI,ROBERTS  (STAN,EDIN,LOIC)

ROSENFEL 67 IRVINE CONF       A H ROSENFELD, P SODING                 (LRL)

BAREYRE  68 PR 165 1731       P BAREYRE, C BRICMAN, G VILLET     (SACLAY)IJP
DONNACH1 68 PL 26B 161        A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139        DONNACHIE  RAPPORTEUR.S TALK           (GLAS)
    ALSO 68 THESIS            R G KIRSOPP                            (EDIN)
MORGAN   68 PR 166 1731       D MORGAN                               (RHEL)

AYED     70 KIEV CONF         R AYED,P BAREYRE, G VILLET           (SACL)IJP
DAVIES   70 NP B21 359        A DAVIES                               (GLAS)
DIEM     70 KIEV CONF.        + SMADJA, CHAVANON, DELER, DOLBEAU+    (SACL)
SAXON    70 PR D2 1790        SAXON, MULVEY, CHINOWSKY            (OXF,LRL)

MAKAROV  71 SJNP 13 510       ,GASILOVA,NELYUBIN,++          (IOFFE INST)IJP
MICKENS  71 LNC  1  707       R E MICKENS                            (FISK)
ALMEHED  72 NP B40 157        +LOVELACE                       (LUND,RUTG)IJP

DEVENISH 73 PL 47B 53         DEVENISH,RANKIN,LYTH        (LOUC+BONN+LANC)IJP
HEMMI1   73 PL 43B 79         HEMMI,INAGAKI+         (KYOTO+SAGA+KEK+TOKY)IJP
HEMMI2   73 NP B55 333        +INAGAKI,KIKUCHI,MAKI,MIYAKE+ (KYOTO,TOKYO)IJP
LEE      73 PRL 31 1029       LEE,SHAW        (UCI+ROYAL HOLLOWAY COLLEGE)IJP
LEMOIGNE 73 PURDUE CONF. 93   +GRANET,MARTY,AYED,BAREYRE,BORGEAUD,+(SACL)IJP
MOORHOUS 73 PL 43B 44         MOORHOUSE, OBERLACK               (GLAS+LBL)IJP
ROSSI    73 NC 13A 59         +PIAZZA,SUSINNO,+     (ROMA,FRAS,NAPL,PAVIA)IJP
    ALSO 71 LNC 2 1183        CARBONARA,FIORE,+     (NAPL,FRAS,PAVIA,ROMA)IJP

AYED     74 PRIVATE COMMCTN.  AYED,BAREYRE                         (SACL)IJP
    ALSO 73 AIX CONFERENCE    AYED,BAREYRE                         (SACL)IJP
BENEVENT 74 NC 19A 529        BENEVENTANO,DANGELO,NOTARISTEFANI,+  (ROMA)IJP
DEVENISH 74 NP B81 330        DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEVENIS2 74 PL 52B 227        DEVENISH,LYTH,RANKIN         (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680        KNIES,MOORHOUSE,OBERLACK          (LBL,GLAS)IJP
METCALF  74 NP B76 253        W J METCALF,R L WALKER                (CIT)IJP
MOORHOUS 74 PRD 9 1           MOORHOUSE,OBERLACK,ROSENFELD      (GLAS+LBL)IJP

CRAWFORD 75 NP B97 125        R L CRAWFORD                         (GLAS)IJP
FELTESSE 75 NP B93 242        +AYED,BAREYRE,BORGEAUD,DAVID,ERNWEIN+(SACL)IJP
LONGACRE 75 PL 55B 415        +ROSENFELD,LASINSKI,SMADJA+       (LBL,SLAC)IJP

BARBOUR  76 SBMTD. TO NP      I. M. BARBOUR,R. L. CRAWFORD         (GLAS)IJP
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Data Card Listings

For notation, see key at front of Listings.

Baryons

N(1470), N(1520)

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                         PAPERS NOT REFERRED TO IN CATA CARDS.

BAREYRE  64 PL 8 137             +BRICMAN,VALLADAS,VILLET, +   (SACLAY,CAEN) IJ
BAREYRE  65 PL 18 342            +BRICMAN, STIRLING, VILLET        (SACLAY)IJP
DALITZ   65 PL 14 159            R H DALITZ, R G MOCRHOUSE        (OXF,RHEL)
JOHNSON  67 UCRL-17683 THESIS C H JOHNSON                             (LRL)
DONNACHI 69 NP 10B 433           A DONNACHIE, R KIRSOPP           (GLAS+EDIN)
WALKER   69 PR 182 1729          R L WALKER                       (CAL TECH)IJP
AYED     70 PL 31B 598           +BAREYRE,VILLET                    (SACLAY)
BERARDO  70 PRL 24 419           +HADDOCK,NEFKENS,..,PARSONS+..   (UCLA+LRL)
AYED     72 BATAVIA CONF         R AYED,P BAREYRE, Y LEMOIGNE         (SACL)

    THE FOLLOWING ARE THEORETICAL PAPERS CONCERNING THE N*1/2(1470) --
RESNICK  66 PR 150 1292          L RESNICK                       (NIELS BOHR)
SCHWARZ  66 PR 152 1325          J H SCHWARZ                            (LRL)
BALL     67 PR 155 1725          JS BALL, GL SHAW, DY WONG   (UCLA,UCI,UCSD)
GOLDBERG 67 PR 154 1558          H GOLDBERG                         (CORNELL)

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1470 MEV REGION - PRODUCTION EXPERIMENTS

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                 91  N*1/2(1470, JP=    ) I=1/2   PRODUCTICN EXPERIMENTS

                 THE BUMP SEEN IN PRODUCTION EXPERIMENTS AT LOW INVARIAN
                 MASS MOST LIKELY CORRESPONDS TO THE P11 (SEE ABOVE)
                 RESONANT STATE, IF ANY.  THE HBC EXPERIMENTS SEE
                 ENHANCEMENTS MAINLY IN THE P PI PI MASS PLOT.  FOR ZERO
                 CHARGE EXCHANGE, SUCH FINAL STATES ARE KNOWN TO HAVE
   LARGE DECK-TYPE BACKGROUND.  THIS FACT COMPLICATES THE INTERPRETATION
   OF THIS BUMP AS A RESCNANCE.

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                 91  N*1/2(1470) MASS (MEV) (PROD.EXP.)

M          (1400.)    APPROX              COCCCNI    64 CNTR + PP 3.6-12 GEV/C
M          (1425.)    APPROX              ADELMAN    65 HBC  + K-P 1.45 GEV/C     7/66
M          (1430.)    APPROX              ANKENBRAN  65 CNTR + PP 7.1 GEV/C       7/66
M          (1400.)    APPROX              BELLETTIN  65 SPRK + PP,D 10-26 GEV/C   7/66
M          (1405.)     (15.)              ANDERSON   66 SPRK + PP, 6-30 GEV/C     7/66
M          (1410.)     (15.)              BLAIR      66 CNTR + PP 2.8-7.9 GEV/C   7/66
M          (1400.)     (30.)              FOLEY      67 CNTR   PI+- P AND PP     11/67
M          (1450.)     (17.)              ALMEIDA    68 HBC  + PP-P2PI ,10GEV/C  10/69
M          (1420.)    APPROX              BELL       68 HBC    PI+- P, 6 GEV/C    6/68
M          (1400.)    APPROX              LAMSA      68 HBC    PI-P , 8 GEV/C     6/68
M   S   175(1446.)     (11.)              SHAPIRA    68 CBC    INTO PPI,PN 7.0   10/69
M   S      (1390.)     (20.)              TAN        68 HBC    PP TO PIP, 6.1    10/69
M       120(1443.)     (15.)              RHODE      69 HBC    PP 22 GEV/C       10/69
M          (1410.)     (13.)              ANDERSON   70 MMS  - PI- P TO PI- MMS   2/71
M          (1430.)     (20.)              BALLAM     71 HBC +- PI+-P AT 16GEV     2/72
M          (1460.)                        BEKETOV    71 HBC  + PI- P 4.45GEV/C    3/72
M          (1461.)     (10.)              BOESEBEC   71 RVUE   PP,PI-P,K-P PROD   3/72
M       120(1462.0)     (6.0)   120/80    MA         71 HBC  + P P TO P N PI     10/71
M            1460. TO 1510.               MORSE      71 HBC +0 PI-P,  7 GEV/C     3/72
M          (1510.0)    (20.0)             MORSE      71 HBC  + PI-P, 25 GEV/C     3/72
M          (1425.)     (25.)              RUSHBROOKE71 HBC  + PP TO P2PI 16GEV    2/72
M          (1411.0)    (10.0)             EDELSTEIN  72 MMS  + PP 6 TO 30 GEV     1/73
M        64(1410.0)    (33.0)             GAGE       72      0 PD  5.9GEV/C      12/72
M          (1464.0)     (7.0)    45/45    KARSHON    72 DBC  + PD--PD2PI 7 GEV   12/72
M          (1440.)     (15.)              RONAT      72  HBC   PI+P TO 3PI P      2/73
M          (1479.)      (8.)              LICHTMAN   74 HBC  + PI+P TO 3PI P      4/75*
M          (1430.)      (8.)              LICHTMAN   74 HBC  + PI-P TO 3PI P      4/75*
M   1      (1450.)                        BLOBEL     75 HBC  + PP TO P(PI+PI-P)   1/76*
M   1   PWA INDICATES PI+PI-P ENHANCEMENT IS PRIMARILY AN                        1/76*
M   1   S-WAVE DELTA++PI- SYSTEM WITH I,JP=1/2,3/2-.                             1/76*
M          (1450.)     (16.)              CAVALLI    75 SPEC + PP TO 2N*,W=23GV   1/76*
M          (1462.)     (11.)              CAVALLI    75 SPEC + PP TO 2N*,W=31GV   1/76*
M          (1466.)     (28.)              CAVALLI    75 SPEC + PP TO 2N*,W=53GV   1/76*
M          (1390.)     (10.)              MUSGRAVE   75 HBC    K+ P TO K PI N    11/75*
M           1350. TO 1400.                STRACHMA   75_ BC    NBAR (N PI)        1/76*
M   S   TAN 68, SHAPIRA 68, AND GAGE 72 ARE ONLY PRODUCTION EXPERIMENTS TO
M   S   SEE PPI DECAY.  HOWEVER THE EFFECT OF SHAPIRA 68, WITH MUCH IMPROVE
M   S   DATA, HAS ALMST DISAPPEARED (YEKUTIEL1 72).
M   B      (1250.)                        BERLAND    74 HBC +0 ISOSPIN ANALYSIS 10/74*
M   B      (1230.)                        BRAUN2     75  BC    PBAR P AND D,5.7 11/75*
M   B      (1230.)                        STRACHMA   75  BC    NBAR (N PI)        1/76*
M   B   THE EFFECT SEEN BY BERLAND 74 IN A PRISM PLOT ANALYSIS, BY BRAUN2        1/76*
M   B   75 IN A DALITZ PLOT FIT, AND BY STRACHMAN 75 IN AN AMPLITUDE             1/76*
M   B   ANALYSIS IS PROBABLY NOT CONNECTED WITH THE N*(1470).  WE                1/76*
M   B   TEMPORARILY LIST THE MASS HERE UNTIL THE SITUATICN IS FURTHER            1/76*
M   B   CLARIFIED.  SEE ALSO COOPER 74.                                          1/76*

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                 91  N*1/2(1470) WIDTH (MEV) (PRCD. EXP.)

W           (100.)                        BELL       68 HBC    PI+- P AND PP      6/68
W   S   175 (198.)     (40.)              SHAPIRA    68 CBC                      10/69
W   S       (150.)     (60.)              TAN        68 HBC  +                   10/69
W       120 (100.)     (15.)              RHODE      69 HBC    PP 22 GEV/C       10/69
W           (210.)     (15.)              ANDERSON   70 MMS  - PI- P TO PI- MMS   2/71
W           (150.)     (40.)              BALLAM     71 HBC +- PI+-P AT 16GEV     2/72
W           (100.)                        BEKETOV    71 HBC  + P PI+ PI- MASS     3/72
W            (60.)     (20.)              BOESEBEC   71 RVUE   PP,PI-P,K-P PROD   3/72
W   T   120  (54.0)    (12.0)   120/80    MA         71 HBC  + P P TO P N PI    .10/71
W   T    NARROW WIDTH SUGGESTS THIS IS NOT THE USUAL N*(1470).                   10/71
W              80. TO  120.               MORSE      71 HBC  + PI-P,  7 GEV/C     3/72
W          (100.0)     (30.0)             MORSE      71 HBC  + PI-P, 25 GEV/C     3/72
W          (125.)      (25.)              RUSHBROOKE71 HBC  + PP TO P2PI 16GEV    2/72
W          (188.0)     (38.0)             EDELSTEIN  72 MMS  + PP 6 TO 30 GEV     1/73
W          (212.0)     (62.0)             GAGE       72 DBC  0 PD  5.9GEV/C      12/72
W          (124.0)     (20.0)             KARSHON    72 CBC  + PD--PD2PI 7 GEV   12/72
W          (100.)      (30.)              RONAT      72  HBC   PI+P TO 3PI P      2/73
W           (50.)      (25.)              LICHTMAN   74 HBC  + PI+P TO 3PI P      4/75*
W           (62.)      (18.)              LICHTMAN   74 HBC  + PI-P TO 3PI P      4/75*
W          (250.)      (95.)              CAVALLI    75 SPEC + PP TO 2N*,W=23GV   1/76*
W          (249.)      (90.)              CAVALLI    75 SPEC + PP TO 2N*,W=31GV   1/76*
W          (205.)     (105.)              CAVALLI    75 SPEC + PP TO 2N*,W=53GV   1/76*
W          (145.)      (35.)              MUSGRAVE   75 HBC    K+ P TO K PI N    11/75*

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                 91  N*1/2(1470) PARTIAL DECAY MODES (PROD. EXP.)

                                                         DECAY MASSES
P1      N*1/2(1470) INTO PI N                           139+ 938
P2      N*1/2(1470) INTO N PIPI(J,I=0)                  938+ 139+ 139
P3      N*1/2(1470) INTO N*3/2(1232) PI                1232+ 139
P4      N*1/2(1470) INTO N PI PI                        938+ 139+ 139
P5      N*1/2(1470) INTO GAMMA N                          0+ 938
P6      N*1/2(1470) INTO N RHO                          938+ 773

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                 91  N*1/2(1470) BRANCHING RATIOS (PRCD. EXP.)

R1      N*1/2(1470) INTO (PI N)/TOTAL                         (P1)
R1             (.66)                 TAN      68 HBC       PP TO PIP, 6.1   10/69

R2      N*1/2(1470) INTO (N*3/2(1232) PI)/TCTAL               (P3)
R2            PROBABLY SEEN          JESPERSEN 68 HBC      PP 22 BEV/C      11/68
R2            PROBABLY SEEN          LAMSA    68 HBC       PI-P 8 BEV/C     11/68

R3      N*1/2(1470) INTO (N PIPI(J,I=0))/TCTAL                (P2)
R3            MAIN DECAY MODE        MORSE    71 HBC   +   PI-P 7,25 GEV/C   3/72

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                          REFERENCES FOR N*1/2(1470) (PROD. EXP.)

COCCCNI  64 PL   8 134       +LILLETHUN,SCANLON,STAHLBRANCT, +      (CERN)
ADELMAN  65 PRL 14 1043      S L ADELMAN               (CAMBRIDGE(CERN))
ANKENBRA 65 NC  35 1052      ANKENBRANDT,CLYDE,CORK,KEEFE,KERTH+    (LRL)
BELLETTI 65 PL  18 167       BELLETTINI,COCCONI,DIDDENS +           (CERN)
ANDERSON 66 PRL 16  855      +BLESER,CCLLINS,FUJII,+            (BNL,CARN)
BLAIR    66 PRL 17  789      +TAYLOR,CHAPMAN,+  (HARWELL,QUEENMARY,RHEL)

FOLEY    67 PRL 19  397      +JONES,LINDENBAUM,LOVE,OZAKI+           (BNL)
ALMEIDA  68 PR 174 1638      +RUSHBROOKE,SCHARENGUIVEL+        (CAVE,DESY)
BELL     68 PRL 20  164      +CRENNELL,HOUGH,KARSHON,LAI+       (BNL,CUNY)
JESPERSE 68 PRL 21 1368      JESPERSEN,KANG,KERNAN+          (IOWA STATE)
LAMSA    68 PR 166 1395      +CASON,BISWAS,DERADO,GROVES,+  (NOTRE DAME)
SHAPIRA  68 PRL 21 1835      +BENARY,EISENBERG,RONAT,YAFFE+        (REHO)
TAN      68 PL 28B 195       TAN,PERL,MARTIN,VHINOWSKU +  (SLAC+LRL+UCI)
RHODE    69 PR 187 1844      RHODE, LEACOCK, KERNAN, JESPERSEN,+    (ISU)
ANDERSON 70 PRL 25 699       +BLESER,BLIEDEN,COLLINS++          (BNL,CARN)

BALLAM   71 PR D4 1946       +CHADWICK,GUIRAGOSSIAN,JOHNSON,++    (SLAC) I
BEKETOV  71 SJNP 13 605      ,ZCMBKOVSKII,KONOVALOV,KRUCHININ,++  (ITEP)IJ
BOESEBEC 71 NP B33 445       BOESEBECK,GRAESSLER,KRAUS,+++     (ABBCHLV) I
MA       71 PRL  26  333     +COLTON                            (MSU+LBL)I
MORSE    71 PR D4 133        +CH,WALKER,CARRCLL,LYNCH +       (WISC+TNTO)IJ
RUSHBROO 71 PR D4 3273       RUSHBROOKE,WILLIAMS+BAREFORD++  (CAVE,LOIC) IJ

EDELSTEI 72 PR D5 1073       EDELSTEIN,CARRIGAN,HIEN,MCMAHON,+(CARN+BNL)
GAGE     72 NP B46 21        W GAGE,E COLTON,W CHINOWSKI            (LBL)
KARSHCN  72 NP B37 371       +YEKUTIELI,YAFFE,SHAPIRA,RONAT,+     (REHO) I
RONAT    72 NP B38 20        +EISENBERG,LYCNS,SHAPIRA,TOAFF+       (REHO)
YEKUTIEL 72 NP B40 77        YEKUTIELI,YAFFE,SHAPIRA,RCNAT +       (REHO)

BERLAND  74 NP B75 93        BERLAND,HABER,HODOLS,HULSIZER,+        (MIT)I
    ALSO 74 PL 51B 187       BERLAND,HABER,HODOUS,HULSIZER,+        (MIT)I
LICHTMAN 74 NP B81 31        LICHTMAN,BISWAS,CASON,KENNEY,MCGAHAN+(NDAM)I

BLOBEL   75 NP B97 201       +ESKREYS,FESEFELDT,FRANZ+  (BONN+HAMB+MPIM)IJP
BRAUN2   75 NP B95 503       +GERBER,MAURER,MICHALON,SCHIBY+ STBRB,LPNP I
CAVALLI  75 LNC 14 353       CAVALLI-SFORZA,CONTA+              (PAVIA+PRIN)
    ALSO 75 LNC 14 345+359   CAVALLI-SFORZA,CONTA+              (PAVIA+PRIN)
MUSGRAVE 75 NP B87 365       +PEETERS,SCREINER,WHITMORE,YUTA         (ANL)
STRACHMA 75 NP B98 120       STRACHMAN,BRAUN,GERBER,MAURER+  (LPNP+STRB)I

                             PAPERS NOT REFERRED TO IN CATA CARDS

GELLERT  66 PRL 17 884       +SMITH,WOJCICKI,COLTON,SCHLEIN + (LRL,UCLA)
ALBERI   68 PR 176 1631      +APPEL,BUDNITZ,CHEN,DUNNING,GOITEIN+ (HARV)
WALKER   68 PRL 20 133       +THOMPSCN,ROBERTSON,OH,LEE,HARTUNG,+ (WISC)
CLEGG    69 NP B13 222       CLEGG                                  (LANC)
ALEXANDE 73 NP B52 221       ALEXANDER,BENARY+(TEL-AVIV+HEIDELBERG+DESY)
ANSORGE  73 NP B63 93        ANSORGE,MADEN,NEALE,RUSHBROOKE         (CAVE)
BEAUPRE  73 NP B66 93              (AACH+BERL+BONN+CERN+NDAM+PENN+TOHO)I
COOPER   74 NP B79 259       COOPER,SEIDL,VANDERVELDE              (MICH)IJP
DEUTSCHM 75 NP B99 397       DEUTSCHMANN+(AACH+BONN+BERL+CERN+CRAC+HEID)

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N(1520)

D'_{13}

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            62  N*1/2(1520, JP=3/2-) I=1/2
            THE EXISTENCE OF THIS RESCNANCE IS WELL ESTABLISHED.

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                 62  N*1/2(1520) MASS (MEV)

M          (1530.0)                  BRANDSEN  65 RVUE    PHASE-SHIFT ANAL  9/66
M          (1536.0)                  ROPER     65 RVUE    PHASE-SHIFT ANAL  9/66
M   1      (1510.0)                  BAREYRE   68 RVUE    PHASE-SHIFT ANAL 11/67
M   1              WHERE CROSS SECTICN IS GREATEST - EYEBALL FIT
M   3      (1541.0)                  DCNNACH1  68 RVUE    PHASE-SHIFT ANAL  6/68
M   6      (1523.0)                  AYED      70 IPWA                      1/71
M   6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M   4      (1512.0)                  DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
M   7      (1520.)                   ALMEHED   72 IPWA                      2/72
M          (1525.)                   AYED      74 IPWA                      2/74
M           1501. TO 1503.           CRAWFORD  75 DPWA    PI N PHOTO-PROD   1/76*
M    L      1524. OR 1520.           LONGACRE  75 IPWA    PI N TO 2PI N    11/75*
M    L  THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.  11/75*
M          (1503.)                   BARBOUR   76 DPWA    PI N PHOTO-PROD   1/76*

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                 62  N*1/2(1520) WIDTH (MEV)

W   1      (125.0)                   BAREYRE   68 RVUE                     11/67
W   3      (149.0)                   DONNACH1  68 RVUE                      6/68
W   6      (131.0)                   AYED      70 IPWA                      1/71
W   4      (106.0)                   DAVIES    70 RVUE    P-S ANAL  SOL A
W   7      (120.)                    ALMEHED   72 IPWA                      2/72
W          (122.)                    AYED      74 IPWA                      2/74
W           115. TO  150.            CRAWFORD  75 DPWA    PI N PHOTO-PROD   1/76*
W    L      120. OR  150.            LONGACRE  75 IPWA    PI N TO 2PI N    11/75*
W          (137.)                    BARBOUR   76 DPWA    PI N PHOTO-PROD   1/76*
        SEE THE NOTES ACCOMPANYING THE MASSES CUOTEC.

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                 62  N*1/2(1520) REAL PART OF POLE PCSITICN (MEV)      11/75*

RE         (1514.)                   LCNGACRE  75 IPWA    PI N TO 2PI N    11/75*

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                 62  N*1/2(1520) 2*IMAG PART CF POLE POSITICN (MEV)    11/75*

IM         (146.)                    LCNGACRE  75 IPWA    PI N TO 2PI N    11/75*

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Baryons

N(1520)

Data Card Listings

For notation, see key at front of Listings.

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                     62  N*1/2(1520) PARTIAL DECAY MODES

                                                             DECAY MASSES
P1      N*1/2(1520) INTO PI N                                139+ 938
P2      N*1/2(1520) INTO N*3/2(1232) PI                     1232+ 139
P3      N*1/2(1520) INTO N PI PI                             938+ 139+ 139
P4      N*1/2(1520)+ INTO NEUTRON PI+                        939+ 139
P5      N*1/2(1520)+ INTO PROTON PI+ PI-                     938+ 139+ 139
P6      N*1/2(1520) INTO N ETA                               939+ 548
P7      N*1/2(1520) INTO N EPSILON                           938+1200
P8      N*1/2(1520) INTO N RHO                               938+ 773
P9      N*1/2(1520) INTO GAM P, HELICITY=1/2                   0+ 938
P10     N*1/2(1520) INTO GAM P, HELICITY=3/2                   0+ 938
P11     N*1/2(1520) INTO GAM N, HELICITY=1/2                   0+ 939
P12     N*1/2(1520) INTO GAM N, HELICITY=3/2                   0+ 939
P13     N*1/2(1520) INTO K LAMBDA                            497+1115
P14     N*1/2(1520) INTO N*3/2(1232) PI,S-WAVE              1232+ 139
P15     N*1/2(1520) INTO N*3/2(1232) PI,D-WAVE              1232+ 139
P16     N*1/2(1520) INTO N RHC,S=3/2,S-WAVE                  938+ 773

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                     62  N*1/2(1520) BRANCHING RATIOS

R1      N*1/2(1520) INTO (PI N)/TOTAL                       (P1)
R1  1         (0.54)                 BAREYRE   68 RVUE                       11/67
R1  3         (0.509)                DONNACH1  68 RVUE                        6/68
R1  6         (0.593)                AYED      70 IPWA                        1/71
R1  4         (0.45)                 DAVIES    70 RVUE    P-S ANAL  SOL A     8/69
R1  7         (0.58)                 ALMEHED   72 IPWA                        2/72
R1             (.558)                AYED      74 IPWA                        2/74
R1      SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.
R1
R1  ALMOST THE ENTIRE INELASTICITY IS IN N PI PI (CNLY N ETA COULD COMPETE,
R1  AND IT DOESNT).  THE N PI PI SEEMS TO BE MAINLY N*3/2(1232) PI, IN BCTH
R1  S AND D WAVES.

R2      N*1/2(1520) INTO (N*3/2(1232) PI)/TOTAL             (P4)
R2             0.20      0.05        KIRZ      66 HBC   0 ASSUMING R1=0.72  9/66
R2             DOMINANT INEL DECAY   OLSSON    66 RVUE    PI P TO PI PI N   9/66
R2  D         (0.40)                 DIEM      70 IPWA    3 BODY ANALYSIS   1/71
R2  D       ASSUMING  R1= 0.5

R3      N*1/2(1520) INTO (N*3/2(1232) PI)/(N PI PI)         (P2)/(P3)
R3              LARGE                THURNAUER 65 RVUE -                     11/67
R3              LARGE                NAMYSLOWS 66 RVUE -                     11/67
R3              LARGE                ROBERTS   67 RVUE -                     11/67
R3              LARGE                ROSENFELD 67 RVUE -                     11/67
R3              LARGE                MORGAN    68 RVUE    ISOBAR MODEL        6/68

R4      N*1/2(1520) INTO (N EPSILCN)/TCTAL                  (P7)
R4            PROBABLY PRESENT       MORGAN    68 RVUE    ISOBAR MODEL        6/68
R4  D         (0.02)                 DIEM      70 IPWA    3 BODY ANALYSIS     1/71
R4  D       ASSUMING  R1= 0.5

R5      N*1/2(1520) INTO (N ETA)/TOTAL                      (P6)
R5  D         (0.006)   APPROX       DAVIES    67 RVUE                       11/67
R5   CAVIES 67 GIVES SEVERAL VALUES DEPENDING ON INPUT DATA.  ALL ARE SMALL
R5  B         (0.014)                BOTKE     69 MPWA    T POLE+ RESON.    10/69
R5  B         (0.003)  (0.001)       DEANS     69 MPWA    T POLE+ RESCN.     5/70
R5  B         (0.002)OR 0.004        CARRERAS  70 MPWA    T POLE+ RESCN.     5/70
R5  B    PARAMETRIZATION USEC COULD BE IN DANGER OF DOUBLE COUNTING
R5             SEEN                  LEMOIGNE  73 DPWA    1488 TC 1685 MEV  2/74

R6      N*1/2(1520) INTO (N RHO )/TOTAL                     (P8)
R6  D         (0.07)                 DIEM      70 IPWA    3 BODY ANALYSIS   1/71
R6  D       ASSUMING  R1= 0.5

R7      N*1/2(1520) FROM PI N TO K LAMBDA                   SQRT(P1*P13)      4/75*
R7 C          -.076     .032         DEVENISH  74         0 FIXED T DISP REL  4/75*
R7 C     EXTRAPOLATION OF PARAMETRIZED AMPLITUDE BELOW THRESHOLD.             4/75*

R8      N*1/2(1520) FRCM PI N INTC N EPSILON                SQRT(P1*P7)      11/75*
R8   L        (0.0) OR  +.17         LONGACRE  75 IPWA    PI N TO 2PI N     11/75*

R9      N*1/2(1520) FROM PI N TO N*3/2(1232) PI,S-WAVE      SQRT(P1*P14)     11/75*
R9   L        (+.27)OR  +.24         LONGACRE  75 IPWA    PI N TO 2PI N     11/75*

R10     N*1/2(1520) FROM PI N TO N*3/2(1232) PI,D-WAVE      SQRT(P1*P15      11/75*
R10  L        (+.24)OR  +.30         LONGACRE  75 IPWA    PI N TO 2PI N     11/75*

R11     N*1/2(1520) FROM PI N TO N RHO,S=3/2,S-WAVE         SQRT(P1*P16)     11/75*
R11  L        (+.32)OR  +.24         LONGACRE  75 IPWA    PI N TO 2PI N     11/75*

R12     N*1/2(1520) FROM PI N TC ETA N                      SQRT(P1*P6)       1/76*
R12  9        (-.011)OR +.058        FELTESSE  75 DPWA  0 1488 TO 1745 MEV  1/76*
R12  9   SUPERCEDES LEMOIGNE 73, USES M AND W OF AYED 74.                     1/76*

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                     62  N*1/2(1520) PHOTCN DECAY AMPL(GEV**-1/2)

      FOR DEFINITICN OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
     REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*1/2(1520) INTO GAM P, HELICITY=1/2  (GEV**-1/2)
A1             .010      .022        DEVENISH  73 DPWA    PI N PHOTO PROD   2/74
A1            (-.026)                HEMMI1    73       + FWD PI0 PHTOPRCD  2/74
A1            -.026      .015        MOORHOUS  73 DPWA    PI N PHOTO-PROD   2/73
A1            -.008      .015        DEVENIS2  74 DPWA    PI N PHOTC-PRCD   4/75*
A1            -.019      .008        KNIES     74 DPWA    PI N PHOTC PROD   2/74
A1            -.006      .006        METCALF   74 DPWA    PI N PHOTO-PROD   2/74
A1             .000      .006        MOORHOUS  74 DPWA    PI N PHOTO-PROD   2/74
A1            -.009      .004        CRAWFORD  75 DPWA    PI N PHOTO-PROD   1/76*
A1            (-.012)                BARBOUR   76 DPWA    PI N PHOTO-PROD   1/76*
A1          . . . . . . . . . .
A1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

A2      N*1/2(1520) INTO GAM P, HELICITY=3/2  (GEV**-1/2)
A2             .180      .017        DEVENISH  73 DPWA    PI N PHOTO PROD   2/74
A2            +.194      .031        MOORHOUS  73 DPWA    PI N PHOTO-PRCD   2/73
A2             .171      .012        DEVENIS2  74 DPWA    PI N PHOTO-PROD   4/75*
A2             .169      .012        KNIES     74 DPWA    PI N PHOTC PROD   2/74
A2            +.165      .011        METCALF   74 DPWA    PI N PHOTO-PRCD   2/74
A2             .174      .006        MOORHOUS  74 DPWA    PI N PHOTO-PRCD   2/74
A2            +.162      .004        CRAWFORD  75 DPWA    PI N PHOTO-PROD   1/76*
A2            (+.158)                BARBOUR   76 DPWA    PI N PHOTC-PRCD   1/76*
A2          . . . . . . . . . .
A2   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

A3      N*1/2(1520) INTO GAM N, HELICITY=1/2  (GEV**-1/2)
A3            -.075      .037        DEVENISH  73 DPWA    PI N PHOTO PROD   2/74
A3            -.085      .014        MOORHOUS  73 DPWA    PI N PHOTO-PROD   2/73
A3 2          +.037      .012        ROSSI     73 CPWA  0 GAM N TO PI- P    4/75*
A3 2     CONVERTED TO OUR CONVENTIONS USING M AND W FROM ROSSI73 AND X=.56    4/75*
A3            (0.)                   BENEVENT  74 DPWA  0 GAM N TO PI- P    4/75*
A3            -.089      .019        DEVENIS2  74 DPWA    PI N PHOTO-PROD   4/75*
A3            -.077      .005        KNIES     74 DPWA    PI N PHOTO PRCD   2/74
A3            -.066      .010        METCALF   74 DPWA    PI N PHOTO-PROD   2/74
A3            -.088      .007        MOORHOUS  74 DPWA    PI N PHOTO-PROD   2/74
A3            -.067      .004        CRAWFORD  75 DPWA    PI N PHOTO-PRCD   1/76*
A3            (-.056)                BARBOUR   76 DPWA    PI N PHOTO-PROD   1/76*
A3          . . . . . . . . . .
A3   AVERAGE MEANINGLESS (SCALE FACTOR = 3.9)

A4      N*1/2(1520) INTO GAM N, HELICITY=3/2  (GEV**-1/2)
A4            -.126      .028        DEVENISH  73 DPWA    PI N PHOTO PRCD   2/74
A4 8          (-.087)                HEMMI2    73         0 GAM N TO PI0 N  4/75*
A4 8     CONVERTED TO OUR CONVENTIONS USING M AND W FROM WALKER69 AND X=.56   4/75*
A4 2          -.016      .016      .018 ROSSI  73 CPWA  0 GAM N TO PI- P    4/75*
A4            -.124      .013        MOORHOUS  73 DPWA    PI N PHOTO-PROD   2/73
A4 5          (-.035)                BENEVENT  74 CPWA  0 GAM N TO PI- P    4/75*
A4 5     CONVERTED TO OUR CONVENTIONS USING M=1520 MEV, W=120 MEV, X=.56      4/75*
A4            -.155      .019        DEVENIS2  74 DPWA    PI N PHOTO-PROD   4/75*
A4            -.120      .010        KNIES     74 DPWA    PI N PHOTO PROD   2/74
A4            -.118      .013        METCALF   74 DPWA    PI N PHOTO-PROD   2/74
A4            -.119      .025        MOORHOUS  74 DPWA    PI N PHOTO-PROD   2/74
A4            -.133      .003        CRAWFORD  75 DPWA    PI N PHOTO-PROD   1/76*
A4            (-.136)                BARBOUR   76 DPWA    PI N PHOTO-PRCD   1/76*
A4          . . . . . . . . . .
A4   AVERAGE MEANINGLESS (SCALE FACTOR = 3.1)

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REFERENCES FOR N*1/2(1520)

SEE A PREVIOUS EDITICN (RMP 37, 633, 1965) FOR EARLIER REFERENCES.


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BRANDSEN 65 PR 139 B1566        +ODCNNELL, MCORHOUSE          (DURHAM, RHEL)IJP
ROPER    65 PR 138 B190         LD ROPER,RM WRIGHT,BT FELD    (LRL-LVMR,MIT)IJP
THURNAUE 65 PRL 14 985          P G THURNAUER                          (ROCH)

KIRZ     66 PRIVATE COMM        J KIRZ                                  (LRL)
    NUMBER EXTRACTED FRCM CATA DISCUSSED IN KIRZ 63. Z 63.
NAMYSLOW 66 PR 157 1328         NAMYSLOWSKI,RAZMI,ROBERTS  (STAN,EDIN,LOIC)
OLSSON   66 PR 145 1309         M G OLSSON, G B YODH                (WISC,UMD)

DAVIES   67 NC 52A 1112         A T DAVIES, R G MOORHOUSE   (GLASGOW, RHEL)
ROBERTS  67 PREPRINT            R G ROBERTS                          (DURHAM)
ROSENFEL 67 IRVINE CONF         A H ROSENFELD, P SODING                 (LRL)

BAREYRE  68 PR 165 1731         P BAREYRE, C BRICMAN, G VILLET     (SACLAY)IJP
DONNACH1 68 PL 26B 161          A DCNNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139          DONNACHIE  RAPPORTEUR.S TALK           (GLAS)
    ALSO 68 THESIS              R G KIRSOPP                            (EDIN)
MORGAN   68 PR 166 1731         D MCRGAN                               (RHEL)

BOTKE    69 PR 180 1417         J C BOTKE                              (UCSB)
DEANS    69 PR 185 1797         S DEANS, J WOOTEN           (UNIV S FLORICA)

AYED     70 KIEV CONF           R AYED,P BAREYRE, G VILLET          (SACL)IJP
CARRERAS 70 NP 16B 35           B CARRERAS, A DONNACHIE           (DARE,MCHS)
DAVIES   70 NP B21 359          A DAVIES                               (GLAS)
DIEM     70 KIEV CONF.          + SMADJA, CHAVANON, DELER, DOLBEAU+  (SACL)
ALMEHED  72 NP B40 157          +LOVELACE                      (LUND,RUTG)IJP

DEVENISH 73 PL 47B 53           DEVENISH,RANKIN,LYTH        (LOUC+BONN+LANC)IJP
HEMMI1   73 PL 43B 79           HEMMI,INAGAKI+         (KYOTO+SAGA+KEK+TOKY)IJP
HEMMI2   73 NP B55 333          +INAGAKI,KIKUCHI,MAKI,MIYAKE+ (KYOTO,TOKYO)IJP
LEMOIGNE 73 PURDUE CONF. 93     +GRANET,MARTY,AYED,BAREYRE,BORGEAUD,+(SACL)IJP
MCORHOUS 73 PL 43B 44           MOORHOUSE, OBERLACK                (GLAS+LBL)IJP
ROSSI    73 NC 13A 59           +PIAZZA,SUSINNO,+     (ROMA,FRAS,NAPL,PAVIA)IJP
    ALSO 71 LNC 2 1183          CARBONARA,FIORE,+     (NAPL,FRAS,PAVIA,ROMA)IJP

AYED     74 PRIVATE COMMCTN.    AYED,BAREYRE                          (SACL)IJP
    ALSO 73 AIX CONFERENCE      AYED,BAREYRE                          (SACL)IJP
BENEVENT 74 NC 19A 529          BENEVENTANO,DANGELO,NOTARISTEFANI,+  (RCMA)IJP
DEVENISH 74 NP B81 330          DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEVENIS2 74 PL 52B 227          DEVENISH,LYTH,RANKIN          (DESY,LANC,BCNN)IJP
KNIES    74 PRD 9 2680          KNIES,MOORHOUSE,OBERLACK           (LBL,GLAS)IJP
METCALF  74 NP B76 253          W J METCALF,R L WALKER                 (CIT)IJP
MOORHOUS 74 PRD 9 1             MOORHOUSE,OBERLACK,RCSENFELD       (GLAS+LBL)IJP

CRAWFCRD 75 NP B97 125          R L CRAWFORD                          (GLAS)IJP
FELTESSE 75 NP B93 242          +AYED,BAREYRE,BORGEAUD,DAVID,ERNWEIN+(SACL)IJP
LONGACRE 75 PL 55B 415          +ROSENFELD,LASINSKI,SMADJA+         (LBL,SLAC)IJP

BARBOUR  76 SBMTD. TO NP        I. M. BARBOUR,R. L. CRAWFCRD          (GLAS)IJP

                                PAPERS NOT REFERREC TO IN CATA CARDS.

KIRZ     63 PR 130 2481         J KIRZ, J SCHWARTZ, R D TRIPP            (LRL)
BAREYRE  65 PL 18 342           + BRICMAN, STIRLING, VILLET        (SACLAY)IJP
CROUCH   65 DESY CONF II 21     +   (BROWN,CEA,HARVARD,MIT,PADOVA,WEIZMANN)
DERADO   65 ATHENS CONF 244     +KENNEY,LAMSA, +        (NOTRE DAME,KENTUCKY)
MERLO    66 P ROY SOC 289 489 J P MERLO, G VALLACAS                  (SACLAY)
    THE ABOVE PAPERS DISCUSS INELASTIC CHANNELS NEAR THE REONANCE.
JOHNSON  67 UCRL-17683 THESIS C H JOHNSCN                                (LRL)
DEANS    69 PRL 177 2623        S R DEANS                    (UNIV S FLORIDA)
DCNNACHI 69 NP 10B 433          A DONNACHIE, R KIRSOPP              (GLAS+EDIN)
WALKER   69 PR 182 1729         R L WALKER                        (CAL TECH)IJP
AYED     70 PL 31B 598          +BAREYRE+VILLET                        (SACLAY)
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Data Card Listings

For notation, see key at front of Listings.

N(1535) S'_{11}

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63   N*1/2(1535, JP=1/2-) I=1/2
     THE EXISTENCE OF THIS RESONANCE IS WELL ESTABLISHED.
     IT IS STRONGLY ASSOCIATED WITH THE ETA N CHANNEL.

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                 63  N*1/2(1535) MASS (MEV)

M            (1519.0)                  HENDRY    65 RVUE     ETA N + S11 PI N  9/66
M            (1570.0)                  MICHAEL   66 RVUE     FITS BAREYRE S11  7/66
M    N       (1557.0) OR  1565.0       UCHIYAMA- 66 RVUE     FITS N ETA DATA   9/66
M    N        FITTING GIVES TWO SOLUTIONS.  PROBLEMS MATCHING PI P PHASE SHIFT
M    1       (1535.0)                  BAREYRE   68 RVUE     PHASE-SHIFT ANAL 11/67
M    1              WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M    3       (1591.0)                  DONNACH1  68 RVUE     PHASE-SHIFT ANAL  6/68
M            (1535.0)    (10.0)        DELCOURT  69 CNTR     PHOTOPRODUCT.     8/69
M    6       (1534.0)                  AYED      70 IPWA                       1/71
M    6    FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M    4       (1502.0)                  DAVIES    70 RVUE     P-S ANAL  SOL A   8/69
M    7       (1500.)                   ALMEHED   72 IPWA                       2/72
M     2      (1551.)                   HICKS     73 MPWA     GAM P-ETA P       9/73
M     2   ONLY STATES FROM TABLE VII OF HICKS73 ARE INCLUDED IN LISTINGS.      9/73
M     2   M AND W ARE FROM SOLUTION C2,BR=SQRT(G)/W WITH G FROM TABLE VII.     9/73
M            (1520.)                   AYED      74 IPWA                       2/74
M             1507. TO 1530.           CRAWFORD  75 DPWA     PI N PHOTO-PROD   1/76*
M     L       1520. OR 1510.           LONGACRE  75 IPWA     PI N TO 2PI N    11/75*
M     L   THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.   11/75*
M            (1501.)                   BARBOUR   76 DPWA     PI N PHOTO-PROD   1/76*

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                 63  N*1/2(1535) WIDTH (MEV)

W             (130.0)                  HENDRY    65 RVUE                       9/66
W             (130.0)                  MICHAEL   66 RVUE                       7/66
W    N        (156.0) OR  144.0        UCHIYAMA- 66 RVUE     SEE NOTE ON MASS  9/66
W    1        (155.0)                  BAREYRE   68 RVUE                      11/67
W    3        (268.0)     APPROX       DONNACH1  68 RVUE                       6/68
W             (120.0)                  DELCOURT  69 CNTR     PHOTOPRODUCT.     8/69
W    6         (96.0)                  AYED      70 IPWA                       1/71
W    4         (36.0)                  DAVIES    70 RVUE     P-S ANAL  SOL A   8/69
W    7         (50.)                   ALMEHED   72 IPWA                       2/72
W     2       (134.)                   HICKS     73 MPWA     GAM P-ETA P       9/73
W              (80.)                   AYED      74 IPWA                       2/74
W              114. TO  167.           CRAWFORD  75 DPWA     PI N PHOTO-PROD   1/76*
W     L         75. OR  100.           LONGACRE  75 IPWA     PI N TO 2PI N    11/75*
W             (128.)                   BARBOUR   76 DPWA     PI N PHOTO-PROD   1/76*
      SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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                 63  N*1/2(1535) REAL PART OF POLE POSITION (MEV)          11/75*

RE        (1496.)                      LONGACRE  75 IPWA     PI N TO 2PI N    11/75*

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                 63  N*1/2(1535) 2*IMAG PART OF POLE POSITION (MEV)        11/75*

IM        (103.)                       LONGACRE  75 IPWA     PI N TO 2PI N    11/75*

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                 63  N*1/2(1535) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1     N*1/2(1535) INTO PI N                              139+ 938
P2     N*1/2(1535) INTO N ETA                             939+ 548
P3     N*1/2(1535) INTO N PI PI                           938+ 139+ 139
P4     N*1/2(1535) INTO N EPSILON                         938+1200
P5     N*1/2(1535) INTO N*3/2(1232) PI                   1232+ 139
P6     N*1/2(1535) INTO N RHO                             938+ 773
P7     N*1/2(1535) INTO GAM P, HELICITY=1/2                 0+ 938
P8     N*1/2(1535) INTO GAM N, HELICITY=1/2                 0+ 939
P9     N*1/2(1535) INTO K LAMDBA                          497+1115
P10    N*1/2(1535) INTO N RHO,S=1/2,S-WAVE                938+ 773

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                 63  N*1/2(1535) BRANCHING RATIOS

R1     N*1/2(1535) INTO (PI N)/TOTAL                   (P1)
R1          (0.69)                HENDRY    65 RVUE                       9/66
R1          (0.32)                MICHAEL   66 RVUE                       9/66
R1   N      (0.71) OR  0.28       UCHIYAMA- 66 RVUE     SEE NOTE ON MASS  9/66
R1          (0.31) OR  0.43       DAVIES    67 RVUE     PIP TO N ETA,B,C 11/67
R1   3      (0.696)               DONNACH1  68 RVUE                       6/68
R1          (0.33)                DELCOURT  69 CNTR                       8/69
R1   6      (0.397)               AYED      70 IPWA                       1/71
R1   4      (0.36)                DAVIES    70 RVUE     P-S ANAL  SCL A   8/69
R1   7      (0.25)                ALMEHED   72 IPWA                       2/72
R1           (.36)                AYED      74 IPWA                       2/74

R2     N*1/2(1535) INTO (N ETA)/TOTAL                  (P2)
R2            DOMINANT INEL DECAY HENDRY    65 RVUE                       9/66
R2          (0.68)                MICHAEL   66 RVUE                       9/66
R2   N      (0.29) OR  0.71       UCHIYAMA- 66 RVUE     SEE NOTE CN MASS  9/66
R2          (0.69) OR  0.45       DAVIES    67 RVUE     PIP TO N ETA,B,C 11/67
R2   B      (0.4)     (0.1)       DEANS     69 MPWA     T POLE+ RESON.    5/70
R2          (0.66)                DELCOURT  69 MPWA                       8/69
R2   B      (0.69) OR  0.696      CARRERAS  70 MPWA     T POLE+ RESCN.    5/70
R2   B   PARAMETRIZATION USEC COULD BE IN DANGER OF DOUBLE COUNTING
R2     THE VALUES OF R2 LISTED ABOVE ARE INCOMPATIBLE WITH THE RESULTS
R2     OF DIEM ET AL. (70)

R3     N*1/2(1535) INTO (N*3/2(1232) PI)/TOTAL         (P5)
R3   D      (0.07)                DIEM      70 IPWA      3 BODY ANALYSIS   1/71
R3   D    ASSUMING  R1= 0.34

R4     N*1/2(1535) INTC (N EPSILCN)/TCTAL              (P4)
R4   D      (0.26)                DIEM      70 IPWA      3 BODY ANALYSIS   1/71
R4   D    ASSUMING  R1= 0.34

R5     N*1/2(1535) INTO (N RHO )/TOTAL                 (P6)
R5   D      (0.20)                DIEM      70 IPWA      3 BODY ANALYSIS   1/71
R5   D    ASSUMING  R1= 0.34

R6     N*1/2(1535) INTO GAMMA PROTCN/TOTAL                    (P7)                9/73
R6   5        .0042    .0014        DEANS     72 MPWA     P ETA PHOTOPROD.       9/73
R6   5  BR=(DEANS72 RADIATIVE WIDTH)/(NOMINAL FULL WIDTH=100 MEV)                9/73
R6   5  THE HICKS73 ENTRY UNDER R7 IS A MORE RECENT RESULT BY SAME GROUP.        9/73

R7     N*1/2(1535) FROM GAMMA PROTON TO ETA PROTON         SQRT(P2*P7)           9/73
R7   2       (.0366)                HICKS     73 MPWA     GAM P-ETA P            9/73

R8     N*1/2(1535) FROM PI N INTO ETA N                    SQRT(P1*P2)           2/74
R8           (+.43)                 LEMOIGNE  73 CPWA      1488 TC 1685 MEV      2/74
R8   A       (+.48)                 FELTESSE  75 DPWA   0 1488 TO 1745 MEV      11/75*
R8   A  SUPERCEDES LEMOIGNE 73, USES M AND W OF AYED 74.                        11/75*

R9     N*1/2(1535) FROM PI N TO K LAMBDA                   SQRT(P1*P9)           4/75*
R9 C        -.691     .214          DEVENISH  74          O FIXED T DISP REL     4/75*
R9 C    EXTRAPOLATION OF PARAMETRIZED AMPLITUDE BELOW THRESHOLD.                 4/75*

R10    N*1/2(1535) FROM PI N TO N*3/2(1232) PI             SQRT(P1*P5)          11/75*
R10  L       (0.0) OR  -.06         LCNGACRE  75 IPWA      PI N TO 2PI N        11/75*

R11    N*1/2(1535) FROM PI N TO N RHO,S=1/2,S-WAVE         SQRT(P1*P10)         11/75*
R11  L       (+.12)OR  +.09         LONGACRE  75 IPWA      PI N TO 2PI N        11/75*

R12    N*1/2(1535) FROM PI N TO N EPSILON                  SQRT(P1*P4)          11/75*
R12  L        (.1) OR  -.09         LCNGACRE  75 IPWA      PI N TO 2PI N        11/75*

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                 63  N*1/2(1535) PHOTON DECAY AMPL(GEV**-1/2)

      FOR DEFINITION OF GAMMA-NUCLECN DECAY AMPLITUDES, SEE MINI-
    REVIEW PRECEDING THE BARYON LISTINGS.

A1     N*1/2(1535) INTO GAM P, HELICITY=1/2 (GEV**-1/2)
A1           .042      .023         DEVENISH  73 DPWA     PI N PHOTO PRCD    2/74
A1          (.015)                  HEMMI1    73        + FWD PIO PHTOPROD   2/74
A1          +.053      .020         MOORHOUS  73 DPWA     PI N PHOTO-PRCD    2/73
A1           .078      .020         DEVENIS2  74 DPWA     PI N PHOTO-PROD    4/75*
A1           .056      .020         KNIES     74 DPWA     PI N PHOTO PROD    2/74
A1          +.063      .013         METCALF   74 DPWA     PI N PHOTO-PROD    2/74
A1           .036      .002         MOORHOUS  74 DPWA     PI N PHOTC-PRCD    2/74
A1          +.082      .007         CRAWFORD  75 DPWA     PI N PHOTO-PRCD    1/76*
A1         (+.063)                  BARBOUR   76 DPWA     PI N PHOTO-PROD    1/76*
A1            . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 4.6)

A2     N*1/2(1535) INTO GAM N, HELICITY=1/2 (GEV**-1/2)
A2          -.026      .029         DEVENISH  73 DPWA     PI N PHOTO PROD    2/74
A2          -.048      .021         MOORHCUS  73 DPWA     PI N PHOTO-PROD    2/73
A2 8        -.031      .024         ROSSI     73 DPWA   0 GAM N TO PI- P     4/75*
A2 8   CCNVERTED TO OUR CONVENTIONS USING M AND W FROM ROSSI73 AND X=.36     4/75*
A2 9       (-.078)                  BENEVENT  74 DPWA   0 GAM N TO PI- P     4/75*
A2 9   CONVERTED TO OUR CONVENTIONS USING M=1520 MEV, W=80 MEV, X=.36        4/75*
A2          -.037      .023         DEVENIS2  74 DPWA     PI N PHOTO-PROD    4/75*
A2          -.052      .005         KNIES     74 CPWA     PI N PHOTO PRCD    2/74
A2          -.051      .021         METCALF   74 DPWA     PI N PHOTO-PROD    2/74
A2          -.027      .009         MOORHOUS  74 DPWA     PI N PHOTO-PROD    2/74
A2          -.088      .011         CRAWFORD  75 DPWA     PI N PHOTO-PROD    1/76*
A2         (-.109)                  BARBOUR   76 DPWA     PI N PHOTO-PROD    1/76*
A2            . . . . . . . . .
A2  AVERAGE MEANINGLESS (SCALE FACTOR = 1.7)

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                        REFERENCES FOR N*1/2(1535)

HENDRY   65 PL 18 171 -        A W HENDRY, R G MOORHOUSE               (RHEL)
    REVIEWS EARLY PHASE-SHEFT-ANALYSIS RESULTS AND PI- P TO ETA N
    EXPERIMENTS. WE TAKE NUMBERS FRCM THE SOLUTION USING BRANDSEN 65.
MICHAEL  66 PL 21 93           C MICHAEL                               (OXF)
UCHIYAMA 66 PR 149 1220        F UCHIYAMA-CAMPBELL, R K LCGAN       (ILL)IJP
DAVIES   67 NC 52A 1112        A T DAVIES, R G MOORHOUSE    (GLASGOW,RHEL)

BAREYRE  68 PR 165 1731        P BAREYRE, C BRICMAN, G VILLET     (SACLAY)IJP
DONNACH1 68 PL 26B 161         A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139         DONNACHIE  RAPPORTEUR.S TALK           (GLAS)
    ALSO 68 THESIS             R G KIRSOPP                            (EDIN)
DEANS    69 PR 185 1797        S DEANS, J WOCTEN          (UNIV S FLORIDA)
DELCCURT 69 PL 29B 75          DELCOURT,LEFRANCOIS,PEREZ-Y-JORBA,+  (ORSA)

AYED     70 KIEV CONF          R AYED,P BAREYRE, G VILLET          (SACL)IJP
CARRERAS 70 NP 16B 35          B CARRERAS, A DONNACHIE          (DARE,MCHS)
DAVIES   70 NP B21 359         A DAVIES                               (GLAS)
DIEM     70 KIEV CONF.         + SMADJA, CHAVANON, DELER, DOLBEAU+    (SACL)

ALMEHED  72 NP B40 157         +LOVELACE                      (LUND,RUTG)IJP
DEANS    72 PN 3 217           +JACOBS, LYONS, HICKS   (U S FL TAMPA+CARN)
DEVENISH 73 PL 47B 53          DEVENISH,RANKIN,LYTH        (LOUC+BONN+LANC)IJP
HEMMI1   73 PL 43B 79          HEMMI,INAGAKI+         (KYOTO+SAGA+KEK+TCKY)IJP
HICKS    73 PRD 7 2614         +DEANS,JACOBS,LYONS+ (CARN+ORNL+SOUTH FLA.)IJP
LEMOIGNE 73 PURDUE CONF. 93    +GRANET,MARTY,AYED,BAREYRE,BORGEAUD,+(SACL)IJP
MOORHOUS 73 PL 43B 44          MOORHOUSE, OBERLACK               (GLAS+LBL)IJP
ROSSI    73 NC 13A 59          +PIAZZA,SUSINNO,+       (ROMA,FRAS,NAPL,PAVIA)IJP
    ALSO 71 LNC 2 1183         CARBONARA,FIORE,+       (NAPL,FRAS,PAVIA,ROMA)IJP

AYED     74 PRIVATE COMMCTN.   AYED,BAREYRE                          (SACL)IJP
    ALSO 73 AIX CONFERENCE     AYED,BAREYRE                          (SACL)IJP
BENEVENT 74 NC 19A 529         BENEVENTANO,DANGELO,NOTARISTEFANI,+  (ROMA)IJP
DEVENISH 74 NP B81 330         DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEVENIS2 74 PL 52B 227         DEVENISH,LYTH,RANKIN        (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680         KNIES,MOORHOUSE,OBERLACK          (LBL,GLAS)IJP
METCALF  74 NP B76 253         W J METCALF,R L WALKER                 (CIT)IJP
MOORHOUS 74 PRD 9 1            MCORHOUSE,OBERLACK,RCSENFELD      (GLAS+LBL)IJP

CRAWFORD 75 NP B97 125         R L CRAWFORD                          (GLAS)IJP
FELTESSE 75 NP B93 242         +AYED,BAREYRE,BORGEAUD,DAVID,ERNWEIN+(SACL)IJP
LONGACRE 75 PL 55B 415         +RCSENFELD,LASINSKI,SMADJA+       (LBL,SLAC)IJP

BARBOUR  76 SBMTD. TO NP       I. M. BARBOUR,R. L. CRAWFCRD          (GLAS)IJP

                               PAPERS NCT REFERRED TO IN CATA CARDS.

BAREYRE  65 PL 18 342          + BRICMAN, STIRLING, VILLET        (SACLAY)IJP
BRANDSEN 65 PR 139 B1566       +ODONNELL, MCORHOUSE         (DURHAM, RHEL)IJP
    BASIS OF NUMBERS WE QUOTE FROM HENDRY 65.
JOHNSON  67 UCRL-17683 THESIS  C H JOHNSON                             (LRL)
LOVELACE 67 HEIDELBERG C. 79   C LOVELACE                         (CERN)IJP
DONNACHI 69 NP 10B 433         A DONNACHIE, R KIRSOPP             (GLAS+EDIN)
AYED     70 PL 31B 598         +BAREYRE+VILLET                       (SACLAY)
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Baryons
N(1535), N(1670)

Data Card Listings
For notation, see key at front of Listings.

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   THE FOLLOWING ARTICLES DEAL WITH THE REACTICNS PI- P TO ETA N
AND GAMMA P TO ETA P NEAR THRESHOLD. THE DATA AND THE THEORETICAL
ARTICLES ARE USEFUL IN UNDERSTANDING THE BEHAVIOR OF THE S11 AMPLI-
TUDE AS DETERMINED IN PI P PHASE-SHIFT ANALYSES. FURTHER REFERENCES
MAY BE FOUND IN THEM.
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          MAINLY EXPERIMENTAL --
BULOS    64 PRL 13 486          +        (BROWN,BRANDEIS,HARVARD,MIT,PADOVA) I
BACCI    66 NC 45A 983          +PENSO,SALVINI,MENCUCCINI,+ (ROMA,FRASCATI)IJP
JONES    66 PL 23 597           +BINNIE,DUANE,HORSEY,MASON,+    (LOIC,RHEL)
RICHARDS 66 PRL 16 1221         +CHIU,EANDI,HELMHOLZ,KENNEY,+  (LRL,HAWAII) IJ
PREPOST  67 PRL 18 82           R PREPOST, D LUNDQUIST, C QUINN  (STANFORD)
BLOCM    68 PRL 21 1100         +HEUSCH, PRESCOTT, ROCHESTER           (CIT)
BULOS    69 PR 187 1827         +LANOU,BORDNER,BASTIEN+(BOST+HARV+MIT+PENN)
HEUSCH   70 PRL 25 1381         +PRESCOTT,ROCHESTER,WINSTEIN           (CIT)
BINNIE   73 PRD 8 2789          +CAMILLERI,DEBENHAM,DUANE,+     (LOIC,SHMP)
          MAINLY THEORETICAL --
BALL     66 PR 149 1191         J S BALL                              (UCLA)
DOBSCN   66 PR 146 1022         P N DOBSON                          (HAWAII)
MINAMI   66 PR 147 1123         S MINAMI                             (OSAKA)
DEANS    67 PR 161 1466         S R DEANS, W G HOLLADAY        (VANDERBILT)
LOGAN    67 PR 153 1634         R K LOGAN, F UCHIYAMA-CAMPBELL         (ILL)
MENCUCCI 67 NC 48A 579          C MENCUCCINI, A REALE             (FRASCATI)
MINAMI   67 PR 162 1619         S MINAMI                             (OSAKA)
MOSS     67 PR 163 1785         T A MOSS                               (LSU)
DEANS    68 PR 165 1886         S R DEANS, W G HOLLADAY        (VANDERBILT)
PAL      68 PR 167 1350         B K PAL                      (NPL NEW DELHI)
BALL     69 PR 177 2257         +GARG+SHAW                        (UCLA+UCI)
LEFIEVRE 70 NC 66A 349          +LERUSTE                              (CDEF)
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1520 MEV REGION – PRODUCTION EXPERIMENTS

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                8  N*1/2(1520, JP=    ) I=1/2   PRODUCTION EXPERIMENTS

                THIS INFORMATION REFERS TO EITHER THE D13 OR THE S11
                STATE SEEN AT THIS MASS.  FOR SPIN-PARITY ANALYSIS OF
                THIS MASS REGION, SEE JOHNSTAD 72.

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                8  N*1/2(1520) MASS (MEV) (PROD. EXP.)

M           1507.0     6.0          A-BORELLI 67 HBC   0 PBAR P 5.7 GEV   10/71
M           1503.      6.           ANDERSON  70 MMS   - PI- P TO PI- MMS  2/71
M           1500.0    10.0          AMALDI    71 CNTR    P P AT 24 GEV    10/71
M           1512.0     2.0          ELLIS     71 CNTR    MMS PP 3.7 GEV/C 10/71
M           1501.0     5.7          EDELSTEIN 72 MMS   + PP 6 TO 30 GEV    1/73
M    1     (1500.)                  OH        72 DBC   0 PI-N TO PI-PI-P   2/73
M    1   DETERMINE J=3/2,D13 PROBABLE                                       2/73
M           1515.     11.           COOPER    74 HBC   0 D P CEX          4/75*
M          (1490.)                  BRAUN1    75 HBC     PBAR P 5.7 GEV  11/75*
M           1510.      7.           MUSGRAVE  75 HBC     K+ P TO K PI N  11/75*
M          (1500.)                  STRACHMA  75  BC     NBAR (N PI)      1/76*
M           1500.      8.           WEBB      75 ISR   + P P TO P N*      1/76*

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                8  N*1/2(1520) WIDTH (MEV) (PROD. EXP.)

W             55.0    15.0          A-BORELLI 67 HBC   0 PBAR P 5.7 GEV   10/71
W            120.     10.           ANDERSON  70 MMS   - PI- P TO PI- MMS  2/71
W            118.0    20.0          AMALDI    71 CNTR    P P AT 24 GEV    10/71
W             88.0     2.0          ELLIS     71 CNTR    MMS PP 3.7 GEV/C 10/71
W            140.0    43.0          EDELSTEIN 72 MMS   + PP 6 TO 30 GEV    1/73
W            106.     39.     33.   COOPER    74 HBC   0 D P CEX          4/75*
W           (200.)                  BRAUN1    75 HBC     PBAR P 5.7 GEV  11/75*
W            101.     26.           MUSGRAVE  75 HBC     K+ P TO K PI N  11/75*
W            150.     50.           WEBB      75 ISR   + P P TO P N*      1/76*

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                8  N*1/2(1520) PARTIAL DECAY MODES (PROD. EXP.)

                                                        DECAY MASSES
P1      N*1/2(1520) INTO PI N                         139+ 938
P2      N*1/2(1520) INTO N*3/2(1232) PI              1232+ 139
P3      N*1/2(1520) INTO N PI PI                      938+ 139+ 139
P4      N*1/2(1520)+ INTC NEUTRON PI+                 939+ 139
P5      N*1/2(1520)+ INTO PROTON PI+ PI-              938+ 139+ 139
P6      N*1/2(1520) INTO N ETA                        939+ 548
P7      N*1/2(1520) INTO N PIPI(J,I=0)                939+ 139+ 139
P8      N*1/2(1520) INTO N RHO                        938+ 773

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                8  N*1/2(1520) BRANCHING RATIOS (PROD. EXP.)

R1      N*1/2(1520) INTO (N PI)/TOTAL                     (P1)
R1          N*(1520)  INTO   (N PI)/TOTAL   PRODUCTION EXPERIMENTS
R1             0.78     0.24           BASSCMPIE 67 HBC  + K+P TO K* N*     11/68

R2      N*1/2(1520) INTO (NEUTRCN PI+)/(P PI+ PI-)        (P4)/(P5)
R2             0.77     0.45           ALEXANDER 67 HBC  + PP 5.5 BEV/C      9/66

R3      N*1/2(1520) INTO (N PI)/(N PI PI)                 (P1)/(P3)
R3             1.25     0.44     0.71  A-BORELLI 67 HBC  0 PBAR P 5.7 BEV/C  9/66

R4      N*1/2(1520) INTC (N*3/2(1232) PI)/(N PI PI)       (P2)/(P3)
R4             0.00     0.09           A-BORELLI 67 HBC                      9/66

R5      N*1/2(1520) INTO (N PI PI)/TOTAL                  (P3)
R5          (0.08) OR LESS             BASSOMPIE 67 HBC  + K+P TO K* N*     11/68

R6      N*1/2(1520) INTO (N ETA)/TOTAL                    (P6)
R6             0.22     0.14           BASSOMPIE 67 HBC  + K+P TO K* N*     11/68

R7      N*1/2(1520) INTC (PI N)/(PI N*3/2(1232))          (P1)/(P2)
R7          (0.42) OR LESS             LEE       67 HBC    PI-P 3.6  GEV/C  11/67

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                - REFERENCES FOR N*1/2(1520) (PRCD. EXP.)

A-BORELL 67 NC 47 232           ALLES-BORELLI,FRENCH,FRISK,MICHEJCA  (CERN)
ALEXANDE 67 PR 154 1284         ALEXANDER,BENARY,CZAPEK,+  (WEIZMANN(CERN))
BASSOMPI 67 PL 25B 440          BASSOMPIERRE, +            (CERN,BRUXELLES)
LEE      67 PR 159 1156         +MOEBS,ROE,SINCLAIR,VANDER VELDE     (MICH)

ANDERSCN 70 PRL 25 699          +BLESER,BLIEDEN,COLLINS++        (BNL,CARN)

AMALDI   71 PL  34B 435         +BIANCASTELLI,BOSIO,+  (I SANITA RCMA+CERN)
ELLIS    71 PRL 27 442          +MAGLICH,NOREM,SANNES,SILVERMAN      (RUTG)

EDELSTEI 72 PR D5 1073          EDELSTEIN,CARRIGAN,HIEN,MCMAHON,+(CARN+BNL)
JOHNSTAD 72 NP B42 588          +MCLLERUD+...+JACOBSEN(BOHR,HELS,OSLO,STOH)IJP
OH       72 PL 42B 497          +FUNG,KERNAN,POE,SCHALK,SHEN          (UCR)IJP

COOPER   74 NP B79 259          COOPER,SEIDL,VANDERVELDE             (MICH)

BRAUN1   75 NP B95 481          +GERBER,MAURER,MICHALCN,SCHIBY+ (STRB,LPNP)I
MUSGRAVE 75 NP B87 365          +PEETERS,SCREINER,WHITMORE,YUTA        (ANL)
STRACHMA 75 NP B98 120          STRACHMAN,BRAUN,GERBER,MAURER+  (LPNP+STRB)I
WEBB     75 PL 55B 331          +TRILLING,TELEGDI+      (AACH+UCLA+UCR+CERN)
    ALSO 75 PL 55B 336          +TRILLING,TELEGDI+      (AACH+UCLA+UCR+CERN)
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N(1670) **D'_{15}**

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                64  N*1/2(1670, JP=5/2-) I=1/2
                THE EXISTENCE OF THIS RESONANCE IS WELL ESTABLISHED.

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                64. N*1/2(1670) MASS (MEV)

M          (1650.0)         APPROX      BRANDSEN  65 RVUE   PHASE-SHIFT ANAL  7/66
M    1     (1680.0)                     BAREYRE   68 RVUE   PHASE-SHIFT ANAL 11/67
M    1           WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M    3     (1678.0)                     DONNACH1  68 RVUE   PHASE-SHIFT ANAL  6/68
M          (1674.0)                     DUKE      68 CNTR   PI-P EL + POL     6/68
M    6     (1675.0)                     AYED      70 IPWA                     1/71
M    6   FRCM ENER. DEP. FIT OF ARGAND DIAGRAM
M    4     (1669.0)                     DAVIES    70 RVUE   P-S ANAL  SOL A   8/69
M    7     (1683.)                      ALMEHED   72 IPWA                     2/72
M          (1660.)                      AYED      74 IPWA                     2/74
M           1652. TO 1687.              CRAWFORD  75 DPWA   PI N PHOTO-PROD   1/76*
M     L     1660. OR 1660.              LONGACRE  75 IPWA   PI N TO 2PI N    11/75*
M     L  THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.   11/75*
M          (1687.)                      BARBCUR   76 DPWA   PI N PHOTO-PROD   1/76*

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                64  N*1/2(1670) WIDTH (MEV)

W    1      (135.0)                     BAREYRE   68 RVUE                    11/67
W    3      (173.0)                     DONNACH1  68 RVUE                     6/68
W    6      (143.0)                     AYED      70 IPWA                     1/71
W    4      (115.0)                     DAVIES    70 RVUE   SOL A AND B       8/69
W    7      (150.)                      ALMEHED   72 IPWA                     2/72
W           (146.)                      AYED      74 IPWA                     2/74
W            165. TO  185.              CRAWFORD  75 OPWA   PI N PHOTO-PRCD   1/76*
W     L      145. OR  150.              LONGACRE  75 IPWA   PI N TO 2PI N    11/75*
W           (172.)                      BARBOUR   76 DPWA   PI N PHOTO-PROD   1/76*
      SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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                64  N*1/2(1670) REAL PART OF POLE PCSITION (MEV)             11/75*

RE         (1663.)                      LONGACRE  75 IPWA   PI N TO 2PI N    11/75*

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                64  N*1/2(1670) 2*IMAG PART CF POLE PCSITICN (MEV)           11/75*

IM         (146.)                       LCNGACRE  75 IPWA   PI N TO 2PI N    11/75*

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                64  N*1/2(1670) PARTIAL DECAY MODES

                                                        DECAY MASSES
P1      N*1/2(1670) INTO PI N                         139+ 938
P2      N*1/2(1670) INTO N ETA                        939+ 548
P3      N*1/2(1670) INTO LAMBCA K                    1115+ 497
P4      N*1/2(1670) INTO N*3/2(1232) PI              1232+ 139
P5      N*1/2(1670) INTO N PI PI                      938+ 139+ 139
P6      N*1/2(1670) INTO GAM P, HELICITY=1/2            0+ 938
P7      N*1/2(1670) INTO GAM P, HELICITY=3/2            0+ 938
P8      N*1/2(1670) INTO GAM N, HELICITY=1/2            0+ 939
P9      N*1/2(1670) INTO GAM N, HELICITY=3/2            0+ 939
P10     N*1/2(1670) INTO SIGMA K                      493+1189
P11     N*1/2(1670) INTO N*3/2(1232) PI,D-WAVE       1232+ 139

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                64  N*1/2(1670) BRANCHING RATIOS

R1      N*1/2(1670) INTO (PI N)/TOTAL                       (P1)
R1   1       (0.41)                     BAREYRE   68 RVUE                    11/67
R1   3       (0.391)                    DCNNACH1  68 RVUE                     6/68
R1   6       (0.392)                    AYED      70 IPWA                     1/71
R1   4       (0.50)                     DAVIES    70 RVUE   P-S ANAL  SOL A   8/69
R1   7       (0.45)                     ALMEHED   72 IPWA                     2/72
R1            (.415)                    AYED      74 IPWA                     2/74
      SEE THE NOTES ACCCMPANYING THE MASSES CUOTED.

R2      N*1/2(1670) INTO (N ETA)/TOTAL                      (P2)
R2           (0.02) OR LESS             TRIPP     67 RVUE                     8/67
R2   B       (0.018)                    BOTKE     69 MPWA   T POLE + RESCN.  10/69
R2   B       (0.006)  (0.004)           DEANS     69 MPWA   T POLE + RESON.   5/70
R2   B       (0.006)OR 0.012            CARRERAS  70 MPWA   T POLE + RESON.   5/70
R2   B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R3      N*1/2(1670) INTO (LAMBDA K)/TOTAL                   (P3)
R3           (0.016)OR LESS             TRIPP     67 RVUE                     8/67
R3   B       (0.001)OR LESS             RUSH      68 MPWA   T POLE + RESON.   8/69
R3   B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING
R3           (0.0028)OR LESS CL=.63     WAGNER    71 IPWA   PI-P TO K LAMB    1/71

R4      N*1/2(1670) INTO (N*3/2(1232) PI)/TOTAL             (P4)
R4 E 12600     0.63       0.1           BRODY     71  HBC   PI-P--2PI N,PWA   6/70
R4 E         ASSUMES ELASTIC BRANCHING RATIO 0.42+-0.04

R5      N*1/2(1670) FROM PI N TO K LAMBDA                   SQRT(P1*P3)       4/75*
R5            -.034     .006            DEVENISH  74        0 FIXED T DISP REL 4/75*

R6      N*1/2(1670) FROM PI N TO ETA N                      SQRT(P1*P2)      11/75*
R6   2       (0.0)OR  (+.009)           FELTESSE  75 DPWA   0 1488 TO 1745 MEV 11/75*
R6   2   USES M AND W OF AYED 74.                                            11/75*

R7      N*1/2(1670) FROM PI N TO K SIGMA                    SQRT(P1*P10)     11/75*
R7   2      LESS THAN .003              DEANS     75 DPWA   PI N TO K SIGMA  11/75*
R7   2   RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                            11/75*
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Data Card Listings

For notation, see key at front of Listings.

Baryons

N(1670), N(1688)

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R8       N*1/2(1670) FROM PI N TO N*3/2(1232) PI,D-WAVE    SQRT(P1*P11)          11/75*
R8   L          (-.45)OR  -.50               LONGACRE  75 IPWA     PI N TO 2PI N     11/75*

   SEE NOTE PRECEDING THE N*1/2(1688) INELASTIC DECAY MODE MEASUREMENTS.

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                  64  N*1/2(1670) PHOTON DECAY AMPL(GEV**-1/2)

      FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
     REVIEW PRECEDING THE BARYON LISTINGS.

A1       N*1/2(1670) INTO GAM P, HELICITY=1/2   (GEV**-1/2)
A1                .027       .030             DEVENISH  73 DPWA     PI N PHOTO PROD    2/74
A1               (.023)                       HEMMI1    73        + FWD PIO PHTOPROD   2/74
A1               +.011       .012             MOORHOUS  73 DPWA     PI N PHOTO-PROD    2/73
A1                .019       .021             DEVENIS2  74 DPWA     PI N PHOTO-PROD    4/75*
A1                .013       .014             KNIES     74 DPWA     PI N PHOTO PROD    2/74
A1               +.010       .013             METCALF   74 DPWA     PI N PHOTO-PROD    2/74
A1                .019       .007             MOORHOUS  74 DPWA     PI N PHOTO-PROD    2/74
A1               +.027       .009             CRAWFORD  75 DPWA     PI N PHOTO-PROD    1/76*
A1              (+.008)                       BARBOUR   76 DPWA     PI N PHOTO-PROD    1/76*
A1              . . . . . . . . . . .
A1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

A2       N*1/2(1670) INTO GAM P, HELICITY=3/2   (GEV**-1/2)
A2                .036       .030             DEVENISH  73 DPWA     PI N PHOTO PROD    2/74
A2               +.021       .020             MOORHOUS  73 DPWA     PI N PHOTO-PROD    2/73
A2                .014       .004             DEVENIS2  74 DPWA     PI N PHOTO-PROD    4/75*
A2                .014       .008             KNIES     74 DPWA     PI N PHOTO PROD    2/74
A2               +.042       .024             METCALF   74 DPWA     PI N PHOTO-PROD    2/74
A2                .016       .002             MOORHOUS  74 DPWA     PI N PHOTO-PROD    2/74
A2               +.015       .006             CRAWFORD  75 DPWA     PI N PHOTO-PROD    1/76*
A2              (+.021)                       BARBOUR   76 DPWA     PI N PHOTO-PROD    1/76*
A2              . . . . . . . . . . .
A2   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

A3       N*1/2(1670) INTO GAM N, HELICITY=1/2   (GEV**-1/2)
A3               -.060       .062             DEVENISH  73 DPWA     PI N PHOTO PROD    2/74
A3               +.010       .040             MOORHOUS  73 DPWA     PI N PHOTO-PROD    2/73
A3               -.029       .023             DEVENIS2  74 DPWA     PI N PHOTO-PROD    4/75*
A3               -.043       .006             KNIES     74 DPWA     PI N PHOTO PROD    2/74
A3                .004       .015             METCALF   74 DPWA     PI N PHOTO-PROD    2/74
A3               -.017       .004             MOORHOUS  74 DPWA     PI N PHOTO-PROD    2/74
A3               -.052       .003             CRAWFORD  75 DPWA     PI N PHOTO-PROD    1/76*
A3              (-.058)                       BARBOUR   76 DPWA     PI N PHOTO-PROD    1/76*
A3              . . . . . . . . . . .
A3   AVERAGE MEANINGLESS (SCALE FACTOR = 4.4)

A4       N*1/2(1670) INTO GAM N, HELICITY=3/2   (GEV**-1/2)
A4               -.072       .022             DEVENISH  73 DPWA     PI N PHOTO PROD    2/74
A4               -.035       .014             MOORHOUS  73 DPWA     PI N PHOTO-PROD    2/73
A4               -.068       .020             DEVENIS2  74 DPWA     PI N PHOTO-PROD    4/75*
A4               -.071       .030             KNIES     74 DPWA     PI N PHOTO PROD    2/74
A4               -.009       .029             METCALF   74 DPWA     PI N PHOTO-PROD    2/74
A4               -.049       .004             MOORHOUS  74 DPWA     PI N PHOTO-PROD    2/74
A4               -.083       .007             CRAWFORD  75 DPWA     PI N PHOTO-PROD    1/76*
A4              (-.080)                       BARBOUR   76 DPWA     PI N PHOTO-PROD    1/76*
A4              . . . . . . . . . . .
A4   AVERAGE MEANINGLESS (SCALE FACTOR = 2.3)


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                                   REFERENCES FOR N*1/2(1670)

BRANDSEN 65 PL 19 420          +ODONNELL, MOORHOUSE          (DURHAM, RHEL)IJP

TRIPP    67 NP B3 10           + LEITH, +       (LRL,SLAC,CERN,HEID,SACLAY)

BAREYRE  68 PR 165 1731        P BAREYRE, C BRICMAN, G VILLET       (SACLAY)IJP
DONNACH1 68 PL 26B 161         A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
   ALSO  68 VIENNA 139         DONNACHIE  RAPPORTEUR.S TALK             (GLAS)
   ALSO  68 THESIS             R G KIRSOPP                              (EDIN)
DUKE     68 PR 166 1448        +JONES,KEMP,MURPHY,THRESHER, +   (RHEL,OXF)IJP
    INSIGHTFUL QUALITATIVE ARGUMENTS CONCERNING EXISTENCE AND IJP.
RUSH     68 PR 173 1776        J E RUSH                         (UNIV ALABAMA)

BOTKE    69 PR 180 1417        J C BOTKE                                (UCSB)
DEANS    69 PR 185 1797        S DEANS, J WOOTEN              (UNIV S FLORIDA)

AYED     70 KIEV CONF          R AYED,P BAREYRE, G VILLET            (SACL)IJP
CARRERAS 70 NP 16B 35          B CARRERAS, A DONNACHIE             (DARE,MCHS)
DAVIES   70 NP B21 359         A DAVIES                                 (GLAS)

BRODY    71 PL 34B 665         +CASHMORE+..+HERNDON+..              (SLAC+LRL)
WAGNER   71 NP B25 411         F WAGNER, C LOVELACE                     (CERN)

ALMEHED  72 NP B40 157         +LOVELACE                          (LUND,RUTG)IJP

DEVENISH 73 PL 47B 53          DEVENISH,RANKIN,LYTH          (LOUC+BONN+LANC)IJP
HEMMI1   73 PL 43B 79          HEMMI,INAGAKI+             (KYOTO+SAGA+KEK+TOKY)IJP
MOORHOUS 73 PL 43B 44          MOORHOUSE, OBERLACK                 (GLAS+LBL)IJP

AYED     74 PRIVATE COMMCTN.   AYED,BAREYRE                            (SACL)IJP
   ALSO  73 AIX CONFERENCE     AYED,BAREYRE                            (SACL)IJP
DEVENISH 74 NP B81 330         DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEVENIS2 74 PL 52B 227         DEVENISH,LYTH,RANKIN          (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680         KNIES,MOORHOUSE,OBERLACK            (LBL,GLAS)IJP
METCALF  74 NP B76 253         W J METCALF,R L WALKER                   (CIT)IJP
MOORHOUS 74 PRD 9 1            MOORHOUSE,OBERLACK,ROSENFELD        (GLAS+LBL)IJP

CRAWFORD 75 NP B97 125         R L CRAWFORD                            (GLAS)IJP
DEANS    75 NP B96 90          +MITCHELL,MONTGOMERY,+          (SFLA,ALABAMA)IJP
FELTESSE 75 NP B93 242         +AYED,BAREYRE,BORGEAUD,DAVID,ERNWEIN+(SACL)IJP
LONGACRE 75 PL 55B 415         +ROSENFELD,LASINSKI,SMADJA+          (LBL,SLAC)IJP

BARBOUR  76 SBMTD. TO NP       I. M. BARBOUR,R. L. CRAWFORD            (GLAS)IJP

                               PAPERS NOT REFERRED TO IN DATA CARDS.

BAREYRE  65 PL 18 342          + BRICMAN, STIRLING, VILLET           (SACLAY)IJP
DUKE     65 PRL 15 468         +JONES,KEMP,MURPHY,PRENTICE, +     (RHEL,OXF)IJP
JOHNSON  67 UCRL-17683 THESIS C H JOHNSON                                (LRL)
DEANS    69 PRL 177 2623       S R DEANS                        (UNIV S FLORIDA)
DONNACHI 69 NP 10B 433         A DONNACHIE, R KIRSOPP              (GLAS+EDIN)
AYED     70 PL 31B 598         +BAREYRE+VILLET                        (SACLAY)
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N(1688)

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65  N*1/2(1688, JP=5/2+) I=1/2   F'15
THE EXISTENCE OF THIS RESONANCE IS WELL ESTABLISHED.


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                  65  N*1/2(1688) MASS (MEV)

M          (1680.0)                      BRANDSEN  65 RVUE    PHASE SHIFT ANAL  7/66
M    1     (1690.0)                      BAREYRE   68 RVUE    PHASE-SHIFT ANAL 11/67
M    1             WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M    3     (1687.0)                      DONNACH1  68 RVUE    PHASE-SHIFT ANAL  6/68
M          (1682.0)                      DUKE      68 CNTR    PI-P EL + POL     6/68
M    6     (1682.0)                      AYED      70 IPWA                      1/71
M    6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M    4     (1685.0)                      DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
M    7     (1688.)                       ALMEHED   72 IPWA                      2/72
M          (1680.)                       AYED      74 IPWA                      2/74
M           1674. TO 1676.               CRAWFORD  75 DPWA    PI N PHOTO-PROD   1/76*
M          (1685.)                       KNASEL    75 DPWA  O PI- P TO KO LAM  11/75*
M     L     1680. OR 1670.               LONGACRE  75 IPWA    PI N TO 2PI N    11/75*
M     L  THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.     11/75*
M          (1680.)                       BARBOUR   76 DPWA    PI N PHOTO-PROD   1/76*

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                  65  N*1/2(1688) WIDTH (MEV)

W    1      (110.0)                      BAREYRE   68 RVUE                     11/67
W    3      (177.0)                      DONNACH1  68 RVUE                      6/68
W    6      (109.0)                      AYED      70 IPWA                      1/71
W    4      (104.0)                      DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
W    7      (140.)                       ALMEHED   72 IPWA                      2/72
W           (126.)                       AYED      74 IPWA                      2/74
W            115. TO  124.               CRAWFORD  75 DPWA    PI N PHOTO-PROD   1/76*
W           (155.)                       KNASEL    75 DPWA  O PI- P TO KO LAM  11/75*
W     L      125. OR  130.               LONGACRE  75 IPWA    PI N TC 2PI N    11/75*
W           (120.)                       BARBOUR   76 DPWA    PI N PHOTO-PROD   1/76*
        SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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                  65  N*1/2(1688) REAL PART OF POLE POSITION (MEV)          11/75*

RE         (1688.)                       LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

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                  65  N*1/2(1688) 2*IMAG PART OF POLE POSITION (MEV)        11/75*

IM          (132.)                       LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

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                  65  N*1/2(1688) PARTIAL DECAY MODES

                                                        DECAY MASSES
P1      N*1/2(1688) INTO PI N                            139+ 938
P2      N*1/2(1688) INTO N ETA                           939+ 548
P3      N*1/2(1688) INTO LAMBDA K                       1115+ 497
P4      N*1/2(1688) INTC N*3/2(1232) PI                 1232+ 139
P5      N*1/2(1688) INTO N PI PI                         938+ 139+ 139
P6      N*1/2(1688) INTO GAM P, HELICITY=1/2               0+ 938
P7      N*1/2(1688) INTO GAM P, HELICITY=3/2               0+ 938
P8      N*1/2(1688) INTO GAM N, HELICITY=1/2               0+ 939
P9      N*1/2(1688) INTO GAM N, HELICITY=3/2               0+ 939
P10     N*1/2(1688) INTO N EPSILON                       938+1200
P11     N*1/2(1688) INTO N RHO                           938+ 773
P12     N*1/2(1688) INTO N*3/2(1232) PI,P-WAVE          1232+ 139
P13     N*1/2(1688) INTO N*3/2(1232) PI,F-WAVE          1232+ 139
P14     N*1/2(1688) INTO N RHO,S=3/2,P-WAVE              938+ 773
P15     N*1/2(1688) INTO SIGMA K                         493+1189

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                  65  N*1/2(1688) BRANCHING RATIOS

R1      N*1/2(1688) INTC (PI N)/TOTAL                         (P1)
R1  1        (0.64)                 BAREYRE   68 RVUE                          11/67
R1  3        (0.560)                DONNACH1  68 RVUE                           6/68
R1  6        (0.593)                AYED      70 IPWA                           1/71
R1  4        (0.54)                 DAVIES    70 RVUE         SOL A AND B       8/69
R1  7        (0.65)                 ALMEHED   72 IPWA                           2/72
R1            (.593)                AYED      74 IPWA                           2/74
        SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

    MORE INFORMATION  ON THE INELASTIC DECAY MODES OF THE 1690 MEV
    BUMP, AS SEEN IN PRODUCTION EXPERIMENTS, MAY BE FOUND BELOW

R2      N*1/2(1688) INTO (N ETA)/TOTAL                        (P2)
R2           (0.015)OR LESS         TRIPP     67 RVUE                           8/67
R2  B        (0.0004)               BOTKE     69 MPWA    T POLE + RESON.       10/69
R2  B        (0.003)  (0.002)       DEANS     69 MPWA    T POLE + RESON.        5/70
R2  B        (0.0005)OR .001        CARRERAS  70 MPWA    T POLE + RESON.        5/70
R2  B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R3      N*1/2(1688) INTO (N ETA)/(PI N)                       (P2)/(P1)
R3           (0.027)OR LESS         HEUSCH    66 RVUE +  PIO, ETA PHOTO         9/66

R4      N*1/2(1688) INTO (LAMBDA K)/TOTAL                     (P3)
R4           (0.0013)OR LESS        TRIPP     67 RVUE                           8/67
R4  B        (0.001)OR LESS         RUSH      68 MPWA    T POLE + RESON.        5/70
R4  B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING
R4           (0.001)OR LESS  CL=.63 WAGNER    71 IPWA    PI-P TO K LAMB         1/71

R5      N*1/2(1688) INTO (N*3/2(1232) PI)/TOTAL               (P4)
R5 E 12600   (0.13)   (0.04)  SOLN.A BRODY     71  HBC    PI-P--2PI N/PWA       6/70
R5 E 12600   (0.39)   (0.10)  SOLN.B BRODY     71  HBC    PI-P--2PI N/PWA       6/70
R5 E        ASSUMES ELASTIC BRANCHING RATIO 0.62+-0.06

R6      N*1/2(1688) FROM PI N TO K LAMBDA                     SQRT(P1*P3)       4/75*
R6            -.009       .009      DEVENISH  74              O FIXED T DISP REL  4/75*
R6            (.01)                 KNASEL    75 DPWA  O PI- P TO KO LAM       11/75*

R7      N*1/2(1688) FROM PI N TO N EPSILON                    SQRT(P1*P10)     11/75*
R7  L        (-.28)OR  -.30         LONGACRE  75 IPWA    PI N TO 2PI N         11/75*

R8      N*1/2(1688) FROM PI N TO N*3/2(1232) PI,P-WAVE    SQRT(P1*P12)         11/75*
R8  L        (+.26)OR  +.25         LONGACRE  75 IPWA    PI N TO 2PI N         11/75*

R9      N*1/2(1688) FROM PI N TO N*3/2(1232) PI,F-WAVE    SQRT(P1*P13)         11/75*
R9  L        (0.) OR  (-.08)        LONGACRE  75 IPWA    PI N TO 2PI N         11/75*
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Baryons

N(1688), N(1700)

Data Card Listings

For notation, see key at front of Listings.

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R10     N*1/2(1688) FROM PI N TC N RHO,S=3/2,P-WAVE       SQRT(P1*P14)        11/75*
R10  L        (+.27)OR  +.30              LONGACRE  75 IPWA     PI N TO 2PI N      11/75*

R11     N*1/2(1688) FRCM PI N TO K SIGMA                  SQRT(P1*P15)        11/75*
R11 2       LESS THAN .001                DEANS      75 DPWA    PI N TO K SIGMA   11/75*
R11 2   RANGE GIVEN IS FROM 3 OF 4 BEST SOLUTIONS, NOT PRESENT IN SLTN.1.         11/75*
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                    65  N*1/2(1688) PHOTCN DECAY AMPL(GEV**-1/2)

         FCR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
         REVIEW PRECEDING THE BARYCN LISTINGS.

A1      N*1/2(1688) INTO GAM P, HELICITY=1/2  (GEV**-1/2)
A1            .015        .023        DEVENISH  73 DPWA     PI N PHOTO PROD    2/74
A1          (-.003)                   HEMMI1    73        + FWD PIO PHTOPRCD   2/74
A1           -.008        .004        MOORHOUS  73 DPWA     PI N PHOTO-PROD    2/73
A1            .027        .019        DEVENIS2  74 DPWA     PI N PHOTO-PROD    4/75*
A1           -.016        .014        KNIES     74 DPWA     PI N PHOTO PRCD    2/74
A1           -.008        .011        METCALF   74 DPWA     PI N PHOTO-PRCD    2/74
A1           -.014        .003        MOORHOUS  74 DPWA     PI N PHOTO-PROD    2/74
A1           -.013        .002        CRAWFORD  75 DPWA     PI N PHOTO-PRCD    1/76*
A1          (-.004)                   BARBOUR   76 DPWA     PI N PHOTO-PROD    1/76*
A1             . . . . . . . .
A1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

A2      N*1/2(1688) INTO GAM P, HELICITY=3/2  (GEV**-1/2)
A2            .146        .031        DEVENISH  73 DPWA     PI N PHOTO PROD    2/74
A2           +.100        .012        MOORHOUS  73 DPWA     PI N PHOTO-PRCD    2/73
A2            .163        .011        DEVENIS2  74 DPWA     PI N PHOTO-PROD    4/75*
A2            .097        .007        KNIES     74 DPWA     PI N PHOTO PROD    2/74
A2            .129        .016        METCALF   74 DPWA     PI N PHOTO-PRCD    2/74
A2            .147        .006        MOORHOUS  74 DPWA     PI N PHOTO-PROD    2/74
A2           +.135        .006        CRAWFORD  75 DPWA     PI N PHOTO-PROD    1/76*
A2          (+.132)                   BARBOUR   76 DPWA     PI N PHOTO-PRCD    1/76*
A2             . . . . . . . .
A2   AVERAGE MEANINGLESS (SCALE FACTOR = 3.0)

A3      N*1/2(1688) INTO GAM N, HELICITY=1/2  (GEV**-1/2)
A3            .035        .049        DEVENISH  73 DPWA     PI N PHOTC PROD    2/74
A3           +.017        .014        MOORHCUS  73 DPWA     PI N PHOTO-PRCD    2/73
A3            .031        .028        DEVENIS2  74 DPWA     PI N PHOTO-PROD    4/75*
A3            .023        .005        KNIES     74 DPWA     PI N PHOTC PRCD    2/74
A3            .008        .018        METCALF   74 DPWA     PI N PHOTO-PROD    2/74
A3            .023        .003        MOORHCUS  74 DPWA     PI N PHOTC-PROD    2/74
A3           +.021        .001        CRAWFORD  75 DPWA     PI N PHOTC-PRCD    1/76*
A3          (+.034)                   BARBOUR   76 DPWA     PI N PHOTO-PRCD    1/76*
A3             . . . . . . . .
A3   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

A4      N*1/2(1688) INTO GAM N, HELICITY=3/2  (GEV**-1/2)
A4           -.018        .039        DEVENISH  73 DPWA     PI N PHOTO PROD    2/74
A4           -.005        .018        MOCRHOUS  73 DPWA     PI N PHOTO-PROD    2/73
A4           -.021        .028        DEVENIS2  74 DPWA     PI N PHOTO-PROD    4/75*
A4            .001        .018        KNIES     74 DPWA     PI N PHOTO PROD    2/74
A4            .00         .030        METCALF   74 DPWA     PI N PHOTO-PRCD    2/74
A4           -.041        .004        MOORHOUS  74 DPWA     PI N PHOTO-PROD    2/74
A4           -.015        .004        CRAWFORD  75 DPWA     PI N PHOTO-PRCD    1/76*
A4          (-.028)                   BARBOUR   76 DPWA     PI N PHOTO-PROD    1/76*
A4             . . . . . . . .
A4   AVERAGE MEANINGLESS (SCALE FACTOR = 2.9)
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                         REFERENCES FOR N*1/2(1688)

         SEE A PREVIOLS EDITICN (RMP 37, 633, 1965) FOR EARLIER REFERENCES.
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BRANDSEN 65 PL 19 420            +ODONNELL, MCORHOUSE          (DURHAM, RHEL)IJP
HEUSCH   66 PRL 17 1019          C A HEUSCH, C Y PRESCOTT, R F DASHEN  (CIT)
TRIPP    67 NP B3 10             + LEITH, +          (LRL,SLAC,CERN,HEID,SACLAY)

BAREYRE  68 PR 165 1731          P BAREYRE, C BRICMAN, G VILLET     (SACLAY)IJP
DCNNACHI 68 PL 26B 161           A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
   ALSO  68 VIENNA 139           DCNNACHIE  RAPPORTEUR.S TALK         (GLAS)
   ALSO  68 THESIS               R G KIRSOPP                          (EDIN)
DUKE     68 PR 166 1448          +JCNES,KEMP,MURPHY,THRESHER, +  (RHEL,OXF)IJP
RUSH     68 PR 173 1776          J E RUSH                     (UNIV ALABAMA)

BOTKE    69 PR 180 1417          J C BOTKE                            (UCSB)
DEANS    69 PR 185 1797          S DEANS, J WOOTEN           (UNIV S FLORIDA)

AYED     70 KIEV CONF            R AYED,P BAREYRE, G VILLET         (SACL)IJP
CARRERAS 70 NP 16B 35            B CARRERAS, A DONNACHIE        (DARE,MCHS)
DAVIES   70 NP B21 359           A DAVIES                             (GLAS)

BRODY    71 PL 34B 253           +CASHMORE+..+HERNDON+..         (SLAC+LRL)
WAGNER   71 NP B25 411           F WAGNER, C LOVELACE                 (CERN)

ALMEHED  72 NP B40 157           +LOVELACE                      (LUND,RUTG)IJP
DEVENISH 73 PL 47B 53            DEVENISH,RANKIN,LYTH       (LOUC+BONN+LANC)IJP
HEMMI1   73 PL 43B 79            HEMMI,INAGAKI+       (KYOTO+SAGA+KEK+TOKY)IJP
MOORHOUS 73 PL 43B 44            MOORHOUSE, OBERLACK            (GLAS+LBL)IJP

AYED     74 PRIVATE COMMCTN.     AYED,BAREYRE                       (SACL)IJP
   ALSO  73 AIX CONFERENCE       AYED,BAREYRE                       (SACL)IJP
DEVENISH 74 NP B81 330           DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEVENIS2 74 PL 52B 227           DEVENISH,LYTH,RANKIN       (DESY,LANC,BCNN)IJP
KNIES    74 PRD 9 2680           KNIES,MOORHOUSE,OBERLACK       (LBL,GLAS)IJP
METCALF  74 NP B76 253           W J METCALF,R L WALKER              (CIT)IJP
MOORHOUS 74 PRD 9 1              MCORHOUSE,OBERLACK,ROSENFELD  (GLAS+LBL)IJP

CRAWFORD 75 NP B57 125           R L CRAWFORD                       (GLAS)IJP
DEANS    75 NP B96 90            +MITCHELL,MONTGOMERY,+     (SFLA,ALABAMA)IJP
KNASEL   75 PRD 11 1             +LINDQUIST,NELSON+     (CHIC,WUSL,OSU,ANL)IJP
LONGACRE 75 PL 55B 415           +ROSENFELD,LASINSKI,SMADJA+     (LBL,SLAC)IJP

BARBOUR  76 SBMTD. TO NP         I. M. BARBOUR,R. L. CRAWFORD       (GLAS)IJP

                         PAPERS NOT REFERRED TO IN DATA CARDS.

CROUCH   65 DESY CONF II 21      +   (BROWN,CEA,HARVARD,MIT,PADOVA,WEIZMANN)
DERADO   65 ATHENS CONF 244      +KENNEY,LAMSA, +       (NOTRE DAME,KENTUCKY)
DUKE     65 PRL 15 468           +JONES,KEMP,MURPHY,PRENTICE, +  (RHEL,OXF)IJP
MERLO    66 P ROY SOC 289 489    J P MERLO, G VALLADAS              (SACLAY)
ROBERTS  67 PREPRINT             R G ROBERTS                        (DURHAM)
BANNER   68 PR 166 1347          +DETOEUF,FAYOUX,HAMEL, +      (SACLAY,CAEN)
   THE ABOVE PAPERS DISCUSS INELASTIC CHANNELS NEAR THE BUMP.
BAREYRE  65 PL 18 342            + BRICMAN, STIRLING, VILLET       (SACLAY)IJP
DEANS    69 PRL 177 2623         S R DEANS                   (UNIV S FLORIDA)
DONNACHI 69 NP 10B 433           A DONNACHIE, R KIRSOPP          (GLAS+EDIN)
AYED     70 PL 31B 598           +BAREYRE+VILLET                    (SACLAY)
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N(1700) 66 N*1/2(1700, JP=1/2-) I=1/2 **S''_{11}**

THE EXISTENCE OF THIS RESCNANCE IS WELL ESTABLISHED.

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                    66  N*1/2(1700) MASS (MEV)

M          (1695.0)                    BRANDSEN  65 RVUE    PHASE-SHIFT ANAL  9/66
M          (1700.0)                    MICHAEL   66 RVUE    FITS BAREYRE S11  7/66
M   1      (1710.0)                    BAREYRE   68 RVUE    PHASE-SHIFT ANAL 11/67
M   1           WHEPE CROSS SECTION IS GREATEST - EYEBALL FIT
M   3      (1710.0)                    DCNNACH1  68 RVUE    PHASE-SHIFT ANAL  8/68
M          (1705.0)     (10.0)         ORITO     69 RVUE    K LAMBDA PS ANAL  8/69
M   6      (1689.0)                    AYED      70 IPWA                      1/71
M   6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M   4      (1766.0)                    DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
M          (1678.0)                    SCHORSCH  70 DPWA    K LAM PHOTOPRC.  10/71
M   A      (1685.0)                    WAGNER    71 IPWA    PI-P TO K LAMB    1/71
M   A   THERE ARE 3 SIMILAR SCLUTICNS
M   7      (1670.)                     ALMEHED   72 IPWA                      2/72
M   2      (1699.)                     HICKS     73 MPWA    GAM P-ETA P       9/73
M   2   ONLY STATES FROM TABLE VII OF HICKS73 ARE INCLUDED IN LISTINGS.       9/73
M   2   M AND W ARE FROM SOLUTION C2,BR=SQRT(G)/W WITH G FROM TABLE VII.      9/73
M   1      (1860.)                     LANGBEIN  73 IPWA    PI N-K SIG,SOL 2  9/73
M   1   S11 AMPLITUDE LARGE BUT NOT RESONANT IN SOLUTION 1 OF LANGBEIN73      9/73
M          (1672.)                     AYED      74 IPWA                      2/74
M          (1675.)                     KNASEL    75 DPWA  O PI- P TO KO LAM  11/75*
M   L       1675. OR 1660.             LCNGACRE  75 IPWA    PI N TC 2PI N    11/75*
M   L   THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.    11/75*
M          (1676.)                     BARBOUR   76 DPWA    PI N PHOTO-PRCD   1/76*
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                    66  N*1/2(1700) WIDTH (MEV)

W          (240.0)                     MICHAEL   66 RVUE                      7/66
W   1      (260.0)                     BAREYRE   68 RVUE                     11/67
W   3      (300.0)                     DCNNACH1  68 RVUE                      8/69
W          (104.0)     (15.0)          ORITO     69 RVUE                      8/69
W   6      (166.0)                     AYED      70 IPWA                      1/71
W   4      (404.0)                     DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
W   4   SOL B GIVES 121 MEV                                                   2/73
W           (99.0)                     SCHORSCH  70 DPWA    K LAM PHOTOPRO.  10/71
W   A      (110.0)OR(140.0)            WAGNER    71 IPWA    PI-P TO K LAMB    1/71
W   7      (120.)                      ALMEHED   72 IPWA                      2/72
W   2      (195.)                      HICKS     73 MPWA    GAM P-ETA P       9/73
W   1      (200.)                      LANGBEIN  73 IPWA    PI N-K SIG,SOL 2  9/73
W          (179.)                      AYED      74 IPWA                      2/74
W          (170.)                      KNASEL    75 DPWA  O PI- P TO KO LAM  11/75*
W   L       150. OR  130.              LONGACRE  75 IPWA    PI N TO 2PI N    11/75*
W          (194.)                      BARBOUR   76 DPWA    PI N PHOTO-PROD   1/76*
    SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.
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                    66  N*1/2(1700) REAL PART OF PCLE POSITION (MEV)         11/75*

RE         (1648.)                     LONGACRE  75 IPWA    PI N TO 2PI N    11/75*
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                    66  N*1/2(1700) 2*IMAG PART OF POLE POSITION (MEV)       11/75*

IM         (117.)                      LONGACRE  75 IPWA    PI N TO 2PI N    11/75*
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                    66  N*1/2(1700) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      N*1/2(1700) INTO PI N                                 139+ 938
P2      N*1/2(1700) INTC N ETA                                939+ 548
P3      N*1/2(1700) INTO LAMBDA K                            1115+ 497
P4      N*1/2(1700) INTO GAM P, HELICITY=1/2                    0+ 938
P5      N*1/2(1700) INTO GAM N, HELICITY=1/2                    0+ 939
P6      N*1/2(1700) INTC N PI PI                              938+ 139+ 139
P7      N*1/2(1700) INTO N EPSILON                            938+1200
P8      N*1/2(1700) INTC N RHC                                938+ 773
P9      N*1/2(1700) INTO K SIGMA                              493+1189
P10     N*1/2(1700) INTC N RHO,S=1/2,S-WAVE                   938+ 773
P11     N*1/2(1700) INTO N*3/2(1232) PI                      1232+ 139
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                    66  N*1/2(1700) BRANCHING RATIOS

R1      N*1/2(1700) INTO (PI N)/TOTAL                       (P1)
R1          (1.0)          APPROX       MICHAEL   66 RVUE                     7/66
R1  3       (0.79)                      DCNNACH1  68 RVUE                     8/69
R1  6       (0.642)                     AYED      70 IPWA                     1/71
R1  4       (0.56)                      DAVIES    70 RVUE    P-S ANAL  SOL A  8/69
R1  7       (0.5)                       ALMEHED   72 IPWA                     2/72
R1           (.586)                     AYED      74 IPWA                     2/74

R2      N*1/2(1700) FROM PI N TO K LAMBDA                   SQRT(P1*P3)       4/75*
R2           (.20)      (.05)           ORITO     69 RVUE                     4/75*
R2  A        (.21)OR .23                WAGNER    71 IPWA     PI- P TO K LAMB 4/75*
R2           -.179       .033           DEVENISH  74        O FIXED T DISP REL 4/75*
R2           (.12)                      KNASEL    75 DPWA  O PI- P TO KO LAM 11/75*

R3      N*1/2(1700) INTO (LAMBCA K)/TOTAL                   (P3)
R3  B       (0.028)       APPROX.       RUSH      68 MPWA     T POLE + RESON.  8/69
R3  B   PARAMETRIZATION USED COULD BE IN CANGER OF DOUBLE COUNTING

R4      N*1/2(1700) INTC (N ETA)/TCTAL                      (P2)
R4  B       (0.013)                     BOTKE     69 MPWA     T POLE + RESON. 10/69
R4  B       (0.03)     (0.02)           DEANS     69 MPWA     T FOLE + RESON.  8/69
R4  C       (0.19) OR 0.27              CARRERAS  70 MPWA     T POLE + RESON.  5/70
R4  B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING
R4  C   CARRERAS 70 USES REGGE POLES + RESONANCES. VALUES SUSPICIOUSLY LARG

R5      N*1/2(1700) FROM GAMMA PROTON TO K LAMBDA           SQRT(P3*P4)       9/73
R5          (0.002)OR LESS              ORITO2    69 CNTR     K LAM PHOTOPRO 10/71
R5          (0.0072)                    SCHORSCH  70 DPWA     K LAM PHOTOPRO. 10/71
R5          (.0060)                     DEANS     72 MPWA     GAM P-K LM,SOL D 9/73

R6      N*1/2(1700) FROM GAMMA PRCTON TO ETA PROTON         SQRT(P2*P4)       9/73
R6  2       (.0101)                     HICKS     73 MPWA     GAM P-ETA P      9/73
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Data Card Listings

For notation, see key at front of Listings.

Baryons

N(1700)

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R7      N*1/2(1700) FROM PI N TO K SIGMA                     SQRT(P1*P9)            9/73
R7   1          (.11)                  LANGBEIN  73 IPWA     PI N-K SIG,SOL 2   9/73
R7  5          (.066)TO  .137          DEANS     75 DPWA     PI N TO K SIGMA   11/75*
R7  5    RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                                11/75*
R7              (.20)                  KNASEL    75 DPWA   0 PI- P TO KO LAM   11/75*

R8      N*1/2(1700) FROM PI N TO N*3/2(1232) PI               SQRT(P1*P11)        11/75*
R8   L        (-.16)OR  -.15           LONGACRE  75 IPWA     PI N TO 2PI N     11/75*

R9      N*1/2(1700) FROM PI N TO N RHO,S=1/2,S-WAVE          SQRT(P1*P10)        11/75*
R9   L        (.23)OR  +.16            LONGACRE  75 IPWA     PI N TO 2PI N     11/75*

R10     N*1/2(1700) FROM PI N TO N EPSILON                   SQRT(P1*P7)         11/75*
R10  L        (-.23)OR  -.25           LONGACRE  75 IPWA     PI N TO 2PI N     11/75*

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                    66  N*1/2(1700) PHOTON DECAY AMPL(GEV**-1/2)

      FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
    REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*1/2(1700) INTO GAM P, HELICITY=1/2 (GEV**-1/2)
A1             .024       .033          DEVENISH  73 DPWA     PI N PHOTO PROD    2/74
A1            +.066       .042          MOORHOUS  73 DPWA     PI N PHOTO-PROD    2/73
A1             .029       .018          DEVENIS2  74 DPWA     PI N PHOTO-PROD    4/75*
A1             .058       .018          KNIES     74 DPWA     PI N PHOTO PROD    2/74
A1            +.012       .015          METCALF   74 DPWA     PI N PHOTO-PROD    2/74
A1             .054       .005          MOORHOUS  74 DPWA     PI N PHOTO-PROD    2/74
A1            +.044       .018          CRAWFORD  75 DPWA     PI N PHOTO-PROD    1/76*
A1           (+.044)                    BARBOUR   76 DPWA     PI N PHOTO-PROD    1/76*
A1           . . . . . . . . . .
A1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.4)

A2      N*1/2(1700) INTO GAM N, HELICITY=1/2 (GEV**-1/2)
A2             .010       .043          DEVENISH  73 DPWA     PI N PHOTO PROD    2/74
A2            -.072       .066          MOORHOUS  73 DPWA     PI N PHOTO-PROD    2/73
A2            -.006       .031          DEVENIS2  74 DPWA     PI N PHOTO-PROD    4/75*
A2            -.015       .035          KNIES     74 DPWA     PI N PHOTO PROD    2/74
A2            -.019       .022          METCALF   74 DPWA     PI N PHOTO-PROD    2/74
A2            -.027       .009          MOORHOUS  74 DPWA     PI N PHOTO-PROD    2/74
A2            -.103       .010          CRAWFORD  75 DPWA     PI N PHOTO-PROD    1/76*
A2           (-.022)                    BARBOUR   76 DPWA     PI N PHOTO-PROD    1/76*
A2           . . . . . . . . . .
A2   AVERAGE MEANINGLESS (SCALE FACTOR = 2.9)

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REFERENCES FOR N*1/2(1700)


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BRANDSEN 65 PL 19 420           +ODONNELL, MOORHOUSE             (DURHAM, RHEL)IJP

MICHAEL  66 PL 21 93            C MICHAEL                                   (OXF)

BAREYRE  68 PR 165 1731         P BAREYRE, C BRICMAN, G VILLET        (SACLAY)IJP
DONNACH1 68 PL 26B 161          A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
   ALSO  68 VIENNA 139          DONNACHIE  RAPPORTEUR.S TALK              (GLAS)
   ALSO  68 THESIS              R G KIRSOPP                               (EDIN)
RUSH     68 PR 173 1776         J E RUSH                          (UNIV ALABAMA)

BOTKE    69 PR 180 1417         J C BOTKE                                 (UCSB)
DEANS    69 PR 185 1797         S DEANS, J WOOTEN              (UNIV S FLORIDA)
ORITO    69 LNC 1 936           S ORITO,S SASAKI                  (TOKYO-OSAKA)
ORITO2   69 INS J 113           S ORITO (THESIS)                        (TOKYO)

AYED     70 KIEV CONF           R AYED,P BAREYRE, G VILLET             (SACL)IJP
CARRERAS 70 NP 16B 35           B CARRERAS, A DONNACHIE             (DARE,MCHS)
DAVIES   70 NP B21 359          A DAVIES                                  (GLAS)
SCHORSCH 70 NP  B25 179         +TIETGE,WEILNBOECK                        (MPIM)

WAGNER   71 NP B25 411          F WAGNER, C LOVELACE                      (CERN)

ALMEHED  72 NP B40 157          +LOVELACE                          (LUND,RUTG)IJP
DEANS    72 PRD 6 1906          DEANS,JACOBS, LYONS,MONTGOMERY (SOUTH FLA.)IJP
DEVENISH 73 PL 47B 53           DEVENISH,RANKIN,LYTH          (LOUC+BONN+LANC)IJP
HICKS    73 PRD 7 2614          +DEANS,JACOBS,LYONS+ (CARN+ORNL+SOUTH FLA.)IJP
LANGBEIN 73 NP B53 251          LANGBEIN,WAGNER                        (MUNICH)IJP
MOORHOUS 73 PL 43B 44           MOORHOUSE, OBERLACK                  (GLAS+LBL)IJP

AYED     74 PRIVATE COMMCTN.    AYED,BAREYRE                             (SACL)IJP
   ALSO  73 AIX CONFERENCE      AYED,BAREYRE                             (SACL)IJP
DEVENISH 74 NP B81 330          DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEVENIS2 74 PL 52B 227          DEVENISH,LYTH,RANKIN          (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680          KNIES,MOORHOUSE,OBERLACK            (LBL,GLAS)IJP
METCALF  74 NP B76 253          W J METCALF,R L WALKER                   (CIT)IJP
MOORHOUS 74 PRD 9 1             MOORHOUSE,OBERLACK,ROSENFELD         (GLAS+LBL)IJP

CRAWFORD 75 NP B97 125          R L CRAWFORD                             (GLAS)IJP
DEANS    75 NP B96 90           +MITCHELL,MONTGOMERY,+           (SFLA,ALABAMA)IJP
KNASEL   75 PRD 11 1            +LINDQUIST,NELSON+          (CHIC,WUSL,OSU,ANL)IJP
LONGACRE 75 PL 55B 415          +ROSENFELD,LASINSKI,SMADJA+         (LBL,SLAC)IJP

BARBOUR  76 SBMTD. TO NP        I. M. BARBOUR,R. L. CRAWFORD             (GLAS)IJP

                                PAPERS NOT REFERRED TO IN DATA CARDS.

BAREYRE  65 PL 18 342           + BRICMAN, STIRLING, VILLET            (SACLAY)IJP
JOHNSON  67 UCRL-17683 THESIS C H JOHNSON                                  (LRL)
DEANS    69 PR  177 2623        S R DEANS                       (UNIV S FLORIDA)
DONNACHI 69 NP 10B 433          A DONNACHIE, R KIRSOPP              (GLAS+EDIN)
AYED     70 PL 31B 598          +BAREYRE+VILLET                         (SACLAY)
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N(1700) **D″13**

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          18  N*1/2(1700, JP=3/2-) I=1/2

          AYED 74 AND LONGACRE 75 BOTH FIND EVIDENCE FOR
          THIS STATE.  THERE IS ADDITIONAL EVIDENCE FROM
          PHOTOPRODUCTION AND ASSOCIATED PRODUCTION.

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                    18  N*1/2(1700) MASS  (MEV)

M   3     (1730.)                       DONNACH2  68 RVUE    PHAS.SHIFT-CERN1 10/69
M   3     (1680.)                       KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
M   3   WHERE MAX. ABSORPTION IS -DONNACH1, 2 ,KIRSOPP EYEBALL FIT CERN 1    10/69
M   A     (1780.0)                      WAGNER    71 IPWA    PI-P TO K LAMB    1/71
M   A  D13 RESONATES ONLY IN ONE OUT OF 3 POSSIBLE SOL.
M         (1670.)                       DEANS     72 MPWA    GAM P-K LM,SOL D  9/73
M   1     (1790.)                       LANGBEIN  73 IPWA    PI N-K SIG,SOL 1  9/73
M   1  NOT SEEN IN SOLUTION 2 OF LANGBEIN73                                    9/73
M         (1710.)                       AYED      74 IPWA                      2/74
M   L      1710. OR 1710.               LONGACRE  75 IPWA    PI N TO 2PI N    11/75*
M   L  THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.       11/75*

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                    18  N*1/2(1700) WIDTH (MEV)

W          (90.)                        DEANS     72 MPWA    GAM P-K LM,SOL D  9/73
W   1     (120.)                        LANGBEIN  73 IPWA    PI N-K SIG,SOL 1  9/73
W         (100.)                        AYED      74 IPWA                      2/74
W   L      100. OR  300.                LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

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                    18  N*1/2(1700) REAL PART OF POLE POSITION (MEV)          11/75*

RE        (1710.)                       LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

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                    18  N*1/2(1700) 2*IMAG PART OF POLE POSITION (MEV)        11/75*

IM        (607.)                        LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

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                    18  N*1/2(1700) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      N*1/2(1700) INTO PI N                                139+ 938
P2      N*1/2(1700) INTO LAMBDA K                           1115+ 497
P3      N*1/2(1700) INTO GAM P,HELICITY=3/2                    0+ 938
P4      N*1/2(1700) INTO GAM P,HELICITY=1/2                    0+ 938
P5      N*1/2(1700) INTO GAM N,HELICITY=3/2                    0+ 939
P6      N*1/2(1700) INTO GAM N,HELICITY=1/2                    0+ 939
P7      N*1/2(1700) INTO K SIGMA                             493+1189
P8      N*1/2(1700) INTO N EPSILON                           938+1200
P9      N*1/2(1700) INTO N*3/2(1232) PI,S-WAVE              1232+ 139
P10     N*1/2(1700) INTO N*3/2(1232) PI,D-WAVE              1232+ 139
P11     N*1/2(1700) INTO N RHO,S=3/2,S-WAVE                  938+ 773

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                    18  N*1/2(1700) BRANCHING RATIOS

R1      N*1/2(1700) FROM GAMMA PROTON TO K LAMBDA         SQRT((P3+P4)*P2)      9/73
R1            (.0077)                   DEANS     72 MPWA    GAM P-K LM,SOL D  9/73

R2      N*1/2(1700) FROM PI N TO K SIGMA                  SQRT(P1*P7)           9/73
R2   1          (.10)                   LANGBEIN  73 IPWA    PI N-K SIG,SOL 1  9/73
R2   2       LESS THAN .017             DEANS     75 DPWA    PI N TO K SIGMA  11/75*
R2   2  RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                              11/75*

R3      N*1/2(1700) INTO PI N/TOTAL                       (P1)
R3            (.089)                    AYED      74 IPWA                      2/74

R4      N*1/2(1700) FROM PI N TO K LAMBDA                 SQRT(P1*P2)          4/75*
R4            +.026      .019           DEVENISH  74        0 FIXED T DISP REL 4/75*

R5      N*1/2(1700) FROM PI N TO N EPSILON                SQRT(P1*P8)         11/75*
R5   L        (-.2) OR  -.2             LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

R6      N*1/2(1700) FROM PI N TO N*3/2(1232) PI,S-WAVE    SQRT(P1*P9)         11/75*
R6   L        (+.15)OR  +.16            LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

R7      N*1/2(1700) FROM PI N TO N*3/2(1232) PI,D-WAVE    SQRT(P1*P10)        11/75*
R7   L        (-.10)OR  -.14            LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

R8      N*1/2(1700) FROM PI N TO N RHO,S=3/2,S-WAVE       SQRT(P1*P11)        11/75*
R8   L        (0.) OR  (-.07)           LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

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                    18  N*1/2(1700) PHOTON DECAY AMPL(GEV**-1/2)

      FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
    REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*1/2(1700) INTO GAM P, HELICITY=1/2  (GEV**-1/2)
A1            -.103      .130           DEVENISH  73 DPWA    PI N PHOTO PROD   2/74
A1            -.048      .050           DEVENIS2  74 DPWA    PI N PHOTO-PROD   4/75*
A1            -.015      .040           KNIES     74 DPWA    PI N PHOTO PROD   2/74
A1             .0        .034           METCALF   74 DPWA    PI N PHOTO-PROD   2/74
A1            (.023)                    MOORHOUS  74 DPWA    PI N PHOTO PROD   2/74
A1            -.012      .010           CRAWFORD  75 DPWA    PI N PHOTO-PROD   1/76*
A1           (-.005)                    BARBOUR   76 DPWA    PI N PHOTO-PROD   1/76*
A1           . . . . . . . . . .
A1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

A2      N*1/2(1700) INTO GAM P, HELICITY=3/2  (GEV**-1/2)
A2             .055      .065           DEVENISH  73 DPWA    PI N PHOTO PROD   2/74
A2            -.006      .014           DEVENIS2  74 DPWA    PI N PHOTO-PROD   4/75*
A2             .030      .040           KNIES     74 DPWA    PI N PHOTO PROD   2/74
A2             .0        .029           METCALF   74 DPWA    PI N PHOTO-PROD   2/74
A2            (.035)                    MOORHOUS  74 DPWA    PI N PHOTO PROD   2/74
A2            -.012      .010           CRAWFORD  75 DPWA    PI N PHOTO-PROD   1/76*
A2           (-.009)                    BARBOUR   76 DPWA    PI N PHOTO-PROD   1/76*
A2           . . . . . . . . . .
A2   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

A3      N*1/2(1700) INTO GAM N, HELICITY=1/2  (GEV**-1/2)
A3             .013      .222           DEVENISH  73 DPWA    PI N PHOTO PROD   2/74
A3            -.021      .058           DEVENIS2  74 DPWA    PI N PHOTO-PROD   4/75*
A3            -.036      .040           KNIES     74 DPWA    PI N PHOTO PROD   2/74
A3             .0        .034           METCALF   74 DPWA    PI N PHOTO-PROD   2/74
A3           (-.015)                    MOORHOUS  74 DPWA    PI N PHOTO PROD   2/74
A3            +.081      .015           CRAWFORD  75 DPWA    PI N PHOTO-PROD   1/76*
A3           (+.017)                    BARBOUR   76 DPWA    PI N PHOTO-PROD   1/76*
A3           . . . . . . . . . .
A3   AVERAGE MEANINGLESS (SCALE FACTOR = 2.3)

A4      N*1/2(1700) INTO GAM N, HELICITY=3/2  (GEV**-1/2)
A4            -.088      .087           DEVENISH  73 DPWA    PI N PHOTO PROD   2/74
A4            -.026      .067           DEVENIS2  74 DPWA    PI N PHOTO-PROD   4/75*
A4             .024      .024           KNIES     74 DPWA    PI N PHOTO PROD   2/74
A4             .0        .044           METCALF   74 DPWA    PI N PHOTO-PROD   2/74
A4            (.028)                    MOORHOUS  74 DPWA    PI N PHOTO PROD   2/74
A4            +.107      .025           CRAWFORD  75 DPWA    PI N PHOTO-PROD   1/76*
A4           (+.022)                    BARBOUR   76 DPWA    PI N PHOTO-PROD   1/76*
A4           . . . . . . . . . .
A4   AVERAGE MEANINGLESS (SCALE FACTOR = 1.7)

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Baryons
N(1700)

Data Card Listings
For notation, see key at front of Listings.


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                                  REFERENCES FOR N*1/2(1700)

DONNACH2 68 VIENNA 139            DONNACHIE  RAPPORTEUR.S TALK          (GLAS)
KIRSOPP  68 THESIS                R G KIRSOPP                           (EDIN)
WAGNER   71 NP B25 411            F WAGNER, C LOVELACE                  (CERN)
DEANS    72 PRD 6 1906            DEANS,JACOBS, LYONS,MONTGOMERY (SOUTH FLA.)IJP
DEVENISH 73 PL 47B 53             DEVENISH,RANKIN,LYTH       (LOUC+BONN+LANC)IJP
LANGBEIN 73 NP B53 251            LANGBEIN,WAGNER                     (MUNICH)IJP

AYED     74 PRIVATE COMMCTN.      AYED,BAREYRE                          (SACL)IJP
    ALSO 73 AIX CONFERENCE        AYED,BAREYRE                          (SACL)IJP
DEVENISH 74 NP B81 330            DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEVENIS2 74 PL 52B 227            DEVENISH,LYTH,RANKIN       (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680            KNIES,MOORHOUSE,OBERLACK         (LBL,GLAS)IJP
METCALF  74 NP B76 253            W J METCALF,R L WALKER                 (CIT)IJP
MOORHOUS 74 PRD 9 1               MOORHOUSE,OBERLACK,ROSENFELD     (GLAS+LBL)IJP

CRAWFORD 75 NP B97 125            R L CRAWFORD                          (GLAS)IJP
DEANS    75 NP B96 90             +MITCHELL,MONTGOMERY,+        (SFLA,ALABAMA)IJP
LONGACRE 75 PL 55B 415            +ROSENFELD,LASINSKI,SMADJA+      (LBL,SLAC)IJP

BARBOUR  76 SBMTD. TO NP          I. M. BARBOUR,R. L. CRAWFORD          (GLAS)IJP

                                  PAPERS NOT REFERRED TO IN DATA CARDS.

HERNDON  72 LBL 1065              +...ROSENFELD...+CASHMORE+...     (LBL,SLAC)
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1700 MEV REGION – PRODUCTION EXPERIMENTS

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                       20  N*1/2(1700, JP=    ) I=1/2   PRODUCTION EXPERIMENTS

                       PARTIAL WAVE ANALYSIS REQUIRES AT LEAST FOUR I=1/2 STAT
                       IN THE 1670 TO 1780 REGION (D15, F15, S11, P11) AND AT
                       LEAST ONE I=3/2 STATE (D33).  OBVIOUSLY, DIFFERENT EXPE
                       IMENTS ARE SEEING DIFFERENT STATES AND OFTEN IT IS NOT
     CLEAR WHAT ISOSPIN STATE IS BEING OBSERVED.  NO EFFORT WAS MADE
     TO SEPARATE THESE EXPERIMENTS ACCORDING TO JP, SINCE NONE OF THE
     REPORTED JP IS FIRMLY ESTABLISHED.  WE LIST ALL THE INFORMATION HERE,
     BUT WE HAVE NOT USED IT IN THE BARYON TABLE.
        FOR SPIN-PARITY ANALYSIS OF THIS MASS REGION, SEE JOHNSTAD 72 AND
     LAMSA 72.  SEE LEDNICKY 75 FOR A SPIN-PARITY ANALYSIS OF P+OMEGA
     PRODUCTION NEAR 1800 MEV.

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                       20  N*1/2(1700) MASS (MEV) (PROD. EXP.)

M         (1695.0)    (9.0)              A-BORELLI 67 HBC  +  PBAR P 5.7 BEV/C  8/67
M         (1734.0)   (21.0)              ALMEIDA   68 HBC  +  PP 10 BEV/C       9/69
M         (1730.0)   (18.0)              GALLOWAY  68 HBC     PI-P 6 GEV/C      8/69
M   1     (1712.0)    (6.0)              BARNES    69 HBC     K-P TO K-P 2PI    7/70
M   1      IJP CONSISTENT WITH S11(1700) OR P11(1780) IN FORMATION
M   A     (1667.0)    (5.0)              BENVENUTI 69 DBC   0 PI-D 2.26 GEV     5/70
M   A        J CONSISTENT WITH 5/2 OR 7/2
M   B  190(1693.)    (15.)               RHODE     69 HBC     PP 22 GEV/C      10/69
M   B  JP IS PROBABLY 5/2+
M         (1691.)     (4.)               ANDERSON  70 MMS  -  PI- P TO PI- MMS  2/71
M      177(1710.)    (10.)               CIRBA     70 HBC  +  PI+ P TO P+3PI    2/71
M       40(1763.)    (25.)               COOPER    70 HBC  +  LAMB. K PROD.     2/71
M      505(1730.0)   (15.0)              CRENNELL  70 HBC  +  PI-P,PI+P 6 GEV   1/71
M       60(1710.)                        KUZNETSOV 70 HLBC -  LAMB. K PROD.     2/71
M   A     (1719.0)    (6.0)              WILLMANN  70 HBC  +  PI+P 13. GEV      5/70
M   A        J CONSISTENT WITH 5/2 OR 7/2
M         (1694.0)    (8.0)              AMALDI    71 CNTR    P P AT 24 GEV    10/71
M         (1730.)    (20.)               BALLAM    71 HBC  +- PI+-P AT 16GEV    2/72
M         (1700.)                        BEKETOV   71 HBC  +  PI- P 4.45GEV/C   3/72
M         (1711.)    (10.)               BOESEBEC  71 RVUE    PP,PI-P,K-P PRCD  3/72
M         (1672.0)    (4.0)              ELLIS     71 CNTR    MMS PP 3.7 GEV/C 10/71
M       80(1650.0)   (10.0)     80/120   MA        71 HBC  +  P P TO P N PI    10/71
M         (1700.0)   (10.0)              MORSE     71 HBC  +  PI-P   25 GEV/C   3/72
M          1670. TO 1730.                MORSE     71 HBC  +0 PI-P   7   GEV/C  3/72
M         (1720.)    (20.)               RUSHBROOKE71 HBC  +  PP TO P2PI 16GEV  2/72
M         (1690.3)    (4.5)              EDELSTEIN 72 MMS  +  PP 6 TO 30 GEV    1/73
M         (1668.0)   (19.0)     24/45    KARSHON   72 CBC  +  PD--PD2PI 7 GEV  12/72
M   C     (1715.0)    (5.0)              LAMSA     72 HBC  +  PI+-P 8TO18 GEV   1/73
M   C   ANALYSIS GIVES JP = 5/2+
M    2    (1660.)  (15.                  OH        72 DBC   0 PI-N TO PI-PI-P   2/73
M    2  DETERMINE J=5/2,F15 PROBABLE                                            2/73
M         (1720.)    (15.)               RONAT     72  HBC    PI+P TO 3PI P     2/73
M   3     (1820.)                        DAVIDSON  74 HBC   + PI-P TO PI- OM P 10/74*
M   3   OMEGA PROTON ENHANCEMENT,MOMENTS ANALYSIS CONSISTENT WITH 2J=1 OR 3    10/74*
M         (1732.)     (7.)               LICHTMAN  74 HBC  +  PI+P TO 3PI P     4/75*
M         (1694.)    (10.)               LICHTMAN  74 HBC  +  PI-P TO 3PI P     4/75*
M   4     (1700.)                        BLOBEL    75 HBC  +  PP TO P(PI+PI-P)  1/76*
M   4   PWA INDICATES PI+PI-P ENHANCEMENT IS PRIMARILY A                        1/76*
M   4   P-WAVE P EPSILON SYSTEM WITH I,JP=1/2,3/2-.                             1/76*
M          1660. TO 1670.                BRAUN1    75 HBC     PBAR P 5.7 GEV   11/75*
M         (1691.)    (11.)               CAVALLI   75 SPEC +  PP TO 2N*,W=23GV  1/76*
M         (1691.)     (8.)               CAVALLI   75 SPEC +  PP TO 2N*,W=31GV  1/76*
M         (1715.)    (10.)               CAVALLI   75 SPEC +  PP TO 2N*,W=53GV  1/76*
M         (1686.)    (12.)               MUSGRAVE  75 HBC     K+ P TO K PI N   11/75*
M         (1650.)                        STRACHMA  75  BC     NBAR (N PI)       1/76*
M          1678.       4.                WEBB      75 ISR  +  P P TO P N*       1/76*

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                       20  N*1/2(1700) WIDTH (MEV) (PROD. EXP.)

W          (70.0)    (20.0)              A-BORELLI 67 HBC                       9/69
W         (140.0)    (57.0)              ALMEIDA   68 HBC  +                    9/69
W          (55.0)    (15.0)              GALLOWAY  68 HBC                       8/69
W   1      (70.0)    (15.0)              BARNES    69 HBC     K-P TO K-P 2PI    7/70
W   A     (105.0)    (16.0)              BENVENUTI 69 DBC   0                   5/70
W   B  190 (235.)    (50.)               RHODE     69 HBC     PP 22 GEV/C      10/69
W         (130.)     (10.)               ANDERSON  70 MMS  -  PI- P TO PI- MMS  2/71
W      177  (66.)    (26.)               CIRBA     70 HBC  +  PI+ P AT 5 GEV/C  2/71
W         (102.)     (40.)               COOPER    70 HBC  +  PI+P, 5.5 GEV/C   2/71
W      505 (130.0)   (30.0)              CRENNELL  70 HBC  +                    1/71
W       60 (220.)                        KUZNETSOV 70 HLBC -  PI-P, 4 GEV/C     2/71
W   A      (63.0)    (12.0)              WILLMANN  70 HBC  +                    5/70
W         (152.0)    (15.0)              AMALDI    71 CNTR    P P AT 24 GEV    10/71
W         (120.)     (50.)               BALLAM    71 HBC  +- PI+-P AT 16GEV    2/72
W          (57.)     (15.)               BOESEBEC  71 RVUE    PP,PI-P,K-P PROD  3/72
W         (102.0)     (9.0)              ELLIS     71 CNTR    MMS PP 3.7 GEV/C 10/71
W       80  (94.0)   (20.0)     80/120   MA        71 HBC  +  P P TO P N PI    10/71
W          (70.)     (20.)               MORSE     71 HBC  +  PI-P   25 GEV/C   3/72
W           70. TO   120.                MORSE     71 HBC  +0 PI-P   7   GEV/C  3/72
W         (120.)     (40.)               RUSHBROOKE71 HBC  +  PP TO P2PI 16GEV  2/72
W         (133.0)    (26.0)              EDELSTEIN 72 MMS  +  PP 6 TO 30 GEV    1/73
W         (168.0)    (64.0)              KARSHON   72 CBC  +  PD--PD2PI 7 GEV  12/72
W          (80.0)  APPROX.               LAMSA     72 HBC     PI P  18.5 GEV/C 12/72
W    2    (128.)   (40.                  OH        72 CBC   0 PI-N TO PI-PI-P   2/73
W          (60.)     (40.)               RONAT     72  HBC    PI+P TO 3PI P     2/73
W         (157.)     (12.)               ABE       74      +  P+P->P+X,JCBN PK  4/75*
W    3    (120.)                         DAVIDSON  74 HBC   + PI-P TO PI- OM P 10/74*
W          (34.)     (14.)               LICHTMAN  74 HBC  +  PI+P TO 3PI P     4/75*
W          (48.)     (20.)               LICHTMAN  74 HBC  +  PI-P TO 3PI P     4/75*
W         (140.)                         BRAUN1    75 HBC     PBAR P 5.7 GEV   11/75*
W         (188.)    (112.)               CAVALLI   75 SPEC +  PP TO 2N*,W=23GV  1/76*
W         (133.)     (38.)               CAVALLI   75 SPEC +  PP TO 2N*,W=31GV  1/76*
W         (100.)     (10.)               CAVALLI   75 SPEC +  PP TO 2N*,W=53GV  1/76*
W         (135.)     (20.)               MUSGRAVE  75 HBC     K+ P TO K PI N   11/75*
W          148.       16.                WEBB      75
       SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

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                  20  N*1/2(1700) PARTIAL DECAY MODES (PROD. EXP.)

                                                              DECAY MASSES
P1      N*1/2(1700) INTO PI N                               139+ 938
P2      N*1/2(1700) INTO N PI PI                            938+ 139+ 139
P3      N*1/2(1700) INTO N*3/2(1232) PI                    1232+ 139
P4      N*1/2(1700)+ INTO NEUTRON PI+                       939+ 139
P5      N*1/2(1700)+ INTO PROTON PI+ PI-                    938+ 139+ 139
P6      N*1/2(1700)+ INTO N*3/2(1232)++ PI-                1232+ 139
P7      N*1/2(1700) INTO N ETA                              939+ 548
P8      N*1/2(1700) INTO LAMBDA K                          1115+ 497
P9      N*1/2(1700) INTO SIGMA K                           1189+ 493
P10     N*1/2(1700) INTO OMEGA PROTON                       783+ 938
P11     N*1/2(1700) INTO RHOO PROTON                        773+ 938

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                  20  N*1/2(1700) BRANCHING RATIOS (PROD. EXP.)

R1      N*1/2(1700) INTO (PI N)/(PI N*3/2(1232))          (P1)/(P3)
R1           (0.77) OR LESS              LEE       67 HBC     PI-P 3.6 GEV/C   11/67
R1   A       (9.0)  OR MORE              BENVENUTI 69 CBC   0                   5/70

R2      N*1/2(1700) INTO (N ETA)/(N PI + N PI PI)         (P7)/(P1+P2)
R2           (0.025)OR LESS              KRAEMER   64 DBC  +  PI+D 1.2
R2           (0.042)OR LESS  CL=.95      A-BORELLI 67 HBC  +  PBAR P 5.7 BEV/C  9/69

R3      N*1/2(1700) INTO (LAMBDA K)/(P PI+ PI-)           (P8)/(P5)
R3           (0.034)OR LESS              ALEXANDER 67 HBC  +  PP 5.5 BEV/C     11/67
R3           (0.07) OR LESS  CL=.95      CIRBA     70 HBC     PI+P AT 5 GEV/C   2/71

R4      N*1/2(1700) INTO (LAMBDA K)/(N PI + N PI PI)      (P8)/(P1+P2)
R4           (0.013)OR LESS  CL=.95      A-BORELLI 67 HBC  +                    8/67
R4            SEEN                       CHINOWSKY 68 HBC     PP TO K+ Y N      6/68
R4   1     LIMITS 0.025 TO 0.11          BARNES    69 HBC     K-P TO K-P 2PI    7/70
R4     25     0.025     0.005            CRENNELL  70 HBC  +                    1/71
R4   A     LESS THAN    0.025            WILLMANN  70 HBC     PI+P TO 3PI P     6/70
R4     25  SEEN. CONS. WITH J=1/2        MORSE     71 HBC   0 PI-P   7   GEV/C  3/72

R5      N*1/2(1700) INTO (N PI)/(N PI PI)                 (P1)/(P2)
R5           (1.26) OR LESS  CL=.95      A-BORELLI 67 HBC  +                    8/67
R5            0.025     0.13             CRENNELL  70 HBC  +                    1/71

R6      N*1/2(1700) INTO (N*3/2(1232) PI)/(N PI PI)       (P3)/(P2)
R6            NO EVIDENCE                A-BORELLI 67 HBC  +                    8/67
            SEE MERLO 66 FOR A REVIEW.

R7      N*1/2(1700) INTO (NEUTRON PI+)/(P PI+ PI-)        (P4)/(P5)
R7            0.67      0.40             ALEXANDER 67 HBC  +  PP 5.5 BEV/C     11/67
R7            0.47      0.25             A-BORELLI 67 HBC     PBAR P 5.5 GEV/C  7/70
R7          . . . . . . . . .
R7   AVG      0.53      0.21      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R7   STUDENT  0.53      0.23      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R8      N*1/2(1700) INTO (N*3/2(1232)++ PI-)/(P PI+ PI-) (P6)/(P5)
R8            0.74      0.14             ALEXANDER 67 HBC  +  PP 5.5 BEV/C     11/67
R8            1.0       0.3              ALMEIDA   68 HBC  +  PP 10 BEV/C       9/66
R8           (0.83)                      KAYAS     68 HBC     PP 8.1 BEV/C     11/68
R8   1     LESS THAN    0.15             BARNES    69 HBC     K-P TO K-P 2PI    7/70
R8           (0.50) OR LESS  CL=.95      CIRBA     70 HBC     PI+P AT 5 GEV/C   2/71
R8            NO EVIDENCE                CRENNELL  70 HBC  +                    1/71
R8   A       (2.3)      (1.6)            WILLMANN  70 HBC     PI+P TO 3PI P     6/70
R8           (1.0)   OR MORE  CL=.95     BEKETOV   71 HBC  +  DEL(1232)++ PI-   3/72
R8            0.75      0.75             BOESEBEC  71 RVUE    PP,PI-P,K-P PROD  3/72
R8            0.35      0.20             RUSHBROOKE71 HBC  +  PP TO P2PI 16GEV  2/72
R8 C          0.65      0.15             LAMSA     72 HBC     PI P  18.5 GEV/C 12/72
R8          . . . . . . . . .
R8   AVG      0.66      0.10      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
R8   STUDENT  0.665     0.099     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R9      N*1/2(1700) INTO (SIG K)/(LAMB K)                 (P9)/(P8)
R9         LESS THAN     .20             COOPER    70 HBC  +  PI+P, 5.5 GEV/C   2/71

R10     N*1/2(1700) INTO (PI N)+/(OMEGA PROTON)           (P1)/(P10)
R10      LESS THAN .36 (90 PCT CL)       DAVIDSON  74 HBC   + PI-P TO PI- OM P 10/74*

R11     N*1/2(1700) INTO (RHOO PROTON)/(OMEGA PROTON)     (P11)/(P10)
R11      LESS THAN .12 (90 PCT CL)       DAVIDSON  74 HBC   + PI-P TO PI- OM P 10/74*

        SEE THE NOTES ACCOMPANYING THE MASSES QUOTEC

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                                  REFERENCES FOR N*1/2(1700) (PROD. EXP.)

KRAEMER  64 PR 136 B496           +MADANSKY,+  (J HOPKINS,NWESTERN,WOODSTOCK) I

ALEXANDE 67 PR 154 1284           ALEXANDER,BENARY,CZAPEK,+  (WEIZMANN(CERN))
A-BORELL 67 NC 47 232             ALLES-BORELLI,FRENCH,FRISK,MICHEJDA  (CERN)
LEE      67 PR 159 1156           +MOEBS,ROE,SINCLAIR,VANDER VELDE     (MICH)

ALMEIDA  68 PR 174 1638           +RUSHBROOKE, +             (CAVE,DESY(CERN))
CHINOWSK 68 PR 165 1466           CHINOWSKY,KINSEY,KLEIN, +          (LRL,SLAC)
GALLOWAY 68 PL 27B 250            GALLOWAY,ALYEA,CRITTENDEN,PRICKETT,+  (IND)
KAYAS    68 NP B5 169             +GUYADER,SENE,YIOU,ALITTI,+  (ORSAY,SACLAY)

BARNES   69 PRL 23 1516           +BASSANO+CHUNG+EISNER+FLAMINTO+KINSON (BNL)IJ
BENVENUT 69 PR 187 1852           BENVENUTI, MARQUIT, OPPENHEIMER (MINN,COLO)
RHODE    69 PR 187 1844           RHODE, LEACOCK, KERNAN, JESPERSEN,+   (ISU)

ANDERSON 70 PRL 25,699            +BLESER,BLIEDEN,COLLINS++          (BNL,CARN)
CIRBA    70 NP B23,533            +VANDERHAGEN+   (EPOL,DURH,NIJM, TORI,BONN)
COOPER   70 NP B23,605            +MANNER,MUSGRAVE,POLLARD,VOYVODIC     (ANL)
CRENNELL 70 PRL 25 187            +LAI, LOUIE, SCARR, SIMS              (BNL)
KUZNETSOV70 SJNP 10,332           +MELNIKOV,RYLTSEVA,CHADRAA,BALINTP   (JINR)
WILLMANN 70 PRL 24 1260           +LAMSA,GAIDOS,EZELL                  (PURD)IJ
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Data Card Listings

For notation, see key at front of Listings.

Baryons

N(1700), N(1780)


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AMALDI   71 PL  34B 435        +BIANCASTELLI,BCSIO,+  (I SANITA RCMA+CERN)
BALLAM   71 PR D4 1946         +CFADWICK,GUIRAGOSSIAN,JOHNSON,++    (SLAC) I
BEKETOV  71 SJNP 13 605        ,ZCMBKOVSKII,KONOVALCV,KRUCHININ,++  (ITEP)IJ
BOESEBEC 71 NP B33 445         BOESEBECK,GRAESSLER,KRAUS,+++      (ABBCHLV) I
ELLIS    71 PRL 27 442         +MAGLICH,NOREM,SANNES,SILVERMAN       (RUTG)
MA       71 PRL  26  333       +CCLTON                            (MSU+LBL)I
MORSE    71 PR D4 133          +OH,WALKER,CARRCLL,LYNCH +        (WISC+TNTO)I
RUSHBROO 71 PR D4 3273         RUSHBROOKE,WILLIAMS+BAREFORD++  (CAVE,LOIC) IJ

EDELSTEI 72 PR D5 1073         EDELSTEIN,CARRIGAN,HIEN,MCMAHCN,+(CARN+BNL)
JOHNSTAD 72 NP B42 588         +MOLLERUD+...+JACOBSEN(BOHR,HELS,OSLO,STOH) IJP
KARSHON  72 NP B37 371         +YEKUTIELI,YAFFE,SHAPIRA,RCNAT,+       (REHO) I
LAMSA    72 NP B37 364         +WILLMANN+..+GO,BISWAS+...       (PURO,NCAM) IJP
OH       72 PL 42B 497         +FUNG,KERNAN,POE,SCHALK,SHEN            (UCR)IJP
RONAT    72 NP B38 20          +EISENBERG,LYCNS,SHAPIRA,TCAFF+        (REHO)

ABE      74 PL 53B 114         +ALSPECTOR,BOMBEROWITZ+       (RUTG,UPNJ,FSU)
DAVIDSON 74 PRL 32 855         CAVIDSON,DZIERBA,FIRESTONE,+  (CIT+BNL+LBL)I
LICHTMAN 74 NP B81 31          LICHTMAN,BISWAS,CASON,KENNEY,MCGAHAN+(NDAM)I

BLOBEL   75 NP B97 201         +ESKREYS,FESEFELDT,FRANZ+  (BCNN+HAMB+MPIM)IJP
BRAUN1   75 NP B95 481         +GERBER,MAURER,MICHALCN,SCHIBY+ (STRB,LPNP)I
CAVALLI  75 LNC 14 353         CAVALLI-SFORZA,CONTA+            (PAVIA+PRIN)
    ALSO 75 LNC 14 345+359     CAVALLI-SFORZA,CONTA+            (PAVIA+PRIN)
MUSGRAVE 75 NP B87 365         +PEETERS,SCREINER,WHITMORE,YUTA         (ANL)
STRACHMA 75 NP B98 120         STRACHMAN,BRAUN,GERBER,MAURER+  (LPNP+STRB)I
WEBB     75 PL 55B 331         +TRILLING,TELEGDI+        (AACH+UCLA+UCR+CERN)
    ALSO 75 PL 55B 336         +TRILLING,TELEGDI+        (AACH+UCLA+UCR+CERN)

                               PAPERS NOT REFERRED TO IN CATA CAROS.

MERLO    66 P ROY SOC 289 489 J P MERLO, G VALLACAS                (SACLAY)
ANTIPOV  75 NP B99 189         +ASCOLI,BAUD+          (CERN-IHEP BOSON SPEC)
LEDNICKY 75 PL 58B 89          R. LEDNICKY                            (JINR)
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N(1780) 14 N*1/2(1780, JP=1/2+) I=1/2 **P''_{11}**

THE EXISTENCE OF THIS RESONANCE IS WELL ESTABLISHED.

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                   14  N*1/2(1780) MASS (MEV)

M   3     (1751.0)                   DONNACH1  68 RVUE    PHASE-SHIFT ANAL  8/69
M         (1640.0)   (70.0)          ORITO     69 RVUE    K LAMBDA PS ANAL  8/69
M         (1700.0)                   ORITO2    69 CNTR    K LAM PHOTOPRC   10/71
M   6     (1645.0)                   AYED      70 IPWA                      1/71
M   6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M   4     (1770.0)                   DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
M         (1809.0)                   SCHORSCH  70 DPWA    K LAM PHOTOPRO.  10/71
M   A     (1685.0)OR(1740.0)         WAGNER    71 IPWA    PI-P TC K LAMB    1/71
M   A   THERE ARE 3 SIMILAR SOLUTIONS
M   7     (1720.)                    ALMEHED   72 IPWA                      2/72
M    2    (1728.)                    HICKS     73 MPWA    GAM P-ETA P       9/73
M    2  ONLY STATES FROM TABLE VII OF HICKS73 ARE INCLUCED IN LISTINGS.     9/73
M    2  M AND W ARE FROM SOLUTICN C2,BR=SQRT(G)/W WITH G FROM TABLE VII.    9/73
M         (1780.)                    LANGBEIN  73 IPWA    PI N-K SIG,SOL 1  9/73
M         (1780.)                    LANGBEIN  73 IPWA    PI N-K SIG,SOL 2  9/73
M         (1729.)                    AYED      74 IPWA                      2/74
M         (1670.)                    KNASEL    75 DPWA  0 PI- P TO KO LAM  11/75*
M    L     1730. OR 1710.            LONGACRE  75 IPWA    PI N TO 2PI N    11/75*
M    L  THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.  11/75*

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                   14  N*1/2(1780) WIDTH (MEV)

W   3      (327.0)                   DONNACH1  68 RVUE                      8/69
W          (310.0)   (50.0)          ORITO     69 RVUE                      8/69
W          (210.0)                   ORITO2    69 CNTR    K LAM PHOTOPRO   10/71
W   6       (50.0)                   AYED      70 IPWA                      1/71
W   4      (445.0)                   DAVIES    70 RVUE    SOL A             8/69
W          (280.0)                   SCHORSCH  70 DPWA    K LAM PHOTOPRO.  10/71
W   A      (160.0)OR(220.0)          WAGNER    71 IPWA    PI-P TO K LAMB    1/71
W   7      (160.)                    ALMEHED   72 IPWA                      2/72
W    2     (203.)                    HICKS     73 MPWA    GAM P-ETA P       9/73
W          (130.)                    LANGBEIN  73 IPWA    PI N-K SIG,SOL 1  9/73
W          (130.)                    LANGBEIN  73 IPWA    PI N-K SIG,SOL 2  9/73
W          (217.)                    AYED      74 IPWA                      2/74
W          (174.)                    KNASEL    75 DPWA  0 PI- P TO KO LAM  11/75*
W    L     (165.) OR (75.)           LONGACRE  75 IPWA    PI N TO 2PI N    11/75*
        SEE THE NOTES ACCCMPANYING THE MASSES QUOTED.

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                   14  N*1/2(1780) REAL PART OF POLE PCSITION (MEV)        11/75*

RE        (1708.)                    LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

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                   14  N*1/2(1780) 2*IMAG PART OF POLE PCSITION (MEV)      11/75*

IM         (17.)                     LCNGACRE  75 IPWA    PI N TO 2PI N    11/75*

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                   14  N*1/2(1780) PARTIAL DECAY MODES

                                                        DECAY MASSES
P1      N*1/2(1780) INTO PI N                          139+ 938
P2      N*1/2(1780) INTG LAMBDA K                     1115+ 497
P3      N*1/2(1780) INTO N ETA                         939+ 548
P4      N*1/2(1780) INTO GAM P, HELICITY=1/2             0+ 938
P5      N*1/2(1780) INTO GAM N, FELICITY=1/2             0+ 939
P6      N*1/2(1780) INTO N PI PI                       938+ 139+ 139
P7      N*1/2(1780) INTO N EPSILCN                     938+1200
P8      N*1/2(1780) INTC N RHC                         938+ 773
P9      N*1/2(1780) INTO K SIGMA                       493+1189
P10     N*1/2(1780) INTO N*3/2(1232) PI               1232+ 139
P11     N*1/2(1780) INTO N RHO,S=1/2,P-WAVE            938+ 773

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                   14  N*1/2(1780) BRANCHING RATIOS

R1      N*1/2(1780) INTO (PI N)/TOTAL                      (P1)
R1  3       (0.32)                   DCNNACH1  68 RVUE                      8/69
R1  6       (0.149)                  AYED      70 IPWA                      1/71
R1  4       (0.43)                   DAVIES    70 RVUE    SOL A             8/69
R1  7       (0.2)                    ALMEHED   72 IPWA                      2/72
R1           (.188)                  AYED      74 IPWA                      2/74

R2      N*1/2(1780) FROM PI N TO K LAMBDA                  SQRT(P1*P2)       4/75*
R2          (.06)     (.03)          ORITO     69 RVUE                       4/75*
R2  A       (.16)OR .21              WAGNER    71           PI- P TO K LAMB  4/75*
R2          -.150      .038          DEVENISH  74         0 FIXED T DISP REL 4/75*
R2           (.10)                   KNASEL    75 DPWA   0 PI- P TO KO LAM  11/75*

R3      N*1/2(1780) INTO (LAMBDA K)/TOTAL                  (P2)
R3  B       (0.003)TO 0.065          RUSH      68 MPWA     T POLE + RESON.   8/69
R3  B    PARAMETRIZATION USEC COULD BE IN DANGER CF DOUBLE COUNTING

R4      N*1/2(1780) INTO (N ETA)/TOTAL                     (P3)
R4  B       (0.19)                   BOTKE     69 MPWA     T POLE + RESON.  10/69
R4  B       (0.09)    (0.05)         DEANS     69 MPWA     T POLE + RESON.   5/70
R4  B       (0.015)OR 0.035          CARRERAS  70 MPWA     T POLE + RESON.   5/70
R4  B    PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R5      N*1/2(1780) FROM GAMMA PRCTCN TO K LAMBDA          SQRT(P2*P4)       9/73
R5          (0.0027)                 ORITO2    69 CNTR     K LAM PHOTOPRC   10/71
R5          (0.0088)                 SCHORSCH  70 DPWA     K LAM PHOTOPRC.  10/71
R5           (.0104)                 DEANS     72 MPWA     GAM P-K LM,SOL D  9/73

R6      N*1/2(1780) FPOM GAMMA PROTON TO ETA PROTCN        SQRT(P3*P4)       9/73
R6   2       (.0075)                 HICKS     73 MPWA     GAM P-ETA P       9/73

R7      N*1/2(1780) FROM PI N TO K SIGMA                   SQRT(P1*P9)       9/73
R7          (.11)                    LANGBEIN  73 IPWA     PI N-K SIG,SOL 1  9/73
R7          (.14)                    LANGBEIN  73 IPWA     PI N-K SIG,SOL 2  9/73
R7  1       (.075)TO  .203           DEANS     75 DPWA     PI N TO K SIGMA  11/75*
R7  1    RANGE GIVEN IS FRCM FOUR BEST SCLUTICNS.                           11/75*

R8      N*1/2(1780) FROM PI N TO N*3/2(1232) PI            SQRT(P1*P10)     11/75*
R8   L       (.13)OR  -.20           LONGACRE  75 IPWA     PI N TO 2PI N    11/75*

R9      N*1/2(1780) FROM PI N TO N RHO,S=1/2,P-WAVE        SQRT(P1*P11)     11/75*
R9   L      (+.32)OR  +.20           LONGACRE  75 IPWA     PI N TO 2PI N    11/75*

R10     N*1/2(1780) FROM PI N TO N EPSILON                 SQRT(P1*P7)      11/75*
R10  L      (+.18)OR  +.28           LONGACRE  75 IPWA     PI N TO 2PI N    11/75*

R11     N*1/2(1780) FROM PI N TO ETA N                     SQRT(P1*P3)      11/75*
R11 5       (+.382)TO +.383          FELTESSE  75 DPWA  0 1488 TO 1745 MEV 11/75*
R11 5    USES M AND W OF AYED 74.  NOTE THAT THIS GIVES A BRANCHING         11/75*
R11 5    RATIO TO ETA N OF AEOUT 80 PCT, IN STRONG DISAGREEMENT WITH        11/75*
R11 5    EARLIER EXPERIMENTS.                                               11/75*

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                   14  N*1/2(1780) PHOTON DECAY AMPL(GEV**-1/2)

         FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
       REVIEW PRECEDING TFE BARYCN LISTINGS.

A1      N*1/2(1780) INTO GAM P, HELICITY=1/2 (GEV**-1/2)
A1             .022      .057        DEVENISH  73 DPWA     PI N PHOTO PRCD   2/74
A1            +.026      .028        MOORHOUS  73 DPWA     PI N PHOTO-PRCD   2/73
A1            -.014      .021        DEVENIS2  74 DPWA     PI N PHOTO-PROD   4/75*
A1             .022      .015        KNIES     74 CPWA     PI N PHOTO PROD   2/74
A1            -.068      .024        METCALF   74 DPWA     PI N PHOTO-PROD   2/74
A1             .016      .025        MOORHOUS  74 DPWA     PI N PHOTO-PRCD   2/74
A1            +.062      .007        CRAWFORD  75 DPWA     PI N PHOTO-PROD   1/76*
A1           (+.005)                 BARBOUR   76 DPWA     PI N PHOTC-PRCD   1/76*
A1             . . . . . . . . . . .
A1   AVERAGE MEANINGLESS (SCALE FACTOR = 2.8)

A2      N*1/2(1780) INTO GAM N, HELICITY=1/2 (GEV**-1/2)
A2            -.028      .067        DEVENISH  73 DPWA     PI N PHOTO PRCD   2/74
A2            +.027      .022        MOORHOUS  73 DPWA     PI N PHOTC-PRCD   2/73
A2            -.060      .061        DEVENIS2  74 DPWA     PI N PHOTO-PROD   4/75*
A2             .027      .015        KNIES     74 DPWA     PI N PHCTC PROD   2/74
A2             .048      .045        METCALF   74 DPWA     PI N PHOTO-PROD   2/74
A2             .057      .022        MOORHOUS  74 DPWA     PI N PHOTO-PROD   2/74
A2            -.020      .016        CRAWFORD  75 DPWA     PI N PHOTO-PROD   1/76*
A2           (-.010)                 BARBOUR   76 DPWA     PI N PHOTO-PROD   1/76*
A2             . . . . . . . . . . .
A2   AVERAGE MEANINGLESS (SCALE FACTOR = 1.4)

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REFERENCES FOR N*1/2(1780)


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DONNACH1 68 PL 26B 161         A CCNNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139         DONNACHIE  RAPPORTEUR.S TALK           (GLAS)
    ALSO 68 THESIS             R G KIRSOPP                            (EDIN)
RUSH     68 PR 173 1776        J E RUSH                       (UNIV ALABAMA)

BOTKE    69 PR 180 1417        J C BOTKE                              (UCSB)
DEANS    69 PR 185 1797        S DEANS, J WOOTEN            (UNIV S FLORIDA)
ORITO    69 LNC 1 936          S CRITO,S SASAKI                (TOKYO-OSAKA)
ORITO2   69 INS J 113          S CRITO (TFESIS)                      (TCKYO)

AYED     70 KIEV CONF          R AYED,P BAREYRE, G VILLET          (SACL)IJP
CARRERAS 70 NP 16B 35          B CARRERAS, A DONNACHIE           (DARE,MCHS)
DAVIES   70 NP B21 359         A DAVIES                               (GLAS)
SCHCRSCH 70 NP  B25 179        +TIETGE,WEILNBOECK                     (MPIM)

WAGNER   71 NP B25 411         F WAGNER, C LOVELACE                   (CERN)

ALMEHED  72 NP B40 157         +LCVELACE                      (LUND,RUTG)IJP
DEANS    72 PRD 6 1906         DEANS,JACOBS, LYONS,MONTGCMERY (SOUTH FLA.)IJP

DEVENISH 73 PL 47B 53          DEVENISH,RANKIN,LYTH        (LOUC+BONN+LANC)IJP
HICKS    73 PRD 7 2614         +DEANS,JACOBS,LYONS+ (CARN+ORNL+SOUTH FLA.)IJP
LANGBEIN 73 NP B53 251         LANGBEIN,WAGNER                    (MUNICH)IJP
MOORHOUS 73 PL 43B 44          MOORHOUSE, OBERLACK              (GLAS+LBL)IJP

AYED     74 PRIVATE COMMCTN.   AYED,BAREYRE                         (SACL)IJP
    ALSO 73 AIX CONFERENCE     AYED,BAREYRE                         (SACL)IJP
DEVENISH 74 NP B81 330         DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEVENIS2 74 PL 52B 227         DEVENISH,LYTH,RANKIN        (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680         KNIES,MOORHOUSE,OBERLACK         (LBL,GLAS)IJP
METCALF  74 NP B76 253         W J METCALF,R L WALKER                (CIT)IJP
MOORHCUS 74 PRD 9 1            MCORHOUSE,OBERLACK,ROSENFELD     (GLAS+LBL)IJP

CRAWFCRD 75 NP B97 125         R L CRAWFORD                         (GLAS)IJP
DEANS    75 NP B96 90          +MITCHELL,MONTGCMERY,+        (SFLA,ALABAMA)IJP
FELTESSE 75 NP B93 242         +AYED,BAREYRE,BORGEAUD,DAVID,ERNWEIN+(SACL)IJP
KNASEL   75 PRD 11 1           +LINDQUIST,NELSON+      (CHIC,WUSL,OSU,ANL)IJP
LCNGACRE 75 PL 55B 415         +ROSENFELD,LASINSKI,SMADJA+      (LBL,SLAC)IJP

BARBCUR  76 SBMTD. TO NP       I. M. BARBCUR,R. L. CRAWFCRD         (GLAS)IJP
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Baryons
N(1780), N(1810), N(1990)

Data Card Listings
For notation, see key at front of Listings.


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                    PAPERS NOT REFERRED TO IN CATA CARDS.

DEANS    69 PR  177 2623      S R DEANS                  (UNIV S FLORIDA)
DONNACHI 69 NP 10B 433        A DONNACHIE, R KIRSOPP         (GLAS+EDIN)
AYED     70 PL 31B 598        +BAREYRE+VILLET                   (SACLAY)
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N(1810) 15 N*1/2(1810, JP=3/2+) I=1/2 P_{13}

THE EXISTENCE OF THIS RESONANCE IS WELL ESTABLISHED.

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                  15  N*1/2(1810) MASS (MEV)

M  3     (1860.0)                 DONNACH1  68 RVUE    PHASE-SHIFT ANAL  6/68
M  X     (1860.0)      APPROX     LEA       69 CNTR    PI-P ELASTIC      8/69
M  X  SEE ALSO APLIN 71
M  6     (1766.0)                 AYED      70 IPWA                      1/71
M  6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M  4     (1844.0)                 DAVIES    70 RVUE    P-S ANAL  SCL A   8/69
M  A     (1800.0)                 WAGNER    71 IPWA    PI-P TO K LAMB    1/71
M  A  P13 RESONATES ONLY IN CNE CUT CF 3 POSSIBLE SOLUTIONS
M  7     (1850.)                  ALMEHED   72 IPWA                      2/72
M   1    (1833.)                  HICKS     73 MPWA    GAM P-ETA P       9/73
M   1  ONLY STATES FROM TABLE VII OF HICKS73 ARE INCLUDED IN LISTINGS.   9/73
M   1  M AND W ARE FROM SOLUTICN C2,BR=SQRT(G)/W WITH G FROM TABLE VII.  9/73
M        (1696.)                  AYED      74 IPWA                      2/74
M        (1850.)                  KNASEL    75 DPWA  0 PI- P TO KO LAM  11/75*
M   L     1695. OR 1720.          LONGACRE  75 IPWA    PI N TO 2PI N    11/75*
M   L  THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75. 11/75*

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                  15  N*1/2(1810) WIDTH (MEV)

W  3      (296.00)                DCNNACH1  68 RVUE                      8/69
W  6      (182.0)                 AYED      70 IPWA                      1/71
W  4      (449.0)                 DAVIES    70 RVUE    SOL A             8/69
W  4   SOL B GIVES 307 MEV                                               2/73
W  A      (220.0)                 WAGNER    71 IPWA    PI-P TO K LAMB    1/71
W  7      (300.)                  ALMEHED   72 IPWA                      2/72
W   1     (250.)                  HICKS     73 MPWA    GAM P-ETA P       9/73
W         (117.)                  AYED      74 IPWA                      2/74
W         (327.)                  KNASEL    75 DPWA  0 PI- P TO KO LAM  11/75*
W   L      (115.)OR (150.)        LONGACRE  75 IPWA    PI N TC 2PI N    11/75*
            SEE THE NOTES ACCOMPANYING THE MASSES QUCTED

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                  15  N*1/2(1810) REAL PART OF PCLE PCSITION (MEV)      11/75*

RE        (1716.)                 LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

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                  15  N*1/2(1810) 2*IMAG PART OF POLE POSITION (MEV)    11/75*

IM        (124.)                  LONGACRE  75 IPWA    PI N TC 2PI N    11/75*

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                  15  N*1/2(1810) PARTIAL DECAY MCDES

                                                      DECAY MASSES
P1     N*1/2(1810) INTO PI N                           139+ 938
P2     N*1/2(1810) INTO LAMBCA K                      1115+ 497
P3     N*1/2(1810) INTC N ETA                          939+ 548
P4     N*1/2(1810) INTO N PI PI                        938+ 139+ 139
P5     N*1/2(1810) INTO GAM P,HELICITY=3/2               0+ 938
P6     N*1/2(1810) INTO GAM P,HELICITY=1/2               0+ 938
P7     N*1/2(1810) INTO GAM N,HELICITY=3/2               0+ 939
P8     N*1/2(1810) INTO GAM N,HELICITY=1/2               0+ 939
P9     N*1/2(1810) INTO SIGMA K                        493+1189
P10    N*1/2(1810) INTC N RHO,S=1/2,P-WAVE             938+ 773

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                  15  N*1/2(1810) BRANCHING RATIOS

R1     N*1/2(1810) INTO (PI N)/TOTAL                   (P1)
R1  3      (0.21)                 DONNACH1  68 RVUE                      8/69
R1  6      (0.149)                AYED      70 IPWA                      1/71
R1  4      (0.40)                 DAVIES    70 RVUE    SCL A             8/69
R1  7      (0.25)                 ALMEHED   72 IPWA                      2/72
R1          (.145)                AYED      74 IPWA                     10/74*

R2     N*1/2(1810) INTO (LAMBDA K)/TOTAL               (P2)
R2  B      (0.014)TO 0.16         RUSH      68 MPWA    T POLE + RESON.   8/69
R2  B   PARAMETRIZATION USEC COULD BE IN DANGER OF DOUBLE COUNTING

R3     N*1/2(1810) INTO (N ETA)/TCTAL                  (P3)
R3  B      (0.0364)               BOTKE     69 MPWA    T POLE + RESON.  10/69
R3  B      (0.003)  (0.003)       DEANS     69 MPWA    T POLE + RESON.   5/70
R3  B      (0.030)OR 0.094        CARRERAS  70 MPWA    T PCLE + RESON.   5/70
R3  B   PARAMETRIZATION USEC COULD BE IN DANGER CF DOUBLE COUNTING

R4     N*1/2(1810) FROM PI N TO K LAMBDA               SQRT(P1*P2)       4/75*
R4  A      (.12)                  WAGNER    71 IPWA    PI- P TO K LAMB   4/75*
R4         -.067      .033        DEVENISH  74       0 FIXED T DISP REL  4/75*
R4         (.13)                  KNASEL    75 DPWA  0 PI- P TO KO LAM  11/75*

R5     N*1/2(1810) FROM GAMMA PROTON TO K LAMBDA       SQRT((P5+P6)*P2)  9/73
R5         (.0082)                DEANS     72 MPWA    GAM P-K LM,SOL D  9/73

R6     N*1/2(1810) FROM GAMMA PROTON TO ETA PROTCN     SQRT((P5+P6)*P3)  9/73
R6   1     (.0052)                HICKS     73 MPWA    GAM P-ETA P       9/73

R7     N*1/2(1810) FROM PI N TO K SIGMA                SQRT(P1*P9)      11/75*
R7  2      (.051)TO  .087         DEANS     75 DPWA    PI N TO K SIGMA  11/75*
R7  2   RANGE GIVEN IS FROM FOUR BEST SOLUTICNS.                        11/75*

R8     N*1/2(1810) FROM PI N TC N RHO,S=1/2,P-WAVE     SQRT(P1*P10)     11/75*
R8   L     (-.35)OR  -.40         LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

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                  15  N*1/2(1810) PHOTCN DECAY AMPL(GEV**-1/2)

    FCR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
  REVIEW PRECEDING THE BARYCN LISTINGS.

A1     N*1/2(1810) INTO GAM P, HELICITY=1/2  (GEV**-1/2)
A1         -.022     .094        DEVENISH  73 DPWA    PI N PHOTO PROD    2/74
A1          .025     .034        DEVENIS2  74 DPWA    PI N PHOTO-PRCD    4/75*
A1         -.004     .032        KNIES     74 DPWA    PI N PHOTO PRCD    2/74
A1          .0       .025        METCALF   74 DPWA    PI N PHOTO-PROD    2/74
A1         +.022     .012        CRAWFORD  75 DPWA    PI N PHOTO-PRCD    1/76*
A1        (+.086)                BARBOUR   76 DPWA    PI N PHOTO-PRCD    1/76*
A1          . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

A2     N*1/2(1810) INTO GAM P, HELICITY=3/2  (GEV**-1/2)
A2         -.001     .106        DEVENISH  73 DPWA    PI N PHOTO PROD    2/74
A2         -.087     .057        DEVENIS2  74 DPWA    PI N PHOTO-PROD    4/75*
A2         -.006     .030        KNIES     74 DPWA    PI N PHOTO PROD    2/74
A2          .0       .022        METCALF   74 DPWA    PI N PHOTO-PRCD    2/74
A2         -.016     .016        CRAWFORD  75 CPWA    PI N PHOTO-PRCD    1/76*
A2        (-.060)                BARBOUR   76 DPWA    PI N PHOTO-PRCD    1/76*
A2          . . . . . . . . .
A2  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

A3     N*1/2(1810) INTO GAM N, HELICITY=1/2  (GEV**-1/2)
A3          .132     .173        DEVENISH  73 DPWA    PI N PHOTO PROD    2/74
A3          .013     .045        DEVENIS2  74 DPWA    PI N PHOTO-PROD    4/75*
A3          .014     .014        KNIES     74 DPWA    PI N PHOTO PROD    2/74
A3          .0       .050        METCALF   74 DPWA    PI N PHOTC-PRCD    2/74
A3         -.037     .022        CRAWFORD  75 DPWA    PI N PHOTO-PRCD    1/76*
A3        (-.020)                BARBOUR   76 DPWA    PI N PHOTC-PROD    1/76*
A3          . . . . . . . . .
A3  AVERAGE MEANINGLESS (SCALE FACTOR = 1.1)

A4     N*1/2(1810) INTO GAM N, HELICITY=3/2  (GEV**-1/2)
A4          .080     .133        DEVENISH  73 DPWA    PI N PHOTO PROD    2/74
A4         -.083     .090        DEVENIS2  74 DPWA    PI N PHOTO-PROD    4/75*
A4         -.008     .025        KNIES     74 DPWA    PI N PHOTC PRCD    2/74
A4          .0       .044        METCALF   74 DPWA    PI N PHOTO-PROD    2/74
A4         -.038     .015        CRAWFORD  75 DPWA    PI N PHCTO-PRCD    1/76*
A4        (+.046)                BARBOUR   76 DPWA    PI N PHOTO-PRCD    1/76*
A4          . . . . . . . . .
A4  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                           REFERENCES FOR N*1/2(1810)

DCNNACH1 68 PL 26B 161        A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139        DONNACHIE  RAPPORTEUR.S TALK           (GLAS)
    ALSO 68 THESIS            R G KIRSOPP                            (EDIN)
RUSH     68 PR 173 1776       J E RUSH                      (UNIV ALABAMA)

BOTKE    69 PR 180 1417       J C BOTKE                              (UCSB)
DEANS    69 PR 185 1797       S DEANS, J WOOTEN           (UNIV S FLORICA)
LEA      69 PL 29B 584        LEA,OADES,WARD,COWAN,+  (RHEL,BRISTOL,DARE)

AYED     70 KIEV CCNF         R AYED,P BAREYRE, G VILLET          (SACL)IJP
CARRERAS 70 NP 16B 35         B CARREPAS, A DCNNACHIE           (DARE,MCHS)
DAVIES   70 NP B21 359        A DAVIES                               (GLAS)

WAGNER   71 NP B25 411        F WAGNER, C LOVELACE                   (CERN)

ALMEHED  72 NP B40 157        +LOVELACE                      (LUND,RUTG)IJP
DEANS    72 PRD 6 1906        DEANS,JACOBS, LYCNS,MCNTGCMERY (SOUTH FLA.)IJP
DEVENISH 73 PL 47B 53         DEVENISH,RANKIN,LYTH       (LOUC+BONN+LANC)IJP
HICKS    73 PRD 7 2614        +CEANS,JACOBS,LYONS+ (CARN+ORNL+SOUTH FLA.)IJP

AYED     74 PRIVATE COMMCTN.  AYED,BAREYRE                        (SACL)IJP
    ALSO 73 AIX CCNFERENCE    AYED,BAREYRE                        (SACL)IJP
DEVENISH 74 NP B81 330        DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEVENIS2 74 PL 52B 227        DEVENISH,LYTH,RANKIN        (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680        KNIES,MOORHCUSE,OBERLACK         (LBL,GLAS)IJP
METCALF  74 NP B76 253        W J METCALF,R L WALKER                 (CIT)IJP

CRAWFORD 75 NP B97 125        R L CRAWFORD                        (GLAS)IJP
DEANS    75 NP B96 90         +MITCHELL,MONTGCMERY,+       (SFLA,ALABAMA)IJP
KNASEL   75 PRD 11 1          +LINDQUIST,NELSON+       (CHIC,WUSL,OSU,ANL)IJP
LONGACRE 75 PL 55B 415        +ROSENFELD,LASINSKI,SMADJA+      (LBL,SLAC)IJP

BARBOUR  76 SBMTD. TO NP      I. M. BARBCUR,R. L. CRAWFORD        (GLAS)IJP

                              PAPERS NOT REFERRED TO IN CATA CARDS.

DEANS    69 PR  177 2623      S R DEANS                   (UNIV S FLORIDA)
DONNACHI 69 NP 10B 433        A DONNACHIE, R KIRSOPP          (GLAS+EDIN)

AYED     70 PL 31B 598        +BAREYRE,VILLET                     (SACLAY)
APLIN    71 NP  B32 253       +COWAN,GIBSON,GILMORE++       (RHEL,BRISTOL)
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N(1990) 17 N*1/2(1990, JP=7/2+) I=1/2 F_{17}

THE MOST RECENT PI N PARTIAL WAVE ANALYSIS, AYED 74, FINDS EVIDENCE FOR THIS STATE. THERE IS ALSO SOME INDICATION IN ASSOCIATED PRODUCTION.

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                  17  N*1/2(1990) MASS (MEV)

M  3     (1983.0)                 DCNNACH1  68 RVUE    PHASE-SHIFT ANAL
M  3     (1995.)                  KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
M  3   WHERE MAX. ABSORPTION IS -DCNNACH1, 2  ,KIRSOPP EYEBALL FIT CERN 1  10/69
M  X     (2000.0)      APPROX     LEA       69 CNTR    PI-P ELASTIC      8/69
M  X  SEE ALSC APLIN 71
M  7     (2000.)                  ALMEHED   72 IPWA                      2/72
M   1    (1970.)                  HICKS     73 MPWA    GAM P-ETA P       9/73
M   1  CNLY STATES FROM TABLE VII OF HICKS73 ARE INCLUDED IN LISTINGS.   9/73
M   1  M AND W ARE FROM SOLUTICN C2,BR=SQRT(G)/W WITH G FROM TABLE VII.  9/73
M   1    (1960.)                  LANGBEIN  73 IPWA    PI N-K SIG,SOL 1  9/73
M   1  NOT SEEN IN SOLUTION 2 CF LANGBEIN73                              9/73
M        (2049.)                  AYED      74 IPWA                      2/74

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Data Card Listings

For notation, see key at front of Listings.

Baryons

N(1990), N(2000), N(2040)

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              17   N*1/2(1990) WIDTH (MEV)

W   3      (225.0)                   DONNACH1  68 RVUE                          8/69
W   3      (250.)                    KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
W   7      (200.)                    ALMEHED   72 IPWA                          2/72
W   1      (300.)                    HICKS     73 MPWA    GAM P-ETA P           9/73
W   1      (170.)                    LANGBEIN  73 IPWA    PI N-K SIG,SOL 1      9/73
W          (119.)                    AYED      74 IPWA                          2/74

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              17   N*1/2(1990) PARTIAL DECAY MODES

                                                                 DECAY MASSES
P1     N*1/2(1990) INTO PI N                                    139+ 938
P2     N*1/2(1990) INTO N PI PI                                 938+ 139+ 139
P3     N*1/2(1990) INTO N ETA                                   939+ 548
P4     N*1/2(1990) INTO LAMBDA K                               1115+ 497
P5     N*1/2(1990) INTO GAM P,HELICITY=3/2                        0+ 938
P6     N*1/2(1990) INTO GAM P,HELICITY=1/2                        0+ 938
P7     N*1/2(1990) INTO GAM N,HELICITY=3/2                        0+ 939
P8     N*1/2(1990) INTO GAM N,HELICITY=1/2                        0+ 939
P9     N*1/2(1990) INTO K SIGMA                                 493+1189

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              17   N*1/2(1990) BRANCHING RATIOS

R1     N*1/2(1990) INTO (PI N)/TOTAL                       (P1)
R1  3        (.09)                   KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
R1  7        (0.15)                  ALMEHED   72 IPWA                          2/72
R1           (.064)                  AYED      74 IPWA                          2/74

R2     N*1/2(1990) INTO (N ETA)/TOTAL                      (P3)
R2  B       (0.02)   (0.02)          DEANS     69 MPWA     T POLE + RESON.      5/70
R2  B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R3     N*1/2(1990) FROM GAMMA PROTON TO K LAMBDA           SQRT((P5+P6)*P4)     9/73
R3          .0034                    DEANS     72 MPWA     GAM P-K LM,SOL D     9/73

R4     N*1/2(1990) FROM GAMMA PROTON TO ETA PROTON         SQRT((P5+P6)*P3)     9/73
R4  1        (.0045)                 HICKS     73 MPWA     GAM P-ETA P          9/73

R5     N*1/2(1990) FROM PI N TO K SIGMA                    SQRT(P1*P9)          9/73
R5  1        (.06)                   LANGBEIN  73 IPWA     PI N-K SIG,SOL 1     9/73
R5  2       (.010)TO   .023          DEANS     75 DPWA     PI N TO K SIGMA  11/75*
R5  2   RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                            11/75*

R6     N*1/2(1990) FROM PI N TO K LAMBDA                   SQRT(P1*P4)       4/75*
R6         -.021      .033           DEVENISH  74          0 FIXED T DISP REL 4/75*

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              17   N*1/2(1990) PHOTON DECAY AMPL(GEV**-1/2)

     FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
   REVIEW PRECEDING THE BARYON LISTINGS.

A1     N*1/2(1990) INTO GAM P, HELICITY=1/2  (GEV**-1/2)                    1/76*
A1           (+.011)                 BARBOUR   76 DPWA     PI N PHOTO-PROD  1/76*

A2     N*1/2(1990) INTO GAM P, HELICITY=3/2  (GEV**-1/2)                    1/76*
A2           (-.008)                 BARBOUR   76 DPWA     PI N PHOTO-PROD  1/76*

A3     N*1/2(1990) INTO GAM N, HELICITY=1/2  (GEV**-1/2)                    1/76*
A3           (-.099)                 BARBOUR   76 DPWA     PI N PHOTO-PROD  1/76*

A4     N*1/2(1990) INTO GAM N, HELICITY=3/2  (GEV**-1/2)                    1/76*
A4           (-.070)                 BARBOUR   76 DPWA     PI N PHOTO-PROD  1/76*

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                             REFERENCES FOR N*1/2(1990)
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DONNACH1 68 PL 26B 161        A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
KIRSOPP  68 THESIS            R G KIRSOPP                          (EDIN)

DEANS    69 PR 185 1797       S DEANS, J WOOTEN           (UNIV S FLORIDA)
LEA      69 PL 29B 584        LEA,OADES,WARD,COWAN,+  (RHEL,BRISTOL,CARE)

ALMEHED  72 NP B40 157        +LOVELACE                          (RUTG)IJP
DEANS    72 PRD 6 1906        DEANS,JACOBS, LYONS,MONTGOMERY (SOUTH FLA.)IJP
HICKS    73 PRD 7 2614        +DEANS,JACOBS,LYONS+ (CARN+ORNL+SOUTH FLA.)IJP
LANGBEIN 73 NP B53 251        LANGBEIN,WAGNER                  (MUNICH)IJP

AYED     74 PRIVATE COMMCTN.  AYED,BAREYRE                       (SACL)IJP
   ALSO 73 AIX CONFERENCE     AYED,BAREYRE                       (SACL)IJP
DEVENISH 74 NP B81 330        DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEANS    75 NP B96 90         +MITCHELL,MONTGOMERY,+       (SFLA,ALABAMA)IJP

BARBOUR  76 SBMTD. TO NP      I. M. BARBOUR,R. L. CRAWFORD       (GLAS)IJP

                              PAPERS NOT REFERRED TO IN DATA CARDS.

DEANS    69 PR  177 2623      S R DEANS                   (UNIV S FLORIDA)
AYED     70 PL 31B 598        +BAREYRE,VILLET                    (SACLAY)
APLIN    71 NP  B32 253       +COWAN,GIBSON,GILMORE++         (RHEL,BRISTOL)
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N(2000) → 06 N*1/2(2000, JP=5/2+) I=1/2 **F''15**

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               THE MOST RECENT PI N PARTIAL WAVE ANALYSIS, AYED 74,
               FINDS EVIDENCE FOR THIS STATE.  THERE IS ALSO SOME
               INDICATION IN ASSOCIATED PRODUCTION.

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              06   N*1/2(2000) MASS (MEV)

M   7      (2175.)                   ALMEHED   72 IPWA                          2/72
M          (1930.)                   DEANS     72 MPWA    GAM P-K LM,SOL D      9/73
M   1      (1970.)                   LANGBEIN  73 IPWA    PI N-K SIG,SOL 2      9/73
M   1   NOT SEEN IN SOLUTION 1 OF LANGBEIN73                                    9/73
M          (1989.)                   AYED      74 IPWA                          2/74

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              06   N*1/2(2000) WIDTH (MEV)

W   7      (150.)                    ALMEHED   72 IPWA                          2/72
W          (112.)                    DEANS     72 MPWA    GAM P-K LM,SOL D      9/73
W   1      (170.)                    LANGBEIN  73 IPWA    PI N-K SIG,SOL 2      9/73
W          (179.)                    AYED      74 IPWA                          2/74

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              06   N*1/2(2000) PARTIAL DECAY MODES

                                                                 DECAY MASSES
P1     N*1/2(2000) INTO PI N                                    139+ 938
P2     N*1/2(2000) INTO LAMBDA K                               1115+ 497
P3     N*1/2(2000) INTO GAM P,HELICITY=3/2                        0+ 938
P4     N*1/2(2000) INTO GAM P,HELICITY=1/2                        0+ 938
P5     N*1/2(2000) INTO GAM N,HELICITY=3/2                        0+ 939
P6     N*1/2(2000) INTO GAM N,HELICITY=1/2                        0+ 939
P7     N*1/2(2000) INTO K SIGMA                                 493+1189

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              06   N*1/2(2000) BRANCHING RATIOS

R1     N*1/2(2000) INTO (PI N)/TOTAL                       (P1)
R1  7        (0.25)                  ALMEHED   72 IPWA                          2/72
R1           (.08)                   AYED      74 IPWA                          2/74

R2     N*1/2(2000) FROM GAMMA PROTON TO K LAMBDA           SQRT((P3+P4)*P2)     9/73
R2           (.0022)                 DEANS     72 MPWA     GAM P-K LM,SOL D     9/73

R3     N*1/2(2000) FROM PI N TO K SIGMA                    SQRT(P1*P7)          9/73
R3  1        (.05)                   LANGBEIN  73 IPWA     PI N-K SIG,SOL 2     9/73
R3  2        (.022)                  DEANS     75 DPWA     PI N TO K SIGMA  11/75*
R3  2   VALUE GIVEN IS FROM SOLUTION 1, NOT PRESENT IN SOLUTIONS 2,3,4.     11/75*

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                             REFERENCES FOR N*1/2(2000)
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ALMEHED  72 NP B40 157        +LOVELACE                          (RUTG)IJP
DEANS    72 PRD 6 1906        DEANS,JACOBS, LYONS,MONTGOMERY (SOUTH FLA.)IJP
LANGBEIN 73 NP B53 251        LANGBEIN,WAGNER                  (MUNICH)IJP
AYED     74 PRIVATE COMMCTN.  AYED,BAREYRE                       (SACL)IJP
   ALSO 73 AIX CONFERENCE     AYED,BAREYRE                       (SACL)IJP
DEANS    75 NP B96 90         +MITCHELL,MONTGOMERY,+       (SFLA,ALABAMA)IJP
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N(2040) → 16 N*1/2(2040, JP=3/2-) I=1/2 **D'''13**

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               THIS STATE IS NOW SEEN BY THE SACLAY GROUP, AYED 74.

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              16   N*1/2(2040) MASS (MEV)

M   3      (2057.0)                  DONNACH1  68 RVUE    PHASE-SHIFT ANAL      6/68
M   3      (2030.)                   DONNACH2  68 RVUE    PHAS.SHIFT-CERN1     10/69
M   3      (2040.)                   KIRSOPP   68 RVUE    PHASE SHIFT ANAL     10/69
M   3   WHERE MAX. ABSORPTION IS -DONNACH1, 2  ,KIRSOPP EYEBALL FIT CERN 1     10/69
M   X      (2030.0)          APPROX  LEA       69 CNTR    PI-P ELASTIC          8/69
M   X   SEE ALSO APLIN 71
M   7      (2075.)                   ALMEHED   72 IPWA                          2/72
M   1      (2090.)                   HICKS     73 MPWA    GAM P-ETA P           9/73
M   1   ONLY STATES FROM TABLE VII OF HICKS73 ARE INCLUDED IN LISTINGS.         9/73
M   1   M AND W ARE FROM SOLUTION C2,ER=SQRT(G)/W WITH G FROM TABLE VII.        9/73
M          (2029.)                   AYED      74 IPWA                          2/74

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              16   N*1/2(2040) WIDTH (MEV)

W          (293.0)                   DONNACH1  68 RVUE                          8/69
W   3      (290.)                    DONNACH2  68 RVUE    PHAS.SHIFT-CERN1     10/69
W   3      (240.)                    KIRSOPP   68 RVUE    PHASE SHIFT ANAL     10/69
W   7      (150.)                    ALMEHED   72 IPWA                          2/72
W   1      (224.)                    HICKS     73 MPWA    GAM P-ETA P           9/73
W          (116.)                    AYED      74 IPWA                          2/74
     SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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              16   N*1/2(2040) PARTIAL DECAY MODES

                                                                 DECAY MASSES
P1     N*1/2(2040) INTO PI N                                    139+ 938
P2     N*1/2(2040) INTO N PI PI                                 938+ 139+ 139
P3     N*1/2(2040) INTO N ETA                                   939+ 548
P4     N*1/2(2040) INTO LAMBDA K                               1115+ 497
P5     N*1/2(2040) INTO GAM P,HELICITY=3/2                        0+ 938
P6     N*1/2(2040) INTO GAM P,HELICITY=1/2                        0+ 938
P7     N*1/2(2040) INTO GAM N,HELICITY=3/2                        0+ 939
P8     N*1/2(2040) INTO GAM N,HELICITY=1/2                        0+ 939
P9     N*1/2(2040) INTO SIGMA K                                 493+1189

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              16   N*1/2(2040) BRANCHING RATIOS

R1     N*1/2(2040) INTO (PI N)/TOTAL                       (P1)
R1  3        (.26)                   DONNACH2  68 RVUE     PHAS.SHIFT-CERN1 10/69
R1  3        (.15)                   KIRSOPP   68 RVUE     PHASE SHIFT ANAL 10/69
R1  7        (0.3)                   ALMEHED   72 IPWA                          2/72
R1           (.100)                  AYED      74 IPWA                          2/74

R2     N*1/2(2040) INTO (N ETA)/TOTAL                      (P3)
R2  B       (0.)    OR 0.009         CARRERAS  70 MPWA     T POLE + RESON.      5/70
R2  B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R3     N*1/2(2040) FROM GAMMA PROTON TO K LAMBDA           SQRT((P5+P6)*P4)     9/73
R3           (.0070)                 DEANS     72 MPWA     GAM P-K LM,SOL D     9/73

R4     N*1/2(2040) FROM GAMMA PROTON TO ETA PROTON         SQRT((P5+P6)*P3)     9/73
R4  1        (.0037)                 HICKS     73 MPWA     GAM P-ETA P          9/73

R5     N*1/2(2040) FROM PI N TO K SIGMA                    SQRT(P1*P9)       11/75*
R5  2       (.014)TO   .037          DEANS     75 DPWA     PI N TO K SIGMA  11/75*
R5  2   RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                            11/75*

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Baryons
N(2040), N(2100), N(2190)

Data Card Listings
For notation, see key at front of Listings.

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               16  N*1/2(2040) PHOTCN DECAY AMPL(GEV**-1/2)

     FCR DEFINITICN OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
     REVIEW PRECEDING THE BARYON LISTINGS.

A1     N*1/2(2040) INTO GAM P, HELICITY=1/2  (GEV**-1/2)
A1           .026     .052          DEVENIS2  74 DPWA    PI N PHOTO-PROD   4/75*

A2     N*1/2(2040) INTO GAM P, HELICITY=3/2  (GEV**-1/2)
A2           .128     .057          DEVENIS2  74 DPWA    PI N PHOTC-PRCD   4/75*

A3     N*1/2(2040) INTO GAM N, HELICITY=1/2  (GEV**-1/2)
A3           .053     .083          DEVENIS2  74 DPWA    PI N PHOTO-PROD   4/75*

A4     N*1/2(2040) INTO GAM N, HELICITY=3/2  (GEV**-1/2)
A4           .100     .141          DEVENIS2  74 DPWA    PI N PHCTC-PRCD   4/75*

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                         REFERENCES FOR N*1/2(2040)

DONNACH1 68 PL 26B 161          A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
DONNACH2 68 VIENNA 139          DONNACHIE  RAPPORTEUR.S TALK          (GLAS)
KIRSOPP  68 THESIS              R G KIRSOPP                           (EDIN)

LEA      69 PL 29B 584          LEA,OADES,WARD,COWAN,+  (RHEL,BRISTOL,DARE)

CARRERAS 70 NP 16B 35           B CARRERAS, A DONNACHIE          (DARE,MCHS)

ALMEHED  72 NP B40 157          +LOVELACE                       (LUND,RUTG)IJP
DEANS    72 PRD 6 1906          DEANS,JACOBS, LYONS,MONTGOMERY (SOUTH FLA.)IJP
HICKS    73 PRD 7 2614          +DEANS,JACOBS,LYONS+ (CARN+ORNL+SOUTH FLA.)IJP

AYED      74 PRIVATE COMMCTN.   AYED,BAREYRE                         (SACL)IJP
  ALSO 73 AIX CONFERENCE        AYED,BAREYRE                         (SACL)IJP
DEVENIS2 74 PL 52B 227          DEVENISH,LYTH,RANKIN        (DESY,LANC,BCNN)IJP
DEANS    75 NP B96 90           +MITCHELL,MONTGOMERY,+        (SFLA,ALABAMA)IJP

                                PAPERS NOT REFERRED TO IN DATA CARDS.

DCNNACHI 69 NP 10B 433          A DCNNACHIE, R KIRSOPP           (GLAS+EDIN)
AYED     70 PL 31B 598          +BAREYRE,VILLET                       (SACLAY)
APLIN    71 NP B32 253          +COWAN,GIBSON,GILMCRE++        (RHEL,BRISTOL)
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N(2100) — S''_{11}

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     04  N*1/2(2100, JP=1/2-) I=1/2
         NOW ALSC SEEN BY SACLAY, AYED 74.

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               04  N*1/2(2100) MASS (MEV)

M         (2070.)                       ROYCHOUD  71 DPWA                  3/72
M    7    (2100.)                       ALMEHED   72 IPWA                  2/72
M         (2283.)                       AYED      74 IPWA                  2/74

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               04  N*1/2(2100) WIDTH (MEV)

W    7    (200.)                        ALMEHED   72 IPWA                  2/72
W         (310.)                        AYED      74 IPWA                  2/74

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               04  N*1/2(2100) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1     N*1/2(2100) INTO PI N                               139+ 938

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               04  N*1/2(2100) BRANCHING RATIOS

R1     N*1/2(2100) INTO (PI N)/TOTAL                        (P1)
R1   7      (0.5)                       ALMEHED   72 IPWA                  2/72
R1          (.14)                       AYED      74 IPWA                  2/74

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                         REFERENCES FOR N*1/2(2100)

ROYCHOUD 71 NP B27 125          R K ROYCHOUDHURY,B H BRANSDEN        (DURH)IJP
ALMEHED  72 NP B40 157          +LOVELACE                       (LUND,RUTG)IJP
AYED      74 PRIVATE COMMCTN.   AYEC,BAREYRE                         (SACL)IJP
  ALSO 73 AIX CONFERENCE        AYED,BAREYRE                         (SACL)IJP

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N(2100) — D''_{15}

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     05  N*1/2(2100, JP=5/2-) I=1/2
         NOW ALSC SEEN BY SACLAY, AYED 74.

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               05  N*1/2(2100) MASS (MEV)

M    7    (2100.)                       ALMEHED   72 IPWA                  2/72
M         (2100.)                       AYED      74 IPWA                  2/74

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               05  N*1/2(2100) WIDTH (MEV)

W    7     (150.)                       ALMEHED   72 IPWA                  2/72
W          (220.)                       AYED      74 IPWA                  2/74

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               05  N*1/2(2100) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1     N*1/2(2100) INTO PI N                               139+ 938

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               05  N*1/2(2100) BRANCHING RATIOS

R1     N*1/2(2100) INTO (PI N)/TOTAL                        (P1)
R1   7      (0.2)                       ALMEHED   72 IPWA                  2/72
R1          (.08)                       AYED      74 IPWA                  2/74

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                         REFERENCES FOR N*1/2(2100)

ALMEHED  72 NP B40 157          +LOVELACE                       (LUND,RUTG)IJP
AYED      74 PRIVATE COMMCTN.   AYED,BAREYRE                         (SACL)IJP
  ALSO 73 AIX CONFERENCE        AYED,BAREYRE                         (SACL)IJP

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N(2190) — G_{17}

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     71  N*1/2(2190, JP=7/2-) I=1/2
         ROYCHOUDHURY 71 FIND SOME INDICATION OF P11 AND F17 IN
         THIS REGION.BRANSDEN 71 ALSO FIND P11,F15,AND G19 RESO-
         NANT NEAR THIS MASS.  AYED 74 FIND A G19.

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               71  N*1/2(2190) MASS (MEV)

M         (2190.0)                      DIDDENS   63 CNTR    PI+- P TOTAL
M         (2210.0)                      HOHLER    64 RVUE    DATA + DISP REL
M         (2190.0)        APPROX        YOKOSAWA  66 CNTR    PI- P DSIG + POL  7/66
M    3    (2265.0)                      DONNACH1  68 RVUE    PHASE-SHIFT ANAL  6/68
M         (2000.0)        APPROX        LEA       69 CNTR    PI-P ELASTIC      8/69
M          2180.      25.               ANDERSON  70 MMS   - PI- P TO PI- MMS  2/71
M    6    (2158.0)                      AYED      70 IPWA                      1/71
M    6  FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M         (2260.0)                      HULL      70 MPWA    SMALL ANGLE PI-P  1/71
M         (2160.0)    (50.0)            AMALDI    71 CNTR    P P AT 24 GEV    10/71
M         (2160.)                       BRANSDEN  71 DPWA                      3/72
M         (2200.)                       ROYCHOUD  71 DPWA                      3/72
M    7    (2225.)                       ALMEHED   72 IPWA                      2/72
M         (2190.)                       OTT       72 MPWA  0 PI-P BKWD ELSTC   2/73
M     1   (2208.)                       HICKS     73 MPWA    GAM P-ETA P       9/73
M     1 ONLY STATES FROM TABLE VII OF HICKS73 ARE INCLUCED IN LISTINGS.        9/73
M     1 M AND W ARE FROM SOLUTION C2,BR=SQRT(G)/W WITH G FROM TABLE VII.       9/73
M         (2208.)     (20.)             ABE       74       + P+P->P+X,JCBN PK  4/75*
M         (2141.)                       AYED      74 IPWA                      2/74
M    2    (2133.)                       AYED      74 IPWA                      2/74
M    2  THIS IS A G19 RESONANCE LISTED HERE UNTIL CONFIRMED.                   2/74

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               71  N*1/2(2190) WIDTH (MEV)

W          (200.0)                      DIDDENS   63 CNTR
W          (200.0)                      HOHLER    64 RVUE                      7/66
W          (220.0)        APPROX        YOKOSAWA  66 CNTR                      7/66
W    3     (298.0)                      DONNACH1  68 RVUE                      6/68
W           275.      70.               ANDERSON  70 MMS   - PI- P TO PI- MMS  2/71
W    6     (325.0)                      AYED      70 IPWA                      1/71
W          (239.0)                      HULL      70 MPWA    SMALL ANGLE PI-P  1/71
W    7     (150.)                       ALMEHED   72 IPWA                      2/72
W     1    (193.)                       HICKS     73 MPWA    GAM P-ETA P       9/73
W          (243.)                       AYED      74 IPWA                      2/74
W    2     (193.)                       AYED      74 IPWA                      2/74
       SEE THE NOTES ACCOMPANYING THE MASSES QUOTEC.

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               71  N*1/2(2190) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1     N*1/2(2190) INTO PI N                               139+ 938
P2     N*1/2(2190) INTC LAMBCA K                           1115+1765
P3     N*1/2(2190) INTO N PI PI                            938+ 139+ 139
P4     N*1/2(2190) INTO GAM P,HELICITY=3/2                   0+ 938
P5     N*1/2(2190) INTO GAM P,HELICITY=1/2                   0+ 938
P6     N*1/2(2190) INTO GAM N,HELICITY=3/2                   0+ 939
P7     N*1/2(2190) INTC GAM N,HELICITY=1/2                   0+ 939
P8     N*1/2(2190) INTO ETA N                              548+ 938
P9     N*1/2(2190) INTO SIGMA K                            493+1189

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               71  N*1/2(2190) BRANCHING RATIOS

R1     N*1/2(2190) INTO (PI N)/TOTAL                        (P1)
R1          (0.3)         APPROX        DIDDENS   63 CNTR                      7/66
R1          (0.3)         APPROX        YOKOSAWA  66 CNTR                      7/66
R1   3      (0.349)                     DCNNACH1  68 RVUE                      6/68
R1   6      (0.150)                     AYED      70 IPWA                      1/71
R1          (0.09)                      HULL      70 MPWA    SMALL ANGLE PI-P  1/71
R1   7      (0.35)                      ALMEHED   72 IPWA                      2/72
R1           (.25)                      OTT       72 MPWA  0 PI-P BKWD ELSTC   2/73
R1           (.161)                     AYED      74 IPWA                      2/74
R1   2       (.095)                     AYED      74 IPWA                      2/74

R2     N*1/2(2190) FROM GAMMA PROTON TO K LAMBDA            SQRT((P4+P5)*P2)   9/73
R2          (.0161)                     DEANS     72 MPWA    GAM P-K LM,SOL D  9/73

R3     N*1/2(2190) FROM GAMMA PROTCN TO ETA PROTCN          SQRT((P4+P5)*P8)   9/73
R3          (.0094)                     HICKS     73 MPWA    GAM P-ETA P       9/73

R4     N*1/2(2190) FROM PI N TO K SIGMA                     SQRT(P1*P9)       11/75*
R4   4      (.014)TO  .019              DEANS     75 DPWA    PI N TO K SIGMA  11/75*
R4   4  RANGE GIVEN IS FRCM FOUR BEST SOLUTICNS.                              11/75*

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                         REFERENCES FOR N*1/2(2190)

DIDDENS  63 PRL 10 262          +JENKINS, KYCIA, RILEY                 (BNL) I
HOHLER   64 PL 12 149           G HOHLER, J GIESECKE             (KARLSRUHE) I
YOKOSAWA 66 PRL 16 714          +SUWA,HILL,ESTERLING, BOOTH        (ANL,CHIC) JP

DONNACH1 68 PL 26B 161          A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
   ALSO 68 VIENNA 139           DCNNACHIE  RAPPORTEUR.S TALK          (GLAS)
   ALSO 68 THESIS               R G KIRSOPP                           (EDIN)

LEA      69 PL 29B 584          LEA,OADES,WARD,COWAN,+  (RHEL,BRISTOL,DARE)

ANDERSON 70 PRL 25,699          +BLESER,BLIEDEN,COLLINS++         (BNL,CARN)
AYED     70 KIEV CONF           R AYED,P BAREYRE, G VILLET           (SACL)IJP
HULL     70 PR D2 1783          J HULL, R LEACOCK                     (ISU)
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Data Card Listings

For notation, see key at front of Listings.

Baryons

N(2190), N(2220), N(2650), N(3030), $N_?(3245)$


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AMALDI   71 PL  34B 435        +BIANCASTELLI,BOSIO,+  (I SANITA ROMA+CERN)
BRANSDEN 71 NP B26 511         ,OGDEN                          (DURH)IJP
   ALSC  70 NP B16 461         ROYCHOUDHURY,PERRIN,BRANSDEN    (DURH)IJP
ROYCHOUD 71 NP B27 125         R K ROYCHOUDHURY,B H BRANSDEN   (DURH)IJP

ALMEHED  72 NP B40 157         +LOVELACE                  (LUND,RUTG)IJP
DEANS    72 PRD 6 1906         DEANS,JACOBS, LYONS,MCNTGOMERY (SOUTH FLA.)IJP
OTT      72 PL 42B 133         +TRISCHUK,VAVRA,RICHARDS,+ (MCGI,STLO,IOWA)IJP
   ALSO  72 MCGILL THESIS     J.VAVRA                         (MCGI) JP
HICKS    73 PRD 7 2614         +DEANS,JACOBS,LYCNS+ (CARN+ORNL+SOUTH FLA.)IJP

ABE      74 PL 53B 114         +ALSPECTOR,BCMBEROWITZ+    (RUTG,UPNJ,FSU)
AYED     74 PRIVATE COMMCTN.   AYED,BAREYRE                    (SACL)IJP
   ALSO  73 AIX CONFERENCE     AYED,BAREYRE                    (SACL)IJP
DEANS    75 NP B96 90          +MITCHELL,MCNTGCMERY,+     (SFLA,ALABAMA)IJP

                    PAPERS NOT REFERRED TO IN DATA CARDS.

AYED     70 PL 31B 598         +BAREYRE,VILLET                 (SACLAY)

         QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN DATA CARDS.

BARGER   66 PRL 16 913         V BARGER, D CLINE               (WISC) P
CARROLL  66 PRL 16 288         +CORBETT,DAMERELL,MIDDLEMAS, +  (RHEL,OXF)J-L
CARROLL  66 PRL 17 1274        +CORBETT,DAMERELL,MIDDLEMAS, +  (RHEL,OXF)J-L
  ERRATUM CHANGING THE RATHER WEAK DETERMINATION OF J-L TO +1      (2.)
KORMANYO 66 PRL 16 709         KORMANYOS,KRISCH,OFALLON, +     (MICH,ANL) P
BUSZA    67 NC 52A 331         +DAVIS,DUFF,HEYMANN, +     (LOUC,WESTFIELD)
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N(2220) — H19

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90  N*1/2(2220, JP=9/2+) I=1/2

THE EXISTENCE OF THIS RESONANCE IS WELL ESTABLISHED.

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                90  N*1/2(2220) MASS (MEV)

M       (2200.)    APPROX.           BUSZA    67 OSPK   LEG.POLYN.ANAL.   2/71
M   6   (2221.0)                     AYED     70 IPWA                     1/71
M   6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M       (2245.0)                     HULL     70 MPWA   SMALL ANGLE PI-P  1/71
M       (2249.)                      AYED     74 IPWA                     2/74

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                90  N*1/2(2220) WIDTH (MEV)

W   6   (258.0)                      AYED     70 IPWA                     1/71
W       (329.0)                      HULL     70 MPWA   SMALL ANGLE PI-P  1/71
W       (347.)                       AYED     74 IPWA                     2/74

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                90  N*1/2(2220) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      N*1/2(2220) INTO PI N                            139+ 938
P2      N*1/2(2220) INTO N ETA                           939+ 548

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                90  N*1/2(2220) BRANCHING RATIOS

R1      N*1/2(2220) INTO (PI N)/TOTAL                    (P1)
R1  6     (0.140)                    AYED     70 IPWA                     1/71
R1        (0.15)                     HULL     70 MPWA   SMALL ANGLE PI-P  1/71
R1        (.204)                     AYED     74 IPWA                     2/74

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                         REFERENCES FOR N*1/2(2220)

BUSZA    67 NC 52A 331         +DAVIS,DUFF,HEYMANN,NIMMON +   (LOUC+LOWC)
AYED     70 KIEV CONF          R AYED,P BAREYRE, G VILLET       (SACL)IJP
HULL     70 PR D2 1783         J HULL, R LEACOCK                (ISU)
AYED     74 PRIVATE COMMCTN.   AYED,BAREYRE                     (SACL)IJP
   ALSO  73 AIX CONFERENCE     AYED,BAREYRE                     (SACL)IJP

                         PAPERS NOT REFERED TO IN DATA CARDS

AYED     70 PL 31B 598         +BAREYRE,VILLET                  (SACLAY)
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N(2650) BUMPS

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72  N*1/2(2650, JP=     ) I=1/2  PRODUCTION EXPERIMENTS

ROYCHOUDHURY 71 CLAIM F15(2400) AND G19(2400) TO BE
POSSIBLE RESONANCES. BRANSDEN 71 FIND THE POSSIBLE
RESONANT CANDIDATES S11(2520) AND H19(2590).

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                72  N*1/2(2650) MASS (MEV) (PROD. EXP.)

M       (2700.0)                     ALVAREZ  64 CNTR   PI PHCTOPROD
M       (2660.0)                     HOHLER   64 RVUE   DATA + DISP REL
M       (2600.0)        APPROX       WAHLIG   64 OSPK 0 PI-P CH EX
M       (2633.0)                     BARGER   66 FIT    TOTAL + CH EX    11/67
M        2649.0      10.0            CITRON   66 CNTR   PI+- P TOTAL      7/66

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                72  N*1/2(2650) WIDTH (MEV) (PROD. EXP.)

W       (100.0)                      ALVAREZ  64 CNTR
W       (200.0)                      HOHLER   64 RVUE                     7/66
W       (425.0)                      BARGER   66 FIT    TOTAL + CH EX    11/67
W        360.0       20.0            CITRON   66 CNTR                     7/66

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                72  N*1/2(2650) PARTIAL DECAY MODES (PROD. EXP.)

                                                          DECAY MASSES
P1      N*1/2(2650) INTO PI N                            139+ 938
P2      N*1/2(2650) INTO LAMBDA K                        1115+ 497
P3      N*1/2(2650) INTO N PI PI                         938+ 139+ 139

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                72  N*1/2(2650) BRANCHING RATIOS (PROD. EXP.)

R1      N*1/2(2650) INTO (PI N)/TOTAL                    (P1)
R1    CNLY (J+1/2)*( PI N/TOTAL) MEASURED FOR THIS STATE
R1  B      (0.456)  (0.018)          BARGER   66 RVUE   TOTAL + CH EXC.  11/67
R1          0.436    0.028           CITRON   66 CNTR   TOTAL CROSS-SEC. 11/67
R1  B      (0.30)                    BARGER   67 RVUE   USES KORMANYOS67 11/67
R1  B   USES REGGE AMP.+RESON. TO CALCULATE DIF. CRCSS SECTIONS AT 180 DEGRE
R1  B   FOR CRITICISM OF THIS METHOD, SEE DOLEN 68.
R1  D      (0.24)                    DIKMEN   67 RVUE   USES KOFMANYOS66 11/67
R1  D   USES ONLY RESONANCES TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGREES
R1         (0.06)                    KORMANYOS 67 CNTR  PI-P AT 180 DEG. 11/67

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                    REFERENCES FOR N*1/2(2650) (PROD. EXP.)

ALVAREZ  64 PRL 12 710         +BAR-YAM,KERN,LUCKEY,OSBORNE, +   (MIT,CEA)
HOHLER   64 PL 12 149          G HOHLER, J GIESECKE         (KARLSRUHE) I
WAHLIG   64 PRL 13 103         +MANNELLI,SODICKSON,FACKLER,WARD, +   (MIT)
BARGER   66 PR 151 1123        V BARGER, M OLSSON                   (WISC)
CITRON   66 PR 144 1101        +GALBRAITH,KYCIA,LEONTIC,PHILLIPS, + (BNL) I
BARGER   67 PR 155 1792        V BARGER, D CLINE                  (WISC) P
DIKMEN   67 PRL 18 798         F N DIKMEN                           (MICH)
KORMANYO 67 PR 164 1661        KORMANYOS, KRISCH, OFALLON, +   (MICH,ANL) P

                    PAPERS NOT REFERREC TO IN DATA CARDS.

BAACKE   67 NC 51A 761         J BAACKE, M YVERT        (KARLSRUHE,ORSAY)J-L
DOLEN    68 PR 166 1768        R DOLEN, D HORN, C SCHMID             (CIT)
WAHLIG   68 PR 168 1515        M A WAHLIG, I MANNELLI           (MIT,PISA)
   FINAL VERSION OF DATA USED IN WAHLIG 64.  IN CONJUNCTION WITH
   CITRON 66 TOTAL CROSS SECTIONS, THIS CHARGE EXCHANGE DATA GIVES
   CCMPLEX ELASTIC SCATTERING AMPLITUDE AT 0 DEGREES.

BRANSDEN 71 NP B26 511         ,OGDEN                          (DURH)IJP
   ALSO  70 NP B16 461         ROYCHOUDHURY,PERRIN,BRANSDEN    (DURH)IJP
ROYCHOUD 71 NP B27 125         R K ROYCHOUDHURY,B H BRANSDEN   (DURH)IJP
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N(3030) BUMPS

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73  N*1/2(3030, JP=     ) I=1/2  PRODUCTION EXPERIMENTS

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                73  N*1/2(3030) MASS (MEV) (PROD. EXP.)

M       (3080.0)                     HOHLER   64 RVUE   DATA + DISP REL   7/66
M       (3030.0)                     CITRON   66 CNTR   PI+- P TOTAL      7/66

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                73  N*1/2(3030) WIDTH (MEV) (PROD. EXP.)

W       (400.0)                      CITRON   66 CNTR                     7/66

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                73  N*1/2(3030) PARTIAL DECAY MODES (PROD. EXP.)

                                                          DECAY MASSES
P1      N*1/2(3030) INTO PI N                            139+ 938
P2      N*1/2(3030) INTO N PI PI                         938+ 139+ 139

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                73  N*1/2(3030) BRANCHING RATIOS (PROD. EXP.)

R1      N*1/2(3030) INTO (PI N)/TOTAL                    (P1)
R1    CNLY (J+1/2)*( PI N/TOTAL) MEASURED FOR THIS STATE
R1  B      (0.088)  (0.016)          BARGER   66 RVUE   TOTAL + CH EXC.  11/67
R1         (0.048)                   CITRON   66 CNTR   TOTAL CROS.SEC.  11/67
R1  B      (0.12)                    BARGER   67 CNTR   USES KORMANYOS66 11/67
R1  B   USES REGGE AMP.+RESON. TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGRE
R1  B   FOR CRITICISM OF THIS METHCD, SEE DCLEN 68.
R1  D      (0.016)                   DIKMEN   67 RVUE   USES KORMANYOS67 11/67
R1  D   USES ONLY RESONANCES TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGREES

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                    REFERENCES FOR N*1/2(3030) (PROD. EXP.)

HOHLER   64 PL 12 149          G HCHLER, J GIESECKE         (KARLSRUHE) I
BARGER   66 PR 151 1123        V BARGER, M OLSSON                   (WISC)
CITRON   66 PR 144 1101        +GALBRAITH,KYCIA,LEONTIC,PHILLIPS, + (BNL) I
BARGER   67 PR 155 1792        V BARGER, D CLINE                  (WISC) P
DIKMEN   67 PRL 18 798         F N DIKMEN                           (MICH)

                    PAPERS NOT REFERREC TO IN DATA CARDS

KORMANYO 67 PR 164 1661        KORMANYOS, KRISCH, OFALLCN, +   (MICH,ANL) P
DOLEN    68 PR 166 1768        R DOLEN, D HCRN, C SCHMID             (CIT)
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$N_?(3245)$ BUMPS →

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74  N* /2(3245, JP=     )            PRODUCTION EXPERIMENTS

EXISTENCE NOT CONCLUSIVELY ESTABLISHED.  I-SPIN
NOT DETERMINED, BUT THE NARROW WIDTH PRECLUDES
IDENTIFICATION WITH THE N*3/2(3230).
OMITTED FROM TABLE.

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                74  N* /2(3245) MASS (MEV) (PROD. EXP.)

M        3245.0      10.0            KORMANYCS 67 CNTR  PI-P 180 DEG EL   6/68

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                74  N* /2(3245) WIDTH (MEV) (PROD. EXP.)

W        (35.0)  OR LESS             KORMANYCS 67 CNTR                    6/68

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Baryons
N?(3245), N(3690), N?(3755), Δ(1232)

Data Card Listings
For notation, see key at front of Listings.

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              74  N* /2(3245) PARTIAL DECAY MODES (PROD. EXP.)
                                                              DECAY MASSES
P1      N* /2(3245) INTO PI N                                 139+ 938
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              74  N* /2(3245) BRANCHING RATIOS (PROD. EXP.)

R1      N* /2(3245) INTO (PI N)/TCTAL                  (P1)
R1      J IS NOT KNOWN.  FOLLOWING IS (J+1/2)*(PI N)/TOTAL
R1           (0.37)                   KORMANYOS 67 CNTR                    6/68

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                      REFERENCES FOR N* /2(3245) (PROD. EXP.)

KORMANYO 67 PR 164 1661       KORMANYOS, KRISCH, OFALLON, +     (MICH,ANL) P

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N(3690) BUMPS

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 75  N*1/2(3690, JP=      ) I=1/2  PRODUCTION EXPERIMENTS
     A BUMP SEEN IN THE INVARIANT MASS OF A VERY COMPLI-
     CATED STATE (N + SEVEN PIS), SO AS EVIDENCE FOR
     A NEW RESONANCE IT IS NOT CONCLUSIVE.  NOT INCLUDED
     IN TABLE.
------ --------- --------- --------- --------- --------- --------- --------

              75  N*1/2(3690) MASS (MEV) (PROD. EXP.)

M          3690.0     10.0            BARTKE    67 HBC  + PI+P 8 PRONGS    8/67
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              75  N*1/2(3690) WIDTH (MEV) (PROD. EXP.)

W            50.0     30.0            BARTKE    67 HBC  +                  8/67
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              75  N*1/2(3690) PARTIAL DECAY MODES (PROD. EXP.)
                                                              DECAY MASSES
P1      N*1/2(3690) INTO N + 7 PIS

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                      REFERENCES FOR N*1/2(3690) (PROD. EXP.)

BARTKE   67 PL 24B 118        +CZYZEWSKI,DANYSZ,+         (CRACOW,ORSAY) I

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N?(3755) BUMPS

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 76  N* /2(3755, JP=      )            PRODUCTION EXPERIMENTS
     A SMALL PEAK IN THE (P P PBAR) INVARIANT MASS FROM
     8.4 BEV/C PI+ P TO PI+ P P PBAR EVENTS.  AS EVIDENCE
     FOR A NEW RESONANCE IT IS NOT CONCLUSIVE.  OMITTED
     FROM TABLE.

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              76  N* /2(3755) MASS (MEV) (PROD. EXP.)

M          3755.0      8.0            EHRLICH   68 HBC  + PI+ P P PBAR     6/68
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              76  N* /2(3755) WIDTH (MEV) (PROD. EXP.)

W            40.0     20.0            EHRLICH   68 HBC  +                  6/68
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              76  N* /2(3755) PARTIAL DECAY MODES (PROD. EXP.)
                                                              DECAY MASSES
P1      N* /2(3755) INTO PI+ P P PBAR                         139+ 938+ 938+ 938

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                      REFERENCES FOR N* /2(3755) (PROD. EXP.)

EHRLICH  68 PRL 20 686        R EHRLICH,R J PLANC,J B WHITTAKER (RUTGERS)

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S=0 I=3/2 NUCLEON STATES (Δ)

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Δ(1232) **P'33**

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 33  N*3/2(1232, JP=3/2+) I=3/2
     THE EXISTENCE OF THIS RESONANCE IS WELL ESTABLISHED.
     SEE CARTER 71 AND CARTER 73 FOR PI N CROSS-SECTION
     DATA IN THIS REGION.
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              33  N*3/2(1232)  MASS (MEV)

M          (1234.)                    ROPER     65 DPWA ++0 PHASE SHIFT AN.
M          (1235.)                    ALMEHED   72 IPWA                    2/72
M    3     (1243.3)   (1241.7)        CHENG     73           FIT CARTER 71 2/74
M    3   THE TWO ENTRIES ARE FROM TWO DIFFERENT PARAMETRIZATIONS OF THE    2/74
M    3   RESONANCE CONTRIBUTUION TO THE P33 PHASE SHIFT.                   2/74
M          (1230.4)                   TSCHANG   73           FIT CARTER71 P33 1/74
M          (1234.)                    AYED      74 IPWA                    2/74

M++         1236.0     0.55           OLSSON    65 RVUE ++ TOTAL-SIGMA DATA
M++  2      1231.0     1.5            CARTER    71 MPWA ++ PI+P SIG. TOTAL 1/74
M++  1      1231.1      .2            CARTER    73 IPWA ++ PI N 88-310 MEV 9/73
M++  1   EXPERIMENTAL QUANTITY-SEE CARTER73 FOR COULOMB BARRIER CORRECTIONS 9/73
M++  2   EXPERIMENTAL QUANTITY-SEE CARTER71 FOR COULOMB BARRIER CORRECTIONS 1/74
M++            . . . . . . . .
M++ AVERAGE MEANINGLESS (SCALE FACTOR = 8.4)

M+         (1231.8)                   BERENDS   75 IPWA +  GAM P TO PI NUC 4/75*
M+          1230.6     1.8            CRAWFORD  75 DPWA    PI N PHOTO-PROD 1/76*
M+         (1231.7)                   BARBOUR   76 DPWA    PI N PHOTO-PROD 1/76*

MO          1236.45    0.65           OLSSON    65 RVUE 0
MO          1232.9     0.6            CARTER    71 MPWA 0 PI-P SIG. TOTAL  1/71
MO             . . . . . . . .
MO  AVERAGE MEANINGLESS (SCALE FACTOR = 4.0)
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              33  N*3/2(1232) WIDTH (MEV)

W          (120.)                     ROPER     65 DPWA ++0 PHASE SHIFT AN.
W          (129.)                     ALMEHED   72 IPWA                    2/72
W    3     (152.2)    (145.8)         CHENG     73           FIT CARTER 71 2/74
W          (120.)                     TSCHANG   73           FIT CARTER71 P33 1/74
W          (120.)                     AYED      74 IPWA                    2/74

W++         120.0      2.0            OLSSON    65 RVUE ++
W++  2      111.1      1.8            CARTER    71 MPWA ++ PI+P SIG. TOTAL 1/74
W++  1      111.5       .4            CARTER    73 IPWA ++ PI N 88-310 MEV 9/73
W++            . . . . . . . .
W++ AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

W+          120.2      3.9            CRAWFORD  75 DPWA    PI N PHOTO-PROD 1/76*
W+         (117.4)                    BARBOUR   76 DPWA    PI N PHOTO-PROD 1/76*

WO          119.6      2.4            OLSSON    65 RVUE 0
WO          114.7      3.0            CARTER    71 MPWA 0 PI-P SIG TOT.    1/71
WO             . . . . . . . .
WO  AVERAGE MEANINGLESS (SCALE FACTOR = 1.3)
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              33  (N*0) - (N*++) MASS DIFFERENCE (MEV)

D    R       (0.45)    (0.85)         OLSSON    65 RVUE
D    2        1.3       1.9           CARTER    71 MPWA ++ PI+-P SIG. TOTAL 1/74
D    1        1.4        .4           CARTER    73 IPWA    PI N 88-310 MEV 9/73
D    R   REDUNDANT WITH DATA IN MASS LISTING.
D              . . . . . . . .
D   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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              33  (N*0)-(N*++) WIDTH DIFFERENCE (MEV)                      9/73

WD   2        6.5       2.2           CARTER    71 MPWA ++ PI+-P SIG. TOTAL 1/74
WD   1       10.3       1.3           CARTER    73 IPWA    PI N 88-310 MEV 9/73
WD             . . . . . . . .
WD  AVERAGE MEANINGLESS (SCALE FACTOR = 1.5)
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              33  N*3/2(1232) REAL PART OF POLE POSITION(MEV)

REE  M     (1214.)                    MICHAEL   67                         2/74
REE        (1211.)                    BALL      72                         2/73
REE  P      1211.6     0.7            PDG       72           FIT DELTA 33  2/73
REE 3      (1210.7)   (1210.7)        CHENG     73           FIT CARTER 71 2/74
REE         1214.5    10.             NOGOVA    73           FIT ALMEHED72 2/74
REE        (1213.)                    SPEARMAN  74           FIT ZERO TRJCTRY 4/75*
REE  M   FIT INCLUDES OLSSON 65 PARAMETERS PLUS SCATTERING LENGTH PLUS 6
REE  M   PHASE SHIFT VALUES FOR TPI=120 TO 492 MEV.
REE  P   ERROR EST. FROM FITS WITH SOMEWHAT VARYING ASSUMPTIONS
REE            . . . . . . . .
REE AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R++  U      1211.5      .6            BALL      75       ++ FIT CARTER 73  11/75*
R++  U      1210.9      .8            LICHTENB  75       ++ FIT CARTER 73  11/75*
R++  C      1209.6      .5            VASAN     75       ++ FIT CARTER 73  1/76*
R++  C   FROM FITS TO COULOMB CORRECTED CARTER 73 PHASE SHIFT.             1/76*
R++  U     (1210.5)TO(1210.8)         VASAN     75       ++ FIT CARTER 73  1/76*
R++  U   FROM FITS TO UNCORRECTED CARTER 73 PHASE SHIFT.                   1/76*
R++            . . . . . . . .
R++ AVERAGE MEANINGLESS (SCALE FACTOR = 1.8)

REO  U     (1211.6)                   BALL      75        0 FIT CARTER 73  11/75*
REO  U      1210.9     1.4            LICHTENB  75        0 FIT CARTER 73  11/75*
REO  C      1210.75     .6            VASAN     75       ++ FIT CARTER 73  1/76*
REO  U     (1210.2)                   VASAN     75       ++ FIT CARTER 73  1/76*
REO            . . . . . . . .
REO AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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              33  N*3/2(1232) IMAG PART OF POLE POSITION(MEV)

IME  M     (52.)                      MICHAEL   67                         2/74
IME        (50.)                      BALL      72                         2/73
IME  P      49.5       1.8            PDG       72           FIT DELTA 33  2/73
IME 3      (50.7)     (50.6)          CHENG     73           FIT CARTER 71 2/74
IME         48.6       5.             NOGOVA    73           FIT ALMEHED72 2/74
IME        (49.)                      SPEARMAN  74           FIT ZERO TRJCTRY 4/75*
IME            . . . . . . . .
IME AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

I++  U      50.1        .6            BALL      75       ++ FIT CARTER 73  11/75*
I++  U      49.6        .75           LICHTENB  75       ++ FIT CARTER 73  11/75*
I++  C      50.4        .5            VASAN     75       ++ FIT CARTER 73  1/76*
I++  U     (49.9)TO (50.0)            VASAN     75       ++ FIT CARTER 73  1/76*
I++            . . . . . . . .
I++ AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

IMO  U     (53.0)                     BALL      75        0 FIT CARTER 73  11/75*
IMO  U      53.25      1.75           LICHTENB  75        0 FIT CARTER 73  11/75*
IMO  C      52.8        .6            VASAN     75       ++ FIT CARTER 73  1/76*
IMO  U     (52.9)TO (53.1)            VASAN     75       ++ FIT CARTER 73  1/76*
IMO            . . . . . . . .
IMO AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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              33  N*3/2(1232) ABSOLUTE VALUE OF POLE RESIDUE (MEV)

ABS        (53.)                      BALL      73           FIT DELTA 33  9/73

A++  C     (52.4)TO (53.2)            VASAN     75       ++ FIT CARTER 73  1/76*
A++  U     (52.1)TO (52.4)            VASAN     75       ++ FIT CARTER 73  1/76*

ABO  C     (54.8)TO (55.0)            VASAN     75       ++ FIT CARTER 73  1/76*
ABO  U     (55.2)TO (55.3)            VASAN     75       ++ FIT CARTER 73  1/76*
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Data Card Listings

For notation, see key at front of Listings.

Baryons
Δ(1232)

33 N*3/2(1232) PHASE OF POLE RESIDUE (RADIANS)

PH		(-.81)	BALL	73	FIT DELTA 33	9/73
P++	C	(-.822)TO -.833	VASAN	75	++ FIT CARTER 73	1/76*
P++	U	(-.823)TO -.830	VASAN	75	++ FIT CARTER 73	1/76*
PHO	C	(-.840)TO -.847	VASAN	75	++ FIT CARTER 73	1/76*
PHO	U	(-.848)TO -.856	VASAN	75	++ FIT CARTER 73	1/76*

33 N*3/2(1232) PARTIAL DECAY MODES

		DECAY MASSES
P1	N*3/2(1232) INTO N PI	938+ 139
P2	N*3/2(1232) INTO N GAMMA	938+ 0
P3	N*3/2(1232) INTO N PI PI	938+ 139+ 139
P4	N*3/2(1232) INTO GAM NUCLEON, HELICITY=1/2	0+ 938
P5	N*3/2(1232) INTO GAM NUCLEON, HELICITY=3/2	0+ 938

33 N*3/2(1232) BRANCHING RATIOS

R1	N*3/2(1232) INTO (N GAMMA)/(N PI) (PERCENT)					(P2)/(P1)	
R1	0.55	0.02	DALITZ	66	RVUE		7/68
R1	0.53	0.025	BERENDS	71	IPWA	PHOTOPROD. ANAL.	10/71
R1	· · · · · · · · · ·						
R1	AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)						
R2	N*3/2(1232)0 INTO (N PI)/TOTAL					(P1)	
R2 2	(.99)		CARTER	71	MPWA	++ PI+-P SIG. TOTAL	1/74
R2	(1.)		AYED	74	IPWA		2/74

33 N*3/2(1232) PHOTON DECAY AMPL(GEV**-1/2)

FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-REVIEW PRECEDING THE BARYON LISTINGS.

A1	N*3/2(1232) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)						
A1	-.144	.014	DEVENISH	73	DPWA	PI N PHOTO PROD	2/74
A1	-.142	.006	MOORHOUS	73	DPWA	PI N PHOTO-PROD	2/73
A1	-.138	.004	KNIES	74	DPWA	PI N PHOTO PROD	2/74
A1	-.140	.006	METCALF	74	DPWA	PI N PHOTO-PROD	2/74
A1	-.142	.001	MOORHOUS	74	DPWA	PI N PHOTO-PROD	2/74
A1	-.130	.002	CRAWFORD	75	DPWA	PI N PHOTO-PROD	1/76*
A1	(-.129)		BARBOUR	76	DPWA	PI N PHOTO-PROD	1/76*
A1	· · · · · · · · · ·						
A1	AVERAGE MEANINGLESS (SCALE FACTOR = 2.7)						
A2	N*3/2(1232) INTO GAM NUCLEON, HELICITY=3/2 (GEV**-1/2)						
A2	-.262	.015	DEVENISH	73	DPWA	PI N PHOTO PROD	2/74
A2	-.259	.016	MOORHOUS	73	DPWA	PI N PHOTO-PROD	2/73
A2	-.253	.002	KNIES	74	DPWA	PI N PHOTO PROD	2/74
A2	-.254	.007	METCALF	74	DPWA	PI N PHOTO-PROD	2/74
A2	-.261	.001	MOORHOUS	74	DPWA	PI N PHOTO-PROD	2/74
A2	-.248	.002	CRAWFORD	75	DPWA	PI N PHOTO-PROD	1/76*
A2	(-.251)		BARBOUR	76	DPWA	PI N PHOTO-PROD	1/76*
A2	· · · · · · · · · ·						
A2	AVERAGE MEANINGLESS (SCALE FACTOR = 4.5)						

REFERENCES FOR N*3/2(1232)

OLSSON 65 PRL 14 118 — M G OLSSON (WISC)
ROPER 65 PR 138 B190 — L D ROPER, R M WRIGHT, B T FELD (LRL+MIT)IJP

DALITZ 66 PR 146 1180 — DALITZ,SUTHERLAND (OXFORD)
CONTAINS REFERENCES TO EARLIER WORK ON DELTA PHOTOPRODUCTION.

MICHAEL 67 PR 156 1677 — MICHAEL (RHEL)IJP
BERENDS 71 NP B30 575 — +WEAVER (CEA,MIT,TUFT)
CARTER 71 NP B26 445 — +WILLIAMS, BUGG, BUSSEY, DANCE (CAVE,RHEL)

ALMEHED 72 NP B40 157 — +LOVELACE (LUND,RUTG)IJP
BALL 72 PRL 28 1143 — +CAMPBELL,LEE,SHAW (UTAH,BOISE,UCI)
PDG 72 PL 39B 103 — SODING,BARTELS,+ (DESY+LBL+BRAN+CERN+HELS)IJP
BALL 73 PRD 7 2789 — BALL,LEE,SHAW (UTAH+UCI)IJP
CARTER 73 NP B58 378 — CARTER,BUGG,CARTER (CAVENDISH+QUEEN MARY)IJP
CHENG 73 PRD 7 2249 — CHENG,LICHTENBERG (IND)IJP
DEVENISH 73 PL 47B 53 — DEVENISH,RANKIN,LYTH (LOUC+BONN+LANC)IJP
MOORHOUS 73 PL 43B 44 — MOORHOUSE, OBERLACK (GLAS+LBL)IJP
NOGOVA 73 NP B61 445 — NOGOVA,PISUT(IP SLOVAK ACAD SCI,COMENIUS U)IJP
ALSO 73 NP B61 438 — NOGOVA,PISUT+(IP SLOVK ACAD SCI,COMENIUS U)IJP
ALSO 73 NP B65 544 — NOGOVA,PISUT+(IP SLOVK ACAD SCI,COMENIUS U)IJP
TSCHANG 73 NP B59 445 — TSCHANG,PARKINSON (FLOR+GAINESVILLE)IJP

AYED 74 PRIVATE COMMCTN. — AYED,BAREYRE (SACL)IJP
ALSO 73 AIX CONFERENCE — AYED,BAREYRE (SACL)IJP
KNIES 74 PRD 9 2680 — KNIES,MOORHOUSE,OBERLACK (LBL,GLAS)IJP
METCALF 74 NP B76 253 — W J METCALF,R L WALKER (CIT)IJP
MOORHOUS 74 PRD 9 1 — MOORHOUSE,OBERLACK,ROSENFELD (GLAS+LBL)IJP
SPEARMAN 74 PRD 10 1660 — T D SPEARMAN (TRINITY COLLEGE,DUBLIN)

BALL 75 PRD 11 1171 — J S BALL,R L GOBLE (UTAH)IJP
BERENDS 75 NP B84 342 — BERENDS,DONNACHIE (LEID,MCHS)
CRAWFORD 75 NP B97 125 — R L CRAWFORD (GLAS)IJP
LICHTENB 75 LNC 12 616 — D B LICHTENBERG (IND)IJP
VASAN 75 COO-3066-58 (PPT) — S. S. VASAN (CARN)IJP

BARBOUR 76 SBMTD. TO NP — I. M. BARBOUR,R. L. CRAWFORD (GLAS)IJP

PAPERS NOT REFERRED TO IN DATA CARDS.

DONNACHI 68 PL 26B 161 — DONNACHIE,LOVELACE,KIRSOPP (CERN)
FONDA 73 PRD 8 353 — FONDA,GHIRARDI,SHAW (ICTP,TRIESTE+TRST)IJP
HENYEY 74 PR D9 302 — HENYEY,KANE (MICH)IJP
OLSSON 74 LNC 10 333 — OLSSON (CERN)IJP
PFEIL 74 NP B73 166 — PFEIL,ROLLNIK,STANKOWSKI (BONN)
SUZUKI 74 NP B68 413 — SUZUKI,KUROKAWA,KONDO (TOKYO)
NIGRO 75 NP B84 201 — NIGRO,SPILLANTINI,VALENTE (PADO,FRAS)

1232 MEV REGION – PRODUCTION EXPERIMENTS

81 N*3/2(1232, JP=3/2+) I=3/2 PRODUCTION EXPERIMENTS

81 N*3/2(1232) MASS (MEV) (PROD. EXP.)

M	1217.	8.	ANDERSON	70	MMS	-	PI- P TO PI- MMS	2/71
M	1227.0	7.0	ELLIS	71	CNTR		MMS PP 3.7 GEV/C	10/71
M	· · · · · · · · · ·							
M AVG	1222.7	5.3	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)					
M STUDENT	1222.7	5.9	AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT					
M++	(1232.0)	(6.0)	FERRO-LUZ	65	HBC	++	K+P TO K0 P PI+	
M++	(1236.0)		DEANS	66	RVUE	++	PI+P TOTAL	7/66
M++	(1233.4)	(4.4)	GIDAL	66	DBC	++	D D TO NN(NN) PI	7/66
M++	(1224.0)	(2.0)	HABER	70	DBC		K-D TO 4 BOD(P)	7/70
M++	1236.0	2.0	COLTON	72	HBC	++	PP TO PI+PN 7GEV	1/73
M++	1226.0	2.0	COLTON	72	HBC	++	TO PI+PI-PP	1/73
M++	1222.0	3.0	COLTON	72	HBC	++	TO PI+PI-PI0PP	1/73
M++	1226.0	2.0	COLTON	72	HBC	++	TO PI+PI-PI-PN	1/73
M++	(1231.)	(3.)	LEWIS	73	HBC	++	K+ P TO K P 2PI	1/76*
M++	1219.	5.	LICHTMAN	74	HBC	++	PI+P TO 3PI P	4/75*
M++	1213.	3.	LICHTMAN	74	HBC	++	PI-P TO 3PI P	4/75*
M++	(1224.)	5. TO 10.	BRAUN2	75	BC		PBAR P AND D,5.7	11/75*
M++	· · · · · · · · · ·							
M++ AVG	1226.3	3.1	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 3.1)					
M++ STUDENT	1225.3	1.4	AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT					
M+	1224. TO 1230.		BRAUN1	75	HBC		PBAR P 5.7 GEV	11/75*
M0	1231.	11.	COOPER	74	HBC	0	D P CEX	4/75*
M0	(1230.)		BRAUN1	75	HBC		PBAR P 5.7 GEV	11/75*
M0	(1220.)	5. TO 10.	BRAUN2	75	BC		PBAR P AND D,5.7	11/75*
M-	(1241.3)	(5.1)	GIDAL	66	DBC	-		7/66
M-	1239.0	5.0	COLTON	72	HBC	-	TO PI+PI-PI-PN	1/73

81 (N*-) - (N*++) MASS DIFFERENCE (MEV) (PROD. EXP.)

D	7.9	6.8	GIDAL	66	DBC

81 N*3/2(1232) WIDTH (MEV) (PROD. EXP.)

W	115.	5.	ANDERSON	70	MMS	-	PI- P TO PI- MMS	2/71
W	105.0	7.0	ELLIS	71	CNTR		MMS PP 3.7 GEV/C	10/71
W	141.	11.	MUSGRAVE	75	HBC		K+ P TO K PI N	11/75*
W	· · · · · · · · · ·							
W AVG	115.2	7.5	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.0)					
W STUDENT	114.5	4.6	AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT					
W++	(125.0)	(30.0)	FERRO-LUZ	65	HBC	++		
W++	(121.0)		DEANS	66	RVUE	++		7/66
W++	(124.0)	(14.0)	GIDAL	66	DBC	++		7/66
W++	(120.0)	(8.0)	HABER	70	DBC		K-D TO 4 BOD(P)	7/70
W++	115.0	6.0	COLTON	72	HBC	++	PP TO PI+PN 7GEV	1/73
W++	127.0	5.0	COLTON	72	HBC	++	TO PI+PI-PP	1/73
W++	122.0	9.0	COLTON	72	HBC	++	TO PI+PI-PI0PP	1/73
W++	106.0	7.0	COLTON	72	HBC	++	TO PI+PI-PI-PN	1/73
W++	(146.)	(10.)	LEWIS	73	HBC	++	K+ P TO K P 2PI	1/76*
W++	166.	14.	LICHTMAN	74	HBC	++	PI+P TO 3PI P	4/75*
W++	134.	7.	LICHTMAN	74	HBC	++	PI-P TO 3PI P	4/75*
W++	(110.)	10. TO 20.	BRAUN2	75	BC		PBAR P AND D,5.7	11/75*
W++	· · · · · · · · · ·							
W++ AVG	123.2	5.7	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.0)					
W++ STUDENT	123.3	3.7	AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT					
W+	110. TO 130.		BRAUN1	75	HBC		PBAR P 5.7 GEV	11/75*
W0	109.	32. 25.	COOPER	74	HBC	0	D P CEX	4/75*
W0	(120.)		BRAUN1	75	HBC		PBAR P 5.7 GEV	11/75*
W0	(120.)	10. TO 20.	BRAUN2	75	BC		PBAR P AND D,5.7	11/75*
W-	(149.0)	(18.0)	GIDAL	66	DBC	-		7/66
W-	237.0	22.0	COLTON	72	HBC	-	TO PI+PI-PI-PN	1/73

REFERENCES FOR N*3/2(1232) (PROD. EXP.)

FERRO-LU 65 NC 36 1101 — FERRO-LUZZI,GEORGE, + (CERN)
DEANS 66 PREPRINT — S R DEANS, W G HOLLADAY (VANDERBILT)
GIDAL 66 PR 141 1261 — G GIDAL, A KERNAN, S KIM (LRL)

ANDERSON 70 PRL 25 699 — +BLESER,BLIEDEN,COLLINS++ (BNL,CARN)
HABER 70 NP 17B 289 — +SHAPIRA,MERRILL,MCNARI++ (SABRE COLL)
ELLIS 71 PRL 27 442 — +MAGLICH,NOREM,SANNES,SILVERMAN (RUTG)
COLTON 72 PR D6 95 — E COLTON, A KIRSCHBAUM (LBL)
LEWIS 73 NP B60 283 — +ALLEN,JACOBS,DANYSZ,ISLAM+(LOWC+LOIC+CDEF)

COOPER 74 NP B79 259 — COOPER,SEIDL,VANDERVELDE (MICH)
LICHTMAN 74 NP B81 31 — LICHTMAN,BISWAS,CASON,KENNEY,MCGAHAN+(NDAM)I

BRAUN1 75 NP B95 481 — +GERBER,MAURER,MICHALON,SCHIBY+ (STRB,LPNP)I
BRAUN2 75 NP B95 503 — +GERBER,MAURER,MICHALON,SCHIBY+ (STRB,LPNP)I
MUSGRAVE 75 NP B87 365 — +PEETERS,SCREINER,WHITMORE,YUTA (ANL)

PAPERS NOT REFERRED TO IN DATA CARDS

ALEXANDE 73 NP B52 221 — ALEXANDER,BENARY+(TEL-AVIV+HEIDELBERG+DESY)
BEAUPRE 73 NP B66 93 — (AACH+BERL+BONN+CERN+NDAM+PENN+TOHO)I
BERLAND 74 NP B75 93 — BERLAND,HABER,HODOUS,HULSIZER,+ (MIT)I
ALSO 74 PL 51B 187 — BERLAND,HABER,HODOUS,HULSIZER,+ (MIT)I
STRACHMA 75 NP B98 120 — STRACHMAN,BRAUN,GERBER,MAURER+ (LPNP+STRB)I

Baryons
Δ(1650), Δ(1670)

Data Card Listings
For notation, see key at front of Listings.

Δ(1650) S_{31}

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82   N*3/2(1650, JP=1/2-) I=3/2
THE EXISTENCE OF THIS RESONANCE IS WELL ESTABLISHED.

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              82  N*3/2(1650) MASS (MEV)

M          (1648.0)   (12.0)          DEVLIN    65 CNTR     PI+- P TOTAL
M    1     (1695.0)                   BAREYRE   68 RVUE     PHASE-SHIFT ANAL 11/67
M    1              WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M    3     (1635.0)                   DONNACH1  68 RVUE     PHASE-SHIFT ANAL  6/68
M    6     (1614.0)                   AYED      70 IPWA                       1/71
M    6   ENER. DEP. FIT OF ARGAND DIAGRAM
M    4     (1617.0)                   DAVIES    70 RVUE     P-S ANAL  SOL A   8/69
M    7     (1620.)                    ALMEHED   72 IPWA                       2/72
M          (1623.)                    AYED      74 IPWA                       2/74
M           1622. TO 1688.            CRAWFORD  75 DPWA     PI N PHOTO-PROD   1/76*
M     L     1625. OR 1600.            LONGACRE  75 IPWA     PI N TO 2PI N    11/75*
M     L  THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.    11/75*
M          (1680.)                    BARBOUR   76 DPWA     PI N PHOTO-PROD   1/76*

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              82  N*3/2(1650) WIDTH (MEV)

W    1      (250.0)                   BAREYRE   68 RVUE                      11/67
W    3      (177.0)                   DONNACH1  68 RVUE                       6/68
W    6      (142.0)                   AYED      70 IPWA                       1/71
W    4      (141.0)                   DAVIES    70 RVUE     P-S ANAL  SOL A   8/69
W    7      (140.)                    ALMEHED   72 IPWA                       2/72
W           (161.)                    AYED      74 IPWA                       2/74
W            125. TO  214.            CRAWFORD  75 DPWA     PI N PHOTO-PROD   1/76*
W     L      160. OR  150.            LONGACRE  75 IPWA     PI N TO 2PI N    11/75*
W           (246.)                    BARBOUR   76 DPWA     PI N PHOTO-PROD   1/76*
W       SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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              82  N*3/2(1650) REAL PART OF POLE POSITION (MEV)          11/75*

RE         (1583.)                    LONGACRE  75 IPWA     PI N TO 2PI N    11/75*

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              82  N*3/2(1650) 2*IMAG PART OF POLE POSITION (MEV)        11/75*

IM          (143.)                    LONGACRE  75 IPWA     PI N TO 2PI N    11/75*

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              82  N*3/2(1650) PARTIAL DECAY MODES

                                                            DECAY MASSES
P1     N*3/2(1650) INTO PI N                                139+ 938
P2     N*3/2(1650) INTO N PI PI                             938+ 139+ 139
P3     N*3/2(1650) INTO GAM NUCLEON, HELICITY=1/2             0+ 938
P4     N*3/2(1650) INTO N*3/2(1232) PI                     1232+ 139
P5     N*3/2(1650) INTO N RHO                               938+ 773
P6     N*3/2(1650) INTO N RHO,S=1/2,S-WAVE                  938+ 773

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              82  N*3/2(1650) BRANCHING RATIOS

R1     N*3/2(1650) INTO (PI N)/TOTAL                        (P1)
R1  3       (0.284)                   DONNACH1  68 RVUE                       6/68
R1  6       (0.317)                   AYED      70 IPWA                       1/71
R1  4       (0.28)                    DAVIES    70 RVUE     P-S ANAL  SOL A   8/69
R1  7       (0.35)                    ALMEHED   72 IPWA                       2/72
R1          (.315)                    AYED      74 IPWA                       2/74

R2     N*3/2(1650) FROM PI N TO N*3/2(1232) PI             SQRT(P1*P4)       11/75*
R2   L        (+.40)OR  +.40          LONGACRE  75 IPWA     PI N TO 2PI N    11/75*

R3     N*3/2(1650) FROM PI N TO N RHO,S=1/2,S-WAVE         SQRT(P1*P6)       11/75*
R3   L        (.18)OR  -.28           LONGACRE  75 IPWA     PI N TO 2PI N    11/75*

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              82  N*3/2(1650) PHOTON DECAY AMPL(GEV**-1/2)

   FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
  REVIEW PRECEDING THE BARYON LISTINGS.

A1     N*3/2(1650) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)
A1           .004     .033            DEVENISH  73 DPWA     PI N PHOTO PROD   2/74
A1          (.113)                    HEMMI1    73        + FWD PI0 PHTOPROD  2/74
A1          +.090     .076            MOORHOUS  73 DPWA     PI N PHOTO-PROD   2/73
A1          -.10      .017            DEVENIS2  74 CPWA     PI N PHOTO-PROD   4/75*
A1           .033     .015            KNIES     74 DPWA     PI N PHOTO PROD   2/74
A1           .105     .038            METCALF   74 DPWA     PI N PHOTO-PROD   2/74
A1           .078     .066            MOORHOUS  74 DPWA     PI N PHOTO-PROD   2/74
A1          +.044     .027            CRAWFORD  75 DPWA     PI N PHOTO-PROD   1/76*
A1         (+.055)                    BARBOUR   76 DPWA     PI N PHOTO-PROD   1/76*
A1        . . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 3.2)

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                              REFERENCES FOR N*3/2(1650)

DEVLIN   65 PRL 14 1031         T J DEVLIN,J SOLOMON,G BERTSCH  (PRINCETON) I

BAREYRE  68 PR 165 1731         P BAREYRE, C BRICMAN, G VILLET      (SACLAY)IJP
DONNACH1 68 PL 26B 161          A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139          DONNACHIE  RAPPORTEUR'S TALK            (GLAS)
    ALSO 68 THESIS              R G KIRSOPP                             (EDIN)

AYED     70 KIEV CONF           R AYED,P BAREYRE, G VILLET              (SACL)IJP
DAVIES   70 NP B21 359          A DAVIES                                (GLAS)

ALMEHED  72 NP B40 157          +LOVELACE                          (LUND,RUTG)IJP
DEVENISH 73 PL 47B 53           DEVENISH,RANKIN,LYTH          (LOUC+BONN+LANC)IJP
HEMMI1   73 PL 43B 79           HEMMI,INAGAKI+            (KYOTO+SAGA+KEK+TOKY)IJP
MOORHOUS 73 PL 43B 44           MOORHOUSE, OBERLACK                   (GLAS+LBL)IJP

AYED     74 PRIVATE COMMCTN.    AYED,BAREYRE                            (SACL)IJP
    ALSO 73 AIX CONFERENCE      AYED,BAREYRE                            (SACL)IJP
DEVENIS2 74 PL 52B 227          DEVENISH,LYTH,RANKIN          (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680          KNIES,MOORHOUSE,OBERLACK             (LBL,GLAS)IJP
METCALF  74 NP B76 253          W J METCALF,R L WALKER                   (CIT)IJP
MOORHOUS 74 PRD 9 1             MOORHOUSE,OBERLACK,ROSENFELD         (GLAS+LBL)IJP
CRAWFORD 75 NP B97 125          R L CRAWFORD                            (GLAS)IJP
LONGACRE 75 PL 55B 415          +ROSENFELD,LASINSKI,SMADJA+        (LBL,SLAC)IJP

BARBOUR  76 SBMTD. TO NP        I. M. BARBOUR,R. L. CRAWFORD            (GLAS)IJP

                                PAPERS NOT REFERRED TO IN DATA CARDS.

CARRUTHE 60 PRL 4 303           P CARRUTHERS                         (CORNELL) I
DEVLIN   62 PR 125 690          T J DEVLIN, B J MOYER, V PEREZ-MENDEZ (LRL) I
HELLAND  64 PR 134 B1062        +DEVLIN,HAGGE,LONGO,MOYER,WOOD          (LRL) I
BAREYRE  65 PL 18 342           + BRICMAN, STIRLING, VILLET          (SACLAY)IJP
JOHNSON  67 UCRL-17683 THESIS C H JOHNSON                               (LRL)
DONNACHI 69 NP B10 433          A DONNACHIE, R KIRSOPP               (GLAS+EDIN)
AYED     70 PL 31B 598          +BAREYRE,VILLET                         (SACLAY)
BOWLER   70 NP B17 331          +CASHMORE                           (U. OXFORD)
DEANS    75 NP B96 90           +MITCHELL,MONTGOMERY,+         (SFLA,ALABAMA)IJP
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Δ(1670) D_{33}

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10   N*3/2(1670, JP=3/2-) I=3/2
THE EXISTENCE OF THIS RESONANCE IS WELL ESTABLISHED.

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              10  N*3/2(1670) MASS (MEV)

M    3     (1691.0)                   DONNACH1  68 RVUE     PHASE-SHIFT ANAL  8/69
M    6     (1722.0)                   AYED      70 IPWA                       1/71
M    6   ENER. DEP. FIT OF ARGAND DIAGRAM
M    4     (1649.0)                   DAVIES    70 RVUE     P-S ANAL  SOL A   8/69
M    7     (1700.)                    ALMEHED   72 IPWA                       2/72
M          (1723.)                    AYED      74 IPWA                       2/74
M           1612. TO 1624.            CRAWFORD  75 DPWA     PI N PHOTO-PROD   1/76*
M          (1660.)     (10.)          GAIDOS    75 HBC   ++ PI+P TO N* 2PI    1/76*
M     L     1725. OR 1680.            LONGACRE  75 IPWA     PI N TO 2PI N    11/75*
M     L  THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.    11/75*
M          (1629.)                    BARBOUR   76 DPWA     PI N PHOTO-PROD   1/76*

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              10  N*3/2(1670) WIDTH (MEV)

W    3      (269.0)                   DONNACH1  68 RVUE                       8/69
W    6      (258.0)                   AYED      70 IPWA                       1/71
W    4      (188.0)                   DAVIES    70 RVUE     SOL A             8/69
W    7      (260.)                    ALMEHED   72 IPWA                       2/72
W           (192.)                    AYED      74 IPWA                       2/74
W            210. TO  268.            CRAWFORD  75 DPWA     PI N PHOTO-PROD   1/76*
W           (180.)     (35.)   (20.)  GAIDOS    75 HBC   ++ PI+P TO N* 2PI    1/76*
W     L      190. OR  240.            LONGACRE  75 IPWA     PI N TO 2PI N    11/75*
W           (222.)                    BARBOUR   76 DPWA     PI N PHOTO-PROD   1/76*
W       SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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              10  N*3/2(1670) REAL PART OF POLE POSITION (MEV)          11/75*

RE         (1681.)                    LONGACRE  75 IPWA     PI N TO 2PI N    11/75*

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              10  N*3/2(1670) 2*IMAG PART OF POLE POSITION (MEV)        11/75*

IM          (245.)                    LONGACRE  75 IPWA     PI N TO 2PI N    11/75*

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              10  N*3/2(1670) PARTIAL DECAY MODES

                                                            DECAY MASSES
P1     N*3/2(1670) INTO PI N                                139+ 938
P2     N*3/2(1670) INTO N PI PI                             938+ 139+ 139
P3     N*3/2(1670) INTO K SIGMA                             493+1189
P4     N*3/2(1670) INTO GAM NUCLEON, HELICITY=1/2             0+ 938
P5     N*3/2(1670) INTO GAM NUCLEON, HELICITY=3/2             0+ 938
P6     N*3/2(1670) INTO N*3/2(1232) PI                     1232+ 139
P7     N*3/2(1670) INTO N*3/2(1232) PI,S-WAVE              1232+ 139
P8     N*3/2(1670) INTO N*3/2(1232) PI,D-WAVE              1232+ 139
P9     N*3/2(1670) INTO N RHO,S=3/2,S-WAVE                  938+ 773

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              10  N*3/2(1670) BRANCHING RATIOS

R1     N*3/2(1670) INTO (PI N)/TOTAL                        (P1)
R1  3       (0.14)                    DONNACH1  68 RVUE                       8/69
R1  6       (0.217)                   AYED      70 IPWA                       1/71
R1  4       (0.12)                    DAVIES    70 RVUE     SOL A             8/69
R1  7       (0.16)                    ALMEHED   72 IPWA                       2/72
R1          (.166)                    AYED      74 IPWA                       2/74

R2     N*3/2(1670) INTO (K SIGMA)/TOTAL                     (P3)
R2  1       (.00002)OR LESS           FEUERBACH 70 RVUE     PI P TO K+ SIG+   7/70
R2  1     ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
R2  1     MODEL USED MAY DOUBLE COUNT.

R3     N*3/2(1670) FROM PI N TO N*3/2(1232) PI,S-WAVE      SQRT(P1*P7)       11/75*
R3   L        (-.25)OR  -.24          LONGACRE  75 IPWA     PI N TO 2PI N    11/75*

R4     N*3/2(1670) FROM PI N TO N*3/2(1232) PI,D-WAVE      SQRT(P1*P8)       11/75*
R4   L        (0.) OR  (-.10)         LONGACRE  75 IPWA     PI N TO 2PI N    11/75*

R5     N*3/2(1670) FROM PI N TO N RHO,S=3/2,S-WAVE         SQRT(P1*P9)       11/75*
R5   L        (.20)OR  +.30           LONGACRE  75 IPWA     PI N TO 2PI N    11/75*

R6     N*3/2(1670) FROM PI N TO K SIGMA                    SQRT(P1*P3)       11/75*
R6  2         (.001)TO  .011          DEANS     75 DPWA     PI N TO K SIGMA  11/75*
R6  2   RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                             11/75*

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              10  N*3/2(1670) PHOTON DECAY AMPL(GEV**-1/2)

   FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
  REVIEW PRECEDING THE BARYON LISTINGS.

A1     N*3/2(1670) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)
A1           .036     .052            DEVENISH  73 DPWA     PI N PHOTO PROD   2/74
A1          +.068     .042            MOORHOUS  73 DPWA     PI N PHOTO-PROD   2/73
A1           .054     .029            DEVENIS2  74 DPWA     PI N PHOTO-PROD   4/75*
A1           .078     .009            KNIES     74 DPWA     PI N PHOTO PROD   2/74
A1           .0       .048            METCALF   74 DPWA     PI N PHOTO-PROD   2/74
A1           .041     .028            MOORHOUS  74 DPWA     PI N PHOTO-PROD   2/74
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Data Card Listings

For notation, see key at front of Listings.

Baryons

Δ(1670), Δ(1690), Δ(1890)

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A1           +.101      .011          CRAWFORD  75 DPWA     PI N PHOTO-PROD    1/76*
A1          (+.120)                   BARBOUR   76 DPWA     PI N PHOTO-PRCD    1/76*
A1           . . . . . . . . .
A1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.4)

A2       N*3/2(1670) INTO GAM NUCLECN, HELICITY=3/2 (GEV**-1/2)
A2            .110      .039          DEVENISH  73 DPWA     PI N PHOTO PROD    2/74
A2           +.022      .052          MOORHOUS  73 DPWA     PI N PHOTO-PROD    2/73
A2            .072      .014          DEVENIS2  74 DPWA     PI N PHOTO-PROD    4/75*
A2            .070      .009          KNIES     74 DPWA     PI N PHOTC PROD    2/74
A2            .0        .041          METCALF   74 DPWA     PI N PHOTO-PROD    2/74
A2            .021      .020          MOORHOUS  74 DPWA     PI N PHOTO-PROD    2/74
A2           +.116      .024          CRAWFORD  75 DPWA     PI N PHOTO-PRCD    1/76*
A2          (+.117)                   BARBOUR   76 DPWA     PI N PHOTO-PROD    1/76*
A2           . . . . . . . . .
A2   AVERAGE MEANINGLESS (SCALE FACTOR = 1.6)

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                              REFERENCES FOR N*3/2(1670)

DCNNACH1 68 PL 26B 161          A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139          CONNACHIE  RAPPORTEUR'S TALK          (GLAS)
    ALSO 68 THESIS              R G KIRSOPP                           (EDIN)

AYED     70 KIEV CCNF           R AYED,P BAREYRE, G VILLET           (SACL)IJP
DAVIES   70 NP B21 359          A DAVIES                              (GLAS)
FEUERBAC 70 NP 16B 85           FEUERBACHER+HOLLADAY            (VANDERBILT)

ALMEHEC  72 NP B40 157          +LOVELACE                        (LUND,RUTG)IJP
DEVENISH 73 PL 47B 53           DEVENISH,RANKIN,LYTH        (LOUC+BONN+LANC)IJP
MOORHOUS 73 PL 43B 44           MOORHOUSE, OBERLACK                (GLAS+LBL)IJP

AYED     74 PRIVATE COMMCTN.    AYEC,BAREYRE                         (SACL)IJP
    ALSO 73 AIX CONFERENCE      AYED,BAREYRE                         (SACL)IJP
DEVENIS2 74 PL 52B 227          DEVENISH,LYTH,RANKIN           (DESY,LANC,BCNN)IJP
KNIES    74 PRD 9 2680          KNIES,MOORHOUSE,OBERLACK           (LBL,GLAS)IJP
METCALF  74 NP B76 253          W J METCALF,R L WALKER                (CIT)IJP
MOORHOUS 74 PRD 9 1             MOORHOUSE,OBERLACK,ROSENFELD       (GLAS+LBL)IJP

CRAWFORD 75 NP B97 125          R L CRAWFORD                         (GLAS)IJP
DEANS    75 NP B96 90           +MITCHELL,MCNTGOMERY,+          (SFLA,ALABAMA)IJP
GAIDOS   75 PRD 12 2565         GAIDOS,MILLER                        (PURD)IJP
LONGACRE 75 PL 55B 415          +ROSENFELD,LASINSKI,SMADJA+        (LBL,SLAC)IJP

BARBOUR  76 SBMTD. TO NP        I. M. BARBOUR,R. L. CRAWFORD         (GLAS)IJP

                                PAPERS NOT REFERRED TO IN CATA CARDS.

DCNNACHI 69 NP 10B 433          A DONNACHIE, R KIRSOPP            (GLAS+EDIN)
AYED     70 PL 31B 598          +BAREYRE,VILLET                       (SACLAY)
BOWLER   70 NP 17B 331          +CASHMORE                          (U. OXFORD)

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Δ(1690) P''_{33}

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                   19  N*3/2(1690, JP=3/2+) I=3/2

                   RECENT ANALYSES INDICATE A POSSIBLE P''33 RESCNANCE
                   SOMEWHERE IN THE 1600-2000 MEV REGION.  SEE ALSO THE
                   N*3/2(2160) LISTINGS.

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                   19  N*3/2(1690) MASS (MEV)

M    3     (1690.)                   DCNNACH2  68 RVUE    PHAS.SHIFT-CERN1  10/69
M    3     (1690.)                   KIRSOPP   68 RVUE    PHASE SHIFT ANAL  10/69
M    3   WHERE MAX. ABSORPTION IS -DONNACH1, 2 ,KIRSOPP EYEBALL FIT CERN 1   10/69
M    6     (1801.0)                  AYED      70 IPWA                        1/71
M    6   ENER. DEP. FIT OF ARGAND DIAGRAM
M    7     (1680.)                   ALMEHED   72 IPWA                        2/72
M          (1904.)                   AYED      74 IPWA                        2/74
M     L     1900. OR 1640.           LONGACRE  75 IPWA    PI N TO 2PI N      11/75*
M     L  THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.   11/75*

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                   19  N*3/2(1690) WIDTH (MEV)

W    3      (281.)                   DCNNACH2  68 RVUE    PHAS.SHIFT-CERN1  10/69
W    3      (240.)                   KIRSOPP   68 RVUE    PHASE SHIFT ANAL  10/69
W    6      (598.0)                  AYED      70 IPWA                        1/71
W    7      (220.)                   ALMEHED   72 IPWA                        2/72
W           (204.)                   AYED      74 IPWA                        2/74
W     L      205. OR  300.           LONGACRE  75 IPWA    PI N TO 2PI N      11/75*
          SEE THE NOTES ACCCMPANYING MASSES QUOTEC

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                   19  N*3/2(1690) REAL PART OF POLE POSITICN (MEV)          11/75*

RE         (1609.)                   LONGACRE  75 IPWA    PI N TO 2PI N      11/75*

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                   19  N*3/2(1690) 2*IMAG PART CF POLE POSITIGN (MEV)        11/75*

IM          (323.)                   LCNGACRE  75 IPWA    PI N TO 2PI N      11/75*

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                   19  N*3/2(1690) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      N*3/2(1690) INTO PI N                            139+ 938
P2      N*3/2(1690) INTO K SIGMA                         493+1189
P3      N*3/2(1690) INTO N*3/2(1232) PI,P-WAVE          1232+ 139

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                   19  N*3/2(169C) BRANCHING RATIOS

R1      N*3/2(1690) INTO (PI N)/TCTAL                        (P1)
R1   3        (.10)                  DONNACH2  68 RVUE    PHAS.SHIFT-CERN1  10/69
R1   3        (.08)                  KIRSOPP   68 RVUE    PHASE SHIFT ANAL  10/69
R1   6       (0.135)                 AYED      70 IPWA                        1/71
R1   7       (0.1)                   ALMEHED   72 IPWA                        2/72
R1            (.194)                 AYED      74 IPWA                        2/74

R2      N*3/2(1690) INTO (K SIGMA)/TOTAL                     (P2)
R2   1       (.00002)OR LESS         FEUERBACH 70 RVUE    PI P TO K+ SIG+     7/70
R2   1      ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
R2   1      MODEL USED MAY DOUBLE COUNT.

R3      N*3/2(1690) FROM PI N TO K SIGMA                   SQRT(P1*P2)      11/75*
R3   2           (.006)TO  .042          DEANS     75 DPWA    PI N TO K SIGMA  11/75*
R3   2    RANGE GIVEN IS FROM FOUR BEST SOLUTICNS.                          11/75*

R4      N*3/2(1690) FROM PI N TC N*3/2(1232) PI,P-WAVE   SQRT(P1*P3)      11/75*
R4    L        (-.36)OR  -.30            LONGACRE  75 IPWA    PI N TO 2PI N    11/75*

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                   19  N*3/2(1690) PHOTON DECAY AMPL(GEV**-1/2)

      FOR DEFINITION OF GAMMA-NUCLECN DECAY AMPLITUDES, SEE MINI-
    REVIEW PRECEDING THE BARYCN LISTINGS.

A1      N*3/2(1690) INTO GAM NUCLECN, HELICITY=1/2 (GEV**-1/2)
A1            .016      .055          DEVENISH  73 DPWA     PI N PHOTO PROD    2/74
A1           -.033      .037          DEVENIS2  74 DPWA     PI N PHOTO-PROD    4/75*
A1            .003      .015          KNIES     74 DPWA     PI N PHOTC PRCD    2/74
A1            .0        .038          METCALF   74 DPWA     PI N PHOTO-PROD    2/74
A1           . . . . . . . . .
A1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

A2      N*3/2(1690) INTO GAM NUCLECN, HELICITY=3/2 (GEV**-1/2)
A2            .074      .064          DEVENISH  73 DPWA     PI N PHOTO PRCD    2/74
A2            .008      .046          DEVENIS2  74 DPWA     PI N PHOTO-PROD    4/75*
A2           -.034      .022          KNIES     74 DPWA     PI N PHOTO PROD    2/74
A2            .0        .033          METCALF   74 DPWA     PI N PHOTC-PROD    2/74
A2           . . . . . . . . .
A2   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                              REFERENCES FOR N*3/2(1690)

DONNACH2 68 VIENNA 139          DONNACHIE  RAPPORTEUR'S TALK          (GLAS)
KIRSOPP  68 THESIS              R G KIRSOPP                           (EDIN)

AYED     70 KIEV CONF           R AYED,P BAREYRE, G VILLET           (SACL)IJP
FEUERBAC 70 NP 16B 85           FEUERBACHER+HOLLADAY            (VANDERBILT)
ALMEHED  72 NP B40 157          +LOVELACE                        (LUND,RUTG)IJP
DEVENISH 73 PL 47B 53           DEVENISH,RANKIN,LYTH        (LOUC+BONN+LANC)IJP

AYED     74 PRIVATE COMMCTN.    AYED,BAREYRE                         (SACL)IJP
    ALSO 73 AIX CCNFERENCE      AYED,BAREYRE                         (SACL)IJP
DEVENIS2 74 PL 52B 227          DEVENISH,LYTH,RANKIN           (DESY,LANC,BCNN)IJP
KNIES    74 PRD 9 2680          KNIES,MCORHCUSE,OBERLACK           (LBL,GLAS)IJP
METCALF  74 NP B76 253          W J METCALF,R L WALKER                (CIT)IJP

DEANS    75 NP B96 90           +MITCHELL,MONTGCMERY,+          (SFLA,ALABAMA)IJP
LONGACRE 75 PL 55B 415          +ROSENFELD,LASINSKI,SMADJA+        (LBL,SLAC)IJP

                                PAPERS NOT REFERRED TO IN DATA CARDS.

AYED     70 PL 31B 598          +BAREYRE,VILLET                       (SACLAY)
BOWLER   70 NP 17B 331          +CASHMORE                          (U. OXFORD)

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Δ(1890) F_{35}

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                   11  N*3/2(1890, JP=5/2+) I=3/2
                   THE EXISTENCE OF THIS RESCNANCE IS WELL ESTABLISHED.

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                   11  N*3/2(1890) MASS (MEV)

M    3     (1913.0)                  DONNACH1  68 RVUE    PHASE-SHIFT ANAL   8/69
M    6     (1837.0)                  AYED      70 IPWA                        1/71
M    6   FROM ENER. DEP. FIT OF ARGANC DIAGRAM
M    4     (1841.0)                  DAVIES    70 RVUE    P-S ANAL  SCL A    8/69
M    7     (1875.)                   ALMEHED   72 IPWA                        2/72
M     1     1890. TO 1986.           MEHTANI   72 DPWA    PI+P TO PI+PIOP    9/73
M          (1890.)                   LANGBEIN  73 IPWA    PI N-K SIG,SOL 1   9/73
M          (1890.)                   LANGBEIN  73 IPWA    PI N-K SIG,SOL 2   9/73
M          (1869.)                   AYED      74 IPWA                        2/74
M     L     1870. OR 1830.           LONGACRE  75 IPWA    PI N TC 2PI N      11/75*
M     L  THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.   11/75*

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                   11  N*3/2(1890) WIDTH (MEV)

W    3      (350.0)                  DCNNACH1  68 RVUE                        8/69
W    6      (198.0)                  AYED      70 IPWA                        1/71
W    4      (136.0)                  DAVIES    70 RVUE    SOL A               8/69
W    7      (250.)                   ALMEHED   72 IPWA                        2/72
W     1      273. TO 322.            MEHTANI   72 DPWA    PI+P TO PI+PIOP    9/73
W           (180.)                   LANGBEIN  73 IPWA    PI N-K SIG,SOL 1   9/73
W           (140.)                   LANGBEIN  73 IPWA    PI N-K SIG,SOL 2   9/73
W           (255.)                   AYED      74 IPWA                        2/74
W     L      255. OR  220.           LONGACRE  75 IPWA    PI N TO 2PI N      11/75*
          SEE NOTES ACCCMPANYING MASSES QUOTED AS FOR N*1/2(1910)

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                   11  N*3/2(1890) REAL PART OF POLE PCSITICN (MEV)          11/75*

RE         (1813.)                   LCNGACRE  75 IPWA    PI N TO 2PI N      11/75*

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                   11  N*3/2(1890) 2*IMAG PART OF POLE POSITION (MEV)        11/75*

IM          (193.)                   LONGACRE  75 IPWA    PI N TO 2PI N      11/75*

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                   11  N*3/2(1890) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      N*3/2(1890) INTO PI N                            139+ 938
P2      N*3/2(1890) INTC N PI PI                         938+ 139+ 139
P3      N*3/2(1890) INTO K SIGMA                         493+1189
P4      N*3/2(1890) INTO N*3/2(1232) PI                 1232+ 139
P5      N*3/2(1890) INTO GAM NUCLECN, HELICITY=1/2          0+ 938
P6      N*3/2(1890) INTO GAM NUCLEON, HELICITY=3/2          0+ 938
P7      N*3/2(1890) INTO N RHO                           938+ 773
P8      N*3/2(1890) INTO N*3/2(1232) PI,P-WAVE          1232+ 139
P9      N*3/2(1890) INTO N*3/2(1232) PI,F-WAVE          1232+ 139
P10     N*3/2(1890) INTC N RHO,S=3/2,P-WAVE              938+ 773

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Baryons
Δ(1890), Δ(1900), Δ(1910)

Data Card Listings
For notation, see key at front of Listings.

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                  11  N*3/2(189C) BRANCHING RATICS

R1      N*3/2(1890) INTO (PI N)/TOTAL                      (P1)
R1  3         (0.16)                 DCNNACH1  68 RVUE                     8/69
R1  6         (0.147)                AYED      70 IPWA                     1/71
R1  4         (0.20)                 DAVIES    70 RVUE    SOL A            8/69
R1  7         (0.18)                 ALMEHED   72 IPWA                     2/72
R1            (.144)                 AYED      74 IPWA                     2/74

R2      N*3/2(1890) INTO (K SIGMA)/TOTAL                   (P3)
R2  1         (0.008)OR LESS         FEUERBACH 70 RVUE    PI P TO K+ SIG+  7/70
R2  1     ASSUME MASS, WICTH, X(ELAST) OF DONNACHIE 68
R2  1     MODEL LSED MAY DOUBLE CCUNT.

R3      N*3/2(1890) INTO (SIGMA K)*(PI N)/TOTAL**2         (P3*P1)
R3            (.0016)OR LESS         KALMUS    70 DPWA    PI+P TO K+ SIG+  1/71

R4      N*3/2(1890)  FRCM PI N TC N*3/2(1232) PI           SQRT(P1*P4)
R4   1     .19 TO .23                MEHTANI   72 DPWA    PI+P TO PI+PIOP  9/73
R4   1  MOSTLY F WAVE DECAY                                                9/73

R5      N*3/2(189C) FROM PI N TO K SIGMA                   SQRT(P1*P3)     9/73
R5            (.06)                  LANGBEIN  73 IPWA    PI N-K SIG,SOL 1 9/73
R5            (.06)                  LANGBEIN  73 IPWA    PI N-K SIG,SOL 2 9/73
R5  2         (.021)TO  .054         DEANS     75 DPWA    PI N TO K SIGMA 11/75*
R5  2   RANGE GIVEN IS FRCM FOUR BEST SOLUTIONS.                          11/75*

R6      N*3/2(1890) FROM PI N TO N*3/2(1232) PI,F-WAVE     SQRT(P1*P9)    11/75*
R6   L        (-.12)OR  -.20         LONGACRE  75 IPWA    PI N TO 2PI N   11/75*

R7      N*3/2(1890) FROM PI N TO N RHO,S=3/2,P-WAVE        SQRT(P1*P10)   11/75*
R7   L        (-.28)OR  -.33         LONGACRE  75 IPWA    PI N TO 2PI N   11/75*
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                  11  N*3/2(1890) PHOTCN DECAY AMPL(GEV**-1/2)

     FOR DEFINITICN OF GAMMA-NUCLECN DECAY AMPLITUDES, SEE MINI-
   REVIEW PRECEDING THE BARYCN LISTINGS.

A1      N*3/2(1890) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)
A1           .019       .027         DEVENIS2  74 DPWA    PI N PHOTO-PROD  4/75*
A1           .042       .016         KNIES     74 DPWA    PI N PHOTO PROD  2/74
A1          +.047       .067         METCALF   74 DPWA    PI N PHOTO-PRCD  2/74
A1          -.003       .009         CRAWFORD  75 DPWA    PI N PHOTO-PROD  1/76*
A1          (+.035)                  BARBOUR   76 DPWA    PI N PHOTO-PROD  1/76*
A1        . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.8)

A2      N*3/2(1890) INTO GAM NUCLEON, HELICITY=3/2 (GEV**-1/2)
A2           .078       .020         DEVENIS2  74 DPWA    PI N PHOTO-PROD  4/75*
A2          -.022       .020         KNIES     74 DPWA    PI N PHOTO PROD  2/74
A2          -.028       .066         METCALF   74 DPWA    PI N PHOTO-PRCD  2/74
A2          -.021       .036         CRAWFORD  75 DPWA    PI N PHOTO-PROD  1/76*
A2          (-.013)                  BARBOUR   76 DPWA    PI N PHOTO-PROD  1/76*
A2        . . . . . . . . .
A2  AVERAGE MEANINGLESS (SCALE FACTOR = 2.2)

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REFERENCES FOR N*3/2(1890)


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DCNNACH1 68 PL 26B 161        A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
   ALSO 68 VIENNA 139         DCNNACHIE  RAPPORTEUR'S TALK           (GLAS)
   ALSO 68 THESIS             R G KIRSOPP                            (EDIN)

AYED      70 KIEV CCNF        R AYED,P BAREYRE, G VILLET          (SACL)IJP
DAVIES    70 NP B21 359       A DAVIES                               (GLAS)
FEUERBAC 70 NP 16B 85         FEUERBACHER+HOLLADAY            (VANDERBILT)
KALMUS    70 PR D2 1824       G KALMUS, G BORREANI, J LOUIE          (LRL)

ALMEHED  72 NP B40 157        +LCVELACE                      (LUND,RUTG)IJP
MEHTANI  72 PRL 29 1634       +FUNG, KERNAN, SCHALK, +          (UCR +LBL)
LANGBEIN 73 NP B53 251        LANGBEIN,WAGNER                   (MUNICH)IJP
AYED      74 PRIVATE COMMCTN. AYEC,EAREYRE                        (SACL)IJP
   ALSO  73 AIX CCNFERENCE    AYED,BAREYRE                        (SACL)IJP
DEVENIS2 74 PL 52B 227        DEVENISH,LYTH,RANKIN     (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680        KNIES,MOORHOUSE,OBERLACK        (LBL,GLAS)IJP
METCALF  74 NP B76 253        W J METCALF,R L WALKER               (CIT)IJP

CRAWFORD 75 NP B97 125        R L CRAWFORD                        (GLAS)IJP
DEANS     75 NP B96 90        +MITCHELL,MCNTGCMERY,+       (SFLA,ALABAMA)IJP
LCNGACRE 75 PL 55B 415        +ROSENFELD,LASINSKI,SMADJA+     (LBL,SLAC)IJP

BARBCUR  76 SBMTD. TO NP      I. M. BARBCUR,R. L. CRAWFORD        (GLAS)IJP

                              PAPERS NOT REFERRED TO IN DATA CARDS.

AYED      70 PL 31B 598       +BAREYRE+VILLET                      (SACLAY)
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Δ(1900) 30 N*3/2(1900, JP=1/2-) I=3/2 **S_{31}** 9/73

THIS EFFECT IS SEEN IN TWO CHANNELS.

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                  30  N*3/2(1900) MASS (MEV)                               9/73

M           (1920.)                  LANGBEIN  73 IPWA    PI N-K SIG,SOL 1 9/73
M           (1870.)                  LANGBEIN  73 IPWA    PI N-K SIG,SOL 2 9/73
M           (2001.)                  AYED      74 IPWA                     2/74
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                  30  N*3/2(1900) WIDTH (MEV)                              9/73

W           (140.)                   LANGBEIN  73 IPWA    PI N-K SIG,SOL 1 9/73
W           (160.)                   LANGBEIN  73 IPWA    PI N-K SIG,SOL 2 9/73
W           (307.)                   AYED      74 IPWA                     2/74
        SEE THE NOTES ACCOMPANYING MASSES QUOTED
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                  30  N*3/2(1900) PARTIAL DECAY MODES                      9/73

                                                           DECAY MASSES
P1      N*3/2(1900) INTO PI N                              139+ 938
P2      N*3/2(1900) INTC K SIGMA                           493+1189
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                  30  N*3/2(190C) BRANCHING RATICS                         9/73

R1      N*3/2(1900) FRCM PI N TO K SIGMA                   SQRT(P1*P2)     9/73
R1            (.11)                  LANGBEIN  73 IPWA    PI N-K SIG,SOL 1 9/73
R1            (.12)                  LANGBEIN  73 IPWA    PI N-K SIG,SOL 2 9/73
R1  1         (.076)                 DEANS     75 DPWA    PI N TO K SIGMA 11/75*
R1  1   VALUE GIVEN IS FRCM SOLUTION 1, NOT PRESENT IN SCLUTICNS 2,3,4.   11/75*

R2      N*3/2(1900) INTO PI N/TOTAL                        (P1)
R2            (.076)                 AYED      74 IPWA                     2/74

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REFERENCES FCR N*3/2(1900)


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LANGBEIN 73 NP B53 251        LANGBEIN,WAGNER                   (MUNICH)IJP
AYED      74 PRIVATE COMMCTN. AYED,BAREYRE                        (SACL)IJP
   ALSC 73 AIX CONFERENCE     AYED,BAREYRE                        (SACL)IJP
DEANS     75 NP B96 90        +MITCHELL,MCNTGCMERY,+       (SFLA,ALABAMA)IJP
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Δ(1910) 12 N*3/2(1910, JP=1/2+) I=3/2 **P_{31}**

THE EXISTENCE OF THIS RESCNANCE IS WELL ESTABLISHED.

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                  12  N*3/2(1910) MASS (MEV)

M    3      (1934.0)                 DCNNACH1  68 RVUE    PHASE-SHIFT ANAL 8/69
M    6      (1783.0)                 AYED      70 IPWA                     1/71
M    6  FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M    4      (1914.0)                 DAVIES    70 RVUE    P-S ANAL  SCL A  8/69
M    7      (1900.)                  ALMEHED   72 IPWA                     2/72
M           (1980.)                  LANGBEIN  73 IPWA    PI N-K SIG,SOL 1 9/73
M           (1950.)                  LANGBEIN  73 IPWA    PI N-K SIG,SOL 2 9/73
M           (1786.)                  AYED      74 IPWA                     2/74
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                  12  N*3/2(1910) WICTH (MEV)

W    3      (339.0)                  DCNNACH1  68 RVUE                     8/69
W    6      (308.0)                  AYED      70 IPWA                     1/71
W    4      (290.)                   DAVIES    70 RVUE    SCL A            8/69
W    7      (200.)                   ALMEHED   72 IPWA                     2/72
W           (190.)                   LANGBEIN  73 IPWA    PI N-K SIG,SOL 1 9/73
W           (170.)                   LANGBEIN  73 IPWA    PI N-K SIG,SOL 2 9/73
W           (222.)                   AYED      74 IPWA                     2/74
        SEE NOTES ACCOMPANYING MASSES CUCTED
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                  12  N*3/2(1910) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      N*3/2(1910) INTO PI N                              139+ 938
P2      N*3/2(1910) INTO N PI PI                           938+ 139+ 139
P3      N*3/2(1910) INTO K SIGMA                           493+1189
P4      N*3/2(1910) INTC N*3/2(1232) PI                   1232+ 139
P5      N*3/2(1910) INTO GAM NUCLEON, HELICITY=1/2           0+ 938
P6      N*3/2(1910) INTO N RHO                             938+ 773
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                  12  N*3/2(1910) BRANCHING RATIOS

R1      N*3/2(1910) INTO (PI N)/TCTAL                      (P1)
R1  3         (0.30)                 DCNNACH1  68 RVUE                     8/69
R1  6         (0.128)                AYED      70 IPWA                     1/71
R1  4         (0.18)                 DAVIES    70 RVUE    SOL A            8/69
R1  7         (0.33)                 ALMEHED   72 IPWA                     2/72
R1            (.158)                 AYED      74 IPWA                     2/74

R2      N*3/2(1910) INTO (K SIGMA)/TOTAL                   (P3)
R2  1         (0.008)OR LESS         FEUERBACH 70 RVUE    PI P TO K+ SIG+  7/70
R2  1     ASSUME MASS, WIDTH, X(ELAST) OF DCNNACHIE 68
R2  1     MODEL LSED MAY DOUBLE COUNT.

R3      N*3/2(1910) FROM PI N TO K SIGMA                   SQRT(P1*P3)     9/73
R3            (.11)                  LANGBEIN  73 IPWA    PI N-K SIG,SOL 1 9/73
R3            (.15)                  LANGBEIN  73 IPWA    PI N-K SIG,SOL 2 9/73
R3  2         (.082)TO  .184         DEANS     75 DPWA    PI N TO K SIGMA 11/75*
R3  2   RANGE GIVEN IS FRCM FOUR BEST SOLUTIONS.                          11/75*
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                  12  N*3/2(1910) PHOTON DECAY AMPL(GEV**-1/2)

     FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
   REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*3/2(1910) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)
A1           .000       .025         DEVENIS2  74 DPWA    PI N PHOTO-PROD  4/75*
A1           .010       .012         KNIES     74 DPWA    PI N PHOTO PROD  2/74
A1          -.032       .065         METCALF   74 DPWA    PI N PHOTO-PRCD  2/74
A1          -.009       .013         CRAWFORD  75 DPWA    PI N PHOTO-PROD  1/76*
A1          (-.031)                  BARBOUR   76 DPWA    PI N PHOTO-PROD  1/76*
A1        . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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REFERENCES FOR N*3/2(1910)


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DCNNACH1 68 PL 26B 161        A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
   ALSO 68 VIENNA 139         DCNNACHIE  RAPPORTEUR'S TALK           (GLAS)
   ALSO 68 THESIS             R G KIRSOPP                            (EDIN)

AYED      70 KIEV CCNF        R AYED,P BAREYRE, G VILLET          (SACL)IJP
DAVIES    70 NP B21 359       A DAVIES                               (GLAS)
FEUERBAC 70 NP 16B 85         FEUERBACHER+HOLLADAY            (VANDERBILT)

ALMEHED  72 NP B40 157        +LOVELACE                      (LUND,RUTG)IJP
LANGBEIN 73 NP B53 251        LANGBEIN,WAGNER                   (MUNICH)IJP

AYED      74 PRIVATE COMMCTN. AYED,BAREYRE                        (SACL)IJP
   ALSO  73 AIX CONFERENCE    AYED,BAREYRE                        (SACL)IJP
DEVENIS2 74 PL 52B 227        DEVENISH,LYTH,RANKIN     (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680        KNIES,MOORHOUSE,OBERLACK        (LBL,GLAS)IJP
METCALF  74 NP B76 253        W J METCALF,R L WALKER               (CIT)IJP
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Data Card Listings

For notation, see key at front of Listings.

Baryons

Δ(1910), Δ(1950), Δ(1960)


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CRAWFORD 75 NP B97 125        R L CRAWFORD                           (GLAS)IJP
DEANS    75 NP B96 90         +MITCHELL,MCNTGCMERY,+       (SFLA,ALABAMA)IJP

BARBOUR  76 SBMTD. TO NP      I. M. BARBOUR,R. L. CRAWFCRD           (GLAS)IJP

                              PAPERS NOT REFERREC TO IN CATA CARDS.

CARYANN  65 PR 138 B433       CARAYANNOPOULOS,TAUTFEST,WILLMANN      (PURD)
   A PARTIAL WAVE ANALYSIS OF PI+P TO SIGMA+ K+
AYED     70 PL 31B 598        +BAREYRE+VILLET                        (SACLAY)
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Δ(1950) — F37

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83  N*3/2(1950, JP=7/2+) I=3/2

THE EXISTENCE OF THIS RESCNANCE IS WELL ESTABLISHED.

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             83  N*3/2(1950) MASS (MEV)

M           (1920.0)                    DUKE       65 CNTR   PI-P EL + PCL       6/68
M           (1950.0)        APPROX      YOKOSAWA   66 CNTR   PI- P DSIG + PCL    7/66
M   1       (1975.0)                    BAREYRE    68 RVUE   PHASE-SHIFT ANAL   11/67
M   1          WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M   3       (1946.0)                    DONNACHI   68 RVUE   PHASE-SHIFT ANAL    6/68
M   6       (1931.0)                    AYED       70 IPWA                       1/71
M   6    FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M   4       (1935.0)                    DAVIES     70 RVUE   P-S ANAL  SOL A     8/69
M           (1950.0)   (30.0)           KALMUS     70 DPWA   PI+P TO K+ SIG+     1/71
M           (1930.)                     ROYCHOUD   71 DPWA                       3/72
M   7       (1925.)                     ALMEHED    72 IPWA                       2/72
M    2       1920 TO 1951               MEHTANI    72 MPWA   PI+P TO PI+PIOP     9/73
M           (1928.)                     AYED       74 IPWA                       2/74
M    L       1930. OR 1925.             LONGACRE   75 IPWA   PI N TO 2PI N      11/75*
M    L   THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.      11/75*

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             83  N*3/2(1950) WIDTH (MEV)

W           (170.0)                     DUKE       65 CNTR                       7/66
W           (200.0)         APPROX      YOKOSAWA   66 CNTR                       7/66
W   1       (180.0)                     BAREYRE    68 RVUE                      11/67
W   3       (221.0)                     DCNNACHI   68 RVUE                       6/68
W   6       (197.0)                     AYED       70 IPWA                       1/71
W   4       (221.0)                     DAVIES     70 RVUE   SOL A               8/69
W           (300.0)    (60.0)           KALMUS     70 DPWA   PI+P TO K+ SIG+     1/71
W   7       (200.)                      ALMEHED    72 IPWA                       2/72
W    2       234 TO 269                 MEHTANI    72 MPWA   PI+P TO PI+PIOP     9/73
W           (237.)                      AYED       74 IPWA                       2/74
W    L       235. OR 240.               LONGACRE   75 IPWA   PI N TO 2PI N      11/75*
     SEE THE NOTES ACCCMPANYING THE MASSES QUOTED.

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             83  N*3/2(1950) REAL PART OF POLE PCSITICN (MEV)                   11/75*

RE          (1924.)                     LCNGACRE   75 IPWA   PI N TO 2PI N      11/75*

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             83  N*3/2(1950) 2*IMAG PART CF POLE PCSITICN (MEV)                 11/75*

IM          (258.)                      LCNGACRE   75 IPWA   PI N TO 2PI N      11/75*

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             83  N*3/2(1950) PARTIAL DECAY MODES

                                                          CECAY MASSES
P1     N*3/2(1950) INTO PI N                              139+ 938
P2     N*3/2(1950) INTO SIGMA K                          1189+ 493
P3     N*3/2(1950) INTO N*3/2(1232) PI                   1232+ 139
P4     N*3/2(1950) INTO Y*1(1385) K                      1384+ 493
P5     N*3/2(1950) INTO N*3/2(1232) RHO                  1232+ 773
P6     N*3/2(1950) INTO NEUTRON PI+ PI+                   939+ 139+ 139
P7     N*3/2(1950) INTO N*3/2(1232) PI PI (NOT RHO)      1232+ 139+ 139
P8     N*3/2(1950) INTO GAM NUCLEON, HELICITY=1/2           0+ 938
P9     N*3/2(1950) INTO GAM NUCLEON, HELICITY=3/2           0+ 938
P10    N*3/2(1950) INTO N RHO                             938+ 773
P11    N*3/2(1950) INTO N*3/2(1232) PI,F-WAVE            1232+ 139
P12    N*3/2(1950) INTO N*3/2(1232) PI,H-WAVE            1232+ 139
P13    N*3/2(1950) INTC N RHO,S=3/2,F-WAVE                938+ 773

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             83  N*3/2(1950) BRANCHING RATIOS

R1     N*3/2(1950) INTO (PI N)/TOTAL                     (P1)
R1          (0.41)                      DUKE       65 CNTR   VERY ENERGY DEP     7/66
R1          (0.4)           APPROX      YOKOSAWA   66 CNTR                       7/66
R1  1       (0.57)                      BAREYRE    68 RVUE                      11/67
R1  3       (0.386)                     DONNACHI   68 RVUE                       6/68
R1  6       (0.496)                     AYED       70 IPWA                       1/71
R1  4       (0.51)                      DAVIES     70 RVUE   SOL A               8/69
R1  7       (0.4)                       ALMEHED    72 IPWA                       2/72
R1          (.405)                      AYED       74 IPWA                       2/74
       SEE THE NOTES ACCOMPANYING THE MASSES CUOTEC.

R2     N*3/2(1950) INTO (SIGMA K)*(PI N)/TCTAL**2        (P2*P1)
R2          SEEN                        BORREANI   68 HBC    PI+P 1.35-1.68     10/69
R2  1       (0.004)   (0.008)           FEUERBACH  70 RVUE   PI P TO K+ SIG+     7/70
R2  1    ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
R2  1    MODEL USED MAY DOUBLE CCUNT.
R2        0.0081   0.0013               KALMUS     70 DPWA   PI+P TO K+ SIG+     1/71

R3     N*3/2(1950) FROM PI N TC N*3/2(1232) PI           SQRT(P1*P3)
R3   2     .37 TO .48                   MEHTANI    72 MPWA   PI+P TO PI+PIOP     9/73
R3   2  MOSTLY F WAVE DECAY                                                      9/73

R4     N*3/2(1950) FROM PI N TO SIGMA K                  SQRT(P1*P2)             9/73
R4          (.04)                       LANGBEIN   73 IPWA   PI N-K SIG,SOL 1    9/73
R4          (.05)                       LANGBEIN   73 IPWA   PI N-K SIG,SOL 2    9/73
R4  5       (.022)TO  .040              DEANS      75 CPWA   PI N TO K SIGMA    11/75*
R4  5   RANGE GIVEN IS FROM FOUR BEST SOLUTICNS.                                11/75*

R5     N*3/2(1950) FROM PI N TO N*3/2(1232) PI,F-WAVE    SQRT(P1*P11)           11/75*
R5   L      (-.25)OR  -.32              LONGACRE   75 IPWA   PI N TO 2PI N      11/75*

R6     N*3/2(1950) FROM PI N TC N RHO,S=3/2,F-WAVE       SQRT(P1*P13)           11/75*
R6   L      (.18)OR  -.24               LONGACRE   75 IPWA   PI N TC 2PI N      11/75*

   MORE INFORMATICN ON INELASTIC CECAY MODES OF BUMPS, SEEN IN PRODUCTION
   EXPERIMENTS AROUND 1950 MEV, MAY BE FOUND IN THE NEXT ENTRY

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             83  N*3/2(1950) PHOTON DECAY AMPL(GEV**-1/2)

   FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
   REVIEW PRECEDING THE BARYON LISTINGS.

A1     N*3/2(1950) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)
A1          -.088      .025             DEVENIS2   74 DPWA   PI N PHOTO-PROD     4/75*
A1          -.070      .012             KNIES      74 CPWA   PI N PHOTO PROD     2/74
A1          -.C59      .029             METCALF    74 DPWA   PI N PHOTO-PRCD     2/74
A1         (-.080)                      MOORHOUS   74 DPWA   PI N PHOTO-PRCD     2/74
A1          -.053      .005             CRAWFORD   75 DPWA   PI N PHOTO-PROD     1/76*
A1         (-.076)                      BARBOUR    76 DPWA   PI N PHOTO-PROD     1/76*
A1         . . . . . . . . .
A1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.3)

A2     N*3/2(1950) INTO GAM NUCLEON, HELICITY=3/2 (GEV**-1/2)
A2          -.080      .021             DEVENIS2   74 DPWA   PI N PHOTO-PROD     4/75*
A2          -.078      .010             KNIES      74 DPWA   PI N PHOTO PRCD     2/74
A2          -.093      .024             METCALF    74 DPWA   PI N PHOTC-PRCD     2/74
A2         (-.180)                      MCORHOUS   74 DPWA   PI N PHOTO-PRCD     2/74
A2          -.038      .014             CRAWFORD   75 DPWA   PI N PHOTC-PRCD     1/76*
A2         (-.065)                      BARBOUR    76 DPWA   PI N PHOTC-PRCD     1/76*
A2         . . . . . . . . .
A2   AVERAGE MEANINGLESS (SCALE FACTOR = 1.5)

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                              REFERENCES FOR N*3/2(1950)

DUKE     65 PRL 15 468        +JONES,KEMP,MURPHY,PRENTICE, +     (RHEL,OXF)IJP
YOKOSAWA 66 PRL 16 714        +SUWA, HILL, ESTERLING, BOOTH      (ANL,CHIC)IJP

BAREYRE  68 PR 165 1731       P BAREYRE, C BRICMAN, G VILLET      (SACLAY)IJP
BORREANI 68 UCRL 18350          BORREANI,KALMUS                        (LRL)
DONNACHI 68 PL 26B 161        A DCNNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139        DONNACHIE  RAPPORTEUR'S TALK            (GLAS)
    ALSO 68 THESIS            R G KIRSOPP                              (EDIN)

AYED     70 KIEV CONF         R AYED,P BAREYRE, G VILLET           (SACL)IJP
DAVIES   70 NP B21 359        A DAVIES                                (GLAS)
FEUERBAC 70 NP 16B 85         FEUERBACHER+HOLLADAY            (VANDERBILT)
KALMUS   70 PR D2 1824        G KALMUS, G BORREANI, J LOUIE            (LRL)

ROYCHOUD 71 NP B27 125        R K ROYCHOUDHURY,B H BRANSCEN        (DURH)IJP

ALMEHED  72 NP B40 157        +LCVELACE                       (LUND,RUTG)IJP
MEHTANI  72 PRL 29 1634       +FUNG, KERNAN, SCHALK, +           (UCR +LBL)
LANGBEIN 73 NP B53 251        LANGBEIN,WAGNER                    (MUNICH)IJP

AYED     74 PRIVATE COMMCTN.  AYED,BAREYRE                         (SACL)IJP
    ALSO 73 AIX CCNFERENCE    AYED,BAREYRE                         (SACL)IJP
DEVENIS2 74 PL 52B 227        DEVENISH,LYTH,RANKIN         (DESY,LANC,BCNN)IJP
KNIES    74 PRD 9 2680        KNIES,MOORHOUSE,OBERLACK        (LBL,GLAS)IJP
METCALF  74 NP B76 253        W J METCALF,R L WALKER                (CIT)IJP
MOORHOUS 74 PRD 9 1           MCORHOUSE,OBERLACK,ROSENFELD   (GLAS+LBL)IJP

CRAWFORD 75 NP B97 125        R L CRAWFORD                         (GLAS)IJP
DEANS    75 NP B96 90         +MITCHELL,MONTGCMERY,+       (SFLA,ALABAMA)IJP
LONGACRE 75 PL 55B 415        +ROSENFELD,LASINSKI,SMADJA+      (LBL,SLAC)IJP

BARBOUR  76 SBMTC. TO NP      I. M. BARBOUR,R. L. CRAWFCRD         (GLAS)IJP

                              PAPERS NOT REFERREC TO IN CATA CARDS.

HOHLER   63 NP 48 470         G HOHLER, G EBEL                 (KARLSRUHE) I
LAYSON   63 NC 27 724         W M LAYSON                            (CERN) IJ
AUVIL    64 NC 33 473         P AUVIL, C LOVELACE                  (LOIC)IJP
HELLAND  64 PR 134 B1062      +DEVLIN,HAGGE,LCNGO,MOYER,WOOD         (LRL) IJ
HOHLER   64 PL 12 149         G HOHLER, J GIESECKE             (KARLSRUHE) I
HOLLADAY 65 PR 139 B1348      W G HOLLADAY                      (VANDERBILT)
JOHNSON  67 UCRL-17683 THESIS C H JOHNSON                              (LRL)
DONNACHI 69 NP 10B 433        A DCNNACHIE, R KIRSOPP            (GLAS+EDIN)
AYED     70 PL 31B 598        +BAREYRE+VILLET                       (SACLAY)
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Δ(1960) — D35

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13  N*3/2(1960, JP=5/2-) I=3/2

THIS EFFECT IS SEEN IN TWO CHANNELS.

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             13  N*3/2(1960) MASS (MEV)

M   3       (1954.0)                    DCNNACHI   68 RVUE   PHASE-SHIFT ANAL    6/68
M   3       (1970.)                     KIRSOPP    68 RVUE   PHASE SHIFT ANAL   10/69
M   X       (1950.0)        APPROX      LEA        69 CNTR   PI-P ELASTIC        8/69
M   X    SEE ALSC APLIN 70
M   3    WHERE MAX. ABSORPTION IS -DONNACHI, 2 ,KIRSOPP EYEBALL FIT CERN 1      10/69
M   7       (2200.)                     ALMEHED    72 IPWA                       2/72
M    1      (1960.)                     LANGBEIN   73 IPWA   PI N-K SIG,SOL 2    9/73
M    1   NOT SEEN IN SOLUTION 1 OF LANGBEIN73                                    9/73
M           (1889.)                     AYED       74 IPWA                       2/74

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             13  N*3/2(1960) WIDTH (MEV)

W   3       (311.00)                    DCNNACHI   68 RVUE                       8/69
W   3       (400.)                      KIRSOPP    68 RVUE   PHASE SHIFT ANAL   10/69
W   7       (600.)                      ALMEHED    72 IPWA                       2/72
W    1      (150.)                      LANGBEIN   73 IPWA   PI N-K SIG,SOL 2    9/73
W           (121.)                      AYED       74 IPWA                       2/74
        SEE THE NOTES ACCOMPANYING MASSES QUOTED

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Baryons
Δ(1960), Δ(2160)

Data Card Listings
For notation, see key at front of Listings.

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                 13  N*3/2(1960) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      N*3/2(1960) INTO PI N                            139+ 938
P2      N*3/2(1960) INTO K SIGMA                         493+1189

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                 13  N*3/2(1960) BRANCHING RATIOS

R1      N*3/2(1960) INTO (PI N)/ TOTAL                 (P1)
R1  3         (.154)               DONNACHI  68 RVUE    PHASE SHIFT ANA. 10/69
R1  3         (.12)                KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
R1  7         (0.25)               ALMEHED   72 IPWA                      2/72
R1            (.081)               AYED      74 IPWA                      2/74

R2      N*3/2(1960) INTO (K SIGMA)/TOTAL                (P2)
R2  1       (0.013)  (0.01)        FEUERBACH 70 RVUE    PI P TO K+ SIG+   7/70
R2  1     ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
R2  1     MODEL USED MAY DOUBLE COUNT.

R3      N*3/2(1960) FROM PI N TO K SIGMA               SQRT(P1*P2)        9/73
R3   1        (.08)                LANGBEIN  73 IPWA    PI N-K SIG,SOL 2  9/73
R3  2         (.018)TO  .035       DEANS     75 DPWA    PI N TO K SIGMA 11/75*
R3  2   RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                        11/75*

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                 13  N*3/2(1960) PHOTON DECAY AMPL(GEV**-1/2)

       FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
       REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*3/2(1960) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)            1/76*
A1           +.003     .016         CRAWFORD  75 DPWA    PI N PHOTO-PROD  1/76*
A1          (-.085)                 BARBOUR   76 DPWA    PI N PHOTO-PROD  1/76*

A2      N*3/2(1960) INTO GAM NUCLEON, HELICIYT=3/2 (GEV**-1/2)            1/76*
A2           -.010     .032         CRAWFORD  75 DPWA    PI N PHOTO-PROD  1/76*
A2          (+.066)                 BARBOUR   76 DPWA    PI N PHOTO-PROD  1/76*

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                              REFERENCES FOR N*3/2(1960)

DONNACHI 68 PL 26B 161          A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
KIRSOPP  68 THESIS              R G KIRSOPP                          (EDIN)

LEA      69 PL 29B 584          LEA,OADES,WARD,COWAN,+  (RHEL,BRISTOL,DARE)
FEUERBAC 70 NP 16B 85           FEUERBACHER+HOLLADAY           (VANDERBILT)
ALMEHED  72 NP B40 157          +LOVELACE                      (LUND,RUTG)IJP

LANGBEIN 73 NP B53 251          LANGBEIN,WAGNER                    (MUNICH)IJP
AYED     74 PRIVATE COMMCTN.    AYED,BAREYRE                         (SACL)IJP
   ALSO  73 AIX CONFERENCE      AYED,BAREYRE                         (SACL)IJP

CRAWFORD 75 NP B97 125          R L CRAWFORD                         (GLAS)IJP
DEANS    75 NP B96 90           +MITCHELL,MONTGOMERY,+       (SFLA,ALABAMA)IJP

BARBOUR  76 SBMTD. TO NP        I. M. BARBOUR,R. L. CRAWFORD        (GLAS)IJP

                                PAPERS NOT REFERRED TO IN DATA CARDS.

DONNACHI 69 NP 10B 433          A DONNACHIE, R KIRSOPP          (GLAS+EDIN)
AYED     70 PL 31B 598          +BAREYRE+VILLET                     (SACLAY)
APLIN    71 NP B32 253          +COWAN,GIBSON,GILMORE++       (RHEL,BRISTOL)

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1950 MEV REGION – PRODUCTION AND σ_{TOTAL} EXP'TS

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                 70  N*3/2(1950, JP=     ) I=3/2    PRODUCTION EXPERIMENTS

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                 70  N*3/2(1950) MASS (MEV) (PROD. EXP.)

M          (1922.0)      APPROX     COOL      56 CNTR   PI+ P TOTAL       7/66
M          (1912.0)   (15.0)        BRISSON   61 CNTR   PI+ P TOTAL       7/66
M          (1900.0)    (9.0)        DEVLIN    65 CNTR   PI+ P TOTAL
M    N     (2080.0)   (12.0)        YOON      67 HBC  + 3 BEV/C PI-P      8/67
M    N      THIS BUMP IS NOT SEEN BY CHUNG 68 AT 3.2 GEV/C
M          (1860.0)                 COLTON    72 HBC ++ PP TO PI+PN 7GEV  1/73
M          (1895.)    (15.)         COLLEY    74 HBC ++ K+P TO K+PPI+PI- 10/74*
M          (1890.)      5. TO 10.   BRAUN2    75  BC    PBAR P AND D,5.7 11/75*
M    C     (1881.)     (6.)         CHUNG     75 HBC ++ PI+ P AND K+ P    1/76*
M    C   MOST PROBABLE JP ASSIGNMENT IS 7/2+.                             1/76*
M          (1880.)    (10.)         GAIDOS    75 HBC ++ PI+P TO N* 2PI    1/76*

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                 70  N*3/2(1950) WIDTH (MEV) (PROD. EXP.)

W           (256.0)   (39.0)        DEVLIN    65 CNTR
W            (40.0)   (20.0)        YOON      67 HBC  +                   8/67
W           (180.0)                 COLTON    72 HBC ++ PP TO PI+PN 7GEV  1/73
W           (230.)    (50.)         COLLEY    74 HBC ++ K+P TO K+PPI+PI- 10/74*
W           (120.)     10. TO 20.   BRAUN2    75  BC    PBAR P AND D,5.7 11/75*
W    C      (219.)    (23.)         CHUNG     75 HBC ++ PI+ P AND K+ P    1/76*
W           (180.)    (30.)         GAIDOS    75 HBC ++ PI+P TO N* 2PI    1/76*

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                 7C  N*3/2(1950) PARTIAL DECAY MODES (PROD. EXP.)

                                                          DECAY MASSES
P1      N*3/2(1950) INTO PI N                            139+ 938
P2      N*3/2(1950) INTO SIGMA K                        1189+ 493
P3      N*3/2(1950) INTO N*3/2(1232) PI                 1232+ 139
P4      N*3/2(1950) INTO Y*1(1385) K                    1384+ 493
P5      N*3/2(1950) INTO N*3/2(1232) RHO                1232+ 773
P6      N*3/2(1950) INTO NEUTRON PI+ PI+                 939+ 139+ 139
P7      N*3/2(1950) INTO N*3/2(1232) PI PI (NOT RHO)    1232+ 139+ 139

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                 70  N*3/2(1950) BRANCHING RATIOS (PROD. EXP.)

R1      N*3/2(1950) INTO (PI N)/TOTAL                   (P1)
R1          (0.57)    (0.12)        DEVLIN    65 CNTR

R2      N*3/2(1950) INTO (SIGMA K)/(PI N)               (P2)/(P1)
R2           0.059     0.024        CHINOWSKY 68 HBC ++ PP TO P SIG K     11/68

R3      N*3/2(1950) INTO N*3/2(1232) PI PI (NOT RHO)    (P7)
R3           SEEN                   CHINOWSKY 68 HBC ++ PP TO (P 3PI) N  11/68
R3           SEEN                   BOGGILD   70  HBC   PP TO N3PI(NTRL)  6/70

R4      N 3/2(1950) INTO (PI N)/(N*3/2(1232) PI)        (P1)/(P3)
R4          (0.55) OR LESS          LEE       67 HBC    PI-P 3.63 BEV/C  11/67

R5      N*3/2(1950) INTO ((PI N)*(NEUTRON PI+ PI+))/TOTAL**2
R5                                                      (P1*P6)
R5           0.05      0.013        GALLOWAY  68 RVUE ++ PI+P TO N 2PI+   6/68

R6      N*3/2(1950) INTO (Y*1(1385) K)/(PI N)           (P4)/(P1)
R6           0.035     0.015        CHINOWSKY 68 HBC ++ PP TO P LAM K PI 11/68

R7      N*3/2(1950) INTO (N*3/2(1232) RHO)/(PI N)       (P5)/(P1)
R7          (0.45)     APPROX       CHINOWSKY 68 HBC ++ PP TO (P 3PI) N  11/68
R7      THIS INCLUDES CORRECTION FOR UNSEEN DECAY (ISPIN FACTOR 5/3).

R8      N*3/2(1950) INTO (N*3/2(1232) RHO)/TOTAL        (P5)
R8           SEEN                   YOON      67 HBC  +                   8/67
R8           NOT SEEN               BOGGILD   70  HBC   PP TO N3PI(NTRL)  6/70

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                              REFERENCES FOR N*3/2(1950) (PROD. EXP.)

COOL      56 PR 103 1082        R COOL, O PICCIONI, D CLARK              (BNL) I
BRISSON   61 NC 19 210          +DETOEUF,FALK-VAIRANT,VAN ROSSUM,+ (SACLAY) I
DEVLIN    65 PRL 14 1031        T J DEVLIN,J SOLOMON,G BERTSCH  (PRINCETON) I
LEE       67 PR 159 1156        +MOEBS,ROE,SINCLAIR,VANDER VELDE        (MICH)
YOON      67 PL 24B 307         +BERENYI,KEY,PRENTICE, +       (TORONTO,WISC)

CHINOWSK 68 PR 171 1421         CHINOWSKY,CONDON,KINSEY,KLEIN,+  (LRL,SLAC)
CHUNG     68 PR 165 1491        S U CHUNG,DAHL,KIRZ,MILLER               (LRL)
GALLOWAY 68 PL 26B 334          K F GALLOWAY                       (INDIANA) I

BOGGILD   70 NP B16 503         +KOREA-AHO+JACOBSEN+ (BOHR+ HELS+OSLO+STOH)
COLTON    72 PR D6 95           E COLTON, A KIRSCHBAUM                   (LBL)
COLLEY    74 NP B69 205         COLLEY,HUQ,JOBES,KINSON,MILNE,+ (BIRM+GLAS)I
BRAUN2    75 NP B95 503         +GERBER,MAURER,MICHALON,SCHIBY+ STBRB,LPNP I
CHUNG     75 PL 57B 384         +PROTOPOPESCU,EISNER+    (BNL+CASE+LBL+UCSC)IJP
   ALSO   75 PRD 12 693         CHUNG,PROTOPOPESCU,EISNER+  (BNL+CASE+UCSC)IJP
GAIDOS    75 PRD 12 2565        GAIDOS,MILLER                          (PURD)IJP

                                PAPERS NOT REFERRED TO IN DATA CARDS.

DEUTSCHM 75 NP B99 397          DEUTSCHMANN+(AACH+BONN+BERL+CERN+CRAC+HEID)

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Δ(2160) →

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                  9  N*3/2(2160,        ) I=3/2

                  EARLY ANALYSES FOUND EVIDENCE FOR A RESONANCE
                  NEAR THIS MASS IN THE P33 PARTIAL WAVE, AND UNLESS
                  STATED OTHERWISE, ALL DATA CARDS BELOW APPLY TO THIS
                  WAVE.  IN ADDITION, ROYCHOUDHURY 71 FIND POSSIBLE
       EVIDENCE FOR P31, D33, AND D35 RESONANCES IN THIS MASS REGION.  IN A
       SIMILAR ANALYSIS BRANSDEN 71 FOUND SOME EVIDENCE FOR S31, D33, AND D35
       RESONANCES IN THIS REGION.  VON SCHLIPPE 72 SUGGESTS A G39.
          THE MOST RECENT PI N ANALYSIS FINDS A G39 RESONANCE IN THIS MASS
       REGION.  THE EFFECT SEEN IN K SIG PROD. IS 100 MEV LOWER IN MASS.
          A PRONOUNCED SHARP DIP IS OBSERVED IN PI+ P BACKWARD SCATTERING AT
       2200 MEV BY REY 74.
          DUAL INTERFERENCE MODEL ANALYSIS OF MA 75 FINDS SIGNAL FOR P33,
       P31, AND D35, BUT NOT FOR G39.

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                  9  N*3/2(2160) MASS  (MEV)

M    3     (2160.)                        KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
M          (2120.)                        ROYCHOUD  71 DPWA                      3/72
M    7     (2150.)                        ALMEHED   72 IPWA                      2/72
M     1    (1980.)                        LANGBEIN  73 IPWA    PI N-K SIG,SOL 1  9/73
M     1  NOT SEEN IN SOLUTION 2 OF LANGBEIN73                                    9/73
M    2     (2174.)                        AYED      74 IPWA                      2/74
M    2   AYED 74 RESULT IS A G39 RESONANCE.                                      2/74
M    4     (2196.)      (46.)      (41.)  REY       74 MPWA ++ PI+ P 180 DEG CS 10/74*
M    4   BAKER 74 AND REY 74 FIND NEGATIVE PARITY (SPIN UNDETERMINED).

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                  9  N*3/2(2160) WIDTH (MEV)

W    3      (260.)                        KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
W    7      (200.)                        ALMEHED   72 IPWA                      2/72
W     1     (190.)                        LANGBEIN  73 IPWA    PI N-K SIG,SOL 1  9/73
W    2      (205.)                        AYED      74 IPWA                      2/74
W    4      (302.)     (143.)             REY       74 MPWA ++ PI+ P 180 DEG CS 10/74*
         SEE THE NOTES ACCOMPANYING MASSES QUOTED

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                  9  N*3/2(216C) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      N*3/2(2160) INTO PI N                            139+ 938
P2      N*3/2(2160) INTO K SIGMA                         493+1189

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                  9  N*3/2(216C) BRANCHING RATIOS

R1      N*3/2(2160) INTO (PI N)/TOTAL                      (P1)
R1  3          (.25)               KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
R1  7         (0.3)                ALMEHED   72 IPWA                      2/72
R1  2          (.045)              AYED      74 IPWA                      2/74
R1  4   REY74 FINDS (J+1/2)X=.81+/-(.54/.39)                            10/74*

R2      N*3/2(2160) FROM PI N TO K SIGMA                SQRT(P1*P2)        9/73
R2   1         (.08)               LANGBEIN  73 IPWA    PI N-K SIG,SOL 1  9/73
R2  5          (.048)TO  .120      DEANS     75 DPWA    PI N TO K SIGMA 11/75*
R2  5   RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                        11/75*

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                              REFERENCES FOR N*3/2(2160)

KIRSOPP  68 THESIS              R G KIRSOPP                          (EDIN)
ROYCHOUD 71 NP B27 125          R K ROYCHOUDHURY,B H BRANSDEN    (DURH)IJP

ALMEHED  72 NP B40 157          +LOVELACE                      (LUND,RUTG)IJP
LANGBEIN 73 NP B53 251          LANGBEIN,WAGNER                    (MUNICH)IJP
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Data Card Listings

For notation, see key at front of Listings.

Baryons

Δ(2160), Δ(2420), Δ(2850)

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AYED       74 PRIVATE COMMCTN.  AYED,BAREYRE                             (SACL)IJP
   ALSO 73 AIX CONFERENCE       AYED,BAREYRE                             (SACL)IJP
REY        74 PRL 32 908        REY,LENNOX,POIRIER,PRETZL             (NDAM+MPIM)IP
   ALSO 74 PRL 33 250           REY,LENNOX,POIRIER,PRETZL             (NDAM+MPIM)IP
   ALSO 75 PRD 11 1777          LENNOX,POIRIER,REY,SANDER+   (NDAM+FNAL+ANL)IP
DEANS      75 NP B96 90         +MITCHELL,MONTGOMERY,+            (SFLA,ALABAMA)IJP

                                PAPERS NOT REFERRED TO IN DATA CARDS.

DONNACHI 69 NP 108 433          A DONNACHIE,R KIRSOPP                (GLAS+EDIN)
BRANSDEN 71 NP B26 511          +OGDEN                                   (DURH)IJP
   ALSO 70 NP B16 461           ROYCHOUDHURY,PERRIN,BRANSDEN             (DURH)IJP
VON SCHL 72 LNC 4 767           VON SCHLIPPE                             (LOWC)IJP
BAKER      74 PRL 32 251        BAKER,EARTLY,PRETAL,PRLSS,+ (FNAL,ANL,NDAM)P
MA         75 PRD 11 1832       MA,SHAW                              (UCSB,SLAC)IJP

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Δ(2420)

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84  N*3/2(2420, JP=11/2+)  I=3/2   H3 11

BOTH ROYCHOUDHURY 71 AND BRANSDEN 71 SEE A POSSIBLE
RESONANT F35 IN THIS MASS REGION. IN ADDITION BRANSDEN
71 FIND A RESONANT P33 AT 2600 MEV.

               84  N*3/2(2420) MASS (MEV)

M  6     (2312.0)                    AYED      70 IPWA                        1/71
M  6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M        (2400.)                     BRANSDEN  71 CPWA                        3/72
M        (2400.)                     ROYCHOUD  71 CPWA                        3/72
M        (2440.)                     OTT       72 MPWA  0 PI-P BKWD ELSTC     2/73
M        (2392.)                     AYED      74 IPWA                        2/74
M  1     (2404.)     (63.)           REY       74 MPWA ++ PI+ P 180 DEG CS 10/74*
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               84  N*3/2(2420) WIDTH (MEV)

W  6     (347.0)                     AYED      70 IPWA                        1/71
W        (289.)                      AYED      74 IPWA                        2/74
W  1     (484.)      (79.)           REY       74 MPWA ++ PI+ P 180 DEG CS 10/74*
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               84  N*3/2(2420) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1     N*3/2(2420) INTO PI N                              139+ 938
P2     N*3/2(2420) INTO SIGMA K                           1197+ 493
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               84  N*3/2(2420) BRANCHING RATIOS

R1     N*3/2(2420) INTO (PI N)/TOTAL                 (P1)
R1  6      (0.113)                   AYED      70 IPWA                        1/71
R1  7      (.4)                      OTT       72 MPWA  0 PI-P BKWD ELSTC     2/73
R1         (.109)                    AYED      74 IPWA                        2/74
R1  1      (.157)    (.070)    (.035)REY       74 MPWA ++ PI+ P 180 DEG CS 10/74*
R1  1   REY 74 DETERMINES (J+1/2)X ONLY, WE HAVE DIVIDED BY 6.               10/74*

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                          REFERENCES FOR N*3/2(2420)

AYED       70 KIEV CONF         R AYED,P BAREYRE, G VILLET               (SACL)IJP

BRANSDEN 71 NP B26 511          +OGDEN                                   (DURH)IJP
   ALSO 70 NP B16 461           ROYCHOUDHURY,PERRIN,BRANSDEN             (DURH)IJP
ROYCHOUD 71 NP B27 125          R K ROYCHOUDHURY,B H BRANSDEN            (DURH)IJP
OTT        72 PL 42B 133        +TRISCHUK,VAVRA,RICHARDS,+ (MCGI,STLO,IOWA)IJP
   ALSO 72 MCGILL THESIS        J. VAVRA                                  (MCGI) JP
AYED       74 PRIVATE COMMCTN.  AYED,BAREYRE                             (SACL)IJP
   ALSO 73 AIX CONFERENCE       AYED,BAREYRE                             (SACL)IJP
REY        74 PRL 32 908        REY,LENNOX,POIRIER,PRETZL             (NDAM+MPIM)IP
   ALSO 74 PRL 33 250           REY,LENNOX,POIRIER,PRETZL             (NDAM+MPIM)IP
   ALSO 75 PRD 11 1777          LENNOX,POIRIER,REY,SANDER+   (NDAM+FNAL+ANL)IP

                                PAPERS NOT REFERRED TO IN DATA CARDS.

BELLAMY    67 PRL 19 476        +BUCKLEY,DOBINSON, +          (WESTFIELD,LOUC) JP

AYED       70 PL 31B 598        +BAREYRE+VILLET                          (SACLAY)

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2420 MEV REGION – PRODUCTION AND σ_{TOTAL} EXP'TS

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               69  N*3/2(2420, JP=    ) I=3/2    PRODUCTION EXPERIMENTS

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               69  N*3/2(2420) MASS (MEV) (PROD. EXP.)

M        (2360.0)                    DIDDENS   63 CNTR    PI+ P TOTAL
M        (2520.0)    (40.0)          ALVAREZ   64 CNTR    PI PHOTOPROD       7/66
M        (2440.0)                    HOHLER    64 RVUE    DATA + DISP REL
M        (2400.0)        APPROX      WAHLIG    64 OSPK  0 PI-P CH EX
M  B     (2452.0)                    BARGER    66 RVUE    TOTAL + CH EX     11/67
M  B   USES REGGE AMP.+RESON. TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGRE
M  B   FOR CRITICISM OF THIS METHOD, SEE DOLEN 68.
M         2423.0     10.0            CITRON    66 CNTR    PI+ P TOTAL        7/66
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               69  N*3/2(2420) WIDTH (MEV) (PROD. EXP.)

W        (200.0)                     DIDDENS   63 CNTR
W        (245.0)                     HOHLER    64 RVUE                       7/66
W  B     (275.0)                     BARGER    66 RVUE    TOTAL + CH EX     11/67
W         310.0      20.0            CITRON    66 CNTR                       7/66
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               69  N*3/2(2420) PARTIAL DECAY MODES (PROD. EXP.)

                                                          DECAY MASSES
P1     N*3/2(2420) INTO PI N                              139+ 938
P2     N*3/2(2420) INTO SIGMA K                           1197+ 493
P3     N*3/2(2420) INTO N*3/2(1232) PI                    1232+ 139
P4     N*3/2(2420) INTO NEUTRON PI+ PI+                   939+ 139+ 139
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               69  N*3/2(2420) BRANCHING RATIOS (PROD. EXP.)

R1     N*3/2(2420) INTO (PI N)/TOTAL                      (P1)
R1         (0.067)       APPROX      DIDDENS   63 CNTR    ASSUMING J=11/2    7/66
R1          0.113     0.0036         CITRON    66 CNTR    ASSUMING J=11/2    7/66
R1  B      (0.12)                    BARGER    67 FIT     ASSUMING J=11/2   11/67
R1  D      (0.163)                   DIKMEN    67 FIT     ASSUMING J=11/2   11/67
R1  D  USES ONLY RESONANCES TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGREES
R1         (0.06)                    KORMANYOS 67 CNTR    ASSUMING J=11/2   11/67

R2     N*3/2(2420) INTO (PI N)*(NEUTRON PI+ PI+)/(TOTAL**2)
R2                                                        (P1*P4)
R2          0.0195    0.0048         GALLOWAY  68 RVUE                       6/68

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                          REFERENCES FOR N*3/2(2420) (PROD. EXP.)

DIDDENS  63 PRL 10 262          +JENKINS, KYCIA, RILEY                    (BNL) I
ALVAREZ  64 PRL 12 710          +BAR-YAM,KERN,LUCKEY,OSBORNE, +      (MIT,CEA)
HOHLER   64 PL 12 149           G HOHLER, J GIESECKE                (KARLSRUHE) I
WAHLIG   64 PRL 13 103          +MANNELLI,SODICKSON,FACKLER,WARD, +     (MIT)
BARGER   66 PR 151 1123         V BARGER, M OLSSON                       (WISC)
CITRON   66 PR 144 1101         +GALBRAITH,KYCIA,LEONTIC,PHILLIPS, +    (BNL) I

BARGER   67 PR 155 1792         V BARGER, D CLINE                        (WISC) P
DIKMEN   67 PRL 18 798          F N DIKMEN                               (MICH)
KORMANYO 67 PR 164 1661         KORMANYOS, KRISCH, OFALLON, +     (MICH,ANL) P
GALLOWAY 68 PL 26B 334          K F GALLOWAY                          (INDIANA) I

                                PAPERS NOT REFERRED TO IN DATA CARDS.

BAACKE   67 NC 51A 761          J BAACKE, M YVERT            (KARLSRUHE,ORSAY)J-L
DOBROWOL 67 PL 24B 203          DOBROWOLSKI,GUSKOV,LIKHACHEV, +        (DUBNA) P
DOLEN    68 PR 166 1768         R DOLEN, D HORN, C SCHMID                 (CIT)
WAHLIG   68 PR 168 1515         M A WAHLIG, I MANNELLI               (MIT,PISA)
   FINAL VERSION OF DATA USED IN WAHLIG 64.  IN CONJUNCTION WITH
   CITRON 66 TOTAL CROSS SECTIONS, THIS CHARGE EXCHANGE DATA GIVES
   COMPLEX ELASTIC SCATTERING AMPLITUDE AT 0 DEGREES.

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Δ(2850) BUMPS

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85  N*3/2(2850, JP=    +) I=3/2   PRODUCTION EXPERIMENTS

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               85  N*3/2(2850) MASS (MEV) (PROD. EXP.)

M        (2870.0)                    HOHLER    64 RVUE    DATA + DISP REL
M        (2700.0)        APPROX      WAHLIG    64 OSPK  0 PI-P CH EX
M        (2850.0)                    BARDADIN  66 HBC  ++ N* TO P + 3 PIS    7/66
M         2850.0     12.0            CITRON    66 CNTR    PI+ P TOTAL        7/66
M        (2883.)     (26.)     (28.) REY       74 MPWA ++ PI+ P 180 DEG CS 10/74*
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               85  N*3/2(2850) WIDTH (MEV) (PROD. EXP.)

W        (150.0)                     BARDADIN  66 HBC  ++                    7/66
W         400.0      40.0            CITRON    66 CNTR                       7/66
W        (380.)     (141.)    (201.) REY       74 MPWA ++ PI+ P 180 DEG CS 10/74*
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               85  N*3/2(2850) PARTIAL DECAY MODES (PROD. EXP.)

                                                          DECAY MASSES
P1     N*3/2(2850) INTO PI N                              139+ 938
P2     N*3/2(2850) INTO P PI PI PI                        938+ 139+ 139+ 139
P3     N*3/2(2850) INTO N PI PI                           938+ 139+ 139
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               85  N*3/2(2850) BRANCHING RATIOS (PROD. EXP.)

R1     N*3/2(2850) INTO (PI N)/TOTAL                      (P1)
R1     ONLY (J+1/2)*( PI N/TOTAL) MEASURED FOR THIS STATE
R1  B      (0.224)   (0.016)         BARGER    66 RVUE    TOTAL + CH EXC.   11/67
R1          0.261     0.048          CITRON    66 CNTR    TOTAL CROSS.SEC.  11/67
R1  B      (0.40)                    BARGER    67 RVUE    USES KORMANYOS66  11/67
R1  B  USES REGGE AMP.+RESON. TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGRE
R1  B  FOR CRITICISM OF THIS METHOD, SEE DOLEN 68.
R1  C      (0.49)                    DIKMEN    67 RVUE    USES KORMANYOS67  11/67
R1  C  USES ONLY RESONANCES TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGREES
R1         (0.39)                    DOBROWOLS 67 CNTR    PI+P AT 180 DEG
R1         (0.10)                    KORMANYOS 67 CNTR    PI-P AT 180 DEG.  11/67
R1  D      (0.06) OR LESS  CL=.95    HALDORSE  72 HBC     PP  19  GEV/C     12/72
R1  D   UPPER LIMIT ON ELASTICITY.ALSO FIND J=9/2 OR MORE.
R1         (.28)      (.13)     (.19) REY      74 MPWA ++ PI+ P 180 DEG CS 10/74*

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                          REFERENCES FOR N*3/2(2850) (PROD. EXP.)

HOHLER   64 PL 12 149           G HOHLER, J GIESECKE                (KARLSRUHE) I
WAHLIG   64 PRL 13 103          +MANNELLI,SODICKSON,FACKLER,WARD, +     (MIT)
BARDADIN 66 PL 21 357           BARDADIN-OTWINOWSKA,DANYSZ, +         (WARSAW)
BARGER   66 PR 151 1123         V BARGER, M OLSSON                       (WISC)
CITRON   66 PR 144 1101         +GALBRAITH,KYCIA,LEONTIC,PHILLIPS, +    (BNL) I

BARGER   67 PR 155 1792         V BARGER, D CLINE                        (WISC) P
DIKMEN   67 PRL 18 798          F N DIKMEN                               (MICH)
DOBROWOL 67 PL 24B 203          DOBROWOLSKI,GUSKOV,LIKHACHEV, +        (DUBNA) P
KORMANYO 67 PR 164 1661         KORMANYOS, KRISCH, OFALLON, +     (MICH,ANL) P
HALDORSE 72 NC 10A 468          HALDORSEN,JACOBSEN                       (OSLO) IJ
REY        74 PRL 32 908        REY,LENNOX,POIRIER,PRETZL             (NDAM+MPIM)IP
   ALSO 74 PRL 33 250           REY,LENNOX,POIRIER,PRETZL             (NDAM+MPIM)IP
   ALSO 75 PRD 11 1777          LENNOX,POIRIER,REY,SANDER+   (NDAM+FNAL+ANL)IP
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Baryons

Δ(2850), Δ(3230), EXOTIC NUCLEONS, Z^{*}'s

Data Card Listings

For notation, see key at front of Listings.

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                         PAPERS NOT REFERRED TO IN DATA CARDS.

BAACKE   67 NC 51A 761        J BAACKE, M YVERT           (KARLSRUHE,ORSAY)J-L
DOLEN    68 PR 166 1768       R DOLEN, D HORN, C SCHMID              (CIT)
WAHLIG   68 PR 168 1515       M A WAHLIG, I MANNELLI             (MIT,PISA)
    FINAL VERSION OF DATA USED IN WAHLIG 64.  IN CONJUNCTION WITH
    CITRON 66 TOTAL CROSS SECTIONS, THIS CHARGE EXCHANGE DATA GIVES
    COMPLEX ELASTIC SCATTERING AMPLITUDE AT 0 DEGREES.

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Δ(3230) BUMPS

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          86  N*3/2(3230, JP=    ) I=3/2  PRODUCTION EXPERIMENTS

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          86  N*3/2(3230) MASS (MEV) (PRCD. EXP.)

M       (3230.0)                    CITRCN    66 CNTR    PI+ P TOTAL      7/66
M       (3296.)    (79.)    (78.)   REY       74 MPWA ++ PI+ P 180 DEG CS 10/74*

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          86  N*3/2(3230) WIDTH (MEV) (PROD. EXP.)

W       (440.0)                     CITRCN    66 CNTR                     7/66
W       (687.)   (1043.)   (323.)   REY       74 MPWA ++ PI+ P 180 DEG CS 10/74*

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          86  N*3/2(3230) PARTIAL CECAY MODES (PROD. EXP.)

                                                       DECAY MASSES
P1     N*3/2(3230) INTC PI N                          139+ 938
P2     N*3/2(3230) INTO N PI PI                       938+ 139+ 139

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          86  N*3/2(3230) BRANCHING RATIOS

R1     N*3/2(3230) INTO (PI N)/TOTAL                        (P1)
R1    CNLY (J+1/2)*( PI N/TOTAL) MEASURED FOR THIS STATE
R1  B       (0.03)   (0.01)         BARGER    66 RVUE    TOTAL + CH EXC.  11/67
R1          (0.06)                  CITRON    66 CNTR    TOTAL CROS. SEC. 11/67
R1  B       (0.03)  TO  0.1         BARGER    67 CNTR    USES KORMANYOS66 11/67
R1  B  USES REGGE AMP.+RESON. TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGRE
R1  B  FOR CRITICISM OF THIS METHOD, SEE DOLEN 68.
R1  D       (0.25)                  DIKMEN    67 RVUE    USES KORMANYOS67 11/67
R1  D  USES ONLY RESONANCES TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGREES
R1          (.45)    (.09)    (.13) REY       74 MPWA ++ PI+ P 180 DEG CS 10/74*

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                      REFERENCES FOR N*3/2(3230) (PROD. EXP.)

BARGER   66 PR 151 1123       V BARGER, M CLSSON                     (WISC)
CITRON   66 PR 144 1101       +GALBRAITH,KYCIA,LEONTIC,PHILLIPS, +   (BNL) I
BARGER   67 PR 155 1792       V BARGER, D CLINE                      (WISC) P
DIKMEN   67 PRL 18 798        F N DIKMEN                             (MICH)
REY      74 PRL 32 908        REY,LENNOX,POIRIER,PRETZL          (NDAM+MPIM)IP
    ALSO 74 PRL 33 250        REY,LENNOX,POIRIER,PRETZL          (NDAM+MPIM)IP
    ALSC 75 PRD 11 1777       LENNCX,POIRIER,REY,SANDER+   (NDAM+FNAL+ANL)IP

                      PAPERS NOT REFERRED TO IN DATA CARDS

KORMANYO 67 PR 164 1661       KORMANYOS, KRISCH, OFALLON, +     (MICH,ANL) P
DOLEN    68 PR 166 1768       R DOLEN, D HORN, C SCHMID              (CIT)

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EXOTIC NUCLEONS – 1640 MEV REGION

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     THIS IS NOT A COMPLETE LIST. WE WILL TABULATE EXOTICS FROM NOW CN

               EX(1640, JP=    ) I=5/2

                   THIS IS NOT A COMPLETE LIST.  WE TABULATE
                   ONLY FRCM 1970 CN.

                   IN A MISSING MASS EXPERIMENT, PI+ P TO PI- X+++,
    BIRULEV 71 FIND NO EVIDENCE FOR EXOTIC (I=5/2) RESONANCES IN THE
    MASS INTERVAL 1.2 TO 2.2 GEV.

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               EX(1640) MASS (MEV)

M   A   29 1627.      12.           PRICE     70 DBC  -- K-D AT 4.91GEV/C  3/71
M   A  FOUR S. D. EFFECT

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               EX(1640) WIDTH (MEV)

W   B   29    30.  OR LESS  CL=.90  PRICE     70 CBC  -- PI-PI-N BUMP      3/71
W   B  CROSS SECTION 13.0+-3.9 MICROBARNS

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               EX(1640) CROSS SECTION LIMITS (MICROBARN)

CS  B        40.   OR LESS          BANNER    70 OSPK +++ PI+P,1.9 GEV/C   7/70
CS  B   I=5/2 LIMIT GIVEN ABOVE IS FOR MASS RANGE 1540-1750 MEV

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                      REFERENCES FOR EX(1640)

BANNER   70 NP B15 205        +CHEZE,HAMEL,TEIGER,ZACCONE +       (SACLAY)
PRICE    70 PL 33B,533        +BERG,SALANT,WATERS,WEBSTER,WEINBERG (VAND)

                      PAPERS NOT REFERRED TO IN DATA CARDS

AMMANN   71 PL   34B 533      +CARMONY,GARFINKEL,GUTAY,MILLER,YEN  (PURD)
BIRULEV  71 SJNP 12  536      +VOVENKO,GUSKOV,DOBROVOLSKII,++      (JINR)
JOHNSCN  71 PL   34B 428      D JCHNSCN                             (ANL)

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<u>Note on the S = +1 Baryon System</u>

Models based on states of three quarks have been successful in the description of the spectrum and decay of the known baryon resonances. Three quarks cannot produce S = +1 baryon resonances (Z^{*}'s), and this has probably been the primary motivation for the great amount of experimental effort that has gone into S = +1 baryon physics below ~ 2 GeV/c during the last several years. In addition, the S = +1 system offers an opportunity to study single and double pion production in a small number of rather distinct quasi-two-body channels ($K\Delta$, $K^{*}N$, and $K^{*}\Delta$). Recent developments in the field are summarized below.

<u>I = 1 System</u>

The most recent $K^{+}p$ total cross-section data are from BNL (CARROLL 73; 0.41 to 1.06 GeV/c) and Arizona-Michigan (BOWEN 73; 0.57 to 1.16 GeV/c). Neither measurement exhibits the dip of approximately 1.5 mb at 0.7 GeV/c reported by BUGG 68 and BOWEN 70. Recent differential elastic cross-section measurements (including extensions and final results of previously reported results) have come from Glasgow-Bologna-Trieste (CAMERON 74; 0.13-0.76 GeV/c), Birmingham-RHEL (ADAMS 73; 0.43 to 0.94 GeV/c), Bristol-RHEL-Aarhus-Southampton (CHARLES 73; 0.7 to 1.9 GeV/c), Maryland-ANL (ABE 75; 0.86 to 2.12 GeV/c), Washington (ADAMS 75; 1.0-1.5 GeV/c at 180°), UCL-RHEL (BARBER 73; 1.37-2.26 GeV/c), Yale-BNL (PATTON 75; 1.7-3.0 GeV/c near 0° and 180°), and ANL (YUTA 74; 2.53, 2.76, and 3.20 GeV/c). Below 750 MeV/c (where the inelastic cross section is less than 0.1 mb), the total elastic cross sections from the first three above experiments also fail to exhibit the dip seen in earlier total cross-section experiments. Coulomb interference effects are observed by CAMERON 74 and ADAMS 73; both confirm the early conclusion of GOLDHABER 62 that the low energy S-wave interaction is repulsive. The most recent polarization measurements are those of Maryland-ANL-Northwestern-FNAL (BARNETT 73; 1.37-2.31 GeV/c) and Yale-BNL (PATTON 75; 1.7-3.0 GeV/c near 0° and 180°). Recent studies of pion production in $K^{+}p$ interactions are those of CERN-Saclay (BERTHON 73; $K N\pi$, 1.21-1.69 GeV/c), CIT-UCLA (LOKEN 72; $K N\pi$ and $K N\pi\pi$, 1.37-2.17 GeV/c),

Data Card Listings

For notation, see key at front of Listings.

Baryons

Z^*'s

France-Saclay-IC-Westfield (BRUNET 72 and LEWIS 73; $KN\pi$, $KN\pi\pi$, and $KN\pi\pi\pi$, 2.11-2.72 GeV/c), and ANL (MUSGRAVE 75; $KN\pi$, 2.53-3.20 GeV/c). The general conclusion is that most pion production is associated with $\Delta(1232)$ and/or $K^*(892)$ production, though other resonances are also produced at the higher energies. The $I=1$ total and partial cross sections are shown as dashed lines in Fig. 1.

Five partial-wave analyses of K^+p elastic scattering have been carried out since 1973. CAMERON 74 performed an elastic energy-independent analysis of data at momenta up to 870 MeV/c, including their new high-statistics cross-section data below 755 MeV/c. S and P waves were kept up to 400 MeV/c with D waves being added at higher momenta, and solutions at different energies were linked by the shortest-path method, yielding a unique overall solution. An energy-dependent fit, with an effective-range parametrization for the S wave and a zero-effective-range scattering-length parametrization for P and D waves, was also performed and agreed well with the energy-independent analysis. The χ^2 per data point (χ^2/ND) was well below 1.0 at most momenta in both fits. Threshold parameters were extracted, the dominant threshold effect being a repulsive S wave. The energy-dependent ADAMS 73 analysis included data at momenta up to 1.5 GeV/c, but was aimed primarily at determining the amplitudes below 1.0 GeV/c. Below about 0.5 GeV/c a zero-effective-range scattering-length parametrization was used for S and P waves, with D and F waves set to zero; at higher energies the η and δ parameters of the S, P, D, and F waves were taken to be polynomials in c.m. momentum. Waves with $\ell \geqslant 4$ were set to the values calculated from two- and three-pion exchange by ALCOCK 73. The best χ^2 values obtained were about 2250 for 1600 degrees of freedom, of which an estimated 300 comes from inconsistent data. Two solutions were found; they are essentially identical below 1 GeV/c but differ significantly at higher energies. MARTIN 75 have performed an energy-dependent analysis of K^+p scattering up to 1.5 GeV/c as part of a simultaneous fit of $I=1$ and $I=0$ KN scattering. Below the inelastic threshold the inverse amplitudes for waves with $J \leqslant 5/2$ were parametrized as rational functions of the c.m. momentum which obeyed elastic unitarity and had correct elastic threshold behavior. To allow for inelasticity a (fitted) negative term was added to the imaginary part of the inverse amplitudes above the inelastic threshold. The F_{17}, G_{17}, and G_{19} waves were also kept, and set to the values calculated by ALCOCK 73. Two similar solutions were found with χ^2/ND = 1.1. ARNDT 74

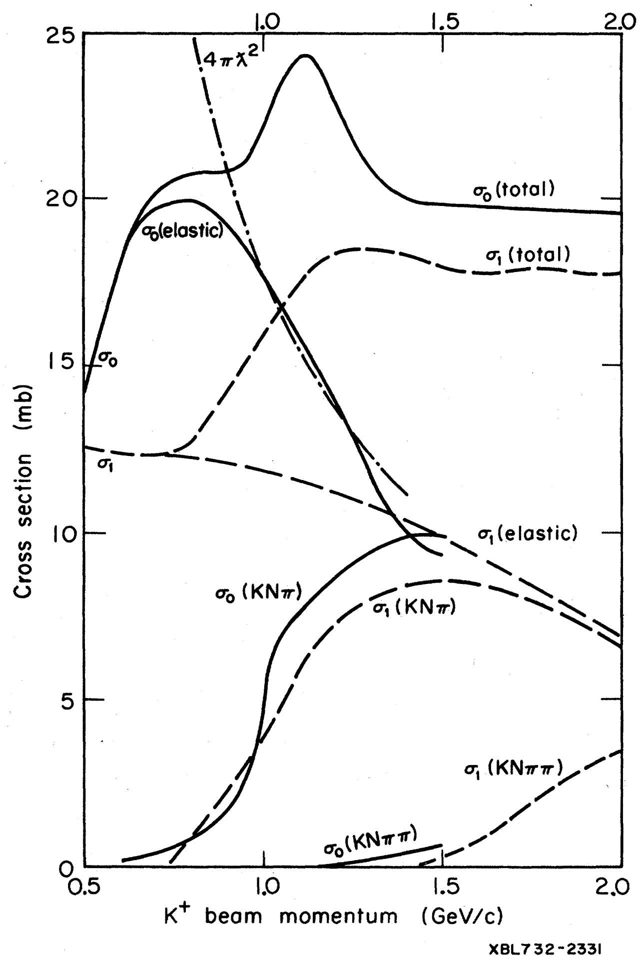
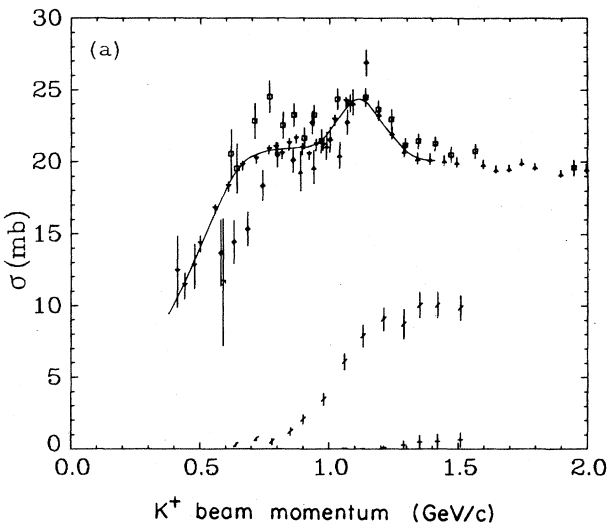


Fig. 1. KN total and partial cross sections. Subscripts indicate isospin; $I=1$ ($I=0$) cross sections are indicated by dashed (solid) curves. The total cross-section curves are from CARROLL 73, who use their recent data and that of BOWEN 73 as well as older data. The elastic $I=1$ curve is hand drawn through new and old elastic data. The inelastic $I=1$ curves are taken from LOKEN 72. The inelastic $I=0$ curves are taken from GIACOMELLI 72, and the elastic $I=0$ curve is obtained by subtracting these from the $I=0$ total cross-section curve of CARROLL 73.

Baryons
Z*'s

Data Card Listings
For notation, see key at front of Listings.

have analyzed data up to 2.0 GeV/c using an energy-dependent, two-channel K-matrix formalism in which the inelastic channel coupling to the S wave is taken to be K*N, and that coupling to higher waves (with $\ell \leqslant 4$) is taken to be KΔ. A unique solution



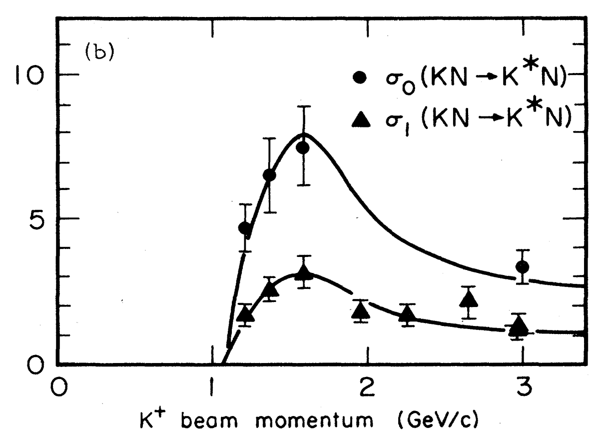


Fig. 2. (a) Unfolded I = 0 cross sections as quoted by the various authors discussed in this mini-review:
◇ BOWEN 73 σ_T
□ BUGG 68 σ_T (as unfolded by CARROLL 73)
▽ CARROLL 73 σ_T
△ COOL 70 σ_T
/ GIACOMELLI 72 σ(πKN)
\- GIACOMELLI 72 σ(ππKN)

(b) Energy dependence of the I = 0 and I = 1 cross sections for the reaction KN → K*N (HIRATA 70).

with a χ^2 per degree of freedom (χ^2/DF) of 1.33 for 3822 data points was found, and it was possible to decrease this to 1.16 by dropping 70 data points with $\chi^2 > 8$ in the original fit. The parametrized P_{13} partial wave had a resonance pole at (1787 - 100 i) MeV. The CUTKOSKY 76 analysis included data from 0.8 to 2.5 GeV/c. The ACE parametrization (see MILLER 72) was used along with contributions from P, ρ, A_2, Λ, Σ, and low mass di-pion exchange, the latter being based on the results of ALCOCK 73. An iterative fitting procedure was followed in which energy-independent fitting was alternated with energy smoothing using a parametrization based on partial-wave dispersion relations which included KΔ, K*N, and K*Δ threshold effects for all waves with $J \leqslant 7/2$. Typical χ^2/DF values were 1.0 to 1.1.

The question of the existence of a Z_1^* in the elastic channel cannot yet be considered settled. The most likely candidate has long been considered to be the P_{13} wave around 1900 MeV. ARNDT 74 found such an effect, but the three other analyses described above which reached high enough energy to observe the effect (ADAMS 73, MARTIN 75, and CUTKOSKY 76) failed to do so. See KELLY 75 for a discussion of the experimental implications of this discrepancy.

Results of the analyses of ADAMS 73 and CUTKOSKY 76 are shown in Figs. 3 and 4. Solution 2 of ADAMS 73 is plotted below 1.0 GeV/c with errors[1] on real and imaginary parts ranging from 3% to 50% for the various waves. The data set used for the results plotted included a preliminary version of the CAMERON 74 data, and the results are similar to those of CAMERON 74. This solution also agrees qualitatively with CUTKOSKY 76 at higher energies; solution 1 disagrees. The results[2] of CUTKOSKY 76 are plotted from 0.8 to 2.5 GeV/c. These results are quantitatively quite different from those of MARTIN 75 and ARNDT 74.

Two multi-channel partial-wave analyses of the I = 1 KN, KΔ, and K*N channels at 1.21, 1.29, 1.38, and 1.69 GeV/c have been performed by LESQUOY 75. One analysis used a quasi-two-body approach, and the other the isobar model approach. It was not possible to draw any firm conclusions about the

K^*N channel or to discriminate between results of other analyses of the elastic channel alone. Results on the $K\Delta$ channel indicate four comparably large waves: SD_{11}, PP_{11}, PP_{13}, and either DD_{13} or DD_{15} depending on the method of analysis. This is in contrast to earlier analyses (e.g., GRIFFITH 72) which found this channel to be dominated by the PP_{13} wave over most of the 1.0 to 1.5 GeV/c region. BERTHON2 73 find (like GRIFFITH 72) no indication in the $K\Delta$ channel of rapid phase variation signaling possible resonant effects.

I = 0 System

The experiments of CARROLL 73 and BOWEN 73 (see above) measured K^+d total cross sections in the same energy ranges as their K^+p measurements. These experiments agree rather well with each other and with older data except that the CARROLL 73 cross sections are systematically higher than those of BOWEN 70 (0.36 to 0.72 GeV/c). Unfolded I = 0 cross sections, new and old, are shown in Fig. 2(a); the disagreement between CARROLL 73 and BOWEN 73 at low energies is primarily due to differences in the unfolding procedure. The I = 0 cross section unfolded from the newer K^+p and K^+d data rises to a plateau in the 0.7 to 0.9 GeV/c region and has a hump of about 3 mb in the 0.9 to 1.3 GeV/c region. Older data had indicated a hump of comparable size in the plateau region. As shown in Figs. 1 and 2(b), the plateau is associated with a broad peak in the elastic cross section, while the hump is associated with a rising K^*N cross section.

In a partial-wave analysis of the I = 0 elastic channel GIACOMELLI 74 fit data in the 0.38 to 1.51 GeV/c region, including the new K^+n differential cross-section data of the BGRT collaboration (GIACOMELLI 73; 0.64 to 1.51 GeV/c). Three types of partial-wave analysis (all with S, P, and D waves only) were used to analyze these data: an energy-dependent analysis (ED) using the parametrization of LEA 68 and I = 1 partial waves from previous solutions of GIACOMELLI 70, ALBROW 71, and LOVELACE 71; an energy-independent analysis (EI-1) which included K^+p data and determined both the I = 0 and I = 1 partial waves; and an energy-independent analysis (EI-2) in which the I = 1 partial waves were fixed at the values of ALBROW 71's solution γ. In analyses EI-1 and EI-2 several variants of the LOVELACE 71 shortest-path technique were used to link solutions at different energies. The solutions found by these different methods fell into three main families denoted A, C, and D, the best χ^2/ND values being 1.4-1.9, 1.6-1.7, and 1.5-1.8, respectively. Examples of each class from an ED analysis using the I = 1 partial waves of GIACOMELLI 70 are shown in Fig. 5. Some criteria for choice between these solutions are offered by comparison with particular features of the data. The single existing measurement of $K^+n \to K^0p$ polarization (RAY 69; 0.60 GeV/c) is consistent with classes C and D only. The I = 0 total cross sections of CARROLL 73 and BOWEN 73 were not included in the fitting, but comparison is made with CARROLL 73 and the data are found to be consistent with class D only. LONDON 74 has calculated $K_Lp \to K_Sp$ amplitudes by combining the best (i.e., lowest χ^2) energy-dependent solution from each of GIACOMELLI 74's classes with existing I = 1 KN and $\bar{K}N$ solutions and compared the results with $K_Lp \to K_Sp$ cross-section data. He finds that the class D solution is preferred. Similar calculations have been made more recently, and with much more regeneration data, by ALEXANDER 75 and CAMERON 75. The former favors class A, while the latter favors classes C and D but is unable to distinguish between them. No conclusive evidence for Z^*'s emerges from the analysis of GIACOMELLI 74; the most likely candidate is the class-D P_{01} wave, but GIACOMELLI 74 point out that the resonance interpretation is questionable for some of the class-D solutions and for all of the class-C solutions. A Breit-Wigner plus quadratic background fit to the class-D P_{01} wave yields the following parameters: M = 1740 MeV, Γ = 300 MeV, x = 0.85.

A more recent effort is the energy-dependent simultaneous I = 0 and I = 1 analysis of MARTIN 75, which makes use of the new K^+n elastic and charge-exchange data of DAMERELL 75. The parametrization used is described above. Two qualitatively similar solutions are found. Both are quite different from all the GIACOMELLI 74 solutions, but the P_{01} wave most resembles that of the class-C solution (see Fig. 5). MARTIN 75 find no significant evidence for resonance-like energy dependence.

Baryons
Z*'s

Data Card Listings
For notation, see key at front of Listings.

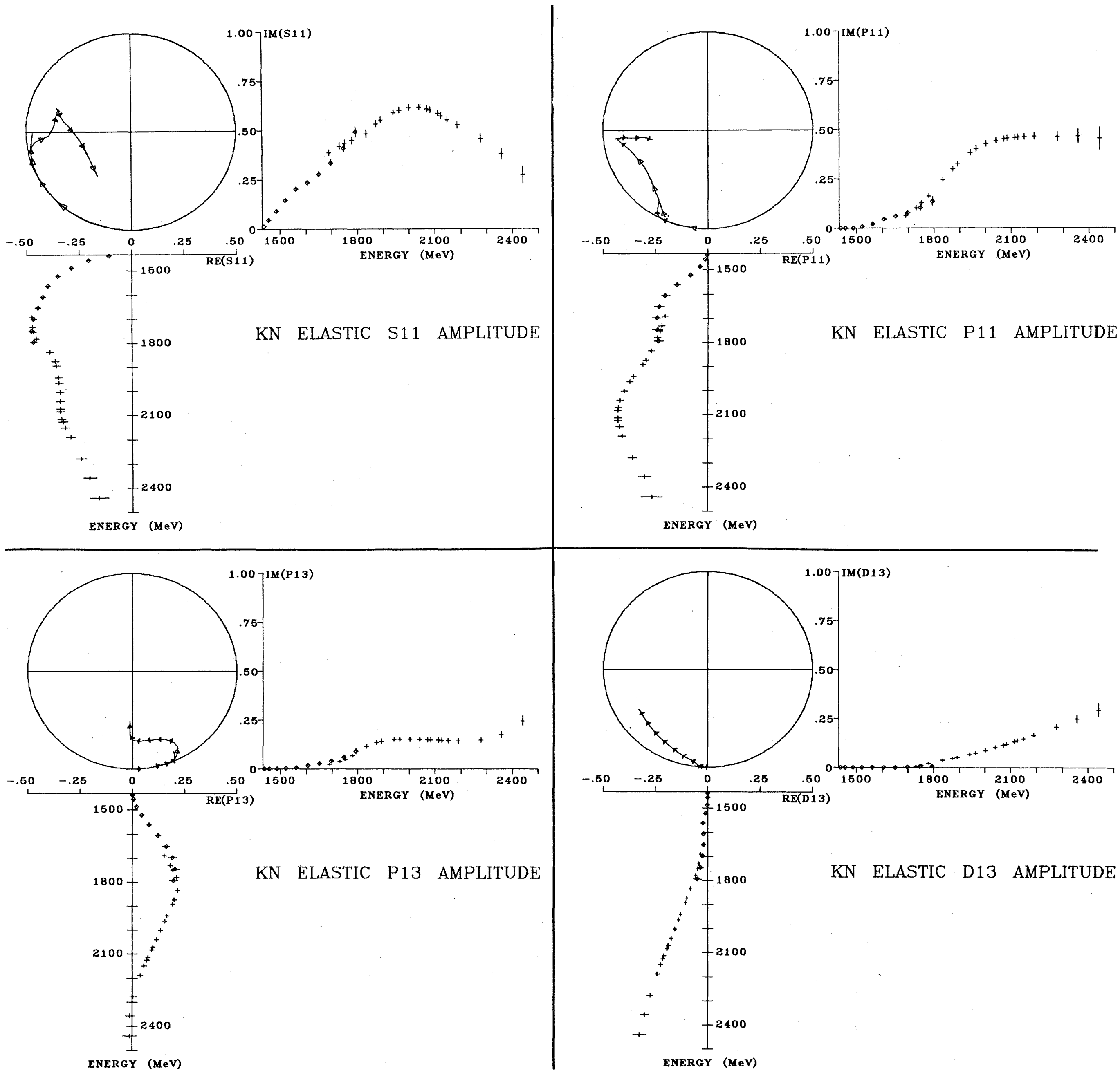


Fig. 3. Amplitudes for I = 1 KN elastic scattering in the J = 1/2 and J = 3/2 waves from ADAMS 73 (ɸ) and CUTKOSKY 76 (†). The energy dependence of each amplitude is displayed by plotting its real and imaginary parts versus energy, in alignment with the corresponding Argand plot. In addition, arrows are plotted on the Argand plots with bases positioned at integer multiples of 100 MeV and a base-to-tip length of 20 MeV. All the energy axes run from elastic threshold to 2500 MeV.

Data Card Listings

For notation, see key at front of Listings.

Baryons

Z*'s

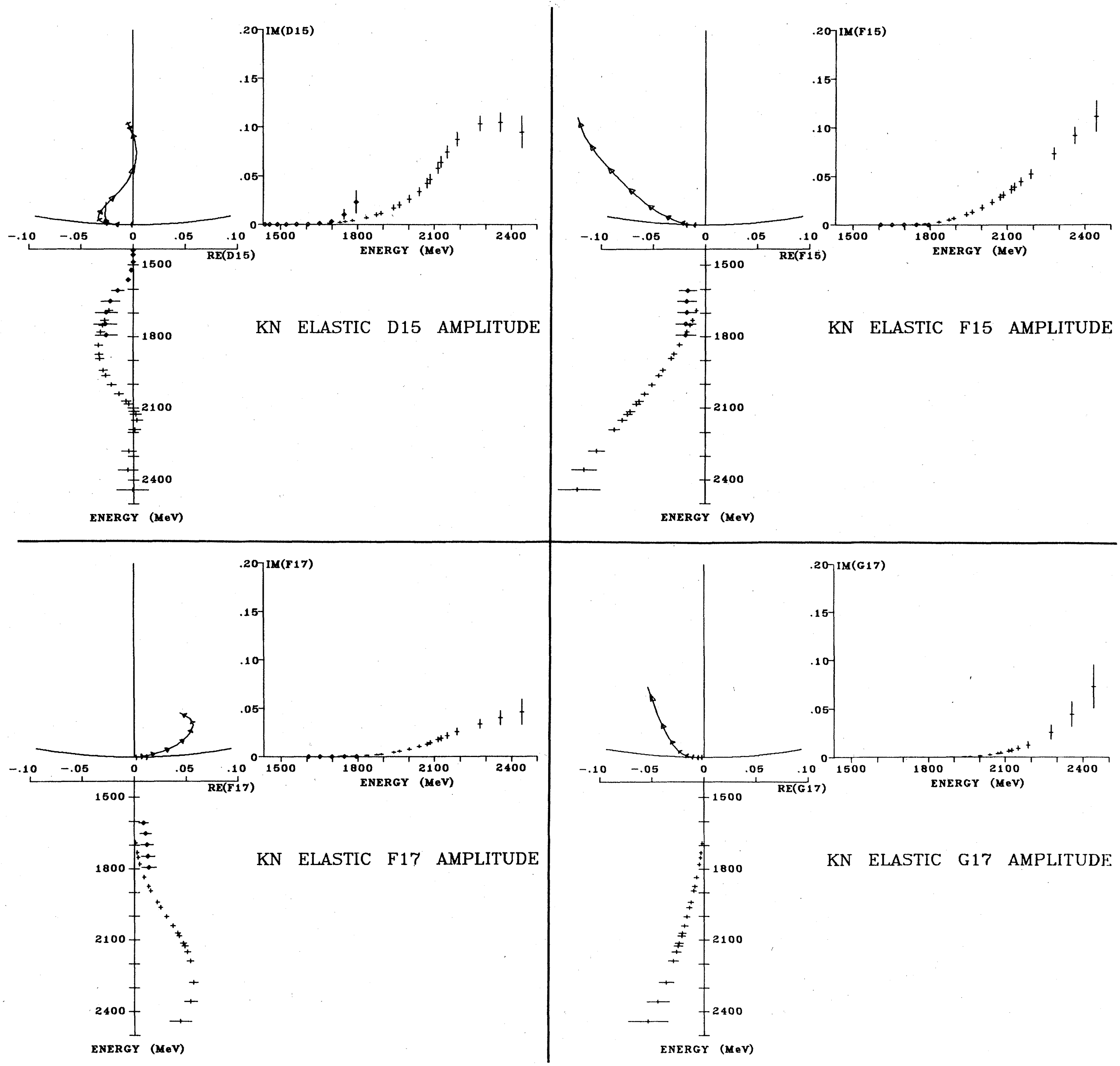


Fig. 4. Amplitudes for I = 1 KN elastic scattering in the J = 5/2 and J = 7/2 waves from ADAMS 73 (⌽) and CUTKOSKY 76 (†). The energy dependence of each amplitude is displayed by plotting its real and imaginary parts versus energy, in alignment with the corresponding Argand plot. In addition, arrows are plotted on the Argand plots with bases positioned at integer multiples of 100 MeV and a base-to-tip length of 20 MeV. All the energy axes run from elastic threshold to 2500 MeV.

Baryons

Z*'s

Data Card Listings

For notation, see key at front of Listings.

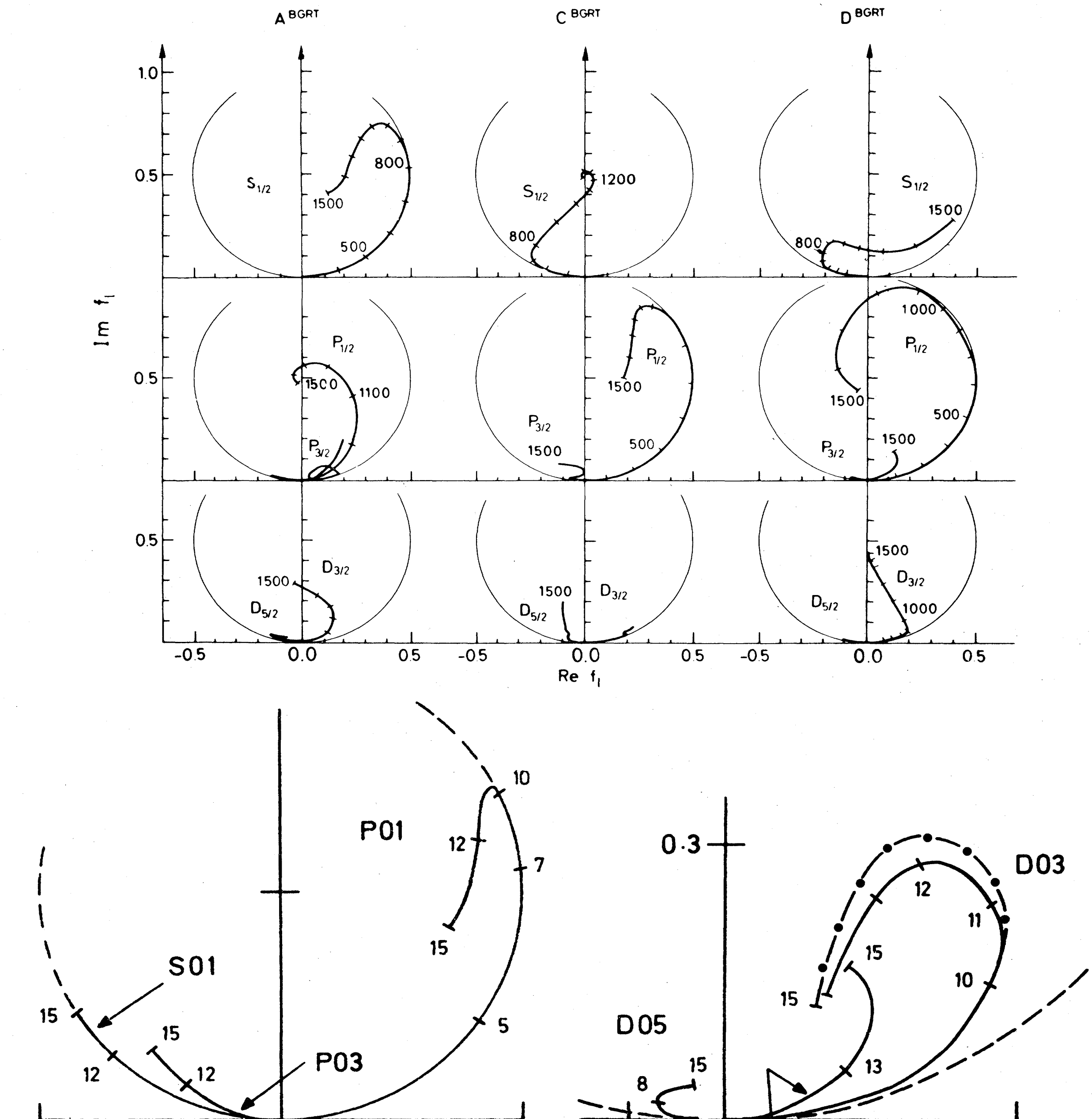


Fig. 5. Amplitudes for I = 0 KN elastic scattering from GIACOMELLI 74 (upper plots) and MARTIN 75 (lower plots). The GIACOMELLI 74 results are from the energy-dependent analysis and exemplify the three main classes of solutions found in the complete analysis; the energy dependence of the amplitudes is displayed by tick marks at integral multiples of 100 MeV. The MARTIN 75 results are from the preferred solution 2, with the solution-1 D_{03} wave (which exhibited the largest difference between solutions 1 and 2 of any wave) shown as a broken line for comparison; the energy dependence of the amplitudes is displayed by tick marks at the indicated integral multiples of 100 MeV.

Data Card Listings

For notation, see key at front of Listings.

Baryons

Z^{*}'s, $Z_0(1780)$, $Z_0(1865)$, $Z_1(1900)$

Production Experiments

There are no new developments in production experiments, and the observation of ERNE 70 that present upper limits for Z^* production are not small still holds. Cross-section limits for the production of broad Z^*'s are comparable to the observed N^* and Y^* production cross sections.

References

1. J. D. Dowell, private communication.

2. R. E. Cutkosky, private communication.

See the Data Card Listings for other references.

S=1 I=0 EXOTIC STATES (Z_0)

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$Z_0(1780)$

95 Z*0(1780, JP=1/2+) I=0 **P_{01}**

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SEE THE MINI-REVIEW PRECEDING THIS LISTING.

WILSON 72 AND GIACOMELLI 74 FIND SOME SOLUTIONS
WITH RESONANT-LIKE BEHAVIOR IN THE P01 PARTIAL WAVE.
THE EFFECT SEEN IN THE I=0 TOTAL CROSS SECTIONS,
IF A RESONANCE, MUST HAVE SPIN=1/2, BECAUSE THE
INELASTIC CROSS SECTION IS VERY SMALL AND THE TOTAL
CROSS SECTION IS ABOUT 4*PI/K**2.

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                    95  Z*0(1780) MASS (MEV)

M            1780.0      10.0           COOL       70 CNTR +  K+P, D TOTAL       1/71
M     D      SEEN                       DOWELL     70 CNTR     K+P,D TOTAL       7/70
M     D      SEE ALSO DISCUSSION OF LYNCH 70                                     7/70
M     W     (1800.)                     WILSON     72 PWA     K+N P01 WAVE       3/72
M     W   ESTIMATE OF PARAMETERS FRCM BW + QUADRATIC BACKGROUND FIT TO P01.      3/72
M      1   (1750.)                      CARROLL    73 CNTR    KN I=0 TCS,FIT 1   9/73
M      1   (1825.)                      CARROLL    73 CNTR    KN I=0 TCS,FIT 2   9/73
M      1  FIT 1=FIT OF SINGLE L=1 BW+BACKGRCUND TO I=0 TCS FROM .4-1.1 GEV/C     9/73
M      1  FIT 2=FIT OF L=1 AND L=2 BWS TO SAME DATA,SEE Z0(1865) FOR L=2 PART    9/73
M           (1740.)                     GIACCMEL   74  PWA    .38-1.51 GEV/C    10/74*

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                    95  Z*C(1780) WIDTH (MEV)

W            (565.0)                    COOL       70 CNTR +  K+P, D TOTAL       1/71
W     W      (300.)                     WILSON     72 PWA     K+N P01 WAVE       3/72
W      1     (600.)                     CARROLL    73 CNTR    KN I=0 TCS,FIT 1   9/73
W      1     (845.)                     CARROLL    73 CNTR    KN I=0 TCS,FIT 2   9/73
W            (300.)                     GIACOMEL   74  PWA    .38-1.51 GEV/C    10/74*

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                    95  Z*0(1780) PARTIAL DECAY MODES

                                                             DECAY MASSES
P1       Z*0(1780) INTO K N                               493+ 939

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                    95  Z*0(1780) BRANCHING RATIOS

R1       Z*0(1780) INTO (K N)/TOTAL                          (P1)
R1             (0.95)                   COOL       70 CNTR +  K+P, D TCTAL       1/71
R1    W        (0.85)                   WILSON     72 PWA     K+N P01 WAVE       3/72
R1     1        (.75)                   CARROLL    73 CNTR    IF J=1/2,FIT 1     9/73
R1     1        (.91)                   CARROLL    73 CNTR    IF J=1/2,FIT 2     9/73
R1              (.85)                   GIACCMEL   74  PWA    .38-1.51 GEV/C    10/74*

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                         REFERENCES FOR Z*0(1780)

COOL       70 DUKE CONF 47        R L COCL                                  (BNL)
    ALSO 69 PL 30B 564            ABRAMS,COOL,GIACOMELLI,KYCIA,LI +         (BNL)
    ALSC 70 PR D1 1887            COOL,GIACOMELLI,KYCIA,LEONTIC,LI +        (BNL)
DOWELL     70 DUKE 53             J.D. DOWELL                               (BIRM)
WILSON     72 NP B42 445          +GRIFFITHS,HIRATA +      (BGNA+GLAS+RCMA+TRST)
CARRCLL    73 PL 45B 531          +KYCIA,LI,MICHAEL,MOCKETT,RAHM+           (BNL)I
GIACCMEL   74 NP B71 138          GIACOMELLI,+             (BGNA+GLAS+ROMA+TRST)IJP

                                  PAPERS NOT REFERRED TO IN DATA CARDS

LYNCH      70 DUKE 9              G LYNCH (REVIEWER OF CR.SEC. DATA)       (LRL)
HIRATA     71 NP B30 157          +GOLDHABER,HALL,SEEGER,THRILLING,WOHL (LBL)IJP
BCWEN      73 PR D7 22            +JENKINS,KALBACH,PETERSEN +          (ARIZ+MICH)
JOHNSCN    74 PL 50B 343          JOHNSON,VLASSOPULOS                  (CERN,DURH)
CAMERON    75 PALERMC CCNF.       +CAPILUPPI+        (BGNA+EDIN+GLAS+PISA+RHEL)IJP

     EXPERIMENTS MAINLY ABOUT ELASTIC CHANNELS --
GOLDHABE 62 PRL 9 135          GOLDHABER,CHINOWSKY,GOLDHABER+   (LRL+UCLA)IJP
RAY       69 PR 183 1183       RAY,BURRIS,FISK,KRAEMER,HILL+     +CAPN+BNL
ARMITAGE 72  NAL PAPER 391     +ASTON,DUERDOTH,ELLISCN,  +      (MCHS+DARE)
GIACOME1 72 NP B42 437         GIACGMELLI +             (BGNA+GLAS+RCMA+TRST)
GIACCMEL 73 NP B56 346         GIACOMELLI,+             (BGNA+GLAS+RCMA+TRST)
    ALSO 73 BGNA PPT. AE-73/4 GIACOMELLI,GRIFITHS,+ (BGNA+GLAS+ROMA+TRST)
LCNDCN    74 PRD 9 1569        LCNDCN                                (BNL)IJP
ALEXANDE 75 PL 58B 484         ALEXANDER,BAR-NIR,BENARY+         (TELA+FEID)IJP
DAMERELL 75 NP B94 374         +HOTCHKISS,WICKENS,BENTLEY+       (RHEL,BIRM)

     EXPERIMENTS MAINLY ABOUT INELASTIC CHANNELS --
GIACOMEL 72 NP B37 577         GIACOMELLI +             (BGNA+GLAS+ROMA+TRST)

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$Z_0(1865)$

96 Z*0(1865, JP=3/2-) I=0 **D_{03}**

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THIS EFFECT IS STRONGLY ASSOCIATED WITH THE K* N
THRESHOLD.  SEE HIRATA 68 AND 70.  WILSON 72 AND
GIACCMELLI2 73 REPORT PARTIAL WAVE ANALYSES.
AARCN 73 CLAIMS A RESONANCE IN A MODEL DEPENDENT
PWA.  SEE ALSO Z*0(1780).

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                    96  Z*0(1865) MASS (MEV)

M          (1860.0)   (15.0)            CARTER     67 THEO    DISPEFSICN REL.    8/67
M          (1868.0)   (10.0)            COOL       70 CNTR    K+P, D TOTAL       8/67
M          (1830.)                      AARCN      73 MPWA    I=0 KN .6-1.6G/C   9/73
M     1    (1840.)                      CARROLL    73 CNTR    KN I=0 TCS,FIT 2   9/73
M     1  FIT2=FIT CF L=1 AND L=2 BWS TO I=0 TCS FROM .4-1.1 GEV/C.               9/73
M     1  SEE Z0(1780) FOR FIT 1 AND L=1 PART OF FIT 2.                           9/73

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                    96  Z*0(1865) WIDTH (MEV)

W           (200.0)   (50.0)            CARTER     67 THEO                       8/67
W           (160.0)   (30.0)            COOL       70 CNTR                       8/67
W           (100.)                      AARON      73 MPWA    I=0 KN .6-1.6G/C   9/73
W     1      (75.)                      CARRCLL    73 CNTR    KN I=0 TCS,FIT 2   9/73

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                    96  Z*0(1865) PARTIAL DECAY MODES

                                                             DECAY MASSES
P1       Z*0(1865) INTO K N                               493+ 939
P2       Z*0(1865) INTC N K*(892)                         938+ 892

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                    96  Z*C(1865) BRANCHING RATICS

R1       Z*0(1865) INTO (K N)/TOTAL                          (P1)
R1              (.155)   (.025)         CARTER     67 THEO    IF J=3/2           9/73
R1              (.115)   (.025)         COOL       70 CNTR    IF J=3/2           9/73
R1    1         (.085)                  CARROLL    73 CNTR    IF J=3/2,FIT 2     9/73

R2       Z*0(1865) INTO N K*(892)                            (P2)
R2               MAIN INELASTIC DECAY   HIRATA     68 HBC                       11/68

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                         REFERENCES FOR Z*0(1865)

CARTER     67 PRL 18 801          A A CARTER                          (CAVENDISH)
HIRATA     68 PRL 21 1485         HIRATA, WOHL, GOLDHABER, TRILLING        (LRL)
COOL       70 PR D1 1887          COOL,GIACCMELLI,KYCIA,LEONTIC,LI +       (BNL)
    ALSO 66 PRL 17 102            +GIACOMELLI,KYCIA,LECNTIC,LI,LUNDBY,+ (BNL) I
    ALSC 69 PL 30B 564            ABRAMS,COOL,GIACOMELLI,KYCIA,LI +        (BNL)
AARON      73 PRD 7 1401          AARCN,RICH,HOGAN,SRIVASTAVA        (LASL+NEAS)IJP
CARROLL    73 PL 45B 531          +KYCIA,LI,MICHAEL,MOCKETT,RAHM+          (BNL)I

                                  PAPERS NOT REFERRED TO IN CATA CARDS

HIRATA     70 DUKE   429          +GCLCHABER,SEEGER,TRILLING+WOHL          (LRL)
AARON      71 PRL 26 407          +AMADO+SILBAR                (NEAS,PENN,LASL)IJP
HIRATA-1   71 NP B33 445          +GOLDHABER,HALL,SEEGER,TRILLING,WOHL     (LBL)
GIACOMEL   72 NP B37 577          GIACOMELLI +             (BGNA+GLAS+ROMA+TRST)
WILSON     72 NP B42 445          +GRIFFITHS,HIRATA +      (BGNA+GLAS+ROMA+TRST)

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S=1 I=1 EXOTIC STATES (Z_1)

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$Z_1(1900)$

97 Z*1(1900, JP=3/2+) I=1 **P_{13}**

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THIS EFFECT IS STRONGLY ASSOCIATED WITH THE K-DELTA
THRESHCLD.  SEE THE MINIREVIEW PRECEDING Z*0(1780)

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                    97  Z*1(1900) MASS (MEV)

M    1     (1932.0)                     AYED       70 IPWA    P13,SOL.I          6/70
M    1     (1899.0)                     AYED       70 IPWA    P13,SOL.II         6/70
M    1     (2030.0)                     AYED       70 IPWA    S11,SOL.III        6/70
M    1      THREE SCLNS IN ORDER OF DECREASING SIGNIFICANCE. THOUGH AYED 70
M    1      GIVE PARAMETERS,THEY CONCLUDE RESCNANT INTERPRETATICN DOUBTFUL.
M     2    (1830.)                      BARNETT    70 IPWA    P13,SCLN III       9/73
M    2      RESONANCE SIGNAL BARELY ABOVE BACKGROUND DUE TO THE LARGE ERRORS
M    2      IN THE AMPLITUDES RESULTING FRCM THE ANALYSIS
M           1900.0      10.0            COOL    -- 70 CNTR ++ K+P TOTAL          1/71
M          (1880.)                      ALBROW     71 IPWA ++  SOL. GAMMA       10/71
M    K     (1890.)                      KATO       71 IPWA    SOL  I(FIT BW)    10/71
M    K     (2040.)                      KATO       71 IPWA    SOL II(FIT BW)    10/71
M    K   KATO 71 ESTIMATE RESCNANCE PARAMETERS -- UPCATED PHASE SHIFTS           3/72
M    K   PUBLISHED IN MILLER 72.                                                 3/72

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Baryons

$Z_1(1900)$, $Z_1(2150)$, $Z_1(2500)$

Data Card Listings

For notation, see key at front of Listings.

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                 97   Z*1(1900) WIDTH (MEV)

W   1        (520.0)                  AYED       70 IPWA     K+P                6/70
W   1        (397.0)                  AYED       70 IPWA     K+P                6/70
W   1        (557.0)                  AYEC       70 IPWA     K+P                6/70
W     2      (120.)                   BARNETT    70 IPWA     P13,SCLN III       9/73
W            (240.0)                  COOL       70 CNTR ++ K+- TOTAL           1/71
W            (190.)                   ALBRCW     71 IPWA ++ SOL. GAMMA         10/71
W   K        (280.)                   KATO       71 IPWA     SCL  I(FIT BW)    10/71
W   K        (260.)                   KATO       71 IPWA     SOL II(FIT BW)    10/71
       SEE THE NOTES ACCOMPANYING MASSES QUOTED.

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                 97   Z1*(1900) REAL PART OF PCLE PCSITION                     4/75*

REE        (1787.)                    ARNDT      74 DPWA     K+ P ELASTIC      4/75*

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                 97   Z1*(1900) IMAGINARY PART OF POLE POSITION                4/75*

IME          (100.)                   ARNDT      74 DPWA     K+ P ELASTIC      4/75*

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                 97   Z*1(1900) PARTIAL DECAY MODES

                                                             DECAY MASSES
P1      Z*1(1900) INTO K N                                 493+ 938
P2      Z*1(1900) INTO N*3/2(1232) K                      1232+ 493

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                 97   Z*1(1900) BRANCHING RATIOS

R1      Z*1(1900) INTO (K N)/TCTAL                          (P1)
R1            (0.10) OR LESS          CARTER     67 THEO     DISPERSION REL.    8/67
R1  1         (0.16)                  AYED       70 IPWA                        6/70
R1  1         (0.20)                  AYED       70 IPWA                        6/70
R1  1         (0.17)                  AYED       70 IPWA                        6/70
R1    2        (.12)                  BARNETT    70 IPWA     P13,SCLN III       9/73
R1            (0.12) (ASSUMING J=3/2) COOL       70 CNTR ++ K+P TOTAL           1/71
R1            (0.15)                  ALBRCW     71 IPWA ++ SOL. GAMMA         10/71
R1  K         (0.22)                  KATO       71 IPWA     SCL  I(FIT BW)    10/71
R1  K         (0.27)                  KATO       71 IPWA     SOL II(FIT BW)    10/71

        SEE NOTES ACCOMPANYING THE MASSES QUOTED.

R2      Z*1(1900) INTO K N*3/2(1232)                        (P2)
R2             MAIN INELASTIC DECAY   BLAND      67 HBC   ++                    8/67
R2       NO EVIDENCE, SPEED HAS MINIM. GRIFFITHS 72 HBC      K+P .9-1.5 GEV/C   3/72

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REFERENCES FOR Z*1(1900)


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BLAND     67 PRL 18 1077          +BOWLER,BRCWN,G+S GOLCHABER,SEEGER,+  (LRL)
CARTER    67 PRL 18 801           A A CARTER                        (CAVENDISH)

AYED      70 PL 32B 404           +BAREYRE, FELTESSE, VILLET          (SACLAY)IJP
BARNETT   70 U MD,RPT 70-101      BARNETT,GOLDMAN,LAASANEN,STEINBERG     (UMD)IJP
   ALSO 70 DUKE 443               BARNETT,GOLDMAN,LAASANEN,STEINBERG     (UMD)IJP
COOL      70 PR D1 1887           +GIACOMELLI, KYCIA, LEONTIC, LI, +     (BNL) I
   ALSO 66 PRL 17 102             COOL,GIACOMELLI,KYCIA,LEONTIC,LI +     (BNL)

ALBROW    71 NP  B30 273          +ANDERSON,ALMEHED,...,UDO,WAGNER      (CERN)IJP
   ALSO 70 DUKE  375              ERNE,SENS,WAGNER                      (CERN)IJP
KATO      71 H.E.PHEN.,MORIOND +KOEHLER,...,YOKOSAWA+BURLESON  (ANL,NWES)IJP
   ALSO 70 DUKE 367               A. YOKOSAWA                            (ANL)IJP
   ALSO 70 PRL 24 615             KATC,KOEHLER,NOVEY,YOKOSAWA+      (ANL,NWES)IJP

GRIFFITH 72 NP B38 365            +HIRATA,HUGHES +       (BGNA+GLAS+ROMA+TRST)
MILLER    72 NP B37 401           +NOVEY,YOKOSAWA,CUTKOSKY +  (ANL+CARN+NWES)IJP

ARNDT     74 PRL 33 987           ARNDT,HACKMAN,ROPER,STEINBERG       (VPI,UMD)IJP
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PAPERS NOT REFFERED TO IN Z*1 DATA CARDS

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    TOTAL-CROSS-SECTION EXPERIMENTS ---
BUGG      68 PR 168 1466          +GILMORE,KNIGHT, +             (RHEL,BIRM,CAVE) I
BOWEN     70 PR D2 2599           +CALDWELL, DIKMEN, JENKINS, KALBACH,+(ARIZ) I
BCWEN     73 PR D7 22             +JENKINS,KALBACH,PETERSEN +       (ARIZ+MICH)
CARROLL   73 PL 45B 531           +KYCIA,LI,MICHAEL,MOCKETT,RAHM+         (BNL)

    A K-MATRIX ANALYSIS OF SOME OF THE EARLY K+P DATA ---
HITE      67 THESIS               G E HITE                           (ILLINOIS)

    THEORETICAL AND MCDEL DEPENDENT ANALYSES
CARRERAS 70 NP B19 349            B CARRERAS, A DCNNACHIE   (DARESBURY, MCHS)
ALCOCK    73 NP B56 301           ALCOCK,COTTINGHAM                     (BRIS)IJP

    EXPERIMENTS MAINLY ABCUT INELASTIC CHANNELS ---
BLAND     68 UCRL-18131 THESIS R W BLAND                                (LRL)
BLAND     69 NP B13 595           +BOWLER, BROWN, KADYK, GOLDHABER, +   (LRL)
BLAND     70 NP B18 537           +BOWLER, BRCWN, GOLDHABER,            (LRL)
   BLAND 69 AND BLAND 70 REPLACE BLAND 67 AND BLAND 68.
HIRATA-1 71 NP B33 445            +GOLDHABER,HALL,SEEGER,TRILLING,WOHL  (LBL)
BRUNET    72 NP B37 114           BRUNET,NARJOUX,DANYSZ+(CDEF+SACL+LOIC+LOWC)
GRIFFITH 72 NP B38 365            +HIRATA,HUGHES,JACOBS+(BGNA,GLAS,ROMA,TRST)IJP
LCKEN     72 PR D6 2346           +BARISH,GCMEZ,DAVIES,SCHLEIN,+   (CIT,UCLA)
BERTHCN   73 NP B63 54            BERTHON,MCNTANET,PAUL,SAETRE+   (CERN+SACL)
LEWIS     73 NP B60 283           LEWIS,ALLEN,JACOBS,DANYSZ+ (LOWC+LOIC+CDEF)
LESQUOY   75 NP B99 346           +MULLER,TRIANTIS,BERTHON+       (SACL+CERN)IJP
MUSGRAVE 75 NP B87 365            +PEETERS,SCREINER,WHITMORE,YUTA        (ANL)

    THE MAIN ELASTIC SCATTERING AND POLARIZATION EXPERIMENTS --
CARROLL   68 PRL 21 1282          +FISCHER, LUNCBY, PHILLIPS, +    (BNL,ROCH)
ANDERS-1 69 PL 28B 611            ANDERSSCN, DAUM, ERNE, LAGNAUX, +    (CERN)
ANDERS-2 69 PL 30B 56             ANDERSSON, CAUM, EPNE, LAGNAUX, +    (CERN)
ASBURY    69 PRL 23 194           +DOWELL, KATO, LUNDQUIST, NOVEY, +(ANL,UMD)
BLAND     69 PL 29B 618           R W BLAND, G GCLDHABER, G H TRILLING  (LRL)
BARBER    70 PL 32B 214           +BROOME, DUFF, HEYMANN, IMRIE,+ (LOUC,RHEL)IJP
GIACCMEL 70 NP B20 301            GIACOMELLI, GRIFFITHS,(BGNA,GLAS,ROMA,TRST)IJP
HALL      70 DUKE   435           +BLAND,GOLDHABER,TRILLING             (LRL)
REBKA     70 PRL 24 160           +ROTHBERG, ETKINS, GLODIS, +         (YALE)IJP
ADAMS     71 PR  D4 2637          +DAVIES,DOWELL,GRAYER,HATTERS+  (BIRM+RHEL)
BARNETT   71 PL 34B 655           +LAASANEN,STEINBERG  +  (UMD+ANL+NWES+FNAL)
EHRLICH   71 PRL 26 925           +ETKIN,GLODIS,HUGHES,KONDO,LU,MORI+  (YALE)
WHITMORE 71 PR D3 1092            +ABRAMS,EISENSTEIN,KIM,CHALLORAN,+    (ILL)
ADAMS     72  NAL PAPER 326       +COX,DAVIES,DOWELL,GRAYER +     (BIRM+RHEL)
CHARLES   72 PL 40B 289           +COWAN,ECWARDS,GIBSON,+    (BRIS,RHEL,SHMP)
   ALSO 72  NAL PAPER 287         CHARLES,COWAN,ECWARDS +    (BRIS+RHEL+SHMP)
DANYSZ    72 NP B42 29            +PENNEY,STEWART,THOMPSON,+ (LOIC,CDEF,LOWC)
ACAMS     73 NP B66 36            ADAMS,COX,DAVIES,DOWELL,+       (BIRM+RHEL)IJP
BARBER    73 NP B61 125           BARBER,BRCCME,BUSZA,DAVIES,DUFF+(LOUC+RHEL)
BARNETT   73 PRD 8 2751           BARNETT,LAASANEN+        (UMD+ANL+NWES+FNAL)
CHARLES   73 PURDUE CONF. 179     CHARLES,EDWARDS,+      (SHMP+AARH+RHEL+BRIS)
CAMERCN   74 NP B78 93            CAMERON,HIRATA,JENNINGS,+  (GLAS,BGNA,TRST)IJP
YUTA      74 NP B81 189           YUTA,BOCK,MUSGRAVE,PEETERS,SCHREINER,+(ANL)I
ABE       75 PRD 11 1719          +BARNETT,GOLDMAN,LAASANEN+          (UMD,ANL)
ADAMS     75 NP B87 41            +CARTER,COOK,GLASS,GREEN                (WASH)
PATTON    75 PRL 34 975           +BARLETTA,EHRLICH,ETKIN+     (YALE,TOKY,BNL)

    PARTIAL-WAVE ANALYSES (SEE ALSC ADAMS 73 ANC CAMERCN 74)
CARRERA1 70 NP B23 525            B CARRERAS, A DONNACHIE               (CARE)IJP
   ALSO 70 DUKE 447               +DCNNACHIE,KIRSOPP          (DARE+MCHS+EDIN)
ERNE      7C DUKE 375             +SENS,WAGNER                          (CERN)IJP
LEA       71 NP  B26 413          +MARTIN,THOMPSON                 (RHEL,LOUC)IJP
LOVELACE 71 NP  B28 141           +WAGNER                               (CERN)IJP
CUTKOSKY 72  NAL PAPER 210        +HICKS,KELLY,SHIH,JOHNSON     (CARN+ILL+ANL)
EHRLICH   72  NAL PAPER 447       +ETKIN,GLODIS,HUGHES,LU,PATTON +      (YALE)
MARTIN    72  PREPRINT            B.R.MARTIN, C.E.MILLER                (LOUC)
MARTIN    75 NP B94 413           B R MARTIN                            (LOUC)
CUTKOSKY 76 NP B102 139           CUTKOSKY,HICKS,KELLY,+        (CARN+IIT+ANL)IJP

    EARLIER ANALYSES THAT CO NOT INCLUDE RECENT POLARIZATION DATA --
LEA       68 PR 165 1770          LEA, MARTIN, OADES              (RHEL,BNL,CERN)
MARTIN    68 PRL 21 1286          B R MARTIN                             (BNL)
CUTKCSKY 70 PR D1 2547            R E CUTKOSKY, B B DEO     (CARNEGIE-MELLCN) I

    LATEST REVIEW TALKS AND PAPERS
LEVISETT 69 LUND CCNF 341         R LEVI SETTI  (RAPPORTEUR)         (CHICAGO)
GOLDHABE 70 DUKE   407            G.GOLDHABER (REVIEWER)                 (LRL)
DOWELL    72  NAL REVIEW          REVIEW TALK IN BARYON SESSION         (BIRM)
LOVELACE 72  NAL REVIEW           RAPPORTEUR'S TALK                     (RUTG)
DOWELL    73 PURDUE CONF. 157     DCWELL                                (BIRM)
CUTKOSKY 74 LONDCN CONF II-54     CUTKOSKY                              (CARN)
KELLY     75 ANL-HEP-CP-75-58     REVIEW TALK IN BARYON SESSION          (LBL)
URBAN     75 PL 60B 77            URBAN                                  (LBL)

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$Z_1(2150)$ BUMPS

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93   Z*1(2150, JP=     ) I=1

A SMALL BUMP IN TOTAL CROSS SECTION AT
PK=1.8 GEV/C

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                 93   Z*1(2150) MASS (MEV)

M         2150.       20.               ABRAMS     70 CNTR ++ K+P TOTAL       10/71

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                 93   Z*1(2150) WIDTH (MEV)

W          (175.)                       ABRAMS     70 CNTR +  K+P TOTAL       10/71

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                 93   Z*1(215C) PARTIAL DECAY MODES

                                                             DECAY MASSES
P1      Z*1(2150) INTO K N                                 493+ 938

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                 93   Z*1(2150) BRANCHING RATICS

R1      Z*1(2150) INTO (K N)/TOTAL                          (P1)
R1        J IS NOT KNOWN, THE FOLLOWING IS (J+1/2)*P1
R1             (0.04)                   ABRAMS     70 CNTR +  K+P TOTAL       10/71

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REFERENCES FCR Z*1(2150)


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ABRAMS    70 PR  D1 1917          +COGL,GIACCMELLI,KYCIA,LEONTIC,LI +   (BNL)
   ALSO 67 PRL 19 257             ABRAMS,COOL,GIACOMELLI,KYCIA,LEONTIC+ (BNL)

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$Z_1(2500)$ BUMPS

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94   Z*1(250C, JP=     ) I=1

A SMALL BUMP IN TCTAL CROSS SECTICN AT
PK=2.7 GEV/C

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                 94   Z*1(2500) MASS (MEV)

M         2500.       20.               ABRAMS     70 CNTR ++ K+P TOTAL       10/71

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                 94   Z*1(2500) WIDTH (MEV)

W          (160.)                       ABRAMS     70 CNTR ++ K+P TOTAL       10/71

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                 94   Z*1(2500) PARTIAL DECAY MODES

                                                             DECAY MASSES
P1      Z*1(2500) INTO K N                                 493+ 938

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                 94   Z*1(2500) BRANCHING RATIOS

R1      Z*1(2500) INTO (K N)/TOTAL                          (P1)
R1        J IS NOT KNOWN, THE FOLLOWING IS (J+1/2)*P1
R1             (0.03)                   ABRAMS     70 CNTR ++ K+P TOTAL       10/71

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REFERENCES FCR Z*1(2500)


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ABRAMS    70 PR  D1 1917          +COGL,GIACOMELLI,KYCIA,LEONTIC,LI +   (BNL)
   ALSO 67 PRL 19 257             ABRAMS,COOL,GIACOMELLI,KYCIA,LEONTIC+ (BNL)

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Data Card Listings

For notation, see key at front of Listings.

Baryons

Λ's and Σ's

Z_1 CROSS SECTION LIMITS

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      SEE MINIREVIEW PRECEDING Z*0

CS  UNITS MICROBARNS
CS          LESS THAN  50.                BASSOMPIE 68 HBC     K+P TO Z*+ PI+    10/69
CS  A LESS THAN .2      +.3       -.1     ANDERSON  69 ASPK +  PI-P TO K-Z*+     10/69
CS  A       ABOVE LIMIT FOR  M=1.2 TO 1.4 GEV -   CL= 99 P.C.
CS  B LESS THAN 1.4     +1.9      -.5     ANDERSON  69 ASPK +  PI-P TO K-Z*+     10/69
CS  B       ABOVE LIMIT FOR  M=1.5 TO 2.5 GEV

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                          REFERENCES FOR Z*1 CROSS SECTION LIMITS

BASSOMPI 68 PL 27B 468       BASSOMPIERRE, +               (CERN,BRUXELLES)
ANDERSON 69 PL 29B 136       +BLESER, BLIEDEN, COLLINS, + (BNL,CARNEGIE)

                          PAPERS NOT REFERRED TO IN DATA CARDS

TYSON    67 PRL 19 255       +GREENBERG,HUGHES,LU,MINEHART,MORI,  (YALE)
MORI     68 PL 28B 152       +GREENBERG,HUGHES,LU,ROTHBERG, +     (YALE)
MORI     69 PR 185 1687      +GREENBERG, HUGHES, LU, MINEHART, +  (YALE)
    MORI 69 REPLACES TYSON 67 AND MORI 68.

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Note on Λ's and Σ's

The number of confirmed Y^* states has not increased greatly in the last few years, although there has been a larger increase in the number of proposed, but unconfirmed, possible new resonances. Since our last edition (1974) we have made only one addition to the Y^* portion of the Baryon Table, the Λ(1860), but have entered four new states into the Data Card Listings, and encountered several further indications that some of the states we list may really be more than one resonance. New high-statistics experiments are needed to clarify the situation.

Just as the recently discovered N^*'s are only weakly coupled to the $\pi N \to \pi N$ reaction, so also are the recently proposed Y^*'s only weakly coupled to the $\bar{K}N \to \bar{K}N$, $\bar{K}N \to \Lambda\pi$, and $\bar{K}N \to \Sigma\pi$ reactions. For this reason the newer Y^*'s are more difficult to uncover; in invariant mass distributions they usually appear as small peaks or make no appearance at all. Rather, when the 2-body reactions are partial-wave analyzed, some of the amplitudes are found to traverse resonance-like counterclockwise circles. The results of partial-wave analysis give J^P information, whereas a peak seen in an invariant mass distribution or a total cross section often cannot be analyzed for its quantum numbers. We will keep information coming from formation experiments and from production experiments separate whenever necessary.

Formation Experiments

Partial-wave analyses have been performed on $\bar{K}N$, $\Lambda\pi$, $\Sigma\pi$, ΞK, and $\Lambda\omega$, plus some quasi-two-body channels. Given the present accuracy of the data it is not possible to perform a completely energy-independent analysis, that is, solve for the partial-wave amplitudes at each energy in a model-independent way.

For the great majority of the analyses done so far, the energy range covered was rather limited, corresponding usually to a single bubble chamber experiment. A disturbing feature that appears when examining the partial waves obtained in a particular analysis is that they do not join smoothly with the partial waves given in analyses done for the same channel in a different energy range. One way to avoid this lack of continuity is to analyze the data in as large an energy range as possible. This has been done by six analyses which are described below and three of which are illustrated in Figs. 1-11. See the Data Card Listings for information on other analyses covering limited energy ranges.

Four of the analyses described below (RLIC 76, LEA 73, LANGBEIN 72, and KIM 71) have attempted a multi-channel approach using data on the three 2-body reactions $\bar{K}N$, $\Lambda\pi$, and $\Sigma\pi$, with a fictitious channel sometimes being introduced to account for the global effect of the remaining final states. The latter have large cross sections, so the present multi-channel analyses do not really impose any more stringent unitarity constraints than those already contained in the single-channel fits. However, there is an advantage in the determination of resonance parameters (masses, widths, and branching fractions) since they are fit simultaneously to data in all three channels. The other two analyses (BAILLON 75 and VAN HORN 75) deal only with the $\Lambda\pi$ channel which is, in principle, the easiest to handle as only one isospin has to be considered and both the differential cross section and baryon polarization are measured simultaneously in bubble chamber experiments. These two analyses cover the mass range 1540-2200 MeV and make use of the Legendre polynomial expansion of the angular distributions.

Baryons
Λ's and Σ's

a) The most recent analysis is the work done by the Rutherford Laboratory-Imperial College collaboration, RLIC 76. Here the $\bar{K}N$, $\Sigma\pi$, and $\Lambda\pi$ channels have been considered in the mass range 1480-2170 MeV. It is a conventional energy-dependent analysis, the presence of a resonance in a partial wave being detected by comparing the goodness of the fit when this wave is parametrized as a smooth background to the alternative fit when a Breit-Wigner is added to the background. The data used have been carefully selected in order to eliminate inconsistencies (usually the older and statistically less accurate points have been rejected). Angular distributions were directly used in the fit except when the quality of the data was such that no loss of information occurred by using Legendre coefficients (e.g., $K^-p \to \Sigma^0\pi^0$). Internal consistency is introduced by requiring that the mass and width of the resonances be the same for each of the three channels; a "weighted average" of the three values has been done when necessary and used as a fixed parameter in the final fit. Argand diagrams from the final solution are given in Figs. 1-11. Some suspected resonances are confirmed by this analysis, but many other reported "resonant effects" are not found and new possible resonances are proposed. The situation, in particular for the low partial waves, is still very confused even for masses as low as ∿ 1600 MeV.

b) The most recent $\Lambda\pi$ analysis, BAILLON 75, is a semi-energy-independent analysis. The D_{15} and F_{17} partial waves were constrained to lie near the well known D_{15}(1765) and F_{17}(2030) resonances, with their generally accepted parameters, in the energy region where they are important. This constraint was found necessary in order to reduce the number of possible solutions and to fix the arbitrary phase. The latter is undetermined, as in all the inelastic channels, and if unconstrained would make it difficult to join amplitudes at neighboring energies. Above a mass of 1750 MeV only one solution is found. Below this mass, two possible solutions are proposed; one of them (solution 1) has a much greater number of "new resonant structures" and is somewhat preferred on the basis of the behavior of the S and P waves for very low masses (around 1580 MeV). Using the method of Barrelet-zeroes[1,2] it is found that only these 2 solutions are possible if resonances are required to exist in the D_{15} and F_{17} waves. To extract the resonance parameters, the amplitudes were fitted to a combination of Breit-Wigner's plus background. The parameters corresponding to both solutions are given in the data cards, and Argand diagrams are shown in Figs. 1-6.

c) VAN HORN 75 has done an energy-dependent fit of the $\Lambda\pi$ channel. In addition to the best fit, VAN HORN 75 also presents all the other ambiguous solutions that can be generated by the method of Barrelet-zeroes. Among the "ambiguous" solutions, seven of them are found to preserve the established resonances D_{13}(1670), D_{15}(1765), F_{15}(1915), and F_{17}(2030), but with couplings to the $\Lambda\pi$ channel which are sometimes very different from their generally accepted values (cf., BAILLON 75). Also, new resonant structures appear in all the waves, particularly in the lower spins. This analysis is instructive in so far as indicating that there could be an entire constellation of other possible resonances beyond those which appear at the primitive stage of the analysis. However, one should keep in mind that these possible resonances do not necessarily correspond to a simple or even plausible parametrization of the amplitudes. (The values we have listed on the data cards correspond to the average of the 20 best original fits of this analysis, all containing the established, plus a few probable, resonances).

d) The analysis of LEA 73 is a multi-channel energy-dependent partial-wave analysis with parametrized K-matrix elements. The momentum range covered is 440 to 1190 MeV/c, and 99 parameters were used in the fit. Established resonances were constrained to have parameters near their generally accepted values, taken from a previous edition of these tables (for this reason we do not list the results of LEA 73 for these resonances in the following data cards). New resonances are identified using poles of the K-matrix. The procedure used to get the resonance parameters is not described, the values of the fitted K-matrix elements are not given, and no explicit comparison of the results with alternative parametrizations is made.

Data Card Listings

For notation, see key at front of Listings.

Baryons

Λ's and Σ's

e) LANGBEIN 72 performed single-energy fits at 40 momenta between 436 and 1226 MeV/c. This work is the nearest approximation to an energy-independent partial-wave analysis existing for the S=-1 system. The partial waves corresponding to established resonances were, however, constrained to have Breit-Wigner forms. Approximately 90 acceptable single-energy fits per energy were generated and were used in shortest-path searches. Several candidates for acceptable shortest paths were generated and a preferred path was chosen by rejecting those that failed to reproduce known resonance behavior. Resonances in this solution were identified by loops in Argand diagrams correlated with peaks in the ≥3-body final-state cross section. Resonance parameters were then extracted by fitting Breit-Wigner's with both multiplicative and additive background. A disturbing characteristic of this work is that the amplitudes which were not specifically chosen to be resonant (sometimes even those, as in the case $D_{15}(1765) \rightarrow \Lambda\pi$) show an erratic behavior which cannot be justified simply by the fluctuation of the data.

f) KIM 71 fit data from threshold to 1226 MeV/c using the Ross and Shaw[3] effective-range expansion of the inverse multi-channel K-matrix. The data in each of seven energy intervals bounded by 0, 534, 658, 806, 916, 1022, 1117, and 1226 MeV/c, were fit with a constant effective-range matrix. Only the $F_{15}(1915)$ was fixed to a Breit-Wigner form, all other waves included being parametrized by the K-matrix formalism. Resonances were identified by a method involving the appearance of loops in the Argand diagram, peaks in the speed plot, and poles of the K-matrix, the exact procedure not being reported.

None of the three older multi-channel fits above extend beyond a mass of 1.9 GeV (the highest-energy data from the only high-statistics experiment existing before 1971, ARMENTEROS 68). These analyses do not join smoothly with either older (LITCHFIELD 71) or more recent (HEMINGWAY 75) partial-wave analyses at higher energies. The three more recent analyses extend to 2.2 GeV, and for masses higher than 2.2 GeV, the only existing work is an energy-dependent analysis of the $\Lambda\pi$ and $\Sigma\pi$ channels for momenta between 1.93 and 2.5 GeV/c by the Saclay-College de France collaboration (BELLEFON1 75 and BELLEFON 76).

Production Experiments

This type of experiment is often difficult to analyze. Information on I=0 states is possible only when there is no I=1 state at a similar mass. The main controversies at the present time concern resonances in the 1600 to 1700 MeV region. See the mini-reviews on Σ(1620) and Σ(1670) in these Listings.

Figures

Argand plots of 15 S=-1 partial waves are shown in Figs. 1-11. The analyses shown were picked largely for illustrative purposes rather than on the basis of our judgment of their quality; as discussed above there are a number of analyses extant and no clear choice of the "best" ones is possible.

Errors on Masses and Widths

Often the quoted errors in partial-wave analyses are only statistical, and the values of masses and widths can change by more than these errors when a new parametrization is used. For this reason we report the values of M, Γ, and x_i obtained by different authors even if they analyze the same data. The spread of these masses and widths is certainly a better estimate of the uncertainties than the statistical errors. Sometimes the errors quoted are obtained by the inspection of various fits done with different hypotheses (see, for example, BERTHON 70, GALTIERI 70, VAN HORN 75, RLIC 76). For three states, Λ(1520), Λ(1815), and Σ(1765), there are enough data available perform an overall fit of the various x_i of the type discussed in the main text (Sec. VII B). In this case we are forced to use the errors, however small they may be, but we warn the reader that the final errors are not to be taken seriously.

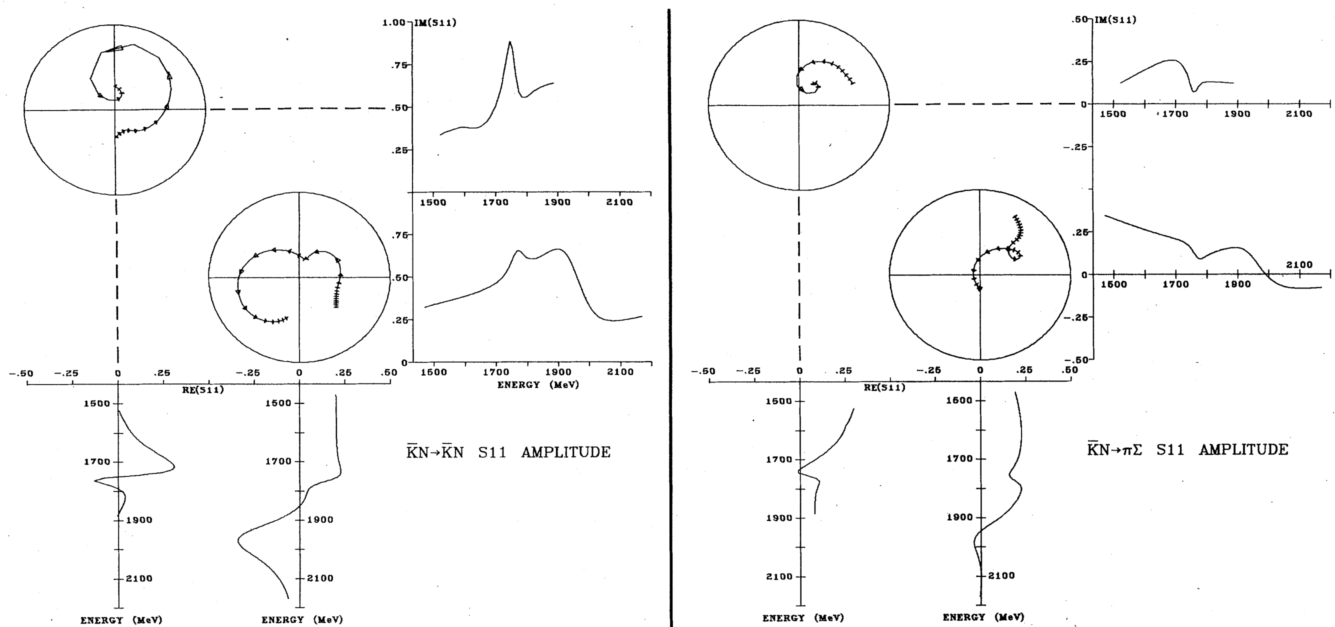
In conclusion, in the Baryon Table we choose not to give errors on masses and total widths determined primarily by partial-wave analyses, but, whenever necessary, to show a range of values. As for the branching ratios, we use the errors when needed to perform an overall fit, but we caution the reader.

Baryons

Λ's and Σ's

Data Card Listings

For notation, see key at front of Listings.



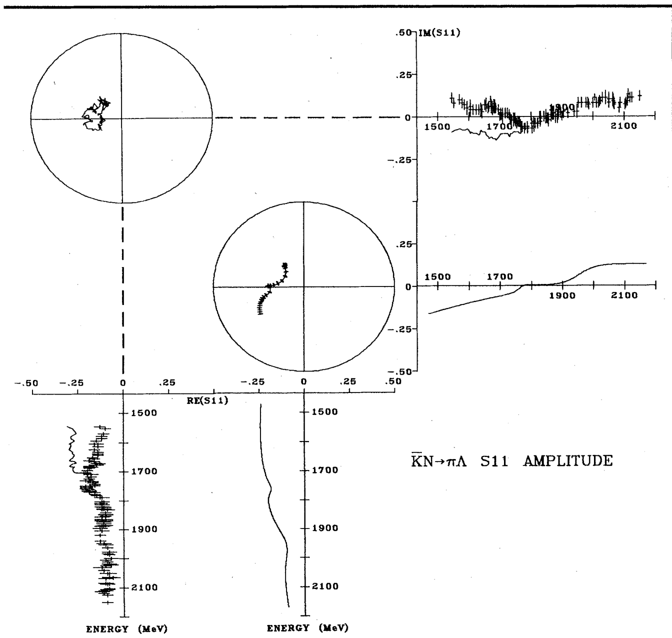
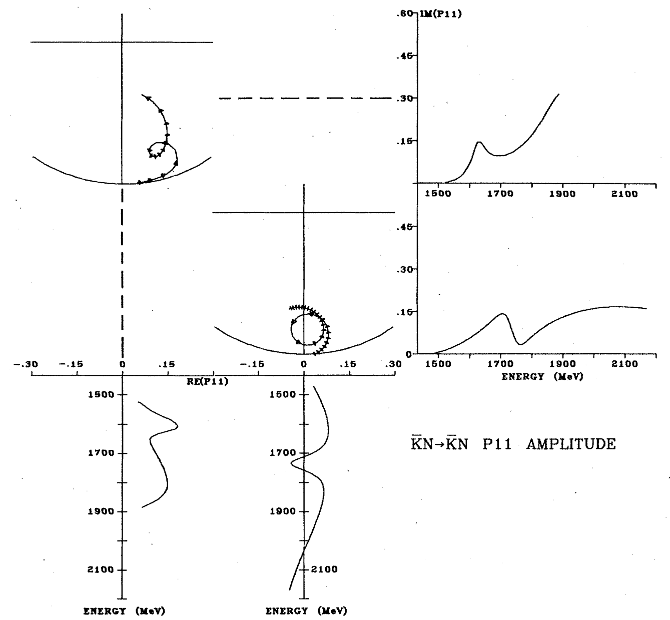
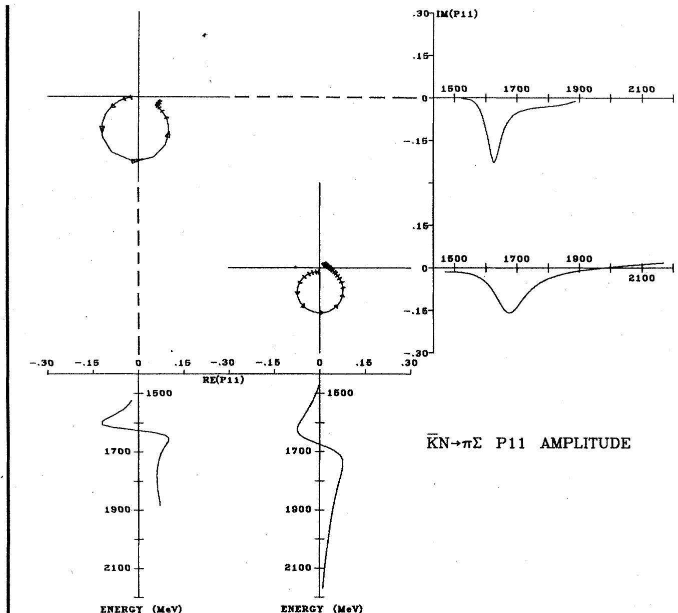


Fig. 1. Amplitudes for $\bar{K}N$ scattering in the S_{11} partial wave. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts versus energy, in alignment with the corresponding Argand plot. In addition, arrows with bases positioned at integral multiples of 25 MeV and a base-to-tip length of 5 MeV are plotted on all the Argand plots except that of BAILLON 75. The results of two different analyses are shown for each channel; the energy axes for the two analyses are aligned for ease of comparison. The energy axes run from elastic threshold to 2200 MeV. The lower Argand plot for each channel is from RLIC 76. The upper plot is from LEA 73 for the elastic and $\pi\Sigma$ channels, and from BAILLON 75 for the $\pi\Lambda$ channel. The Argand plot and the real-and-imaginary-part data with error bars for BAILLON 75 are from their solution 1; below 1770 MeV the real and imaginary parts of their solution 2 are also shown as a solid line. The only established resonance in this wave is the $\Sigma(1750)$; see the Data Card Listings for other possible resonances in the S_{11} wave.





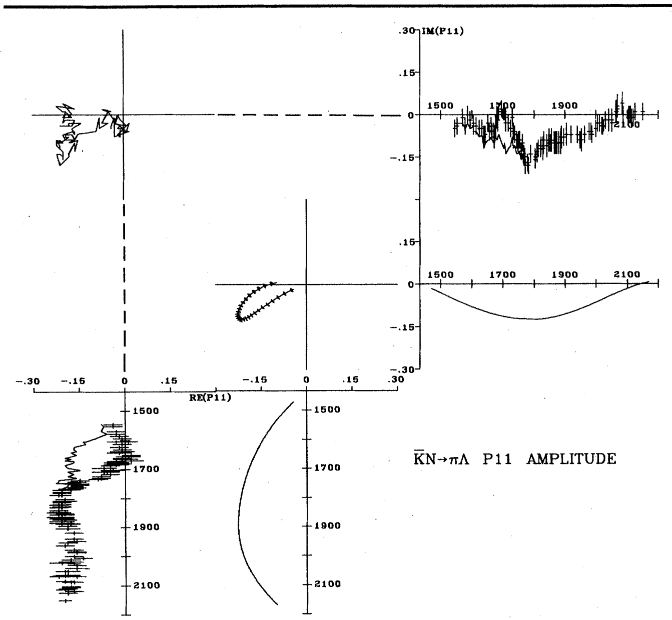


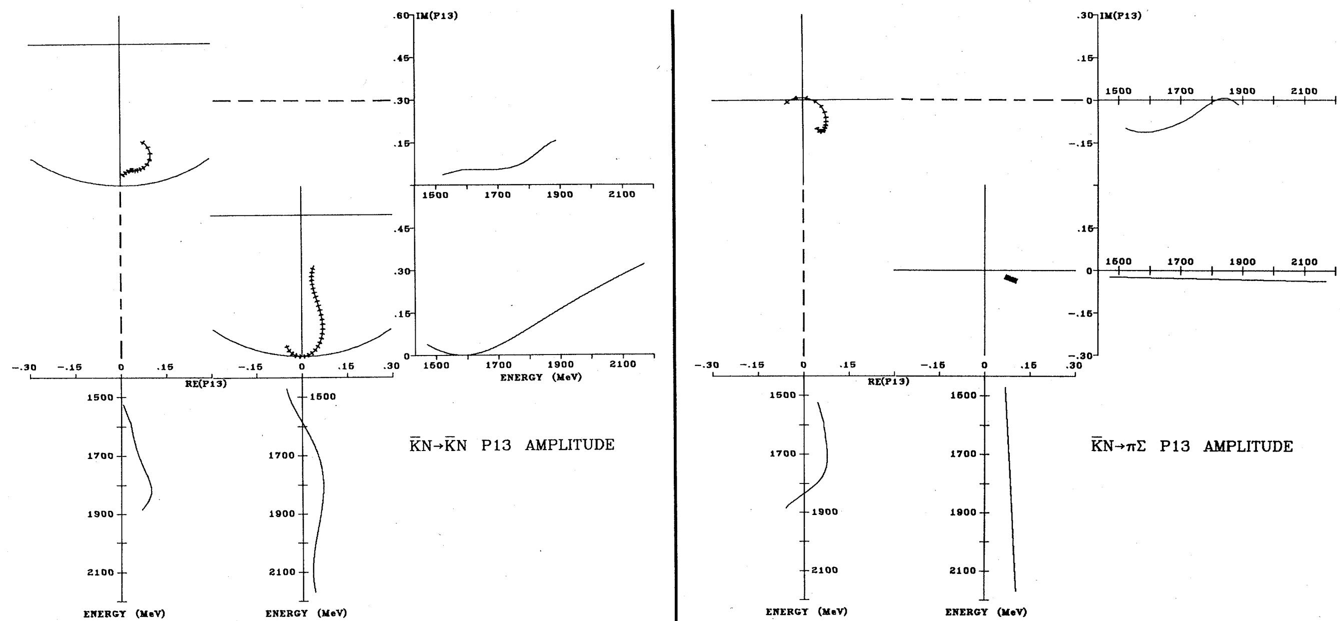
Fig. 2. Amplitudes for $\bar{K}N$ scattering in the P_{11} partial wave. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts versus energy, in alignment with the corresponding Argand plot. In addition, arrows with bases positioned at integral multiples of 25 MeV and a base-to-tip length of 5 MeV are plotted on all the Argand plots except that of BAILLON 75. The results of two different analyses are shown for each channel; the energy axes for the two analyses are aligned for ease of comparison. The energy axes run from elastic threshold to 2200 MeV. The lower Argand plot for each channel is from RLIC 76. The upper plot is from LEA 73 for the elastic and $\pi\Sigma$ channels, and from BAILLON 75 for the $\pi\Lambda$ channel. The Argand plot and the real-and-imaginary-part data with error bars for BAILLON 75 are from their solution 1; below 1770 MeV the real and imaginary parts of their solution 2 are also shown as a solid line. This wave contains the Σ pole but no established resonances; see the Data Card Listings for possible resonances in the P_{11} wave.

Baryons

Λ's and Σ's

Data Card Listings

For notation, see key at front of Listings.



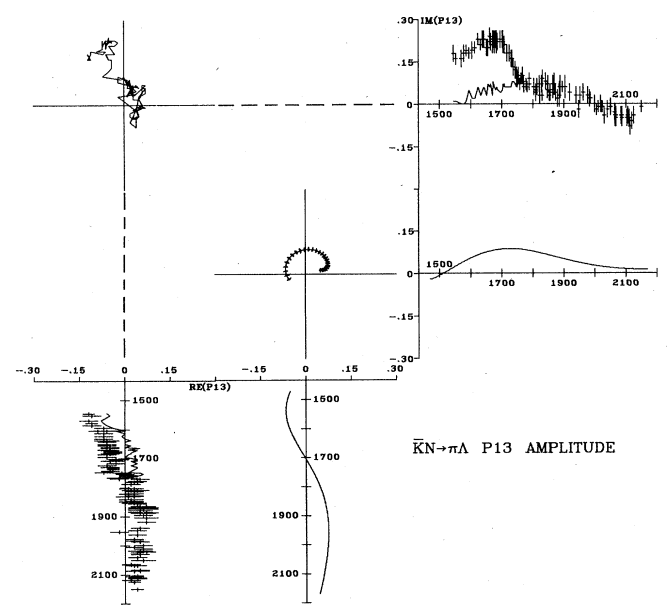


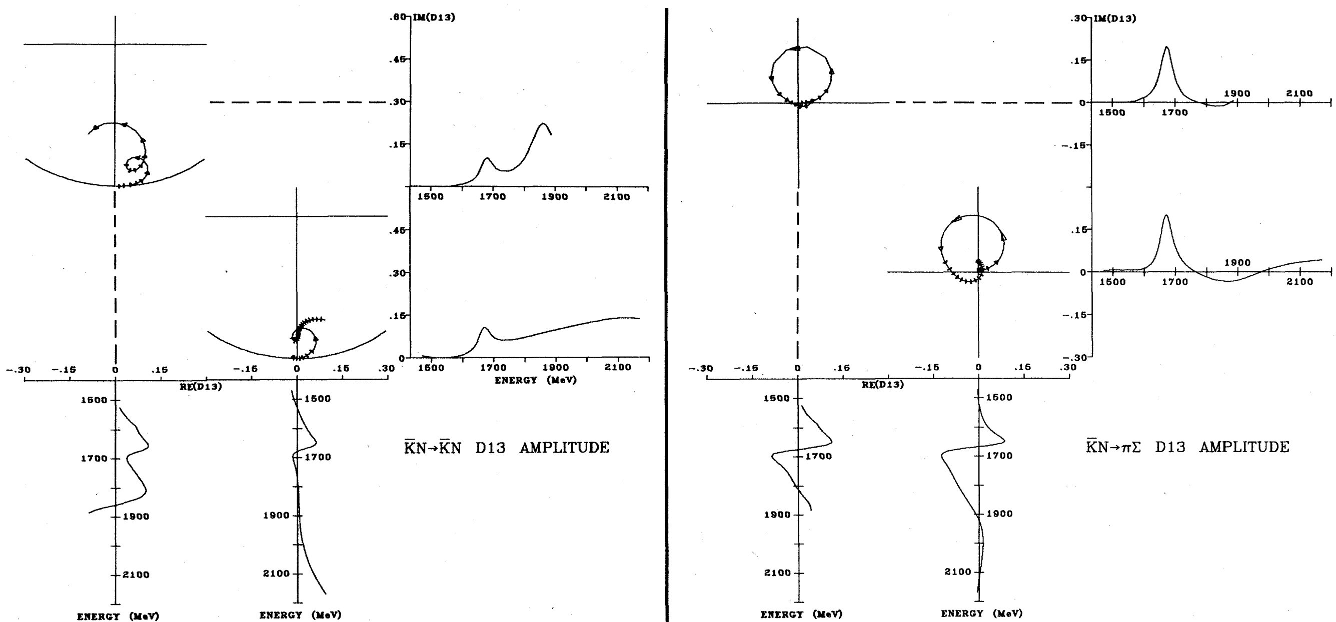
Fig. 3. Amplitudes for $\bar{K}N$ scattering in the P_{13} partial wave. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts versus energy, in alignment with the corresponding Argand plot. In addition, arrows with bases positioned at integral multiples of 25 MeV and a base-to-tip length of 5 MeV are plotted on all the Argand plots except that of BAILLON 75. The results of two different analyses are shown for each channel; the energy axes for the two analyses are aligned for ease of comparison. The energy axes run from elastic threshold to 2200 MeV. The lower Argand plot for each channel is from RLIC 76. The upper plot is from LEA 73 for the elastic and $\pi\Sigma$ channels, and from BAILLON 75 for the $\pi\Lambda$ channel. The Argand plot and the real-and-imaginary-part data with error bars for BAILLON 75 are from their solution 1; below 1770 MeV the real and imaginary parts of their solution 2 are also shown as a solid line. The only established resonance in this wave is the $\Sigma(1385)$ which lies below elastic threshold and does not appear here; see the Data Card Listings for other possible resonances in the P_{13} wave.

Data Card Listings

For notation, see key at front of Listings.

Baryons

Λ's and Σ's



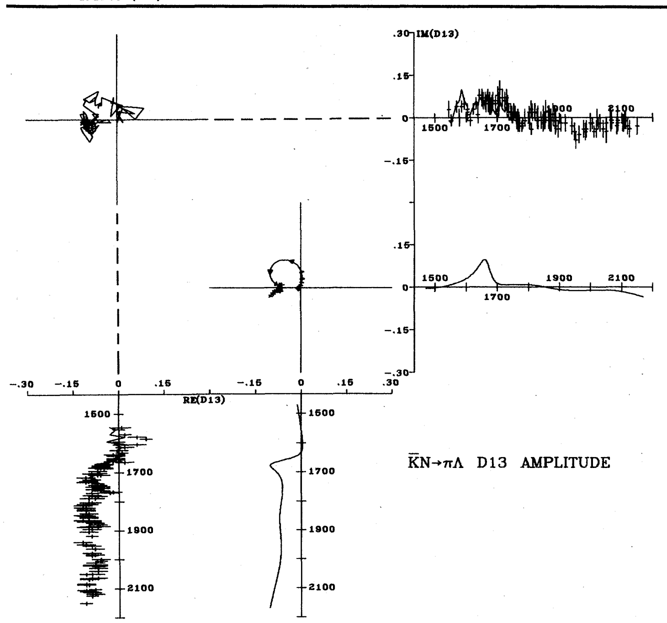


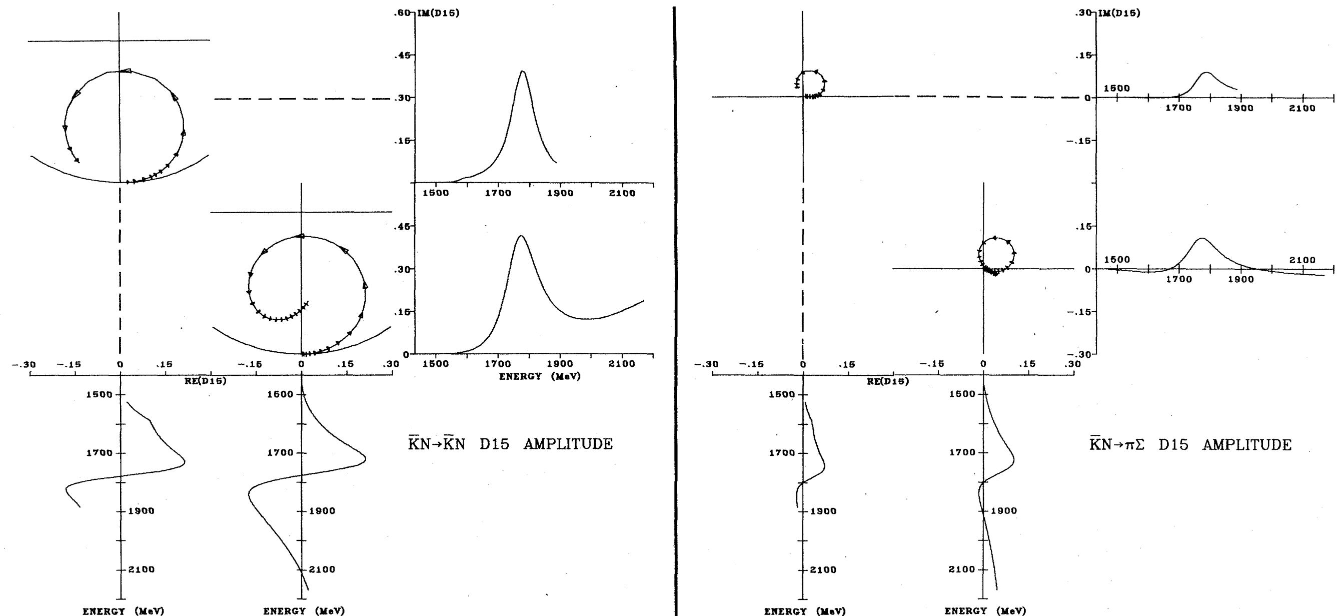
Fig. 4. Amplitudes for $\bar{K}N$ scattering in the D_{13} partial wave. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts versus energy, in alignment with the corresponding Argand plot. In addition, arrows with bases positioned at integral multiples of 25 MeV and a base-to-tip length of 5 MeV are plotted on all the Argand plots except that of BAILLON 75. The results of two different analyses are shown for each channel; the energy axes for the two analyses are aligned for ease of comparison. The energy axes run from elastic threshold to 2200 MeV. The lower Argand plot for each channel is from RLIC 76. The upper plot is from LEA 73 for the elastic and $\pi\Sigma$ channels, and from BAILLON 75 for the $\pi\Lambda$ channel. The Argand plot and the real-and-imaginary-part data with error bars for BAILLON 75 are from their solution 1; below 1770 MeV the real and imaginary parts of their solution 2 are also shown as a solid line, which is barely visible because the two solutions agree well in this wave. Established resonances in this wave are the $\Sigma(1670)$ and the $\Sigma(1940)$; see the Data Card Listings for another possible resonance in the D_{13} wave.

Baryons

Λ's and Σ's

Data Card Listings

For notation, see key at front of Listings.



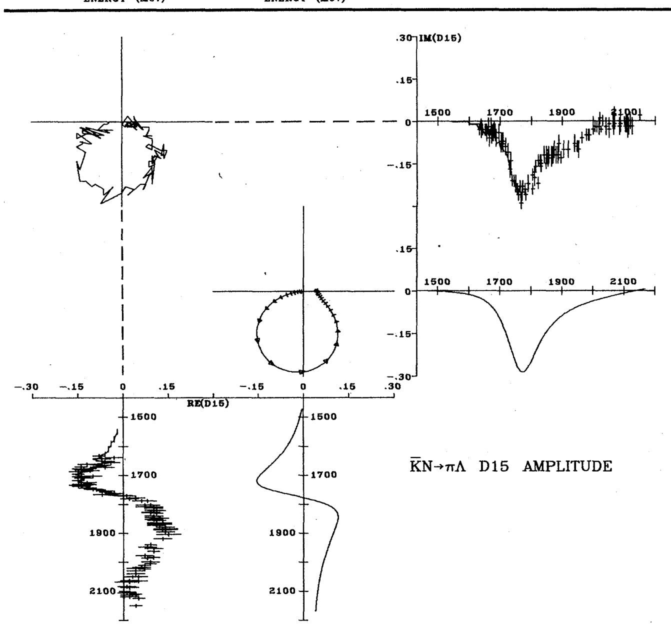


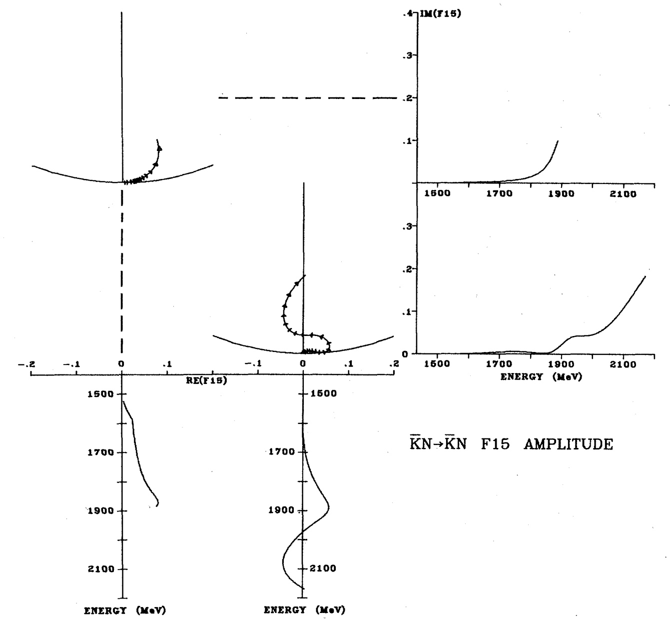
Fig. 5. Amplitudes for $\bar{K}N$ scattering in the D_{15} partial wave. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts versus energy, in alignment with the corresponding Argand plot. In addition, arrows with bases positioned at integral multiples of 25 MeV and a base-to-tip length of 5 MeV are plotted on all the Argand plots except that of BAILLON 75. The results of two different analyses are shown for each channel; the energy axes for the two analyses are aligned for ease of comparison. The energy axes run from elastic threshold to 2200 MeV. The lower Argand plot for each channel is from RLIC 76. The upper plot is from LEA 73 for the elastic and $\pi\Sigma$ channels, and from BAILLON 75 for the $\pi\Lambda$ channel. The Argand plot and the real-and-imaginary-part data with error bars for BAILLON 75 are from their solution 1; below 1770 MeV the real and imaginary parts of their solution 2 are also shown as a solid line, which is barely visible because the two solutions agree well in this wave. The only established resonance in the D_{15} wave is the $\Sigma(1765)$.

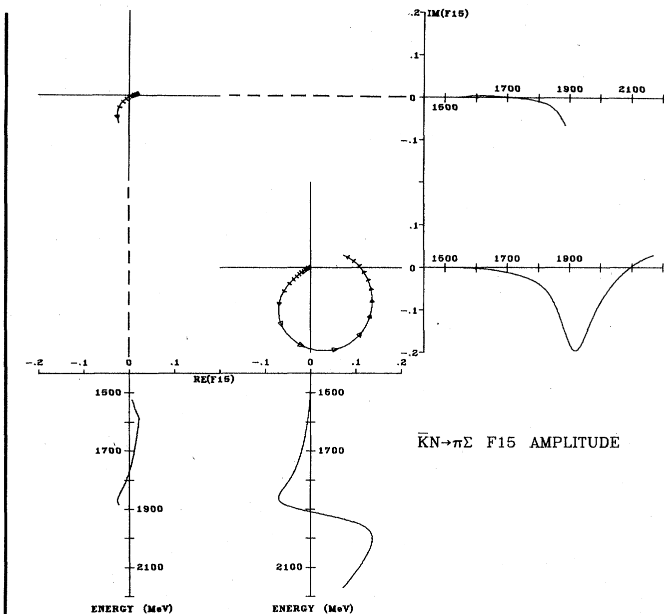
Data Card Listings

For notation, see key at front of Listings.

Baryons

Λ's and Σ's





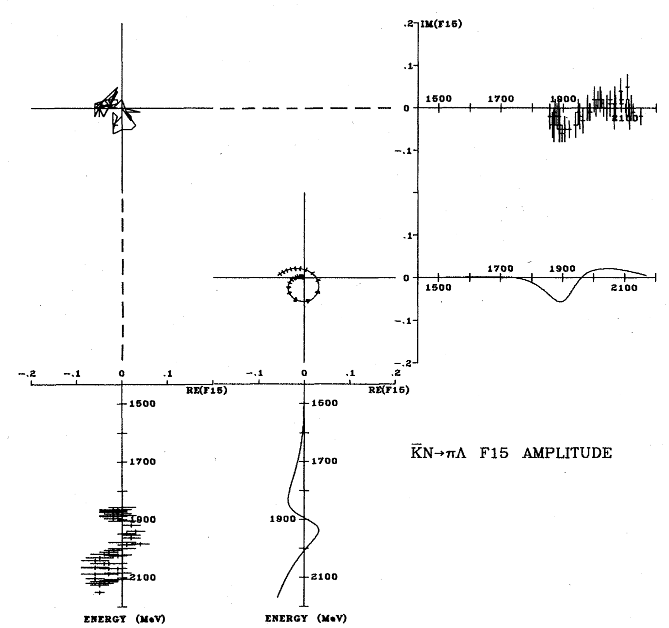
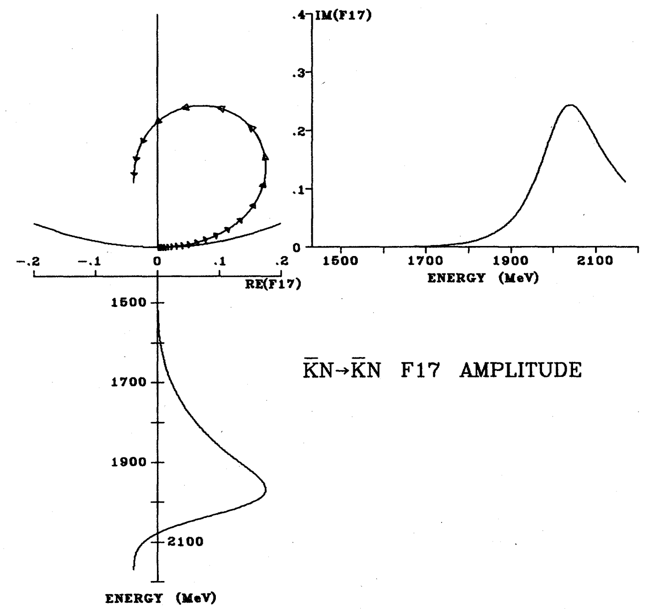
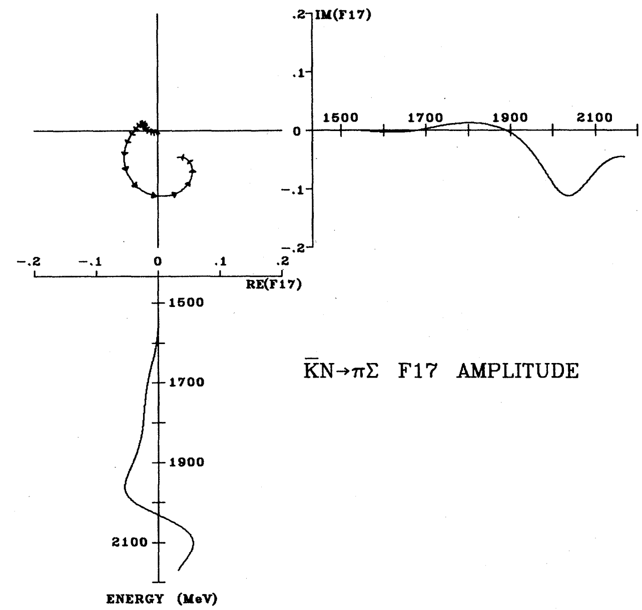


Fig. 6. Amplitudes for $\bar{K}N$ scattering in the F_{15} partial wave. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts versus energy, in alignment with the corresponding Argand plot. In addition, arrows with bases positioned at integral multiples of 25 MeV and a base-to-tip length of 5 MeV are plotted on all the Argand plots except that of BAILLON 75. The results of two different analyses are shown for each channel; the energy axes for the two analyses are aligned for ease of comparison. The energy axes run from elastic threshold to 2200 MeV. The lower Argand plot for each channel is from RLIC 76. The upper plot is from LEA 73 for the elastic and $\pi\Sigma$ channels, and from BAILLON 75 for the $\pi\Lambda$ channel. The only established resonance in this wave is the $\Sigma(1915)$; see the Data Card Listings for another possible resonance in the F_{15} wave.

Baryons
Λ's and Σ's

Data Card Listings
For notation, see key at front of Listings.





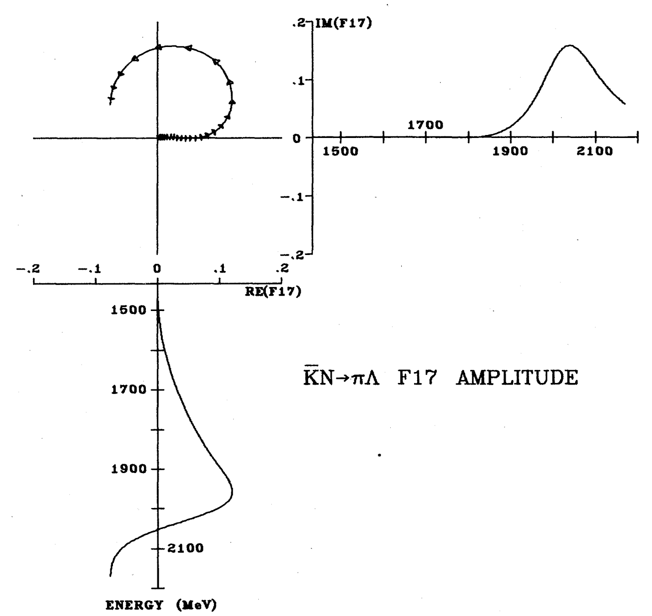


Fig. 7. Amplitudes for $\bar{K}N$ scattering in the F_{17} partial wave. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts versus energy, in alignment with the corresponding Argand plot. In addition, arrows with bases positioned at integral multiples of 25 MeV and a base-to-tip length of 5 MeV are plotted on all the Argand plots. The energy axes run from elastic threshold to 2200 MeV. All the results shown are from RLIC 76. The only established resonance in the F_{17} wave is the Σ(2030).

Data Card Listings

For notation, see key at front of Listings.

Baryons

Λ's and Σ's

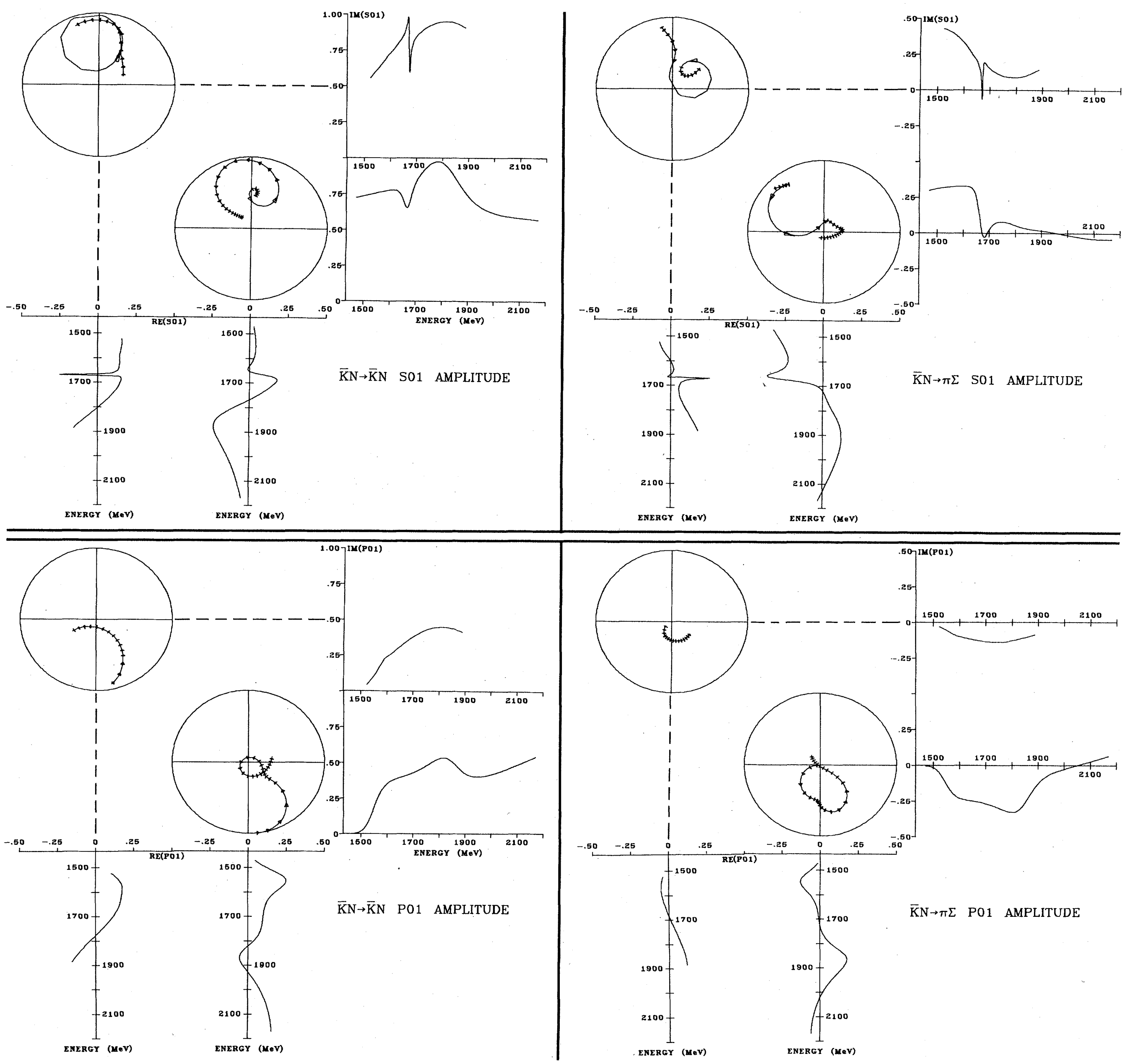


Fig. 8. Amplitudes for K̄N scattering in the S_{01} and P_{01} partial waves. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts versus energy, in alignment with the corresponding Argand plot. In addition, arrows with bases positioned at integral multiples of 25 MeV and a base-to-tip length of 5 MeV are plotted on all the Argand plots. The results of two different analyses are shown for each channel; the energy axes for the two analyses are aligned for ease of comparison. The energy axes run from elastic threshold to 2200 MeV. The lower Argand plot for each amplitude is from RLIC 76; the upper plot is from LEA 73. Established resonances in the S_{01} wave are the Λ(1405) (which lies below threshold and does not appear here), the Λ(1670), and the Λ(1870); the P_{01} wave contains the Λ pole but no established resonances. See the Data Card Listings for possible resonances in the P_{01} wave.

Baryons

Λ's and Σ's

Data Card Listings

For notation, see key at front of Listings.

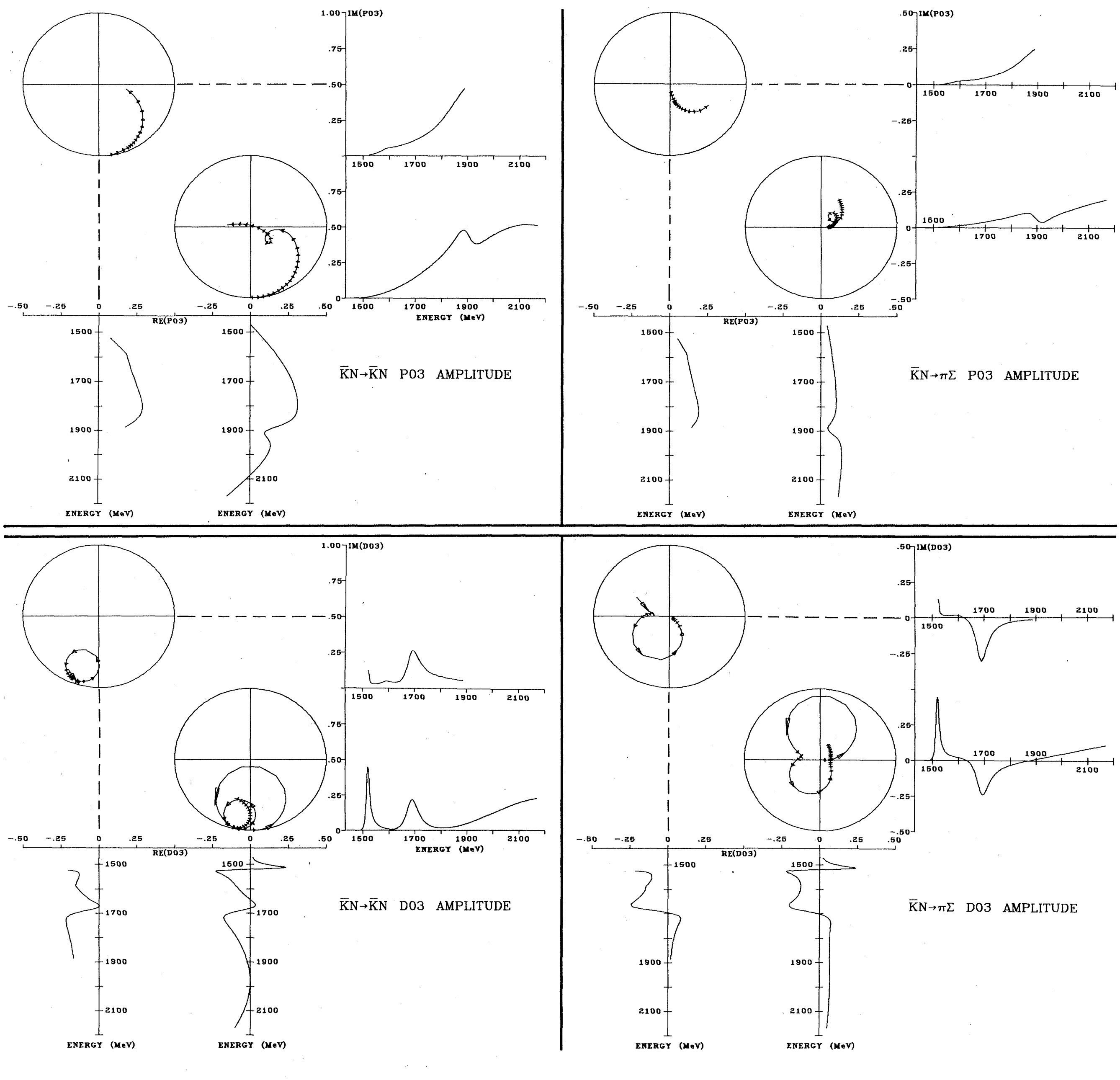


Fig. 9. Amplitudes for $\bar{K}N$ scattering in the P_{03} and D_{03} partial waves. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts versus energy, in alignment with the corresponding Argand plot. In addition, arrows with bases positioned at integral multiples of 25 MeV and a base-to-tip length of 5 MeV are plotted on all the Argand plots. The results of two different analyses are shown for each channel; the energy axes for the two analyses are aligned for ease of comparison. The energy axes run from elastic threshold to 2200 MeV. The lower Argand plot for each amplitude is from RLIC 76; the upper plot is from LEA 73. Established resonances in these waves are the $\Lambda(1860)$ in the P_{03} wave and the $\Lambda(1520)$ and $\Lambda(1690)$ in the D_{03} wave. See the Data Card Listings for another possible resonance in the D_{03} wave.

Data Card Listings

For notation, see key at front of Listings.

Baryons

Λ's and Σ's

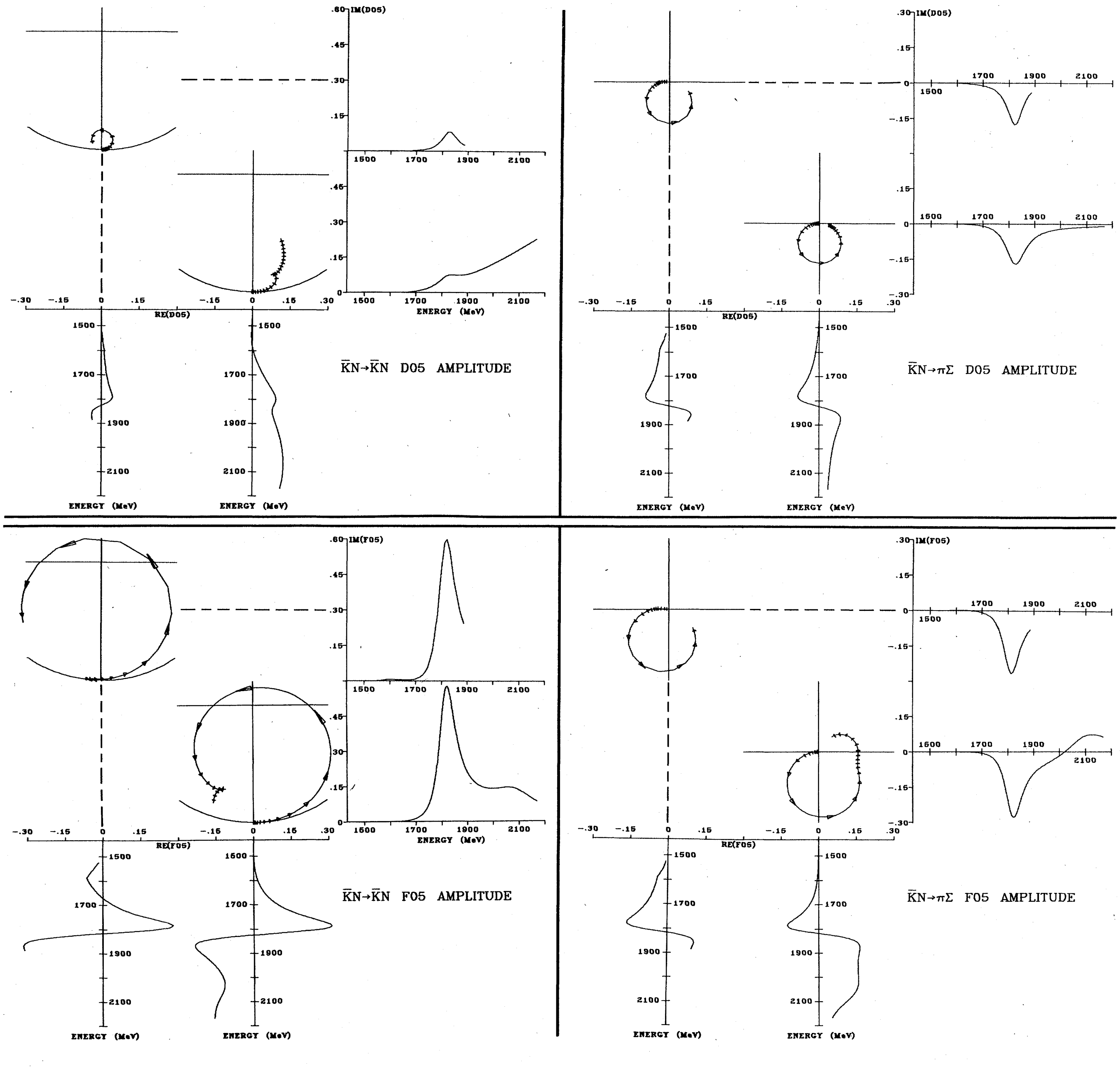


Fig. 10. Amplitudes for $\bar{K}N$ scattering in the D_{05} and F_{05} partial waves. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts versus energy, in alignment with the corresponding Argand plot. In addition, arrows with bases positioned at integral multiples of 25 MeV and a base-to-tip length of 5 MeV are plotted on all the Argand plots. The results of two different analyses are shown for each channel; the energy axes for the two analyses are aligned for ease of comparison. The energy axes run from elastic threshold to 2200 MeV. The lower Argand plot for each amplitude is from RLIC 76; the upper plot is from LEA 73. Established resonances in these waves are the $\Lambda(1830)$ in the D_{05} wave and the $\Lambda(1815)$ in the F_{05} wave. See the Data Card Listings for another possible resonance in the F_{05} wave.

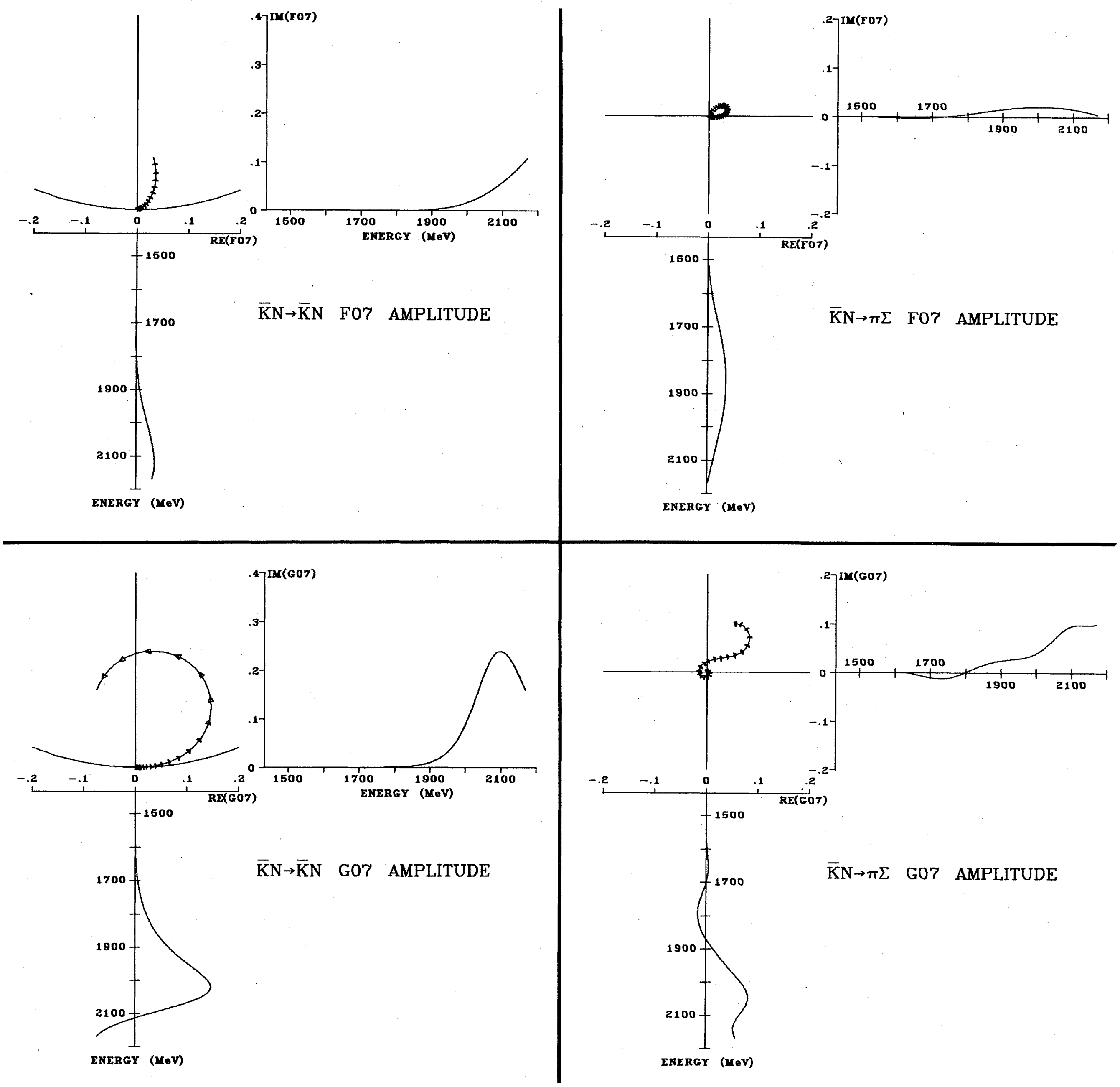


Fig. 11. Amplitudes for $\bar{K}N$ scattering in the F_{07} and G_{07} partial waves. The energy dependence of each amplitude is displayed by plotting its real and imaginary parts versus energy, in alignment with the corresponding Argand plot. In addition, arrows with bases positioned at integral multiples of 25 MeV and a base-to-tip length of 5 MeV are plotted on all the Argand plots. The energy axes run from elastic threshold to 2200 MeV. All the results shown are from RLIC 76. The only established resonance in these waves is the Λ(2100) in the G_{07} wave. See the Data Card Listings for a possible resonance in the F_{07} wave.

Data Card Listings

For notation, see key at front of Listings.

Baryons

Λ's and Σ's, Λ, Λ(1330), Λ(1405)

Conclusions

Table I is an attempt to evaluate the status of the various Y^*'s. The evaluations are of course partly subjective. A blank indicates that there is no corresponding evidence at all. This may mean either that the relevant couplings are small or that the resonance does not really exist. The Baryon Table includes only the well-established resonances. It seems clear, however, that whereas any particular one of the questionable resonances may disappear with the next analysis, there are probably many new resonances underlying those already established.

References

1. E. Barrelet, Nuovo Cimento 8A, 331 (1972).
2. P. Litchfield, Proceedings of the IInd Aix-en-Provence Conference (1973).
3. M. Ross and G. Shaw, Ann. Phys. (N.Y.) 13, 147 (1961).

For other references see the Data Card Listings.

TABLE I. STATUS OF Y* RESONANCES
THOSE WITH AN OVERALL STATUS OF *** OR **** ARE INCLUDED IN THE MAIN BARYCN TABLE. THE OTHERS AWAIT CCNFIRMATION.

PARTICLE	LIJ	OVERALL STATUS	STATUS AS SEEN IN -- TOTAL≠ CR. SEC.	KBAR N	LAM PI	SIG PI	OTHER CHANNELS
LAM(1115)	P01	****					WEAK TO N PI
LAM(1330)		DEAD					
LAM(1405)	S01	****		****	F	****	
LAM(1520)	D03	****	****	****	O	****	LAM2PI,LAM GAM
LAM(1600)	P01	*		*		*	
LAM(1670)	S01	****		****	R	****	LAM ETA
LAM(1690)	D03	****	****	****	B	****	LAM2PI,SIG2PI
LAM(1800)	P01	**		***	I	**	
LAM(1800)	G09	*		*		*	
LAM(1815)	F05	****	****	****	D	****	SIG(1385) PI
LAM(1830)	D05	****		***	D	****	
LAM(1860)	P03	***	**	***	E	**	
LAM(1870)	S01	**		***	N	*	
LAM(2010)		**			F	*	LAM CMG
LAM(2020)	F07	*		*	O	*	
LAM(2100)	G07	****	****	****	R	***	XI K,LAM OMG
LAM(2110)	F05	**		**	B	*	LAM CMG
LAM(2350)		****	****	****	I		
LAM(2585)		***	***	*	D		
SIG(1190)	P11	****					WEAK TO N PI
SIG(1385)	P13	****			****	****	
SIG(1440)	PE	DEAD					
SIG(1480)	PE	*		*	*	*	
SIG(1580)	D13	**	**	*	**		
SIG(1620)	S11	**		**	*	*	
SIG(1660)	P11	**		**	*	**	
SIG(1670)	D13	****	**	***	****	****	SEVERAL CTHERS
SIG(1670)	PE	**		**	**	**	SEVERAL OTHERS
SIG(1690)	PE	**	*	*	**	*	LAM 2-PI
SIG(1750)	S11	***		**	**	*	SIG ETA
SIG(1765)	D15	****	****	****	****	***	SEVERAL OTHERS
SIG(1770)	P11	*		*	*		
SIG(1840)	P13	*		*	**	*	
SIG(1880)	P11	**		**	**		
SIG(1915)	F15	****	***	***	****	***	
SIG(1940)	D13	***		*	***	**	
SIG(2000)	S11	*			*		
SIG(2030)	F17	****	****	****	****	**	XI K
SIG(2070)	F15	*				*	
SIG(2080)	P13	**			**		
SIG(2100)	G17	*			*	*	
SIG(2250)		****	****	*	*	*	
SIG(2455)		***	***	*			
SIG(2620)		***	***	*			
SIG(3000)		**		*	*		

**** GOOD, CLEAR, AND UNMISTAKABLE.
*** GOOD, BUT IN NEED OF CLARIFICATION OR NOT ABSOLUTELY CERTAIN.
** NEEDS CCNFIRMATICN.
* WEAK.

≠ ATTRIBUTED TO THE STATE CLOSEST TO WHERE THE CROSS SECTION PEAKS.

S=−1 I=0 HYPERON STATES (Λ)

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****** ********* ********* ********* ********* ********* ********* ********
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Λ

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18  LAMBCA(1115,JP=1/2+)  I=0
SEE STABLE PARTICLE DATA CARD LISTINGS
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Λ(1330) BUMPS

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87  Y*0(1330, JP=     ) I=0        PRODUCTICN EXPERIMENTS
SEE TFE MINI-REVUE AT THE START OF TFE Y* LISTINGS.

A PEAK WAS SEEN NEAR 1330 MEV IN THE LAMBCA GAMMA
SPECTRUM IN THREE PI-PROPANE EXPERIMENTS (YUNG-CHANG
64, BUBELEV 67, AND BOZOKI 68).  ALL MORE RECENT
RESULTS INDICATE THAT TFERE IS NO RESCNANACE NEAR TFIS MASS VALUE.

****** ********* ********* ********* ********* ********* ********* ********

                        REFERENCES FOR Y*0(1330) (PROD. EXP.)

Y-CHANG  64 DUBNA CONF I 615  YUNG-CHANG, IN, KLADNITSKAYA, +      (DUBNA)
BUBELEV  67 PL 24B 246        +CHADRAA, CHUVILO, +  (JINR,BUCHAPEST,CERN)
DAHL     67 PR 163 1377       CAHL, HARDY, FESS, KIRZ, MILLER        (LRL)
BOZOKI   68 PL 28B 360        +FENYVES, GEMESY, +        (BUDAPEST,DUBNA)
TAN      69 PRL 23 101        T H TAN                               (SLAC)
MAYEUR   70 PL 33B 441        +VAN BINST,WILQUET+++     (BRUX,CERN,TUFT)
COLAS    75 NP B91 253        COLAS,FARWELL,FERRER,SIX              (ORSA)

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Λ(1405) **S'_{01}**

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37  Y*0(1405, JP=1/2-) I=0
    PRODUCTICN EXPERIMENTS

THIS RESONANCE CAN BE IDENTIFIED WITH THE VIRTUAL BOUND
STATE IN TFE KBAR-N SYSTEM FOUND IN THE ANALYSIS OF LOW
ENERGY K-P INTERACTION.  WE LIST SUCF EXPERIMENTS SEPA-
RATELY BELOW.  WE USE CNLY PRODUCTION EXPERIMENTS FOR
AVERAGING CF MASSES AND WIDTHS.

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              37  Y*C(1405) MASS (MEV) (PROD. EXP.)

M          (1405.0)                  ALSTCN     61 HBC   K-P 1.15 BEV/C
M          (1410.0)                  ALEXANDER  62 HBC   PI-P 2.1 BEV/C
M          (1405.0)                  ALSTON     62 HBC   K-P 1.2-.5 BEV/C
M          (1382.0)   (8.0)          ENGLER     65 HDBC  PI-P, PI+D 1.68   7/66
M           1400.0    24.0           MUSGRAVE   65 HBC   PBAR P 3-4 BEV/C  7/66
M        67 1400.0     5.0           BIRMINGHA  66 HBC   K-P 3.5           9/67
M       120 1405.0     5.0           GALTIERI   68 CBC   K-D 2.1-2.7BEV/C  6/68
M           . . . . . . . . . .
M   AVG     1402.4     3.5     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT1402.4      3.9     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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              37  Y*0(1405) WIDTH (MEV) (PROD. EXP.)

W           (20.0)                   ALSTCN     61 HBC                     7/66
W            35.0      5.0           ALEXANDER  62 HBC
W           (50.0)                   ALSTON     62 HBC
W           (89.0)    (20.0)         ENGLER     65 HCBC                    7/66
W            60.0     20.0           MUSGRAVE   65 HBC                     7/66
W        67  50.0     10.0           BIRMINGHA  66 HBC   K-P 3.5           9/67
W       120  35.0      8.0           GALTIERI   68 CBC   K-C 2.1-2.7BEV/C  6/68
W           . . . . . . . . . .
W   AVG      38.1      3.9     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W   STUDENT  37.9      4.3     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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              37  Y*0(1405) PARTIAL DECAY MODES (PROD. EXP.)
                                                          DECAY MASSES
P1     Y*0(1405) INTO SIGMA PI                           1197+ 139

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                        REFERENCES FOR Y*0(1405) (PROD. EXP.)

ALSTON   61 PRL 6 698         +ALVAREZ,EBERHARD,GOCD,GRAZIANO, +     (LFL) I
ALEXANDE 62 PRL 8 447         ALEXANDER,KALBFLEISCH,MILLER,SMITH     (LRL) I
ALSTON   62 CERN CCNF 311     +ALVAREZ,FERRO-LUZZI,ROSENFELD, +      (LRL) I
ENGLER   65 PRL 15 224        +FISK,KRAEMER,MELTZER,WESTGARD,+ (CARN,BNL) IJ
MUSGRAVE 65 NC 35 735         +PETMEZAS,+    (BIRM,CERN,EPOL,LOIC,SACLAY)

BIRMINGH 66 PR  152  1148     BIRMINGHAM,GLASGOW,LOIC, CXFORD,RUTFERFCRD
GALTIERI 68 PRL 21 573        BARBARO-GALTIERI,CHADWICK +      (LRL,SLAC)

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Baryons
Λ(1405), Λ(1520)

Data Card Listings
For notation, see key at front of Listings.

1405 MEV REGION: EXTRAPOLATIONS BELOW THRESHOLD

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                    24  Y*0(1405, JP=1/2-) I=0
                        EXTRAPOLATION BELOW THRESHOLD

                        SEE NOTE IN Y*0(1405) PRODUCTICN EXPERIMENTS -THE DIF-
                        FICULTIES IN EXTRAPOLATING FROM THE PHYSICAL REGION TO
                        THE RESONANCE LOCATICN ARE DISCUSSED BY DALITZ 67.

                          THE QUESTION ON WHETHER Y*(1405) IS A KBAR-N BCUND
    STATE OR A CDD POLE (DALITZ 70, RAJASEKARAN 72 HAS BEEN INVESTIGATED
    BY CLINE 71, MARTIN 71, GALTIERI 72, AND DOBSON 72.  THE LAST TWO
    PAPERS CONCLUDE THAT THE DATA CANNOT TELL THE DIFFERENCE.

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                    24  Y*0(1405) MASS (MEV)

M          1410.7      (1.0)          KIM        65 HBC     O-EFF-RANGE FIT   7/66
M          1409.6      (1.7)          SAKITT     65 HBC     O-EFF-RANGE FIT   7/66
M                         DATA OF SAKITT ARE USED IN FIT BY KITTEL.
M          1407.5      (1.2)          KITTEL     66 HBC     O-EFF-RANGE FIT   7/66
M          1403.0      (3.0)          KIM        67 HBC     K MATRIX FIT(KP)  8/67
M          1416.0      (4.0)          MARTIN     69 HBC     CONST. K MATRIX  10/69
M         (1421.0)                    MARTIN     70 RVUE    CONST. K MATRIX   6/70
M    1    (1406.)                     CHAO       73 DPWA    O-RNG. FIT.SOL B  9/73
M    1  SEE ALSO THE ACCCMPANYING PAPER OF THOMAS73.                          9/73

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                    24  Y*0(14C5) WIDTH (MEV)

W            37.0      (3.2)          KIM        65 HBC                       7/66
W            28.2      (4.1)          SAKITT     65 HBC                       7/66
W            34.1      (4.1)          KITTEL     66 HBC                       7/66
W            50.0      (5.0)          KIM        67 HBC     K MATRIX FIT(KP)  8/67
W            29.0      (6.0)          MARTIN     69 HBC     CONST. K MATRIX  10/69
W           (20.0)                    MARTIN     70 RVUE    CONST. K MATRIX   6/70
W    1      (55.)                     CHAO       73 DPWA    O-RNG. FIT.SOL B  9/73
W    1  ASYMMETRIC RESONANCE SHAPE,W/2=41 MEV BELOW RESONANCE,14 MEV ABOVE.   9/73

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                        REFERENCES FOR Y*0(1405) (FROM EXTRAPOLATICNS)

KIM       65 PRL 14 29          J K KIM                          (CCLUMBIA)IJP
SAKITT    65 PR 139 B719        +DAY,GLASSER,SEEMAN,FRIEDMAN, +   (UMD,LRL)IJP
KITTEL    66 PL 21 349          W KITTEL, G CTTER, I WACEK        (VIENNA)IJP
KIM       67 PRL 19 1074        J KIM                               (YALE)JP
MARTIN    69 PR 183 1352        B R MARTIN, M SAKITT             (LOUC+BNL)
MARTIN    70 NP B16 479         A D MARTIN, G G ROSS              (DURHAM)IJP
CHAO      73 NP B56 46          CHAO,KRAEMER,THOMAS,MARTIN (RHEL+CARN+LOUC)IJP
   ALSO   73 NP B56 15          THOMAS,ENGLER,FISK,KRAEMER          (CARN)IJ

                        PAPERS NOT REFERRED TO IN DATA CARDS

ABRAMS    65 PR 139 B454        G S ABRAMS, B SECHI-ZORN            (UMD)IJP
DONALD    66 PL 22 711          + EDWARDS, LYS, NISAR, MOORE    (LIVERPOOL)
KADYK     66 PRL 17 599         +CREN, G+S GCLDHABER, TRILLING       (LRL)IJP
   FIT SOLUTIONS GIVING AN I=0 S1                          (2 RESCNANCE.)
   ABRAMS 65, KADYK 66, ANC DONALD 66 SUPPORT THOSE EFFECTIVE-RANGE-
DALITZ    67 PR 153 1617        DALITZ, WONG, RAJASEKARAN   (OXFORD,BOMBAY)
DALITZ    70 DUKE-HR 70 03      R D DALITZ                          (OXF)
CLINE     71 PRL 26 1194        D CLINE,R LAUMANN,J MAPP           (WISC)
MARTIN    71 PL 35B 62          A D MARTIN,B R MARTIN,ROSS (DURH+LOUC+RHEL)
DOBSON    72 PR D6 3256         P N DOBSON,R MCELHANEY             (HAWA)
GALTIERI  72 LBL 555            A.BARBARO-GALTIERI                  (LBL)
RAJASEKA  72 PR D5 610          RAJASEKARAN                        (TATA)
   ALSC EARLIER PAPERS CITED IN RAJASEKARAN72
SHAW      73 PURDUE CCNF. 417   SHAW                               (UCI)IJP
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Λ(1520) D'03

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                    38  Y*0(1520, JP=3/2-) I=0

                        PRODUCTION AND FORMATION EXPERIMENTS AGREE QUITE WELL
                        WITH EACH OTHER, THERFORE, THEY HAVE NOT BEEN SEPARATED
                        FOR THIS PARTICLE.
                          THE CECAY MODE LAMBDA PI PI IS LARGELY DUE TO
    Y*1(1385) PI.  CNLY THE VALUES OF (Y*1(1385) PI)/(LAMBDA PI PI) GIVEN
    BY MAST 72 AND CORDEN 75 ARE BASED ON REAL 3-BODY PARTIAL WAVE ANLAYSES
    (THE CLDER RESULTS BEING OBTAINED USING CRUDER METHODS).  THE
    DISCREPANCY BETWEEN THE 2 RESULTS IS ESSENTIALLY DUE TO THE DIFFERENT
    HYPOTHESIS MACE CONCERNING THE SHAPE OF THE EPSILON MESON.

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                    38  Y*0(1520) MASS (MEV)

M        145 1517.2      3.0            GALTIERI  63 CBC     K-D 1.51 BEV/C
M            1519.4      2.0            WATSON    63 HBC     K-P ALL CHANNELS
M         29 1520.0      4.0            ALMEIDA   64 HBC     K-P 1.45 BEV/C
M           (1511.0)   (15.0)           MUSGRAVE  65 HBC     PBAR P 3-4 BEV/C  7/66
M         30(1510.0)    (2.0)           BIRMINGHA 66 HBC     K-P 3.5           9/67
M    B       1517.2      1.2            BURKHARDT 69 HBC     K-P .8-1.2 GEV/C 10/69
M    B              QUOTED ERROR INCREASED TO ACCOUNT FOR CISAGREEMENT BETWEEN
M    B              TWO MEASUREMENTS DONE BY SAME AUTHORS (K-P AND SIGMA PI)
M           (1519.)                     KIM       71 DPWA    K-MATRIX ANAL.    3/71
M      1669 1517.+/-1. TO 1521.+/-1.    BERTHON   74 HBC   O QUASI 2 BODY CS  10/74*
M      2000 1519.4       .3             CORDEN    75 CBC     K- D 1.4-1.8GV/C  4/75*
M            1519.       1.             RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
M            . . . . . . . . . . .
M    AVG     1519.24     0.29     AVERAGE (ERROR INCLUDES SCALE FACTCR OF 1.0)
M    STUDENT1519.26      0.31     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    38  Y*0(1520) WIDTH (MEV)

W              16.4      2.0            WATSCN    63 HBC
W             (19.0)   (19.0)           MUSGRAVE  65 HBC                       7/66
W        30   (50.0)   (10.0)           BIRMINGHA 66 HBC     K-P 3.5           9/67
W             (18.0)  OR LESS           DAHL      67 HBC                       9/66
W              14.7      1.8            BURKHARDT 69 HBC     K-P .8-1.2 GEV/C 10/69
W             (16.)                     KIM       71 DPWA    K-MATRIX ANAL.    3/71
W      2000    15.5      1.6            CORDEN    75 DBC     K- D 1.4-1.8GV/C  4/75*
W              15.        .5            RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
W              . . . . . . . . . . .
W    AVG       15.09     0.45     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W    STUDENT   15.09     0.49     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    38  Y*C(1520) PARTIAL DECAY MCDES

                                                                DECAY MASSES
P1      Y*0(1520) INTO KBAR N                                   497+ 939
P2      Y*0(1520) INTO SIGMA PI                                1197+ 139
P3      Y*0(1520) INTO LAMBDA PI PI                            1115+ 139+ 139
P4      Y*0(1520) INTO LAMBDA GAMMA                            1115+   0
P5      Y*0(1520) INTO SIGMAO GAMMA                            1192+   0
P6      Y*0(1520) INTO SIGMA PI PI                             1197+ 139+ 139
P7      Y*0(1520) INTO (Y*1(1385)+PI)                          1384+ 139
P8      Y*0(1520) INTO Y*1(1385) PI INTO LAMBDA PI PI          1115+ 139+ 139
         NOTE THAT P8/P7 IS THE BRANCHING FRACTICN FOR Y*1(1385) INTO LM PI     9/73
P9      Y*0(1520) INTO LAMBDA EPSILON                          1518+1200

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<u>FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS</u>

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The <u>diagonal</u> elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the <u>off-diagonal</u> elements are the <u>normalized</u> correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

	P 1	P 2	P 3	P 4	P 5	P 6
P 1	.4548+-.C056					
P 2	-.6145	.4145+-.0063				
P 3	-.2207	-.4080	.0950+-.0043			
P 4	-.0704	-.1138	-.0453	.0C79+-.0014		
P 5	-.1806	-.2920	-.1162	-.0248	.0192+-.0034	
P 6	-.0269	-.0434	-.0173	-.0037	-.0095	.0086+-.0005

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                    38  Y*C(1520) BRANCHING RATICS

R1      Y*0(1520) INTO (SIGMA PI)/(KBAR N)                  (P2)/(P1)
R1             1.72       .78           MUSGRAVE  65 HBC                        8/67
R1             0.96      0.20           DAHL      67 HBC      PI-P 1.6-4 GEV/C  9/66
R1             0.73      0.11           CAUBER    67 HBC      K-P AT 2.GEV/C    8/67
R1             1.06       .14           SCHEUER   68 DBC    O K-N 3 GEV/C      10/69
R1             0.82      0.08           BURKHARDT 69 HBC      K-P .8-1.2 GEV/C 10/69
R1            (1.06)    (.12)           BERTHCN   74 HBC    O QUASI 2 BODY CS  10/74*
R1    4         .96       .06           RLIC      76 DPWA     KBAR N MULTICHNL  1/76*
R1    4  KBAR N TO SIGMA PI AMPLITUDE AT RESONANCE IS +.46 +/- .01              1/76*
R1             . . . . . . . . . . .
R1   AVG       0.902     0.049    AVERAGE (ERROR INCLUDES SCALE FACTCR CF 1.2)
R1   STUDENT   0.905     0.050    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R1   FIT       0.911     0.023   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R2      Y*0(1520) INTO (LAMBCA PI PI)/(KBAR N)              (P3)/(P1)
R2             0.17      0.05           DAHL      67 HBC      PI-P 1.6-4 GEV/C  9/66
R2             0.21      0.18           DAUBER    67 HBC      K-P AT 2.GEV/C    8/67
R2              .19       .04           SCHEUER   68 CBC    O K-N 3 GEV/C      10/69
R2             0.22      0.03           BURKHARDT 69 HBC      K-P .8-1.2 GEV/C 10/69
R2            (0.2)                     KIM       71 DPWA     K-MATRIX ANAL.    3/71
R2            (.27)     (.13)           BERTHON   74 HBC    O QUASI 2 BODY CS  10/74*
R2             . . . . . . . . . . .
R2   AVG       0.202     0.021    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2   STUDENT   0.202     0.024    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R2   FIT       0.209     0.010   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R3      Y*0(1520) INTO (SIGMA PI)/(LAMBDA PI PI)            (P2)/(P3)
R3             4.5       1.0            ARMENTERO 65 HBC                        7/66
R3             3.3       1.1            BIRMINGHA 66 HBC      K-P 3.5           9/67
R3             3.9       1.0            UHLIG     67 HBC      K-P .9-1.0 BEV/C  9/66
R3             . . . . . . . . . . .
R3   AVG       3.94      0.59     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3   STUDENT   3.94      0.65     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R3   FIT       4.36      0.23    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R4      Y*0(1520) INTO (LAMBCA GAMMA)/TOTAL (PERCENT)       (P4)
R4      238    0.80      0.14           MAST      68 HBC    O USING ELAST=.45  11/68
R4             . . . . . . . . . . .
R4   FIT       0.79      0.14    FROM FIT (ERROR INCLUDES SCALE FACTCR OF 1.0)

R5      Y*0(1520) INTO (SIGMAO GAMMA)/TOTAL (PERCENT)       (P5)
R5    S        2.0        .35           MAST      68 HBC      SEE NOTE S       10/69
R5    S     RATIOS CALCULATED FRCM R4,ASSUMING SU(3). NEEDED TO CONSTRAIN
R5    S     ALL THE Y*0(1520) BRANCHING RATICS TO BE UNITY.
R5             . . . . . . . . . . .
R5   FIT       1.92      0.34    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R6      Y*0(1520) INTO (KBAR N)/TOTAL                       (P1)
R6             0.29      0.05           WATSON    63 HBC      K-P ALL CHANNELS 10/71
R6              .447      .018          GALTIERI  69 HBC      K- P .28-.45 G/C 10/69
R6             0.47      0.03           COLLEY    71 CBC      K-N 1.5 GEV PROD 10/71
R6            (0.45)                    KIM       71 DPWA     K-MATRIX ANAL.    3/71
R6              .448      .014          CORDEN    75 CBC      K- D 1.4-1.8GV/C  4/75*
R6            (.42)                     MAST      76 HBC    O K- P CEX          1/76*
R6              .47       .01           RLIC      76 DPWA     KBAR N MULTICHNL  1/76*
R6             . . . . . . . . . . .
R6   AVG       0.4570    0.0071   AVERAGE (ERROR INCLUDES SCALE FACTCR OF 1.0)
R6   STUDENT   0.4582    0.0085   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R6   FIT       0.4548    C.0056 FRCM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R7      Y*0(1520) INTO (SIGMA PI)/TCTAL                     (P2)
R7             0.55      0.09           WATSON    63 HBC      K-P ALL CHANNELS 10/71
R7             0.418      .017          GALTIERI  69 HBC    O K-P .28-.45GEV/C  6/69
R7             0.43     (0.03)          COLLEY    71 CBC      K-N 1.5 GEV PROD 10/71
R7            (0.46)                    KIM       71 DPWA     K-MATRIX ANAL.    3/71
R7    3         .426      .014          CORDEN    75 CBC      K- D 1.4-1.8GV/C  4/75*
R7    3  SUPERSEDES COLLEY 71                                                   1/76*
R7             . . . . . . . . . . .
R7   AVG       0.425     0.011    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R7   STUDENT   0.424     0.012    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R7   FIT       0.4145    0.0063 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R8      Y*0(1520) INTO (SIGMA PI PI)/TCTAL                  (P6)
R8              .010      .0015         GALTIERI  69 HBC    O K-P .28-.45GEV/C 10/69
R8    2         .0085     .0006         MAST2     73 MPWA     K-P TO 2PI SIG    9/73
R8    2  BASED ON ASSUMED ELASTICITY CF .46                                     9/73
R8 A            .007      .002          CORDEN    75 DBC      K- D 1.4-1.8GV/C  4/75*
R8 A     CONSIDERABLE FRACTICN OF THE SIGMA PI PI DECAY PROCEEDS VIA THE        4/75*
R8 A     Y*1(1385) PI INTERMEDIATE STATE.                                       4/75*
R8             . . . . . . . . . . .
R8   AVG       0.00858   0.00054  AVERAGE (ERRCR INCLUDES SCALE FACTOR OF 1.0)
R8   STUDENT   0.00858   0.00059  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R8   FIT       0.00857   0.00054 FROM FIT (ERROR INCLUDES SCALE FACTCR OF 1.0)
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Data Card Listings

For notation, see key at front of Listings.

Baryons

Λ(1520), Λ(1600), Λ(1670)

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R9      Y*0(1520) TO Y*1(1385) PI TO LM PI PI/LM PI PI   (P8)/(P3)           9/73
R9          MORE THAN   0.10             CLINE      69 CBC    K-D TO 2PI LAM N  9/69
R9   B         0.39     C.10             BURKHARDT 71 HBC    LAM. 3PI PROD.    3/71
R9   C        (1.0)                      CHAN       72 IPWA   K-P TO LAM 2PI    2/73
R9   M         0.82     0.10             MAST       73 IPWA   K-P TO 2PI LAM   12/72
R9              .58      .22             CORDEN     75 CBC    K- D 1.4-1.8GV/C  4/75*
R9   B  CENTRAL BIN(1514-1524) GIVES .74+-.10 -- OTHER BINS LCWER BY 2-5SIG
R9   C  CNLY THE Y*(1385)DS03 SEEMS TC CONTRIBUTE
R9   M  BOTH Y*(1385)DS03 AND SIGMA (PI PI)DP03 CCNTRIBUTE
R9          . . . . . . . . . .
R9  AVERAGE MEANINGLESS (SCALE FACTOR = 2.2)

R10     Y*0(1520) INTO (Y*1(1385) PI)/TOTAL                  (P7)
R10            0.041    0.005            CHAN       72 HBC    K-P TO LAM 2PI    3/71

R11     Y*0(1520) INTO (LAMBCA PI PI)/TOTAL                  (P3)
R11            0.10     (0.02)           COLLEY     71 CBC    K-N 1.5 GEV PROD 10/71
R11  1          .11      .01             MAST       73 IPWA   K-P TO 2PI LAM    9/73
R11  1  BASED ON ASSUMEC ELASTICITY OF .46+/-.02                                9/73
R11  3          .091     .006            CCRDEN     75 CBC    K- D 1.4-1.8GV/C  4/75*
R11  3  SUPERSEDES COLLEY 71                                                    1/76*
R11         . . . . . . . . . .
R11 AVG        0.0960   0.0084  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.6)
R11 STUDENT    0.0956   0.0062  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R11 FIT        0.0950   0.0043 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R12     Y*0(1520) INTO (LAMBCA EPSILON)/TOTAL                (P9)               4/75*
R12             .20      .08             CORDEN     75 CBC    K- D 1.4-1.8GV/C  4/75*

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                                REFERENCES FOR Y*0(1520)

GALTIERI 63 PL 6 296             A BARBARO-GALTIERI,A HUSSAIN,RD TRIPP (LRL)
WATSCN   63 PR 131 2248          M B WATSON, M FERRO-LUZZI, R D TRIPP  (LPL)IJP
ALMEIDA  64 PL 9 204             S P ALMEIDA, G R LYNCH                (CERN)
ARMENTER 65 PL 19 338            ARMENTEROS,F-LUZZI, +    (CERN,HEID,SACLAY)
MUSGRAVE 65 NC 35 735            +PETMEZAS,+      (BIRM,CERN,EPOL,LOIC,SACLAY)

BIRMINGH 66 PR  152  1148        BIRMINGHAM,GLASGOW,I.C., OXFORD,RUTHERFORD
DAHL     67 PR 163 1377          DAHL,HARDY,HESS,KIRZ,MILLER           (LRL)
DAUBER   67 PL 248 525           +MALAMUD,SCHLEIN,SLATER,STCRK        (UCLA)
UHLIG    67 PR 155 1448          +CHARLTCN,CCNDCN,GLASSER,YODH,+   (UMD,NRL)
MAST     68 PRL 21 1715          MAST,ALSTCN,BANGERTER,GALTIERI+       (LRL)
SCHEUER  68 NP B8 503            SABRE COLLAB.     (SACL+AMST+BGNA+REHO+EPOL)

BURKHARD 69 NP B14 106           +FILTHUTH+KLUGE+..   (HEID+EFI+CERN+SACLAY)
CLINE    69 LNC 2 407            +LAUMANN+MAPP                         (WISC)
GALTIERI 69 LUND 352             BARBARO-GALTIERI,BANGERTER,MAST,TRIPP (LPL)
    ALSO 70 DUKE 95              R D TRIPP                             (LRL)

BURKHARDT71 NP  B27 64           +FILTHUTH,KLUGE,OBERLACK++ (HEID+CERN+SACL)
COLLEY   71 NP  B31 61           +COX,EASTWOOD,FRY+..  (BIRM+EDIN+GLAS+LOIC)
KIM      71 PRL 27 356           J K KIM                              (HARV)IJP
    ALSO 70 DUKE 161             J. K. KIM                            (HARV)IJP

CHAN     72 PRL 28 256           +BUT.-SHAFER,HERTZBACH,KOFLER++ (MASA,YALE)
MAST     73 PR D7 5              +ALSTON-GARNJCST,BANGERTER,+...       (LBL) IJP
MAST2    73 PRD 7 3212           +BANGERTER,ALSTON-GARNJOST,+          (LBL)IJP
BERTHON  74 NC 21A 146           BERTHON,TRISTRAM,+     (CDEF+RHEL+SACL+STRB)   U
CORDEN   75 NP B84 306           CORDEN,COX,CARTNELL,KENYON,ONEALE,+  (BIRM)

MAST     76 LBL-4294 (PRPNT)  MAST,ALSTON-GARNJOST,BANGERTER+          (LBL)
RLIC     76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSON,ROSS+    (RHEL+LOIC)IJP

                                PAPERS NOT REFERRED TO IN DATA CARDS

BERLEY   70 PR D1 1996           +YAMIN,KOFLER,MANN,MEISNER+ (BNL,MASA,YALE)IJP
GOLOWICH 74 PRD 10 3861          EUGEN GOLOWICH                        (SLAC)

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Λ(1600) — P'01

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101   Y*0(1600, JP=1/2+) I=0                                                    1/76*

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                    101   Y*0(1600) MASS (MEV)                                 1/76*

M   1     (1570.)                        KIM        71 DPWA   K-MATRIX ANAL.    1/76*
M   1  POSSIBLE EFFECT IN SIGMA PI AND KBAR N CHANNELS.
M         1620.0      10.0               LANGBEIN   72 IPWA   MULTICHANNEL      1/76*
M         1573.       25.                RLIC       76 DPWA   KBAR N MULTICHNL  1/76*
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.7)

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                    101   Y*0(160C) WIDTH (MEV)                                1/76*

W   1       (50.)                        KIM        71 DPWA   K-MATRIX ANAL.    1/76*
W            60.0     10.0               LANGBEIN   72 IPWA   MULTICHANNEL      1/76*
W           147.      50.                RLIC       76 DPWA   KBAR N MULTICHNL  1/76*
W          . . . . . . . . . .
W   AVG      63.3      9.8     AVERAGE (ERROR INCLUDES SCALE FACTCR OF 1.0)
W   STUDENT  62.8     10.8     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
        SEE THE NOTES ACCOMPANYING MASSES CUCTED

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                    101   Y*0(1600) PARTIAL DECAY MODES                        1/76*

                                                         CECAY MASSES
P1      Y*0(1600) INTO KBAR N                         497+ 939
P2      Y*0(1600) INTO SIGMA PI                      1197+ 139

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                    101   Y*0(1600) BRANCHING RATIOS                           1/76*

R1      Y*0(1600) INTO (KBAR N)/TCTAL                        (P1)               1/76*
R1            0.25      0.15             LANGBEIN   72 IPWA   MULTICHANNEL      1/76*
R1             .24       .04             RLIC       76 DPWA   KBAR N MULTICHNL  1/76*
R1         . . . . . . . . . .
R1  AVERACE MEANINGLESS (SCALE FACTOR = 1.0)

R2      Y*0(1600) FRCM KBAR N INTO SIGMA PI                  SQRT(P1*P2)        1/76*
R2            0.28      0.09             LANGBEIN   72 IPWA   MULTICHANNEL      1/76*
R2            -.16       .04             RLIC       76 DPWA   KBAR N MULTICHNL  1/76*
R2         . . . . . . . . . .
R2  AVERACE MEANINGLESS (SCALE FACTOR = 1.2)

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                                REFERENCES FOR Y*0(1600)

KIM      71 PRL 27 356           J K KIM                              (HARV)IJP
    ALSO 70 DUKE 161             J. K. KIM                            (HARV)IJP

LANGBEIN 72 NP B47 477           +WAGNER                              (MPIM)IJP

RLIC     76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSCN,ROSS+    (RHEL+LOIC)IJP

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Λ(1670) — S''01

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40   Y*0(1670, JP=1/2-) I=0
          SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

            THIS RESONANCE IS WELL ESTABLISHED.
            (SEE THE NOTE FOR THE Y*0(1330)).

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                    40   Y*0(1670) MASS (MEV)

M    M     (1666.0)OR(1675.0)            BERLEY     65 HBC   0 K-P TO LAM ETA     7/66
M    M     THE FIRST VALUE ASSUMES THE BRANCHING RATIO INTO LAMBDA ETA IS
M        SMALL, THE SECOND THAT IT IS LARGE.  BECAUSE THE RESONANCE IS NEAR
M        THE LAMBDA ETA THRESHOLC, THE BRANCHING RATIO AFFECTS THE MOMENTUM
M        DEPENDENCE OF THE TOTAL WIDTH, AND THUS ALSO THE RESONANCE PARA-
M        METERS OBTAINED BY FITTING TO THE DATA.
M     N    (1663.0)     (3.0)            ARMENT-1   68 HBC   0 ELASTIC, CH EXCH 11/68
M     N    (1678.0)     (2.0)            ARMENT-2   68 HBC   0 K-P TO SIGMA PI  11/68
M     A     1674.0      (5.0)            ARMENT-3   69 HBC   0 MULTICHANNEL      9/69
M     N     1662.0      (3.0)            ARMENT-4   69 HBC   0 ELAST,CH.EXC.ED   9/69
M     N     1680.0      (1.0)            ARMENT-4   69 HBC   0 K-P TO SIG PI.ED  9/69
M           1674.0                       BERLEY     69 HBC   0 K-P TO SIGMA PI   6/70
M           1683.0      (5.0)            GALTIERI   70 HBC   0 SIG PI,EDPWA      7/70
M           1670.                        KIM        71 DPWA    K-MATRIX ANAL.    3/71
M           1640.0     (40.0)            LANGBEIN   72 IPWA    MULTICHANNEL     .12/72
M           1700.      (10.)             BAXTER     73 DPWA  0 K- P TO NEUTRALS 10/74*
M           1672.       (1.)             HART       73 DPWA    EL+CX,.7-.8GEV/C  2/74
M           1665.       (5.)             PREVOST    74 DPWA 0- K-N TO S(1385)PI 10/74*
M           1670.       (5.)             RLIC       76 DPWA    KBAR N MULTICHNL  1/76*
M     A          THE MULTICHANNEL ANALYSIS INCLUDES ELASTIC AND SIGMA PI .   10/69
M     N    THE APPARENT DISCREPANCY BETWEEN THESE RESULTS IS PROBABLY NOT
M        SERIOUS.  THE ERRORS GIVEN ARE JUST STATISTICAL.  THE SYSTEMATIC
M        ERRORS THAT RESULT FRCM THE RESTRICTIVE PARAMETRIZATION FORCED ON
M        THE PARTIAL-WAVE AMPLITUDES ARE NOT INCLUDED, AND CAN BE LARGE.

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                    40   Y*0(1670) WIDTH (MEV)

W    M       (22.0)OR(15.0)              BERLEY     65 HBC   0 SEE NOTE M ABCVE  7/66
W     N      (26.0)      (8.0)           ARMENT-1   68 HBC   0 SEE NOTE N ABOVE 11/68
W     N      (26.0)      (5.0)           ARMENT-2   68 HBC   0                  11/68
W     A       23.0       (3.0)           ARMENT-3   69 HBC   0                   9/69
W     N       38.0      (15.0)           ARMENT-4   69 HBC   0 ELAST,CH EXC.ED   9/69
W     N       33.0       (5.0)           ARMENT-4   69 HBC   0 K-P TO SIG PI.ED  9/69
W             31.0                       BERLEY     69 HBC   0 K-P TO SIGMA PI   6/70
W             25.0       (5.0)           GALTIERI   70 HBC   0 SIG PI,EDPWA      7/70
W             35.                        KIM        71 DPWA    K-MATRIX ANAL.    3/71
W             45.0      (20.0)           LANGBEIN   72 IPWA    MULTICHANNEL     12/72
W             65.       (20.)            BAXTER     73 DPWA  0 K- P TO NEUTRALS 10/74*
W             19.        (2.)            HART       73 DPWA    EL+CX,.7-.8GEV/C  2/74
W             19.        (5.)            PREVOST    74 DPWA 0- K-N TO S(1385)PI 10/74*
W             45.       (10.)            RLIC       76 DPWA    KBAR N MULTICHNL  1/76*
          SEE THE NOTES ACCOMPANYING THE MASSES QUCTED

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                    40   Y*0(1670) PARTIAL DECAY MODES

                                                         DECAY MASSES
P1      Y*0(1670) INTO KBAR N                         497+ 939
P2      Y*0(1670) INTO LAMBDA ETA                    1115+ 548
P3      Y*0(1670) INTO SIGMA PI                      1189+ 139
P4      Y*0(1670) INTO SIGMA(1385) PI                 139+1384

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                    40   Y*C(1670) BRANCHING RATICS

R1      Y*0(1670) INTO (KBAR N)/TOTAL                        (P1)
R1    P      (0.14)     (0.04)           ARMENT-1   68 HBC   0 OLD DATA         11/68
R1            0.17                       ARMENT-3   69 HBC   0                   9/69
R1    P       0.14      (0.04)           ARMENT-4   69 HBC   0 NEW DATA          9/69
R1    A      (0.39)     (0.05)           CCNFORTO   71 HBC   0 K-P,ELAST,CEX     6/70
R1            0.28                       KIM        71 DPWA    K-MATRIX ANAL.    3/71
R1            0.35      (0.06)           LANGBEIN   72 IPWA    MULTICHANNEL     12/72
R1             .36       (.03)           HART       73 DPWA    EL+CX,.7-.8GEV/C  2/74
R1             .20       (.03)           RLIC       76 DPWA    KBAR N MULTICHNL  1/76*
R1    A     EFFECT BELOW REGION ANALYZED. VALUE OF .18 DOES NOT
R1    A   AFFECT FIT OR VALUES OF CTHER PARAMETERS.
R1    P     THIS IS THE DIAMETER OF THE CIRCLE IN THE ARGAND PLOT.  IT IS
R1        SUPERIMPOSED ON A LARGE BACKGROUND.

R2      Y*0(1670) FROM KBAR N TO LAMBDA ETA                  SQRT(P1*P2)
R2    M      (0.20) OR 0.23              BERLEY     65 HBC   0 SEE NOTE M ABOVE  7/66
R2           (0.26)                      ARMENT-3   69 HBC   0                   9/69
R2           (0.24)                      KIM        71 DPWA    K-MATRIX ANAL.    3/71
R2            +.20       (.05)           BAXTER     73 DPWA  0 K- P TO NEUTRALS 10/74*
        SEE THE NCTES ACCCMPANYING MASSES CUOTED

R3      Y*0(1670) FROM KBAR N TO SIGMA PI                    SQRT(P1*P3)
R3    1      (-0.25)    (0.06)           ARMENT-2   68 HBC   0 OLD DATA
R3    1      (-0.27)                     ARMENT-3   69 HBC   0                   9/69
R3    1      (-0.30)    (0.03)           ARMENT-4   69 HBC   0 NEW CATA          9/69
R3    1   PUBLISHED SIGN CHANGED TO AGREE WITH LUND 1969 CONVENTICN (SEE TEXT) 10/74*
R3           -0.27                       BERLEY     69 HBC   0 K-P TO SIGMA PI   6/70
R3           -0.29      (C.C3)           GALTIERI   70 HBC   0 SIG PI,EDPWA      7/70
R3           -0.38                       KIM        71 DPWA    K-MATRIX ANAL.    3/71
R3            -.28       (.05)           BAXTER     73 DPWA  0 K- P TO NEUTRALS 10/74*
R3            -.23       (.03)           LONDCN     75 HLBC  0 K- P TO SIGO PIO  4/75*
R3            -.31       (.03)           RLIC       76 DPWA    KBAR N MULTICHNL  1/76*

R4      Y*0(1670) FROM KBAR N TO SIGMA(1385) PI              SQRT(P1*P4)
R4            -.18       .05             PREVOST    74 DPWA 0- K-N TO S(1385)PI 10/74*

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Baryons

Λ(1670), Λ(1690), Λ(1800)

Data Card Listings

For notation, see key at front of Listings.

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                              REFERENCES FOR Y*0(1670)

BERLEY    65 PRL 15 641        +CONNOLLY, HART, RAUM, STONEHILL, +    (BNL)IJP
ARMENT-1  68 NP B8 195         ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
ARMENT-2  68 NP B8 223         ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP

ARMENT-3  69 LUND PAPER 229    ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
   VALUES ARE QUOTED IN LEVI SETTI 69.
ARMENT-4  69 NP B14 91         ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
BERLEY    69 PL 30B 430        + HART, RAHM, WILLIS, YAMAMOTO          (BNL)IJP
GALTIERI  70 DUKE 173          A. BARBARO GALTIERI                     (LRL)IJP
CONFORTO  71 NP  B34  41       +LEVI SETTI,LASINSKI..OBERLACK++ (EFI+HEID)IJP
KIM       71 PRL 27 356        J K KIM                                (HARV)IJP
   ALSO   70 DUKE 161          J. K. KIM                              (HARV)IJP
LANGBEIN  72 NP B47 477        +WAGNER                                (MPIM)IJP
BAXTER    73 NP B67 125        BAXTER,BUCKINGHAM,CORBETT,DUNN,+     (OXFORD)IJP
HART      73 PURDUE CONF. 311  +RICE,BACASTOW,FUNG,+  (TENN+UCR+MASA+BUFF)IJP
PREVOST   74 NP B69 246        PREVOST,BARLOUTAUD,+         (SACL+CERN+HEID)
LONDON    75 NP B85 289        LONDON,YU,BOYD,+  (BNL,CERN,EPOL,ORSA,TORI)

RLIC      76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSON,ROSS+    (RHEL+LOIC)IJP

                          PAPERS NOT REFERRED TO IN DATA CARDS

BIRMINGH  66 PR 152 1148         (BIRMINGHAM,GLASGOW,LOIC,OXFORD,RUTHERFD)
LEVISETT  69 LUND 339          R LEVI SETTI  (RAPPORTEUR)          (CHICAGO)

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Λ(1690) 55 Y*0(1690, JP=3/2-) I=0 **D''_{03}**

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SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

THIS RESONANCE IS WELL ESTABLISHED.

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                         55  Y*0(1690) MASS (MEV)

M          (1696.0)    (3.0)          ARMENT-1   68 HBC    0 ELASTIC, CH EXCH 11/68
M          (1681.0)    (2.0)          ARMENT-3   68 HBC    0 K-P TO SIGMA PI  11/68
M           1681.      (8.)           BARTLEY    68 DBC    0 K-P AND K-D DATA 11/68
M           1655.0     (4.0)          BUGG       68 CNTR   0 K-P, D TOTAL      7/68
M   M      (1697.0)    (2.0)          CONFORTO   68 HBC    0 ELASTIC, CH EXCH 11/68
M    A      1691.0     (2.0)          ARMENT-4   69 HBC    0 ELAS,CH EXC.ED    9/69
M    A      1688.0     (2.0)          ARMENT-4   69 HBC    0 K-P TO SIG PI.ED  9/69
M           1689.0                    BERLEY     69 HBC    0 K-P TO SIGMA PI   6/70
M           1701.0     (4.0)          BERTANZA   69 HBC    0 ELASTIC, CH EXCH  9/69
M           1680.0     (5.0)          GALTIERI   70 HBC    0 SIG PI,EDPWA      7/70
M           1688.0     (3.0)          CONFORTO   71 HBC    0 K-P,ELAST,CEX     6/70
M           1690.                     KIM        71 DPWA     K-MATRIX ANAL.    3/71
M           1680.0    (20.0)          LANGBEIN   72 IPWA     MULTICHANNEL     12/72
M           1670.     (10.)           BAXTER     73 DPWA   0 K- P TO NEUTRALS 10/74*
M           1684.      (3.)           HART       73 DPWA     EL+CX,.7-.8GEV/C  2/74
M           1690.      (5.)           RLIC       76 DPWA     KBAR N MULTICHNL  1/76*
M   M   THE Y*0(1690) IS AT THE EDGE OF THE ENERGY REGION ANALYZED BY
M   M  CONFORTO.  THE SAME DATA AS WELL AS OTHERS EXTENDING TO LOWER
M   M  ENERGIES ARE INCLUDED IN ARMENTEROS 1.
M    A   ANALYSIS INCLUDES OLD AND NEW DATA OF CHS COLLAB.  .43-.8 GEV/C     10/69
M    A   THE APPARENT DISCREPANCY BETWEEN THE SIGMA PI AND OTHER RESULTS IS
M    A PROBABLY NOT SERIOUS.  THE ERRORS GIVEN ARE JUST STATISTICAL.  THE
M    A SYSTEMATIC ERRORS THAT RESULT FROM THE RESTRICTIVE PARAMETRIZATION
M    A OF THE PARTIAL-WAVE AMPLITUDES ARE NOT INCLUDED, AND CAN BE LARGE.

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                         55  Y*0(1690) WIDTH (MEV)

W           (35.0)     (7.0)          ARMENT-1   68 HBC    0 OLD DATA         11/68
W           (85.0)     (7.0)          ARMENT-3   68 HBC    0 OLD DATA         11/68
W            48.      (15.)           BARTLEY    68 DBC    0 K-P AND K-D DATA 11/68
W            40.0      (7.0)          BUGG       68 CNTR   0                   7/68
W   M       (27.0)     (5.0)          CONFORTO   68 HBC    0 SEE NOTE M ABOVE 11/68
W    A       31.0      (7.0)          ARMENT-4   69 HBC    0 ELAS,CH EXC.ED    9/69
W    A       72.0      (6.0)          ARMENT-4   69 HBC    0 K-P TO SIG PI ED  9/69
W            57.0                     BERLEY     69 HBC    0 K-P TO SIGMA PI   6/70
W            28.0      (8.0)          BERTANZA   69 HBC    0                   9/69
W            85.0     (10.0)          GALTIERI   70 HBC    0 SIG PI,EDPWA      7/70
W            64.0      (5.0)          CONFORTO   71 HBC    0 K-P,ELAST,CEX     6/70
W            55.                      KIM        71 DPWA     K-MATRIX ANAL.    3/71
W            40.0     (10.0)          LANGBEIN   72 IPWA     MULTICHANNEL     12/72
W            30.      (10.)           BAXTER     73 DPWA   0 K- P TO NEUTRALS 10/74*
W            86.       (9.)           HART       73 DPWA     EL+CX,.7-.8GEV/C  2/74
W            60.       (5.)           RLIC       76 DPWA     KBAR N MULTICHNL  1/76*
        SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

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                         55  Y*0(1690) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      Y*0(1690) INTO KBAR N                             497+ 939
P2      Y*0(1690) INTO SIGMA PI                           1189+ 139
P3      Y*0(1690) INTO LAMBDA PI PI                       1115+ 139+ 139
P4      Y*0(1690) INTO SIGMA PI PI                        1189+ 139+ 139
P5      Y*0(1690) INTO Y*1(1385) PI S-WAVE                 139+1384
P6      Y*0(1690) INTO LAMBDA ETA                         1115+ 548

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                         55  Y*0(1690) BRANCHING RATIOS

     THE SUM OF ALL THE QUOTED BRANCHING RATIOS IS MORE THAN 1.0.  THE
   TWO-BODY RATIOS ARE FROM PARTIAL WAVE ANALYSES, AND THUS PROBABLY ARE
   MORE RELIABLE THAN THE THREE-BODY RATIOS, WHICH ARE DETERMINED FROM
   BUMPS IN CROSS SECTIONS.  OF THE LATTER, THE SIGMA PI PI BUMP LOOKS
   MORE SIGNIFICANT (THE ERROR GIVEN FOR THE LAMBDA PI PI RATIO LOOKS UN-
   REASONABLY SMALL).  HARDLY ANY OF THE SIGMA PI PI DECAY CAN BE VIA
   Y*1(1385), FOR THEN NINE TIMES AS MUCH LAMBDA PI PI DECAY WOULD BE
   REQUIRED.

R1      Y*0(1690) INTO (KBAR N)/TOTAL                     (P1)
R1           (0.18)    (0.03)         ARMENT-1   68 HBC    0                  11/68
R1           (0.23)                   BUGG       68 CNTR   0 ASSUMING J=3/2    7/68
R1  M        (0.22)    (0.03)         CONFORTO   68 HBC    0 SEE NOTE M ABOVE 11/68
R1            0.18     (0.02)         ARMENT-4   69 HBC    0 NEW DATA          9/69
R1            0.28     (0.04)         BERTANZA   69 HBC    0                   9/69
R1  N        (0.34)    (0.02)         CONFORTO   71 HBC    0 K-P,ELAST,CEX     6/70
R1            0.22                    KIM        71 DPWA     K-MATRIX ANAL.    3/71
R1            0.15     (0.05)         LANGBEIN   72 IPWA     MULTICHANNEL     12/72
R1            .24      (.01)          HART       73 DPWA     EL+CX,.7-.8GEV/C  2/74
R1            .24      (.03)          RLIC       76 DPWA     KBAR N MULTICHNL  1/76*
R1  N   EFFECT IS AT END OF REGION ANALYZED. THIS COULD AFFECT VALUE OF X1.
R1      FROM ALL ABOVE WE ESTIMATE  X=0.20                                     3/72

R2      Y*0(1690) FROM KBAR N TO SIGMA PI                 SQRT(P1*P2)
R2  1       (-0.33)    (0.02)         ARMENT-3   68 HBC    0 OLD DATA         11/68
R2  1       (-0.36)    (0.02)         ARMENT-4   69 HBC    0 NEW DATA          9/69
R2  1   PUBLISHED SIGN CHANGED TO AGREE WITH LUND 1969 CONVENTION (SEE TEXT) 10/74*
R2           -0.27                    BERLEY     69 HBC    0 K-P TO SIGMA PI   6/70
R2           -0.31     (0.03)         GALTIERI   70 HBC    0 SIG PI,EDPWA      7/70
R2           -0.40                    KIM        71 DPWA     K-MATRIX ANAL.    3/71
R2            0.26     (0.07)         LANGBEIN   72 IPWA     MULTICHANNEL     12/72
R2           -.20      (.03)          BAXTER     73 DPWA   0 K- P TO NEUTRALS 10/74*
R2           -.28      (.03)          LONDON     75 HLBC   0 K- P TO SIGO PIO  4/75*
R2           -.25      (.03)          RLIC       76 DPWA     KBAR N MULTICHNL  1/76*

R3      Y*0(1690) FROM KBAR N TO LAMBDA PI PI             SQRT(P1*P3)
R3  B        (0.25)    (0.02)         BARTLEY    68 HDBC   0 LAM 2PI CROS SEC 11/68
R3  B   ONLY CROSS-SECTION DATA USED. ENHANCEMENT NOT SEEN BY PREVOST 71,      3/72

R4      Y*0(1690) FROM KBAR N TO SIGMA PI PI              SQRT(P1*P4)
R4           (0.21)                   ARMENT-2   68 HDBC   0 K-N TO SIG PI PI 11/68

R5      Y*0(1690) FROM KBAR N INTO LAMBDA ETA             SQRT(P1*P6)
R5            .00      (.03)          BAXTER     73 DPWA   0 K- P TO NEUTRALS 10/74*

R6      Y*0(1690) FROM KBAR N TO Y*1(1385) PI S-WAVE      SQRT(P1*P5)
R6           +.27       .04           PREVOST    74 DPWA 0- K-N TO S(1385)PI 10/74*

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                              REFERENCES FOR Y*0(1690)

ARMENT-1  68 NP B8 195         ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
ARMENT-2  68 NP B8 216         ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY) I
ARMENT-3  68 NP B8 223         ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
BARTLEY   68 PRL 21 1111       +CHU,DOWD,GREENE,+      (TUFTS,FSU,BRANDEIS) I
BUGG      68 PR 168 1466       +GILMORE, KNIGHT, +          (BIRM,CAVE,RHEL) I
   ALSO   67 PRL 18 62         DAVIES,DOWELL,+              (BIRM,CAVE,RHEL) I
CONFORTO  68 NP B8 265         +HARMSEN, LASINSKI, +      (CHICAGO,HEIDEL)IJP

ARMENT-4  69 NP B14 91         ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
BERLEY    69 PL 30B 430        + HART, RAHM, WILLIS, YAMAMOTO          (BNL)IJP
BERTANZA  69 PR 177 2036       +BIGI,CARRARA,CASALI, +       (PISA,BNL,YALE)IJP

GALTIERI  70 DUKE 173          A. BARBARO GALTIERI                     (LRL)IJP
CONFORTO  71 NP  B34  41       +LEVI SETTI,LASINSKI..OBERLACK++ (EFI+HEID)IJP
KIM       71 PRL 27 356        J K KIM                                (HARV)IJP
   ALSO   70 DUKE 161          J. K. KIM                              (HARV)IJP
LANGBEIN  72 NP B47 477        +WAGNER                                (MPIM)IJP
BAXTER    73 NP B67 125        BAXTER,BUCKINGHAM,CORBETT,DUNN,+     (OXFORD)IJP
HART      73 PURDUE CONF. 311  +RICE,BACASTOW,FUNG,+  (TENN+UCR+MASA+BUFF)IJP
PREVOST   74 NP B69 246        PREVOST,BARLOUTAUD,+         (SACL+CERN+HEID)

LONDON    75 NP B85 289        LONDON,YU,BOYD,+  (BNL,CERN,EPOL,ORSA,TORI)
RLIC      76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSON,ROSS+    (RHEL+LOIC)IJP

                          PAPERS NOT REFERRED TO IN DATA CARDS

PREVOST   71  AMSTERDAM CONF   + CHS COLLABORATION          (CERN+HEID+SACL)

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Λ(1800) 77 Y*0(1800, JP=1/2+) I=0 **P''_{01}**

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SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

THE EVIDENCE FOR THIS STATE IS SOMEWHAT CONFUSED.  IT
WAS FIRST SUGGESTED IN A PARTIAL WAVE ANALYSIS OF
KBAR N DATA BY THE BEHAVIOUR OF THE P01 AMPLITUDE
WHEN IT WAS PARAMETRIZED AS A TWO-STRAIGHT-LINE
BACKGROUND (ARMENTEROS 68).
   A WIDER AND MORE ELASTIC P01 RESONANCE AT ABOUT THE SAME MASS IS
SUGGESTED BY THE ANALYSIS OF BAILEY 69.  THIS USES CONSIDERABLY LESS
DATA THAN ALL OTHER ANALYSIS, FOR THIS REASON WE DO NOT QUOTE ANY
PARAMETERS FOR THE OTHER PARTIAL WAVES OBTAINED IN THIS ANALYSIS.
   ALMOST ALL THE RECENT ANALYSES CONTAIN A P01 STATE, AND SOMETIMES
TWO, BUT THE MASSES AND BRANCHING RATIOS OBTAINED IN THE VARIOUS
ANALYSES ARE RATHER DIFFERENT.

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                         77  Y*0(1800) MASS (MEV)

M   O      (1745.0)                   ARMENTERO  68 HBC    0 ELASTIC, CH EXCH 11/68
M          (1740.0)                   BAILEY     69 DPWA   0 ELASTIC, CH EXCH 10/70
M          (1800.0)                   ARMENTERO  70 HBC    0 ELASTIC, CH EX    6/70
M          (1750.0)                   ARMENTERO  70 HBC    0 SIGMA PI          6/70
M   N      (1690.0)   (10.0)          GALTIERI   70 HBC    0 SIG PI,EDPWA      7/70
M   N   ERROR STATIST. ONLY- NO ERROR DUE TO PARTICULAR P.W.ANAL. INCLUDED     1/71
M          (1755.)                    KIM        71 DPWA     K-MATRIX ANAL.    3/71
M           1780.0     20.0           LANGBEIN   72 IPWA     MULTICHANNEL     12/72
M           1746.      10.            PREVOST    74 DPWA 0- K-N TO S(1385)PI 10/74*
M           1853.      20.            RLIC       76 DPWA     KBAR N MULTICHNL  1/76*
M   O   OLD ANALYSIS, USING OLD DATA.
M       . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 3.4)

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                         77  Y*0(1800) WIDTH (MEV)

W          (147.0)                    ARMENTERO  68 HBC    0
W          (300.0)                    BAILEY     69 DPWA   0 ELASTIC, CH EXCH 10/70
W           (30.0)                    ARMENTERO  70 HBC    0 ELASTIC, CH EX    6/70
W           (70.0)                    ARMENTERO  70 HBC    0 SIGMA PI          6/70
W   N       (22.0)                    GALTIERI   70 HBC    0 SIG PI,EDPWA      7/70
W           (35.)                     KIM        71 DPWA     K-MATRIX ANAL.    3/71
W           120.0      10.0           LANGBEIN   72 IPWA     MULTICHANNEL     12/72
W            46.       20.            PREVOST    74 DPWA 0- K-N TO S(1385)PI 10/74*
W           166.       20.            RLIC       76 DPWA     KBAR N MULTICHNL  1/76*
W       . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 3.1)
        SEE THE NOTES ACCOMPANYING MASSES QUOTED

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                         77  Y*0(1800) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      Y*0(1800) INTO KBAR N                             497+ 939
P2      Y*0(1800) INTO SIGMA PI                           1197+ 139
P3      Y*0(1800) INTO SIGMA(1385) PI                      139+1384

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                      77  Y*0(1800) BRANCHING RATIOS

R1      Y*0(1800) INTO (KBAR N)/TOTAL                     (P1)
R1            (0.4)                   ARMENTERO 68 DPWA  0 ELASTIC, CH EXCH 11/68
R1            (0.55)                  BAILEY    69 DPWA  0 ELASTIC, CH EXCH 10/70
R1            (0.15)                  ARMENTERO 70 DPWA  0 ELASTIC, CH EXCH 10/70
R1            (0.30)                  KIM       71 DPWA    K-MATRIX ANAL.    3/71
R1             0.36      0.05         LANGBEIN  72 IPWA    MULTICHANNEL     12/72
R1              .21       .04         RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
R1           . . . . . . . . .
R1   AVERAGE MEANINGLESS (SCALE FACTOR = 2.3)

R2      Y*0(1800) FROM KBAR N INTO SIGMA PI              SQRT(P1*P2)
R2   2        (+0.20)                 ARMENTERO 70 DPWA  0 K-P TO SIGMA PI    6/70
R2   2  PUBLISHED SIGN CHANGED TO AGREE WITH LUND 1969 CCNVENTION (SEE TEXT) 10/74*
R2   N        (-0.13)   (0.03)        GALTIERI  70 DPWA  0 K-P TO SIGMA PI    7/70
R2            (0.17)                  KIM       71 DPWA    K-MATRIX ANAL.     3/71
R2            (0.01) OR LESS          LANGBEIN  72 IPWA    MULTICHANNEL      12/72
R2             -.24       .04         RLIC      76 DPWA    KBAR N MULTICHNL   1/76*

R3      Y*0(1800) FROM KBAR N TO SIGMA(1385) PI          SQRT(P1*P3)
R3             +.18       .10         PREVOST   74 DPWA 0- K-N TO S(1385)PI 10/74*
           SEE THE NOTES ACCOMPANYING MASSES QUOTED

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                       REFERENCES FOR Y*0(1800)

ARMENTER 68 NP B8 195          ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
BAILEY   69 THESIS UCRL-50617 DAVID SAAL BAILEY          (LRL LIVERMORE)IJP
ARMENTER 70 DUKE CCNF 123      ARMENTEROS, BAILLON, +      (CERN, HEIDEL)IJP
GALTIERI 70 DUKE CONF 173      A BARBARO-GALTIERI                   (LRL)IJP
KIM      71 PRL 27 356         J K KIM                             (HARV)IJP
   ALSO 70 DUKE 161            J. K. KIM                           (HARV)IJP
LANGBEIN 72 NP B47 477         +WAGNER                             (MPIM)IJP

PREVOST  74 NP B69 246         PREVOST,BARLOUTAUD,+        (SACL+CERN+HEID)
RLIC     76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSON,ROSS+    (RHEL+LOIC)IJP

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Λ(1800)

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102  Y*0(1800, JP=9/2-) I=0   G09                                        1/76*

        THIS NARROW RESONANCE SEEMS NECESSARY TO FIT A PEAK
        IN THE A7 COEFFICIENT OF THE K-P ANGULAR DISTRIBUTION.
        IT IS NOT REQUIRED IN ANY OTHER CHANNEL.

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                      102  Y*C(1800) MASS (MEV)                           1/76*

M          1808.       5.             RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

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                      102  Y*0(1800) WIDTH (MEV)                          1/76*

W            27.       5.             RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

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                      102  Y*0(1800) PARTIAL DECAY MODES                  1/76*

                                                            DECAY MASSES
P1      Y*0(1800) INTO KBAR N                              497+ 939
P2      Y*0(1800) INTO SIGMA PI                           1197+ 139

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                      102  Y*0(1800) BRANCHING RATIOS                     1/76*

R1      Y*0(1800) INTO (KBAR N)/TOTAL                     (P1)            1/76*
R1              .04       .01         RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

R2      Y*0(1800) FROM KBAR N INTO SIGMA PI              SQRT(P1*P2)      1/76*
R2           LESS THAN .04            RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

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                       REFERENCES FOR Y*0(1800)

RLIC      76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSCN,ROSS+    (RHEL+LOIC)IJP

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Λ(1815)

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39  Y*0(1815, JP=5/2+) I=0   F'05
    SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

    THIS STATE IS WELL ESTABLISHED. MOST OF THE QUOTED ER-
    RORS ARE STATISTICAL ONLY. THE SYSTEMATIC ERRORS DUE TO
    THE PARTICULAR PARAMETRIZATION USED IN THE P.W.A. ARE
 NOT INCLUDED. FOR THIS REASON WE DO NOT CALCULATE WEIGHTED AVERAGES FOR
 MASS AND WIDTH.

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                       39  Y*0(1815) MASS (MEV)

M    N      1813.0      (2.0)         ARMENT-1  67 HBC   0 K-P TO SIGMA PI    8/67
M    N      1816.0      (4.0)         BELL      67 HDBC  0 K-N TO SIGMA PI   11/67
M    N      1817.0      (2.0)         ARMENT-3  68 HBC   0 ELASTIC, CH EXCH 11/68
M    N      1819.0      (4.0)         BUGG      68 CNTR  0 K-P, D TOTAL       6/68
M    N      1825.0      (1.0)         BRICMAN   70 CNTR  0 TOTAL AND CH EX    6/70
M    N      1819.0      (1.0)         BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX   1/71
M           1830.0     (10.0)         COOL      70 CNTR    K-P, D TOTAL      10/70
M           1820.0     (10.0)         GALTIERI  70 DPWA  0 K-P TO SIGMA PI    7/70
M    N      1818.0      (2.0)         CONFORTO  71 DPWA  0 ELASTIC, CH EXCH   6/70
M           1810.                     KIM       71 DPWA    K-MATRIX ANAL.     3/71
M    N      1823.0      (3.0)         KANE      72 DPWA  0 K-P TO PI SIG     10/71
M    N      1818.0      (3.0)         LANGBEIN  72 IPWA    MULTICHANNEL      12/72
M    N      1822.       (2.)          RLIC      76 DPWA    KBAR N MULTICHNL   1/76*
M    N   ERROR STATIST. CNLY- NO ERROR DUE TO PARTICULAR P.W.ANAL. INCLUDED   1/71

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                       39  Y*0(1815) WIDTH (MEV)

W              87.0      (15.0)       ARMENT-1  67 HBC   0                    8/67
W              64.0      (12.0)       BELL      67 HDBC  0                   11/67
W     N        71.0       (4.0)       ARMENT-3  68 HBC   0 ELASTIC, CH EXCH 11/68
W     N        75.0       (7.0)       BUGG      68 CNTR  0 K-P, D TOTAL       6/68
W     N        80.0       (6.0)       BRICMAN   70 CNTR  0 TOTAL AND CH EX    6/70
W     N        79.0       (3.0)       BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX   1/71
W             100.0                   COOL      70 CNTR    K-P, D TOTAL      10/70
W             100.0      (20.0)       GALTIERI  70 DPWA  0 K-P TO SIGMA PI    7/70
W     N        90.0       (4.0)       CONFORTO  71 DPWA  0 ELASTIC, CH EXCH   6/70
W              70.                    KIM       71 DPWA    K-MATRIX ANAL.     3/71
W     N       104.0      (16.0)       KANE      72 DPWA  0 K-P TO PI SIG     10/71
W     N        70.0       (5.0)       LANGBEIN  72 IPWA    MULTICHANNEL      12/72
W     N        81.        (5.)        RLIC      76 DPWA    KBAR N MULTICHNL   1/76*
        SEE THE NOTES ACCOMPANYING MASSES QUOTED

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                       39  Y*0(1815) PARTIAL DECAY MODES

                                                            DECAY MASSES
P1      Y*0(1815) INTO KBAR N                              497+ 939
P2      Y*0(1815) INTO SIGMA PI                           1189+ 139
P3      Y*0(1815) INTO Y*1(1385) PI P-WAVE                 139+1384
P4      Y*0(1815) INTO SIGMA PI PI                        1192+ 139+ 139
P5      Y*0(1815) INTO ETA LAMBDA                          548+1115

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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

	P 1	P 2	P 3	P 4	P 5
P 1	.6009+-.0214				
P 2	-.5154	.1155+-.0080			
P 3	-.1541	.0795	.1390+-.0261		
P 4	-.4139	.0216	-.7638	.1292+-.0308	
P 5	-.0642	.0331	.0099	-.2505	.0153+-.0086

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                       39  Y*0(1815) BRANCHING RATIOS

        ERRORS QUOTED BY EXPERIMENTERS DO NOT INCLUDE UNCERTAINTY DUE
        TO PARAMETRIZATICN USED IN THE P.W.A.  THEY SHOULD BE INCREASED.

R1      Y*0(1815) INTO (KBAR N)/TOTAL                     (P1)
R1             0.62      0.02         ARMENT-3  68 HBC   0 ELASTIC, CH EXCH 11/68
R1            (0.72)                  BUGG      68 CNTR  0 K-P, D TOTAL       6/68
R1             0.65      0.02         BRICMAN   70 CNTR  0 TOTAL AND CH EX    6/70
R1             0.58      0.02         BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX   1/71
R1            (0.8)                   COOL      70 CNTR    K-P, D TOTAL      10/70
R1             0.63      0.01         CONFORTO  71 DPWA  0 ELASTIC, CH EXCH   6/70
R1            (0.52)                  KIM       71 DPWA    K-MATRIX ANAL.     3/71
R1             0.47      0.02         LANGBEIN  72 IPWA    MULTICHANNEL      12/72
R1              .57       .02         RLIC      76 DPWA    KBAR N MULTICHNL   1/76*
R1           . . . . . . . . .
R1  AVG        0.601     0.023   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 3.5)
R1  STUDENT    0.614     0.010   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R1  FIT        0.601     0.021  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 3.2)

R2      Y*0(1815) FROM KBAR N INTO SIGMA PI              SQRT(P1*P2)
R2   1        -0.27      0.01         ARMENT-1  67 DPWA  0 K-P TO SIGMA PI   10/74*
R2   1 PUBLISHED SIGN CHANGED TO AGREE WITH LUND 1969 CONVENTION (SEE TEXT)  10/74*
R2             0.23      0.025        BELL      67 DPWA  0 K-P TO SIGMA PI   11/67
R2            -0.26      0.03         GALTIERI  70 DPWA  0 K-P TO SIGMA PI    7/70
R2            (0.26)                  KIM       71 DPWA    K-MATRIX ANAL.     3/71
R2            -0.268     0.027        KANE      72 DPWA  0 K-P TO PI SIG     10/71
R2             0.25      0.03         LANGBEIN  72 IPWA    MULTICHANNEL      12/72
R2             -.28       .03         RLIC      76 DPWA    KBAR N MULTICHNL   1/76*
R2           . . . . . . . . .
R2  AVG MOD    0.2645    0.0078  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2  STUDENT    0.2650    0.0087  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R2  FIT        0.2635    0.0078 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3      Y*0(1815) FROM KBAR N TO Y*1(1385) PI P-WAVE     SQRT(P1*P3)
R3  A         (0.3)     (0.05)        ARMENT-2  67 HBC   0 K-P TO LAM P+ P+
R3             +.27       .03         PREVOST   74 DPWA 0- K-N TO S(1385)PI 10/74*
R3           . . . . . . . . .
R3  FIT        0.289     0.027   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R4      Y*0(1815) INTO (Y*1(1385) PI)/TOTAL               (P3)
R4             0.20      0.05         BIRGE     65 HBC   0 K-P TO LAM PI PI   7/66
R4           . . . . . . . . .
R4  FIT        0.139     0.026   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R5      Y*0(1815) INTO (SIGMA PI PI)/TOTAL                (P4)
R5   P      NO CLEAR SIGNAL           ARMENT-4  68 HDBC  0 K-N TO SIG PI PI 11/68
R5   P    THERE IS A SUGGESTICN CF A BUMP, ENOUGH TO BE CONSISTENT WITH
R5      WHAT IS EXPECTED FROM SIGMA PI DECAY OF THE Y*1(1385) -- ABOUT 0.02.
R5           . . . . . . . . .
R5  FIT        0.129     0.031   FROM FIT

R6      Y*0(1815) FROM KBAR N TO ETA LAMBDA              SQRT(P1*P5)          9/73
R6             -.096     .040     .020 RADER     73 MPWA                      9/73
R6           . . . . . . . . .
R6  FIT        0.096     0.027   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                       REFERENCES FOR Y*0(1815)

BIRGE    65 ATHENS CONF  296  +ELY,KALMUS,KERNAN,LOUIE,SAHOURIA, +  (LRL)IJP
ARMENT-1 67 PL 24B 198        ARMENTEROS, F LUZZI, + (CERN,HEIDEL,SACLAY)IJP
ARMENT-2 67 ZEIT PHYS 202 486 ARMENTEROS, F LUZZI, + (CERN,HEIDEL,SACLAY)IJP
BELL     67 PRL 19 936        R B BELL                              (LRL)IJP
ARMENT-3 68 NP B8 195         ARMENTEROS, BAILLCN, + (CERN,HEIDEL,SACLAY)IJP
ARMENT-4 68 NP B8 216         ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY) I
BUGG     68 PR 168 1466       +GILMORE, KNIGHT,    +     (RHEL+BIRM+CAVE) I
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Baryons
$\Lambda(1815)$, $\Lambda(1830)$, $\Lambda(1860)$

Data Card Listings
For notation, see key at front of Listings.

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BRICMAN   70 PL 31B 152            +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
BRICMAN1  70 PL 33B 511            +FERRO-LUZZI,LAGNAUX              (CERN)
COOL      70 PR D1 1887            +GIACOMELLI, KYCIA, LEONTIC, LI, +   (BNL) I
GALTIERI  70 DUKE CONF 173         A BARBARO-GALTIERI                  (LRL)IJP

CONFORTO  71 NP  B34  41           +LEVI SETTI,LASINSKI..OBERLACK++ (EFI+HEID)IJP
KIM       71 PRL 27 356            J K KIM                            (HARV)IJP
    ALSO  70 DUKE 161              J. K. KIM                          (HARV)IJP

KANE      72 PR D5 1583            D F KANE                            (LBL)IJP
LANGBEIN  72 NP B47 477            +WAGNER                            (MPIM)IJP
RADER     73 NC 16A 178            +BARLOUTAUD,+    (SACL+HEID+CERN+RHEL+CDEF)
PREVOST   74 NP B69 246            PREVOST,BARLOUTAUD,+        (SACL+CERN+HEID)

RLIC      76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSON,ROSS+    (RHEL+LOIC)IJP

                                   PAPERS NOT REFERRED TO IN DATA CARDS

         THE FOLLOWING PAPERS ARE NOW OF ONLY HISTORICAL INTEREST --

CHAMBERL  62 PR 125 1696           CHAMBERLAIN,CROWE,KEEFE,KERTH, +      (LRL) I
GALTIERI  63 PL 6 296              A BARBARO-GALTIERI,A HUSSAIN,RD TRIPP (LRL)IJ
SODICKSO  64 PR 133 B757           SODICKSON,MANNELLI,FRISCH,WAHLIG (MIT(BNL)) J
HOLLEY    65 UCRL-16274 THESIS W R HOLLEY                              (LRL) J
BIRMINGH  66 PR  152  1148         BIRMINGHAM,GLASGOW,I.C., OXFORD,RUTHERFORD
COOL      66 PRL 16 1228           +GIACOMELLI,KYCIA,LEONTIC,LUNDBY +    (BNL)I
GELFAND   66 PRL 17 1224           +HARMSEN,LEVI-SETTI,PREDAZZI+       (EFI,ANL)
ARMENTER  67 NP B3 592             ARMENTEROS,FERRO-LUZZI+  (CERN,HEID,SACLAY)IJP
CONFORTO  68 NP B8 265             +HARMSEN, LASINSKI, +        (CHICAGO,HEIDEL)IJP
LASINSKI  68 PR 163 1792           LASINSKI, LEVI SETTI, PREDAZZI     (CHICAGO) JP
PREVOST   71  AMSTERDAM CONF       + CHS COLLABORATION          (CERN+HEID+SACL)

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$\Lambda(1830)$ — D_{05}

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               56  Y*0(1830, JP=5/2-) I=0

               SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

               THE BEST EVIDENCE FOR THIS RESONANCE COMES FROM THE
               SIGMA PI CHANNEL.  IT IS WELL ESTABLISHED.

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               56  Y*0(1830) MASS (MEV)

M    N     1827.0     (3.0)          ARMENTERO 67 HBC    0 K-P TO SIGMA PI    8/67
M    N     1837.0    (11.0)          BELL      67 HBC    0 K-P TO SIGMA PI   11/67
M    N     1807.0    (10.0)          ARMENTERO 68 HBC    0 ELASTIC, CH EXCH 11/68
M          1840.0    (15.0)          GALTIERI  70 DPWA   0 K-P TO SIGMA PI    7/70
M    N     1831.0     (5.0)          CONFORTO  71 DPWA   0 ELASTIC, CH EXCH  6/70
M          1830.                     KIM       71 DPWA     K-MATRIX ANAL.    3/71
M    K    (1720.)                    KIM       71 DPWA     K-MATRIX ANAL.    3/71
M          1832.0      (5.0)         KANE      72 DPWA   0 K-P TO PI SIG    10/71
M          1810.0    (10.0)          LANGBEIN  72 IPWA     MULTICHANNEL     12/72
M          1825.     (10.)           RLIC      76 DPWA     KBAR N MULTICHNL  1/76*
M    K POSSIBLE EFFECT MAINLY IN SIGMA PI.  NOT CLEAR IF UNCORRELATED
M    K WITH THE 1830 EFFECT
M    N   ERROR STATIST. ONLY- NO ERROR DUE TO PARTICULAR P.W.ANAL. INCLUDED  1/71

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               56  Y*C(183C) WIDTH (MEV)

W            75.0     (9.0)          ARMENTERO 67 HBC    0 K-P TO SIGMA PI    8/67
W            74.0    (18.0)          BELL      67 HBC    0 K-P TO SIGMA PI    8/67
W           123.0    (32.0)          ARMENTERO 68 HBC    0 ELASTIC, CH EXCH 11/68
W           150.0    (30.0)          GALTIERI  70 DPWA   0 K-P TO SIGMA PI    7/70
W           104.0    (35.0)          CONFORTO  71 DPWA   0 ELASTIC, CH EXCH  6/70
W            80.                     KIM       71 DPWA     K-MATRIX ANAL.    3/71
W    K      (20.)                    KIM       71 DPWA     K-MATRIX ANAL.    3/71
W            88.0    (10.0)          KANE      72 DPWA   0 K-P TO PI SIG    10/71
W            60.0    (20.0)          LANGBEIN  72 IPWA     MULTICHANNEL     12/72
W            94.     (10.)           RLIC      76 DPWA     KBAR N MULTICHNL  1/76*
        SEE THE NOTES ACCOMPANYING MASSES QUOTED

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               56  Y*C(1830) PARTIAL DECAY MODES

                                                            DECAY MASSES
P1      Y*0(1830) INTO KBAR N                             497+ 939
P2      Y*0(1830) INTO SIGMA PI                          1189+ 139
P3      Y*C(1830) INTO Y*1(1385) PI D-WAVE                139+1384
P4      Y*0(1830) INTO ETA LAMBDA                         548+1115

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               56  Y*0(1830) BRANCHING RATIOS

R1      Y*0(1830) INTO (KBAR N)/TOTAL                        (P1)
R1           0.09     (0.01)         ARMENTERO 68 HBC    0 ELASTIC, CH EXCH 11/68
R1           0.03     (0.02)         BRICMAN1  70 DPWA     SIGTOT,ELAS,CHEX  1/71
R1           0.05     (0.02)         CONFORTO  71 DPWA   0 ELASTIC, CH EXCH  6/70
R1          (0.24)                   KIM       71 DPWA     K-MATRIX ANAL.    3/71
R1           0.10     (0.03)         LANGBEIN  72 IPWA     MULTICHANNEL     12/72
R1            .04      (.03)         RLIC      76 DPWA     KBAR N MULTICHNL  1/76*

R2      Y*0(1830) FROM KBAR N INTO SIGMA PI               SQRT(P1*P2)
R2   A     (-0.15)    (0.02)         ARMENTERO 67 DPWA   0 K-P TO SIGMA PI  10/74*
R2   A  PUBLISHED SIGN CHANGED TO AGREE WITH LUND 1969 CONVENTION (SEE TEXT) 10/74*
R2           0.19     (0.01)         BELL      67 DPWA   0 K-P TO SIGMA PI  11/67
R2          -0.16     (0.03)         GALTIERI  70 DPWA   0 K-P TO SIGMA PI   7/70
R2           0.15                    KIM       71 DPWA     K-MATRIX ANAL.    3/71
R2          -0.138    (0.018)        KANE      72 DPWA   0 K-P TO PI SIG    10/71
R2           0.27     (0.07)         LANGBEIN  72 IPWA     MULTICHANNEL     12/72
R2           -.17      (.03)         RLIC      76 DPWA     KBAR N MULTICHNL  1/76*

R3      Y*0(1830) FROM KBAR N TO ETA LAMBDA               SQRT(P1*P4)        9/73
R3           -.044      .020         RADER     73 MPWA                       9/73

R4      Y*0(1830) FROM KBAR N TO Y*1(1385) PI D-WAVE      SQRT(P1*P3)
R4           +.13       .03          PREVOST   74 DPWA 0- K-N TO S(1385)PI 10/74*

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                                   REFERENCES FOR Y*0(1830)

ARMENTER  67 PL 24B 198            ARMENTEROS, F-LUZZI, + (CERN,HEIDEL,SACLAY)IJP
BELL      67 PRL 19 936            R B BELL                            (LRL)IJP
ARMENTER  68 NP B8 195             ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
CONFORTO  68 NP B8 265             +HARMSEN, LASINSKI, +        (CHICAGO,HEIDEL)IJP
    IS SUPERSEDED BY CONFORTO 71.
BRICMAN1  70 PL 33B 511            +FERRO-LUZZI,LAGNAUX                  (CERN)
GALTIERI  70 DUKE CONF 173         A BARBARO-GALTIERI                   (LRL)IJP
CONFORTO  71 NP  B34  41           +LEVI SETTI,LASINSKI..OBERLACK++ (EFI+HEID)IJP
KIM       71 PRL 27 356            J K KIM                            (HARV)IJP
    ALSO  70 DUKE 161              J. K. KIM                          (HARV)IJP
KANE      72 PR D5 1583            D F KANE                            (LBL)IJP
LANGBEIN  72 NP B47 477            +WAGNER                            (MPIM)IJP
RADER     73 NC 16A 178            +BARLOUTAUD,+    (SACL+HEID+CERN+RHEL+CDEF)

PREVOST   74 NP B69 246            PREVOST,BARLOUTAUD,+        (SACL+CERN+HEID)
RLIC      76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSON,ROSS+    (RHEL+LOIC)IJP

                                   PAPERS NOT REFERRED TO IN DATA CARDS

PREVOST   71  AMSTERDAM CONF       + CHS COLLABORATION          (CERN+HEID+SACL)
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$\Lambda(1860)$ — P_{03}

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               60  Y*0(1860, JP=3/2+) I=0

               THE JP=3/2+ ASSIGNMENT IS CONSISTENT WITH ALL
               AVAILABLE DATA (INCLUDING POLARIZATION) AND RECENT
               PARTIAL WAVE ANALYSES. THE DOMINANT INELASTIC
               MODES REMAIN UNKNOWN.  SEE ALSO Y*0(2010) MINI-REVIEW.

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               60  Y*0(1860) MASS (MEV)

M   A  F07 1864.0      2.0           ARMENTERO 68 DPWA   0 ELASTIC, CH EXCH 11/68
M    N     1870.0      5.0           BUGG      68 CNTR   0 K-P TOTAL         7/68
M   A  F07 1877.0      6.0           BRICMAN   70 CNTR   0 TOTAL AND CH EX   6/70
M          1870.0      6.0           BRICMAN1  70 DPWA   0 SIGTOT,ELAS,CHEX  1/71
M    N     1883.0     10.0           CONFORTO  71 DPWA   0 ELASTIC, CH EXCH  6/70
M   1     (1710.)                    KIM       71 DPWA     K-MATRIX ANAL.    3/71
M          1850.0     20.0           LANGBEIN  72 IPWA     MULTICHANNEL     12/72
M    2    (1868.)                    LEA       73 DPWA     MULTICHNL K-MTRX  9/73
M          1894.      10.            HEMINGWA  75 DPWA   0 K- P TO KBAR N   11/75*
M    3    (1900.)                    NAKKASYA  75 DPWA   0 K-P TO LAM. OMG.  1/76*
M          1900.       5.            RLIC      76 DPWA     KBAR N MULTICHNL  1/76*
M   A    THESE TWO ANALYSES GAVE THE F07 ASSIGNMENT, THEY HAVE TO BE         1/71
M   A    DISCARDED IN VIEW OF CONFORTO 70 AND BRICMAN1 70
M    N   DUE TO PARTICULAR PARAMETERIZATION USED,ERROR CAN BE LARGE         1/71
M   1  POSSIBLE EFFECT MAINLY IN SIGMA PI. WE TENTATIVELY LIST IT HERE.
M    2  ONLY UNCONSTRAINED STATES FROM TABLE 1 OF LEA73 ARE IN LISTINGS.    9/73
M    3  FOUND IN ONE OF TWO BEST SOLUTIONS.                                 1/76*
M            . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 2.3)

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               60  Y*0(1860) WIDTH (MEV)

W   A  F07   39.0      7.0           ARMENTERO 68 DPWA   0 ELASTIC, CH EXCH 11/68
W    N       40.0     10.0           BUGG      68 CNTR   0 K-P TOTAL         7/68
W   A  F07   24.0     15.0           BRICMAN   70 CNTR   0 TOTAL AND CH EX   6/70
W            37.0     10.0           BRICMAN1  70 DPWA   0 SIGTOT,ELAS,CHEX  1/71
W    N       80.0     20.0           CONFORTO  71 DPWA   0 ELASTIC, CH EXCH  6/70
W   1       (20.)                    KIM       71 DPWA     K-MATRIX ANAL.    3/71
W           125.0     20.0           LANGBEIN  72 IPWA     MULTICHANNEL     12/72
W    2     (323.8)                   LEA       73 DPWA     MULTICHNL K-MTRX  9/73
W           107.      10.            HEMINGWA  75 DPWA   0 K- P TO KBAR N   11/75*
W    3     (100.)                    NAKKASYA  75 DPWA   0 K-P TO LAM. OMG.  1/76*
W            72.      10.            RLIC      76 DPWA     KBAR N MULTICHNL  1/76*
W        SEE THE NOTES ACCOMPANYING MASSES QUOTED
W            . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 2.9)

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               60  Y*0(1860) PARTIAL DECAY MODES

                                                            DECAY MASSES
P1      Y*0(1860) INTO KBAR N                             497+ 939
P2      Y*0(1860) INTO SIGMA PI                          1189+ 139
P3      Y*0(1860) INTO LAMBDA OMEGA                      1115+ 783

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               60  Y*C(1860) BRANCHING RATIOS

R1      Y*0(1860) INTO (KBAR N)/TOTAL                        (P1)
R1  A  F07    0.12      0.02         ARMENTERO 68 HBC    0 ELASTIC, CH EXCH 11/68
R1          (J+1/2)P1= 0.40          BUGG      68 CNTR   0                   7/68
R1  A  F07    0.07      0.02         BRICMAN   70 CNTR   0 TOTAL AND CH EX   6/70
R1            0.14      0.02         BRICMAN1  70 DPWA   0 SIGTOT,ELAS,CHEX  1/71
R1   N        0.25      0.03         CONFORTO  71 DPWA   0 ELASTIC, CH EXCH  6/70
R1            0.37      0.05         LANGBEIN  72 IPWA     MULTICHANNEL     12/72
R1   2       (.32)                   LEA       73 DPWA     MULTICHNL K-MTRX  9/73
R1             .24       .04         HEMINGWA  75 DPWA   0 K- P TO KBAR N   11/75*
R1             .18       .02         RLIC      76 DPWA     KBAR N MULTICHNL  1/76*
R1       SEE THE NOTES ACCOMPANYING MASSES QUOTED
R1           . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 2.5)

R2      Y*0(1860) INTO SIGMA PI                              (P2)
R2   P      PROBABLY SEEN            GALTIERI  68 DBC    0 K-N TO SIG PI PI 11/68
R2            (0.03) OR LESS         LANGBEIN  72 IPWA     MULTICHANNEL     12/72
R2   P   POSSIBLY THIS BUMP SEEN AT 1840+-10 MEV WITH A WIDTH OF 35+-10 MEV
R2      IS THE Y*0(1830), WHICH DECAYS STRONGLY TO SIGMA PI.  HOWEVER THE
R2      NARROW WIDTH HERE ARGUES FOR ITS BEING THE Y*0(1860).

R3      Y*0(1860) FROM KBAR N TO SIGMA PI                 SQRT(P1*P2)        9/73
R3   2        (+.15)                 LEA       73 DPWA     MULTICHNL K-MTRX  9/73
R3             -.09      .03         RLIC      76 DPWA     KBAR N MULTICHNL  1/76*

R4      Y*0(1860) FROM KBAR N INTO LAMBDA OMEGA           SQRT(P1*P3)        1/76*
R4   3        (.032)                 NAKKASYA  75 DPWA   0 K-P TO LAM. OMG.  1/76*

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                                   REFERENCES FOR Y*0(1860)

ARMENTERO68 NP B8 195              ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
BUGG      68 PR 168 1466           +GILMORE, KNIGHT, +        (RHEL,BIRM,CAVE) I
GALTIERI  68 PRL 21 573            BARBARO-GALTIERI, MATISON, +      (LRL,SLAC)

BRICMAN   70 PL 31B 152            +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
BRICMAN1  70 PL 33B 511            +FERRO-LUZZI,LAGNAUX                  (CERN)
CONFORTO  71 NP  B34  41           +LEVI SETTI,LASINSKI..OBERLACK++ (EFI+HEID)IJP
KIM       71 PRL 27 356            J K KIM                            (HARV)IJP
    ALSO  70 DUKE 161              J. K. KIM                          (HARV)IJP
LANGBEIN  72 NP B47 477            +WAGNER                            (MPIM)IJP
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Data Card Listings

Baryons

For notation, see key at front of Listings. Λ(1860), Λ(1870), Λ(2010), Λ(2020), Λ(2100)

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LEA       73 NP B56 77           +MARTIN,MOORHOUSE+  (RHEL+LOUC+GLAS+AARHUS)IJP
HEMINGWA  75 NP B91 12           HEMINGWAY,EADES,HARMSEN+    (CERN,HEID,MPIM)IJP
NAKKASYA  75 NP B93 85           A. NAKKASYAN                          (CERN)IJP

RLIC      76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSON,ROSS+    (RHEL+LOIC)IJP

                                 PAPERS NOT REFERRED TO IN DATA CARDS

ARMENTER 67 NP B3 592            ARMENTEROS, F-LUZZI, + (CERN,HEIDEL,SACLAY)IJP
    REPLACED BY ARMENTEROS 68 AND CONFORTO 68.
CONFORTO 68 NP B8 265            +HARMSEN, LASINSKI, +      (CHICAGO,HEIDEL)IJP
    SUPERSEDED BY CONFORTO 71.
LEVISETT 69 LUND 339             R.LEVI SETTI  (RAPPORTEUR)               (EFI)
ALBROW    71 NP  B29 413         +ANDERSON,BOSNJAKOVIC,DAUM,ERNZ,+       (CERN)

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Λ(1870) → S₀₁‴

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36  Y*0(1870, JP=1/2-) I=0

THE S01 AMPLITUDE SHOWS A SECOND RESONANCE BEHAVIOR AT
ABOUT 1800 MEV IN 4 ANALYSES.  THE ELASTICITY OF
KIM 71 IS SURPRISINGLY LARGE.

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               36  Y*0(1870) MASS (MEV)

M        (1872.0)   (10.0)       BRICMAN   70 DPWA    TOT, ELAS, CHEX    1/71
M        (1780.)                 KIM       71 DPWA    K-MATRIX ANAL.     3/71
M         1830.0    (20.0)       LANGBEIN  72 IPWA    MULTICHANNEL      12/72
M         1825.     (20.)        RLIC      76 DPWA    KBAR N MULTICHNL   1/76*

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               36  Y*0(1870) WIDTH (MEV)

W         (100.0)   (20.0)       BRICMAN   70 DPWA    TOT, ELAS, CHEX    1/71
W          (40.)                 KIM       71 DPWA    K-MATRIX ANAL.     3/71
W           70.0    (15.0)       LANGBEIN  72 IPWA    MULTICHANNEL      12/72
W          230.     (20.)        RLIC      76 DPWA    KBAR N MULTICHNL   1/76*

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               36  Y*0(1870) PARTIAL DECAY MODES

                                                         DECAY MASSES
P1      Y*0(1870) INTO KBAR N                           497+ 939
P2      Y*0(1870) INTO SIGMA PI                        1197+ 139

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               36  Y*0(1870) BRANCHING RATIOS

R1      Y*0(1870) INTO (KBAR N)/TOTAL                  (P1)
R1           (0.18)    (0.02)    BRICMAN   70 DPWA    TOT, ELAS, CHEX    1/71
R1           (0.80)              KIM       71 DPWA    K-MATRIX ANAL.     3/71
R1            0.35     (0.15)    LANGBEIN  72 IPWA    MULTICHANNEL      12/72
R1             .37     (.05)     RLIC      76 DPWA    KBAR N MULTICHNL   1/76*

R2      Y*0(1870) FROM KBAR N TO SIGMA PI              SQRT(P1*P2)
R2           (0.24)              KIM       71 DPWA    K-MATRIX ANAL.     3/71
R2            -.08     (.05)     RLIC      76 DPWA    KBAR N MULTICHNL   1/76*

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                                 REFERENCES FOR Y*0(1870)
BRICMAN  70 PL 33B 511           C BRICMAN, M FERRO-LUZZI, J P LAGNAUX(CERN)IJP
KIM       71 PRL 27 356          J K KIM                               (HARV)IJP
   ALSO  70 DUKE 161             J. K. KIM                             (HARV)IJP
LANGBEIN 72 NP B47 477           +WAGNER                               (MPIM)IJP

RLIC      76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSON,ROSS+    (RHEL+LOIC)IJP

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Λ(2010) →

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89  Y*0(2010,          ) I=0

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

SEVERAL AMBIGUOUS RESONANCE POSSIBILITIES ARISE FROM
THE ANALYSES LISTED HERE.  POSSIBLE QUANTUM NUMBERS
ARE D3 (GALTIERI 70, SIGMA PI), D3+F5 OR P3+D5 OR
P1+D3 (BRANDSTETTER 72, LAMBDA OMEGA).  A MORE RECENT
LAMBDA OMEGA ANALYSIS (NAKKASYAN 75) FINDS TWO BEST SOLUTIONS, EACH
WITH THE Y*0(2100) AND ONE ADDITIONAL RESONANCE WHICH CAN BE EITHER
THE Y*0(1860,JP=3/2+) OR THE Y*0(2110,JP=5/2+).

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               89  Y*0(2010)  MASS (MEV)

M        (2010.0)    (30.0)      GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70
M    1     1935. TO 1971.        BRANDSTE  72 DPWA  0 K-P TO LAM. OMG.  1/74
M    1     1951. TO 2034.        BRANDSTE  72 DPWA  0 K-P TO LAM. OMG.  1/74
M    1  PARAMETERS QUOTED ARE RANGES FROM THREE BEST FITS, THE LOWER      11/75*
M    1  (HIGHER) MASS STATE PROBABLY HAS J.LE.3/2(5/2).                   11/75*

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               89  Y*0(2010) WIDTH (MEV)

W         (130.0)    (50.0)      GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70
W    1      180. TO  240. (LWR. MASS) BRANDSTE 72 DPWA 0 K-P TO LAM. OMG. 1/74
W    1       73. TO  154. (HGR. MASS) BRANDSTE 72 DPWA 0 K-P TO LAM. OMG. 1/74
        SEE THE NOTES ACCOMPANYING MASSES QUOTED

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               89  Y*0(2010) PARTIAL DECAY MODES

                                                         DECAY MASSES
P1      Y*0(2010) INTO KBAR N                           497+ 939
P2      Y*0(2010) INTO SIGMA PI                        1197+ 139
P3      Y*0(2010) INTO LAMBDA OMEGA                    1115+ 783

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               89  Y*0(2010) BRANCHING RATIOS

R1      Y*0(2010) FROM KBAR N TO SIGMA PI                SQRT(P1*P2)
R1           (-0.20)    (0.04)       GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70

R2      Y*0(2010) FROM KBAR N INTO LAMBDA OMEGA          SQRT(P1*P3)
R2    1        (.17) TO   .25 (LWR.)   BRANDSTE  72 DPWA  0 K-P TO LAM. OMG.  1/74
R2    1        (.04) TO   .15 (HGR.)   BRANDSTE  72 DPWA  0 K-P TO LAM. OMG.  1/74

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                                 REFERENCES FOR Y*0(2010)

GALTIERI 70 DUKE CONF 173        A BARBARO-GALTIERI                     (LRL)IJP
BRANDSTE 72 NP B39 13            BRANDSTETTER,BUTTERWORTH,+ (RHEL+CDEF+SACL)

                                 PAPERS NOT REFERRED TO IN DATA CARDS.

NAKKASYA 75 NP B93 85            A. NAKKASYAN                          (CERN)IJP

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Λ(2020) → F₀₇

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27  Y*0(2020, JP=7/2+) I=0

EFFECTS IN THIS PARTIAL WAVE HAVE OBSERVED AT SOMEWHAT
DIFFERENT ENERGIES IN TWO CHANNELS. HOWEVER, LITCHFIELD
71 NOTE THAT THE NEED FOR THIS STATE IN THEIR ANALYSIS
RESTS SOLELY ON A POSSIBLY INCONSISTENT POLARIZATION
MEASUREMENT AT 1.784 GEV/C.  THE STATE WAS NOT REQUIRED
IN THE KBAR N TO KBAR N ANALYSIS OF HEMINGWAY 75, BUT
COULD NOT BE CONCLUSIVELY RULED OUT.

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               27  Y*0(2020) MASS (MEV)

M        (2020.0)    (20.0)      GALTIERI  70 DPWA  0 K-P TO SIGMA PI    7/70
M        (2100.)     (30.)       LITCHFIE  71 DPWA    K-P TO KBAR N     10/71

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               27  Y*0(2020) WIDTH (MEV)

W         (160.0)    (30.0)      GALTIERI  70 DPWA  0 K-P TO SIGMA PI    7/70
W         (120.)     (30.)       LITCHFIE  71 DPWA    K-P TO KBAR N     10/71

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               27  Y*0(2020) PARTIAL DECAY  MODES

                                                         DECAY MASSES
P1      Y*0(2020) INTO KBAR N                           497+ 939
P2      Y*0(2020) INTO SIGMA PI                        1197+ 139

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               27  Y*0(2020) BRANCHING RATIOS

R1      Y*0(2020) INTO (KBAR N)/TOTAL                    (P1)
R1           (0.05)    (0.02)        LITCHFIE  71 DPWA    K-P TO KBAR N     10/71

R2      Y*0(2020) FROM KBAR N TO SIGMA PI                SQRT(P1*P2)
R2          (-0.15)    (0.02)        GALTIERI  70 DPWA  0 K-P TO SIGMA PI    7/70

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                                 REFERENCES FOR Y*0(2020)

GALTIERI 70 DUKE CONF 173        A BARBARO-GALTIERI                     (LRL)IJP
LITCHFIE 71 NP  B30 125          LITCHFIELD,...+LESQUOY,+.. (RHEL+CDEF+SACL)IJP

                                 PAPERS NOT REFERRED TO IN DATA CARDS.

HEMINGWA 75 NP B91 12            HEMINGWAY,EADES,HARMSEN+    (CERN,HEID,MPIM)IJP

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Λ(2100) → G₀₇

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41  Y*0(2100, JP=7/2-) I=0

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

THIS ENTRY ONLY INCLUDES RESULTS FROM PARTIAL-WAVE
ANALYSES.  PARAMETERS OF PEAKS SEEN IN CROSS-SECTIONS
AND INVARIANT-MASS DISTRIBUTIONS AROUND 2100 MEV ARE
GIVEN IN THE NEXT ENTRY.  EVENTUALLY THE PARTIAL-WAVE ANALYSES SHOULD
GIVE THE BEST RESULTS, AS THEY ISOLATE THE G07 WAVE.  THIS SUPERIORITY
IS, HOWEVER, PROBABLY NOT YET ATTAINED, AND WE RELY ON BOTH ENTRIES
FOR PARAMETERS GIVEN IN THE MAIN BARYON TABLE.

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               41  Y*0(2100) MASS (MEV)

M          (2120.0)                  WOHL      66 HBC      K-P CH EX        7/66
M    A     (2080.0)    (10.0)        BURGUN    68 DPWA  0 K-P TO XI K      10/69
M    L     (2130.0)    (20.0)        BERTHON1  70 DPWA  0 K-P TO SIGMA PI  10/70
M           2110.0     (20.0)        GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70
M           2100.      (15.)         LITCHFIE  71 DPWA    K-P TO KBAR N    10/71
M     L     2110.0     (30.0)        LITCHFIE  71 DPWA    K-P TO SIG PI    10/71
M     1     2113. TO 2154.           BRANDSTE  72 DPWA  0 K-P TO LAM. OMG.  1/74
M           2092.0     (12.0)        KANE      72 DPWA  0 K-P TO PI SIG    10/71
M           2105.      (10.)         HEMINGWA  75 DPWA  0 K- P TO KBAR N   11/75*
M     2     2110. OR 2089.           NAKKASYA  75 DPWA  0 K-P TO LAM. OMG. 11/75*
M           2110.      (10.)         RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
M     2  QUOTED PARAMETERS CORRESPOND TO THE TWO BEST SOLUTIONS FOUND.        11/75*
M     2  EACH HAS THE Y*0(2100) AND ONE ADDITIONAL RESONANCE (P3 OR F5).      11/75*
M    A     BURGUN 68 SEE A RESONANCE-LIKE EFFECT IN THIS REGION IN THE
M       REACTION K-P TO XI K.  HOWEVER, AS THEY POINT OUT, IT IS NOT CLEAR
M       WHETHER IT IS MAINLY THE G07 Y*0(2100) OR INSTEAD A SO FAR OTHERWISE
M       UNOBSERVED RESONANCE WITH A SPIN LESS THAN 7/2.
M    L   LITCHFIELD 71 IS AN UPDATE OF BERTHON1 70                             3/72
M     1  PARAMETERS QUOTED ARE RANGES FROM THREE BEST FITS.                    1/74

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Baryons
Λ(2100), Λ(2110)

Data Card Listings
For notation, see key at front of Listings.

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                      41  Y*C(2100) WIDTH (MEV)

W           (145.0)                      WOHL     66 HBC                        7/66
W    A       (80.0)    (10.0)            BURGUN   68 DPWA  0 K-P TO XI K       10/69
W            140.0     (15.0)            BERTHON1 70 DPWA  0 K-P TO SIGMA PI   10/70
W             60.0     (25.0)            GALTIERI 70 DPWA  0 K-P TO SIGMA PI    7/70
W    B      (170.) TO 300.   .           LITCHFIE 71 DPWA    K-P TO KBAR N     10/71
W    B  LARGER VALUE CORRESPCNDS TC PURE B.W. LOWER VALUE , TO B.W. + BCKGRD
W     L      140.0     (50.0)    (30.0)  LITCHFIE 71 CPWA    K-P TO SIG PI     10/71
W     1      208. TO  229.               BRANDSTE 72 DPWA  0 K-P TO LAM. OMG.   1/74
W            144.0     (26.0)            KANE     72 DPWA  0 K-P TO PI SIG     10/71
W            241.      (30.)             HEMINGWA 75 DPWA  0 K- P TO KBAR N    11/75*
W     2      244. OR  302.               NAKKASYA 75 DPWA  0 K-P TO LAM. JMG.  11/75*
W            250.      (30.)             RLIC     76 CPWA    KBAR N MULTICHNL   1/76*
       SEE THE NOTES ACCOMPANYING MASSES CUOTED

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                      41  Y*0(2100) PARTIAL DECAY MODES

                                                                DECAY MASSES
P1      Y*0(2100) INTO KBAR N                                  497+ 939
P2      Y*0(2100) INTO SIGMA PI                               1197+ 139
P3      Y*0(2100) INTO XI K                                   1321+ 497
P4      Y*0(2100) INTO LAMBDA OMEGA                           1115+ 783
P5      Y*0(2100) INTO ETA LAMBDA                              548+1115

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                      41  Y*0(2100) BRANCHING RATIOS

R1      Y*0(2100) INTO (KBAR N)/TCTAL                      (P1)
R1          (0.25)                       WOHL     66 HBC                        7/66
R1   D      (0.33)                       DAUM     68 CNTR    K-P ELA,POL,SIGT   7/70
R1           0.30      (.03)             LITCHFIE 71 DPWA    K-P TO KBAR N    .10/71
R1            .31      (.03)             HEMINGWA 75 DPWA  0 K- P TO KBAR N    11/75*
R1            .30      (.03)             RLIC     76 DPWA    KBAR N MULTICHNL   1/76*
R1   D   DAUM 68 ASSUMES (J+1/2)*X VALUE SEEN IN TOTAL CRCSS SECTION.

R2      Y*0(2100) FROM KBAR N INTO SIGMA PI                SQRT(P1*P2)
R2   L     (+0.16)     (0.02)            BERTHON1 70 DPWA  0 K-P TO SIGMA PI   10/70
R2          +0.06      (0.03)            GALTIERI 70 DPWA  0 K-P TO SIGMA PI    7/70
R2    L      0.16      (0.05)            LITCHFIE 71 DPWA    K-P TO SIG PI     10/71
R2          +0.096     (0.037)           KANE     72 DPWA  0 K-P TO PI SIG     10/71
R2          +.12       (.04)             RLIC     76 DPWA    KBAR N MULTICHNL   1/76*

R3      Y*0(2100) FROM KBAR N TO XI K                      SQRT(P1*P3)
R3          (0.05)                       TRIPP    67 RVUE  0 K-P TO XI K        8/67
R3   B      (0.09)     (0.01)            BURGUN   68 DPWA  0 K-P TO XI K       10/69
R3          (0.003)                      MULLER   69 DPWA  0                    7/70
R3           0.035     0.018             LITCHFIE 71 DPWA    K-P TO XI K        3/72
R3   B   BURGUN 68 UPDATED BY LITCHFIELD 71, WHO TAKES SOLUTION C OF BURGUN     3/72

R4      Y*0(2100) FROM KBAR N INTO LAMBDA OMEGA            SQRT(P1*P4)
R4   1       (.05) TO  .11               BRANDSTE 72 DPWA  0 K-P TO LAM. OMG.   1/74
R4   2      (.122)OR  .154               NAKKASYA 75 DPWA  0 K-P TO LAM. OMG.  11/75*

R5      Y*0(2100) FROM KBAR N TO ETA LAMBDA                SQRT(P1*P5)          9/73
R5           -.050     .020              RADER    73 MPWA                       9/73
       SEE THE NOTES ACCOMPANYING MASSES QUOTED

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                      REFERENCES FOR Y*0(2100)

WOHL     66 PRL 17 107          C G WOHL, F T SOLMITZ, M L STEVENSON  (LRL)IJP
TRIPP    67 NP B3 10            + LEITH, +    (LRL,SLAC,CERN,HEIDEL,SACLAY)
BURGUN   68 NP B8 447           +MEYER,PAULI, +      (SACLAY,COLFRANCE,RHEL)
DAUM     68 NP B7 19            +ERNE, LAGNAUX, SENS, STEUER, UDO    (CERN)JP
    CCNFIRMS THE SPIN-PARITY ASSIGNMENT.
MULLER   69 THESIS,UCRL 19372 R A MULLER                               (LRL)

BERTHON1 70 NP B24 417          +VRANA, BUTTERWCRTH, + (CCEF, RHEL, SACLAY)IJP
GALTIERI 70 DUKE CONF 173       A BARBARO-GALTIERI                     (LFL)IJP
LITCHFIE 71 NP  B30 125         LITCHFIELD,...+LESCUOY,+.. (RHEL+CDEF+SACL)IJP

BRANDSTE 72 NP B39 13           BRANCSTETTER+...+TALLINI   (RHEL,CDEF,SACL) IJP
KANE     72 PR D5 1583          D F KANE                               (LBL)IJP
RADER    73 NC 16A 178          +BARLOUTAUD,+     (SACL+HEID+CERN+RHEL+CDEF)

HEMINGWA 75 NP B91 12           HEMINGWAY,EADES,HARMSEN+   (CEPN,HEID,MPIM)IJP
NAKKASYA 75 NP B93 85           A. NAKKASYAN                          (CERN)IJP

RLIC     76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSCN,ROSS+    (RHEL+LOIC)IJP

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Λ(2110)

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                      35  Y*0(2110, JP=5/2+) I=0
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F_{05}

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                           BERTHON1 70 FIND EITHER F05 OR D05 POSSIBLE IN
                      THE SIC PI CHANNEL, WITH F05 SLIGHTLY PREFERRED.
                      IN THE KBAR N CHANNEL, LITCHFIELD 71 (SAME GROUP)
                      FIND ONLY D05. AS USUAL, THE STATISTICS ARE MUCH
                      BETTER IN THE ELASTIC CHANNEL.
                 ALTHOUGH KANE 72 FINDS AN F05 EFFECT, THE UNUSUALLY BROAD
       WIDTH MAY INVALIDATE A RESONANT INTERPRETATION.  HOWEVER RLIC 76 AND
       BELLEFCN 76 ALSO FIND AN F05.  THE WEIGHT OF THE EVIDENCE IS THUS IN
       FAVOR OF F05.  SEE ALSO THE Y*0(2010) MINI-REVIEW.

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                      35  Y*0(2110) MASS (MEV)

M          (2110.)     (10.)             BERTHON1 70 DPWA -  K- P TO SIG PI     1/71
M       D05 2140.       40.              LITCHFIE 71 DPWA    K-P TO KBAR N     10/71
M    A     (2141.0)    (6.0)             KANE     72 DPWA  0 K-P TO PI SIG     10/71
M    1     (2103.)                       NAKKASYA 75 DPWA  0 K-P TO LAM. OMG.   1/76*
M          (2140.)     (20.)             BELLEFON 76 DPWA  0 K- P TO SIG PI     1/76*
M          (2100.)     (50.)             RLIC     76 DPWA    KBAR N MULTICHNL   1/76*
M    A  RESCNANCE OUTSIDE RANGE OF DATA.
M    1  FOUND IN CNE OF TWO BEST SOLUTICNS.                                     1/76*

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                      35  Y*0(2110) WIDTH (MEV)

W           (185.)     (30.)             BERTHCN1 70 DPWA -  K- P TO SIG PI     1/71
W       D05  120.       40.              LITCHFIE 71 DPWA    K-P TO KBAR N     10/71
W    A      (504.0)    (10.0)            KANE     72 DPWA  0 K-P TO PI SIG     10/71
W    1      (391.)                       NAKKASYA 75 DPWA  0 K-P TO LAM. OMG.   1/76*
W           (140.)     (20.)             BELLEFON 76 DPWA  0 K- P TO SIG PI     1/76*
W           (200.)     (50.)             RLIC     76 DPWA    KBAR N MULTICHNL   1/76*

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                      35  Y*0(2110) PARTIAL DECAY MODES

                                                                DECAY MASSES
P1      Y*0(2110) INTO KBAR N                                  497+ 939
P2      Y*0(2110) INTO SIGMA PI                               1197+ 139
P3      Y*0(2110) INTO LAMBDA OMEGA                           1115+ 783

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                      35  Y*0(2110) BRANCHING RATIOS

R1      Y*0(2110) FROM KBAR N TO SIGMA PI                  SQRT(P1*P2)
R1          (+.17)     (.03)             BERTHON1 70 DPWA -  K- P TO SIG PI     1/71
R1   A     (+0.156)    (0.013)           KANE     72 DPWA  0 K-P TO PI SIG     10/71
R1          (+.14)     (.01)             BELLEFCN 76 DPWA  0 K- P TO SIG PI     1/76*
R1          (+.10)     (.03)             RLIC     76 DPWA    KBAR N MULTICHNL   1/76*

R2      Y*0(2110) INTO (KBAR N)/TCTAL                      (P1)
R2      D05    0.14      0.04            LITCHFIE 71 DPWA    K-P TO KBAR N     10/71
R2            (.07)    (.03)             RLIC     76 DPWA    KBAR N MULTICHNL   1/76*

R3      Y*0(2110) FROM KBAR N INTC LAMBDA OMEGA            SQRT(P1*P3)          1/76*
R3   1        (.112)                     NAKKASYA 75 DPWA  0 K-P TO LAM. OMG.   1/76*

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                      REFERENCES FOR Y*0(2110)

BERTHON1 70 NP B24 417          +VRANA,BUTTERWORTH,+      (CDEF,RHEL,SACLAY)IJP
LITCHFIE 71 NP  B30 125         LITCHFIELD,...+LESQUOY,+.. (RHEL+CDEF+SACL)IJP
KANE     72 PR D5 1583          D F KANE                               (LBL)IJP

NAKKASYA 75 NP B93 85           A. NAKKASYAN                          (CERN)IJP
BELLEFON 76 SBMTD. TO NP        DE BELLEFCN,BILLCIR,BERTHCN+     (CDEF+SACL)IJP
RLIC     76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSON,ROSS+      (RHEL+LOIC)IJP

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2100 MEV REGION – PRODUCTION AND σ_{TOTAL} EXP'TS

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                      25  Y*0(2100, JP=     ) I=0       PRODUCTICN EXPERIMENTS

                      SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

                      SEE THE NOTE TO THE G07 Y*0(2100), WHICH PRECEDES THIS
                      ENTRY.  HERE WE LIST ONLY PARAMETERS OF PEAKS IN CROSS
                      SECTIONS ANC INVARIANT-MASS DISTRIBUTIONS.  THE CROSS-
     SECTION PEAKS ARE AT LEAST DCMINANTLY ASSOCIATED WITH THE Y*0(2100),
     BUT MAY CONTAIN A SMALL CONTRIBUTION FRCM THE SUGGESTED BUT NOT ESTAB-
     LISHED OTHER RESCNANCES IN THIS REGICN.

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                      25  Y*0(2100) MASS (MEV) (PROC. EXP.)

M         (2097.0)     (6.0)             BOCK     65 HBC     PBAR P 5.7 BEV/C   7/66
M          2100.0      (7.0)             BUGG     68 CNTR    K-P, D TCTAL       6/68
M          2121.0      (5.0)             BRICMAN  70 CNTR  0 TOTAL AND CH EX    6/70
M          2107.0     (10.0)             COOL     70 CNTR    K-P, D TOTAL      10/70
M         (2135.0)    (20.0)             LU       70 CNTR  0 GAMMA P TO K+ Y*   1/71

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                      25  Y*0(2100) WIDTH (MEV) (PROD. EXP.)

W           (24.0)    (14.0)    (24.0)   BOCK     65 HBC     INTO KBAR N (PI)   7/66
W           140.0     (15.0)             BUGG     68 CNTR                       6/68
W           147.0     (15.0)             BRICMAN  70 CNTR  0 TOTAL AND CH EX    6/70
W           185.0                        COOL     70 CNTR    K-P, D TOTAL      10/70
W           (40.0)                       LU       70 CNTR  0 GAMMA P TO K+ Y*   1/71

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                      25  Y*0(2100) PARTIAL DECAY MODES (PROD. EXP.)

                                                                DECAY MASSES
P1      Y*0(2100) INTO KBAR N                                  497+ 939
P2      Y*C(2100) INTO KBAR N PI                               497+ 939+ 139
P3      Y*0(2100) INTO LAMBDA ETA                             1115+ 548
P4      Y*0(2100) INTO LAMBCA OMEGA                           1115+ 783

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                      25  Y*0(2100) BRANCHING RATIOS (PROD. EXP.)

R1      Y*0(2100) INTO (KBAR N)/TCTAL                      (P1)
R1        THESE VALUES OF ELASTICITIES ASSUME J=7/2 --
R1           0.305                       BUGG     68 CNTR                       6/68
R1           0.24      (0.02)            BRICMAN  70 CNTR  0 TOTAL AND CH EX    6/70
R1           0.4                         COOL     70 CNTR    K-P, D TOTAL      10/70

R2      Y*0(2100) INTO KBAR N PI                           (P2)
R2                SEEN                   BOCK     65 HBC

R3      Y*0(2100) FROM KBAR N INTO LAMBDA ETA              SQRT(P1*P3)
R3            (0.09) OR LESS             FLATTE 2 67 HBC   0 K-P TO LAM ETA     6/68

R4      Y*0(2100) INTO (LAMBCA OMEGA)/TOTAL                (P4)
R4            (0.1)  OR LESS             FLATTE 1 67 HBC   0 K-P TO LAM OMEGA   8/67

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                      REFERENCES FOR Y*0(2100) (PROD. EXP.)

BOCK     65 PL 17 166           +COOPER,FRENCH,KINSON, +        (CERN,SACLAY)
FLATTE 1 67 PR 155 1517         S M FLATTE                             (LRL)
FLATTE 2 67 PR 163 1441         S M FLATTE, C G WOHL                   (LRL)
BUGG     68 PR 168 1466         +GILMORE,KNIGHT, +           (RHEL,BIRM,CAVE) I

BRICMAN  70 PL 31B 152          +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
COOL     70 PR D1 1887          +GIACOMELLI, KYCIA, LEONTIC, LI, +    (BNL) I
LU       70 PR D2 1846          +GREENBERG, HUGHES, MINEHART, MORI,+ (YALE)

                                PAPERS NOT REFERRED TO IN DATA CARDS

COOL     66 PRL 16 1228         +GIACOMELLI,KYCIA,LEONTIC,LI,LUNDBY,+ (BNL) I
     SUPERSEDED BY COOL 70.

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Data Card Listings

For notation, see key at front of Listings.

Baryons

Λ(2350), Λ(2585), Σ⁺, Σ⁻, Σ⁰, Σ(1385)

Λ(2350) BUMPS

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42  Y*0(2350, JP=    ) I=0       PRODUCTICN EXPERIMENTS

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

DAUM 68 FAVORS JP=7/2- OR 9/2+. BRICMAN 70 FAVORS 9/2+.
LASINSKI 71 SUGGESTS THREE STATES IN THIS REGICN
USING A POMERON + RESCNANCES MODEL.  THERE IS NOW ALSO
ONE FORMATION EXPERIMENT WHICH WE INCLUDE HERE, DE BELLEFCN 76, WHICH
FINDS 9/2+ FROM A DPWA OF KBAR N TO SIGMA PI.

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            42  Y*0(2350) MASS (MEV) (PRCD. EXP.)

M        2340.0    (7.0)          BUGG      68 CNTR    K-P, D TOTAL      6/68
M        2358.0    (6.0)          BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
M        2344.0   (15.0)          COOL      70 CNTR    K-P, D TOTAL     10/70
M       (2360.0)  (20.0)          LU        70 CNTR  0 GAMMA P TO K+ Y*  1/71
M        2360.     10.            BELLEFCN  76 DPWA  0 K- P TO SIG PI    1/76*

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            42  Y*0(2350) WIDTH (MEV) (PROD. EXP.)

W         140.0   (20.0)          BUGG      68 CNTR    K-P, D TOTAL      6/68
W         324.0   (30.0)          BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
W        (190.0)                  COOL      70 CNTR    K-P, D TOTAL     10/70
W         (55.0)                  LU        70 CNTR  0 GAMMA P TO K+ Y*  1/71
W         120.     15.            BELLEFON  76 DPWA  0 K- P TO SIG PI    1/76*

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            42  Y*0(2350) PARTIAL DECAY MCDES (PROD. EXP.)

                                                    DECAY MASSES
P1     Y*0(2350) INTO KBAR N                      497+ 939
P2     Y*0(2350) INTO SIGMA PI                   1197+ 139

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            42  Y*0(2350) BRANCHING RATIOS (PROD. EXP.)

R1     Y*0(2350) INTO (KBAR N)/TOTAL                 (P1)
R1        J IS NOT DETERMINEC.  THE FCLLOWING IS (J+1/2)*P1.
R1         (0.57)                 BUGG      68 CNTR    K-P, D TOTAL      6/68
R1          1.1      0.25         BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
R1         (1.0)                  COOL      70 CNTR    K-P, D TOTAL     10/70

R2     Y*0(2350) FROM KBAR N INTO SIGMA PI          SQRT(P1*P2)          1/76*
R2          -.10      .02         BELLEFON  76 DPWA  0 K- P TO SIG PI    1/76*

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                    REFERENCES FOR Y*0(2350) (PROD. EXP.)

BUGG      68 PR 168 1466      +GILMORE,KNIGHT, +           (RHEL,BIRM,CAVE) I
DAUM      68 NP B7 19         +ERNE, LAGNAUX, SENS, STEUER, UDO     (CERN)JP
BRICMAN   70 PL 31B 152       +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
COOL      70 PR D1 1887       +GIACOMELLI, KYCIA, LEONTIC, LI, +     (BNL) I
LU        70 PR D2 1846       +GREENBERG, HUGHES, MINEHART, MORI,+ (YALE)

BELLEFCN 76 SBMTD. TO NP      DE BELLEFON,BILLOIR,BERTHON+    (CDEF+SACL)IJP

                    PAPERS NOT REFERRED IN DATA CARDS
COOL      66 PRL 16 1228      +GIACOMELLI,KYCIA,LECNTIC,LI,LUNDBY,+ (BNL) I
    SUPERSEDED BY COOL 70.
LASINSKI 71 NP  B29  125      T A LASINSKI                          (EFI)IJP
BELLEF02 75 NC 28A 289        DE BELLEFON,BERTHON,BILLOIR+    (CDEF+SACL)
    PRESENTLY LISTED UNDER Y*1(2250), BUT ISOSPIN UNDETERMINED.
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Λ(2585) BUMPS

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7  Y*0(25E5, JP=    ) I=0       PRODUCTICN EXPERIMENTS

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

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            7  Y*0(25E5) MASS (MEV) (PRCD. EXP.)

M        2585.0    45.0           ABRAMS    70 CNTR    K-P, D TOTAL     10/70
M       (2530.0)  (25.0)          LU        70 CNTR  0 GAMMA P TO K+ Y*  1/71

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            7  Y*0(25E5) WIDTH (MEV) (PROD. EXP.)

W        (300.0)                  ABRAMS    70 CNTR    K-P, D TCTAL     10/70
W        (150.0)                  LU        70 CNTR  0 GAMMA P TC K+ Y*  1/71

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            7  Y*0(2585) PARTIAL CECAY MCDES (PROD. EXP.)

                                                    DECAY MASSES
P1     Y*0(25E5) INTO KBAR N                      497+ 939

------ --------- --------- --------- --------- --------- --------- --------

            7  Y*0(25E5) BRANCHING RATIOS (PROD. EXP.)

R1     Y*0(2585) INTO (KBAR N)/TCTAL                 (P1)
R1        J IS NOT KNCWN.  THE FCLLCWING IS (J+1/2)*P1.
R1         (1.0)                  ABRAMS    70 CNTR    K-P, D TOTAL     10/70
R1  C      (0.12)    (0.12)       BRICMAN   70 CNTR    TOTAL AND CH EX  10/70
R1  C   RESONANCE AT END OF REGION ANALYZED -- NO CLEAR SIGNAL.

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                    REFERENCES FOR Y*0(2585) (PROD. EXP.)

ABRAMS    70 PR 1D 1917       +COCL, GIACCMELLI, KYCIA, LEONTIC, +  (BNL) I
BRICMAN   70 PL 31B 152       +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
LU        70 PR D2 1846       +GREENBERG, HUGHES, MINEHART, MORI,+ (YALE)

                    PAPERS NOT REFERRED TO IN DATA CARDS

COOL      66 PRL 16 1228      +GIACOMELLI,KYCIA,LECNTIC,LUNDBY +    (BNL)I
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****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
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S=-1 I=1 HYPERON STATES (Σ)

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****** ********* ********* ********* ********* ********* ********* ********
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Σ⁺

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19  SIGMA+(1189, JP=1/2+) I=1

SEE STABLE PARTICLE DATA CARD LISTINGS

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****** ********* ********* ********* ********* ********* ********* ********
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Σ⁻

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20  SIGMA-(1198, JP=1/2+) I=1

SEE STABLE PARTICLE DATA CARD LISTINGS

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****** ********* ********* ********* ********* ********* ********* ********
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Σ⁰

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21  SIGMA0(1193, JP=1/2+) I=1

SEE STABLE PARTICLE CATA CARD LISTINGS

****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
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Σ(1385) P'_{13}

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43  Y*1(1385, JP=3/2+) I=1

FOR DISCUSSION OF INCCNSISTENCY OF ERRORS AND OUR
MODIFICATIONS, SEE NOTE CN K*(892)

FOR THE TABLES WE USE CNLY THE UNSTARREC DATA, WHICH
ATTEMPTS TO OBTAIN THE SEPARATE CHARGE-STATE MASSES AN
WICTHS.  SEE HOWEVER THE IDEOGRAMS INSERTED IN LISTING
THESE INDICATE SERICUS SYSTEMATICS, PERHAPS ARISING FROM INTERFERENCE E
FECTS THAT CHANGE WITH PRODUCTION MECHANISM AND BEAM MOMENTUM.

------ --------- --------- --------- --------- --------- --------- --------

            43  Y*1(1385) MASS (MEV)

M       141(1384.0)               ALSTCN    60 HBC  +- K-P 1.15 BEV/C
M          (1385.0)               BERGE     61 HBC  +- K-P .4-.85 BEV/C
M        38(1384.0)               MARTIN    61 HBC  +0 K20 P .98 BEV/C
M          (1392.0)    (7.0)      COLLEY    62 HLBC -0 PI- PRP 2. BEV/C
M          (1389.0)    (3.0)      BALTAY    65 HBC  +- PBAR P 3.7 BEV/C  7/66
M          (1392.0)   '(10.0)     MUSGRAVE  65 HBC  +-0PBAR P 3-4 BEV/C  7/66
M           1380.       5.        AMMANN    73 CBC     K-N 4.5GEV/C      9/73
M          (1386.)                ATHERTCN  75 HBC     PBAR P 5.7 GEV/C  1/76*

MO      106(1381.0)    (4.0)      CURTIS    63 CSPK  0 PI-P 1.5 BEV/C
MO      330 1385.1      2.0       THCMAS    73 HBC     PI-P TO PIOKOLM   9/73
MO 2   3100 1380.       1.3       BORENSTE  74 HBC  +-0K-P TO(1385)+PIS 10/74*
MO 2     FROM FIT TO LAM PIO MASS SPECTRUM (IN LAM PI+ PI- PIO EVENTS) WITH
MO 2      WO FIXED AT 34 MEV.
MO          . . . . . . . . .
MO  AVG     1381.5      2.3     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.1)
MO  STUDENT1381.3       1.4     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

M+   E 154 1376.0       3.9       ELY       61 HLBC +  K-P 1.11 BEV/C
M+   E             ERROR OF 3.0 ENLARGED TO 3.9 BY US,BECAUSE LT STATIST.ERR. 10/69
M+     170 1375.0       3.9       COOPER    64 HBC  +  K-P 1.45 BEV/C
M+     859 1381.0       1.6       HUWE      64 HBC  +  K-P 1.22 BEV/C
M+     750 1382.0       1.0       ARMENTERO 65 HBC  +  K-P .9-1.2 BEV/C
M+   S 250 1382.6       2.1       SMITH     65 HBC  +  K-P 1.95 BEV/C    9/66
M+   S 250 1384.3       1.9       SMITH     65 HBC  +  K-P 1.8 BEV/C     9/66
M+   S             ERROR OF 1.4 ENLARGED TO 2.1 BY US,BECAUSE <  STATIST.ER.  10/69
M+   S             ERROR OF 1.1 ENLARGED TO 1.9 BY US,BECALSE <  STATIST.ER.  10/69
M+   B  40 1383.0       4.0       BIRMINGHA 66 HBC  +  K-P 3.5           9/67
M+   B             ERROR OF 2.0 ENLARGED TO 4.0 BY US,BECAUSE <  STATIST.ERR. 10/69
M+         1378.0       5.0       LONDON    66 HBC  +  K-P 2.24 BEV/C    7/66
M+    1260 1384.4       1.0       SIEGEL    67 HBC  +  K-P AT 2.1 GEV/C 10/69
M+         1390.0       6.0       AGUILAR   70 HBC  +  K-P 4 GEV/SIG.PI  5/70
M+         1384.8       2.0       ATHERTON  71 HBC       LAM PI+ + C.C. 10/71
M+     470 1382.0       2.0       AGUILAR   72 HBC   + K-P TO LAM+PIS   10/74*
M+    2300 1383.5        .85      HABIBI    73 HBC     K-P TO 2PI LAM    9/73
M+    3740(1382.)      (1.)       BERTHON   74 HBC   0 QUASI 2 BODY CS  10/74*
M+    6846 1381.        1.        BORENSTE  74 HBC  +-0K-P TO(1385)+PIS 10/74*
M+         1380.        2.        BARDADIN  75 HBC  +  K- P 14.3 GEV/C   1/76*
M+          . . . . . . . . .
M+  AVG     1382.53     0.50    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
M+  STUDENT1382.51      0.50    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                       (SEE IDEOGRAM BELOW )
```
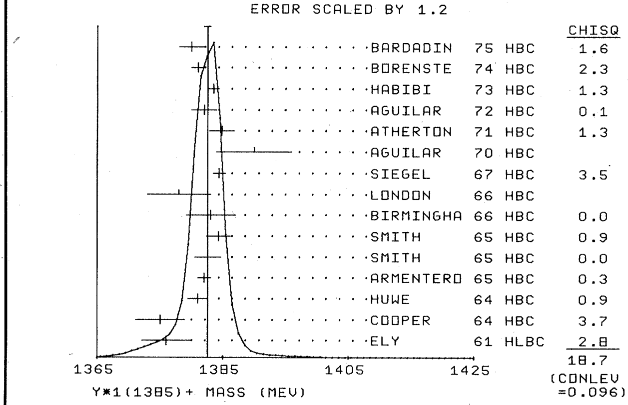

WEIGHTED AVERAGE = 1382.53 ± 0.50
ERROR SCALED BY 1.2



Baryons

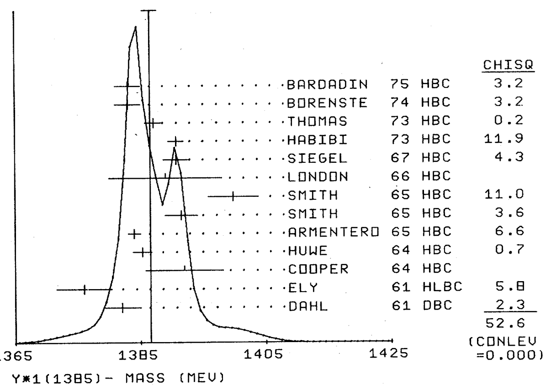
Σ(1385)

Data Card Listings

For notation, see key at front of Listings.

```
M-       93 1382.0        3.0              DAHL       61 CBC  -  K-C 0.45 BEV/C
M-    E 224 1376.0        4.4              ELY        61 HLBC -
M-    E              ERROR OF 3.0 ENLARGED TO 4.4 BY US,BECAUSE <  STATIST.ERR. 10/69
M-      200 1392.0        6.2              COOPER     64 HBC  -
M-     1086 1385.3        1.5              HUWE       64 HBC  -
M-     1380 1384.0        1.0              ARMENTERO  65 HBC  -
M-    S 120 1391.5        2.6              SMITH      65 HBC  -  K-P 1.8 BEV/C      9/66
M-    S  58 1399.8        4.0              SMITH      65 HBC  -  K-P 1.95 BEV/C     9/66
M-    S              ERROR OF 1.8 ENLARGEC TO 2.6 BY US,BECALSE <  STATIST.ER.  10/69
M-    S              ERROR OF 1.4 ENLARGED TO 4.0 BY US,BECAUSE <  STATIST.ER.  10/69
M-          1389.0        9.0              LCNDCN     66 HBC  -                  7/66
M-      370 1390.7        2.0              SIEGEL     67 HBC  -  K-P AT 2.1 GEV/C 10/69
M-     1900 1390.7        1.2              HABIBI     73 HBC     K-P TO 2PI LAM     9/73
M-      722 1387.1        1.3              THOMAS     73 HBC     PI-P TO PI-K+LM    9/73
M-     3060(1389.)       (1.)              BERTHON    74 HBC   0 QUASI 2 BODY CS  10/74*
M-     2303 1383.         2.               BORENSTE   74 HBC  +-OK-P TO(1385)+PIS 10/74*
M-          1383.         2.               BARDADIN   75 HBC  -  K- P 14.3 GEV/C   1/76*
M-          . . . . . . . . .
M-   AVG    1386.6        1.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.3)
M-   STUDENT1386.15       0.80    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                          (SEE IDEOGRAM BELOW )
```

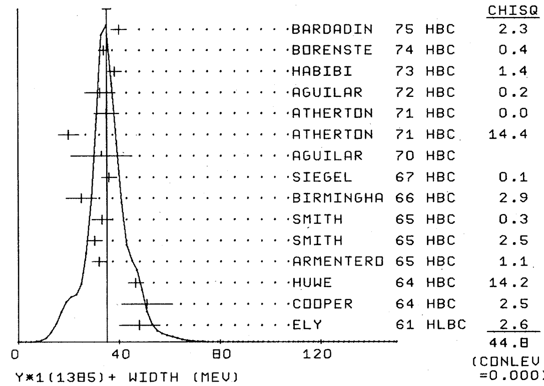
WEIGHTED AVERAGE = 1386.6 ± 1.2
ERROR SCALED BY 2.3




```
43  (Y*-) - (Y*+) MASS DIFFERENCE (MEV)

D   R       (0.0)     (4.2)          ELY        61 HLBC +- K-P 1.11 BEV/C      8/66
D   R      (17.)      (7.)           COOPER     64 HBC                        10/69
D   R       (4.3)     (2.2)          HUWE       64 HBC  +- K-P 1.22 BEV/C      8/66
D   R       (2.0)     (1.5)          ARMENTERO  65 HBC  +- K-P .9-1.2 BEV/C    8/66
D   R       (7.2)     (2.1)          SMITH      65 HBC  +- K-P 1.8 BEV/C       9/66
D   R      (17.2)     (2.0)          SMITH      65 HBC  +- K-P 1.95 BEV/C      9/66
D   R      (11.0)     (9.0)          LONDON     66 HBC  +- K-P 2.24 BEV/C      8/66
D            9.0       6.0           LCNDCN     66 HBC  +- LAMBDA 3 PI EVTS    7/66
D   R       (6.3)     (2.0)          SIEGEL     67 HBC     K-P AT 2.1 GEV/C   10/69
D   R       (7.2)     (1.4)          HABIBI     73 HBC     K-P TO 2PI LAM      9/73
D   R     REDUNDANT WITH CATA IN MASS LISTING.
```

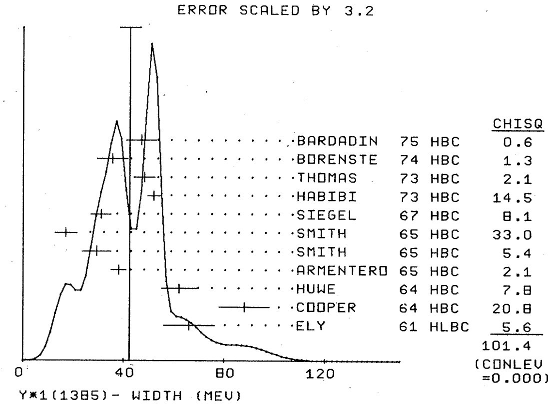
```
43  Y*1(1385) WIDTH (MEV)

W           (64.0)                   ALSTCN     60 HBC  +-
W           (40.0)                   BERGE      61 HBC  +-
W           (20.0)  OR LESS,         MARTIN     61 HBC  +0
W           (80.0)   (10.0)          COLLEY     62 HLBC -0
W           (30.0)    (9.0)          CURTIS     63 OSPK  0
W           (26.0)    (5.0)          BALTAY     65 HBC  +-                     7/66
W           (38.0)    (9.0)          MUSGRAVE   65 HBC  +-0                    7/66
W            61.      10.            AMMANN     73 DBC      K-N 4.5GEV/C       9/73
W            89.      23.            ATHERTON   75 HBC      PBAR P 5.7 GEV/C   1/76*
W           . . . . . . . . .
W   AVG      65.5     10.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
W   STUDENT  65.2     10.2     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

WO     330   39.3      6.1           THCMAS     73 HBC      PI-P TO PIOKOLM    9/73
WO    3100 CONSISTENT WITH WO=W+=W-  BORENSTE   74 HBC  +-OK-P TO(1385)+PIS 10/74*

W+           48.0      8.0           ELY        61 HLBC +
W+           51.0     10.0           COOPER     64 HBC  +
W+           46.5      3.0           HUWE       64 HBC  +
W+           32.0      3.0           ARMENTERO  65 HBC  +
W+           30.3      3.1           SMITH      65 HBC  +  K-P 1.8 BEV/C       9/66
W+           33.1      3.8           SMITH      65 HBC  +  K-P 1.95 BEV/C      9/66
W+       40  25.0      6.0           BIRMINGHA  66 HBC  +  K-P 3.5             9/67
W+     1260  36.0      3.0           SIEGEL     67 HBC     K-P AT 2.1 GEV/C   10/69
W+           33.      12.0           AGUILAR    70 HBC  +  K-P 4 GEV/SIG.PI    5/70
W+ T     40  20.       4.            ATHERTON   71 HBC     LAM PI+ + C.C.     10/71
W+ T    FIT B.W. + PHASE SPACE BCKGRD
W+ R     40  35.       5.            ATHERTON   71 HBC     LAM PI+ + C.C.     10/71
W+           32.5      6.0           AGUILAR    72 HBC   + K-P TO LAM+PIS     10/74*
W+     2300  38.3      2.6           HABIBI     73 HBC     K-P TO 2PI LAM      9/73
W+ 1   6846  34.       2.            BORENSTE   74 HBC  +-OK-P TO(1385)+PIS 10/74*
W+           40.       3.2           BARCADIN   75 HBC  +  K- P 14.3 GEV/C     1/76*
W+ 1  RESULTS FROM LAM PI+ PI- AND LAM PI+ PI- PIO COMBINED BY US.
W+ R    FIT B.W. AND NO BCKGRD
W+          . . . . . . . . .
W+  AVG      35.2      1.7     AVERAGE (ERROR INCLUDES SCALE FACTCR OF 1.9)
W+  STUDENT  35.0      1.2     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                     (SEE IDECGRAM BELOW )
```

WEIGHTED AVERAGE = 35.2 ± 1.7
ERROR SCALED BY 1.9




```
W-          (40.0)                   DAHL       61 CBC  -
W-           66.0     10.0           ELY        61 HLBC -
W-           88.0     10.0           COOPER     64 HBC  -
W-           62.0      7.0           HUWE       64 HBC  -
W-           38.0      3.0           ARMENTERO  65 HBC  -
W-           29.2      5.7           SMITH      65 HBC  -  K-P 1.80 BEV/C      9/66
W-           17.1      4.4           SMITH      65 HBC  -  K-P 1.95 BEV/C      9/66
W-      370  31.0      4.0           SIEGEL     67 HBC     K-P AT 2.1 GEV/C   10/69
W-     1900  51.9      2.5           HABIBI     73 HBC     K-P TO 2PI LAM      9/73
W-      722  48.2      4.0           THCMAS     73 HBC     PI-P TO PI-KOLM     9/73
W- 1   2303  35.5      6.            BORENSTE   74 HBC  +-OK-P TO(1385)+PIS 10/74*
W-           47.       6.            BARCADIN   75 HBC  -  K- P 14.3 GEV/C     1/76*
W-          . . . . . . . . .
W-  AVG      42.4      4.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 3.2)
W-  STUDENT  42.7      2.7     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                     (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 42.4 ± 4.2
ERROR SCALED BY 3.2




```
43  Y*1(1385) REAL PART OF POLE POSITION                                    4/75*

RE+       1379.0     1.0             LICHTENB  74       +  EXTRAP HABIBI73    4/75*
RE-       1383.0     1.0             LICHTENB  74       -  EXTRAP HABIBI73    4/75*
```

```
43  Y*1(1385) IMAGINARY PART OF POLE POSITION                               4/75*

IM+         17.5     1.5             LICHTENB  74       +  EXTRAP HABIBI73    4/75*
IM-         22.5     1.5             LICHTENB  74       -  EXTRAP HABIBI73    4/75*
```

```
43  Y*1(1385) PARTIAL CECAY MODES

                                                       DECAY MASSES
P1     Y*1(1385) INTO LAMBDA PI                       1115+ 139
P2     Y*1(1385) INTO SIGMA PI                        1197+ 139
P3     Y*1(1385) INTO LAMBCA GAMMA                    1115+   0
P4     Y*1(1385) INTO KBAR N                           493+ 938
P5     Y*1(1385) INTO SIGMA GAMMA                     1197+   0
```

Data Card Listings

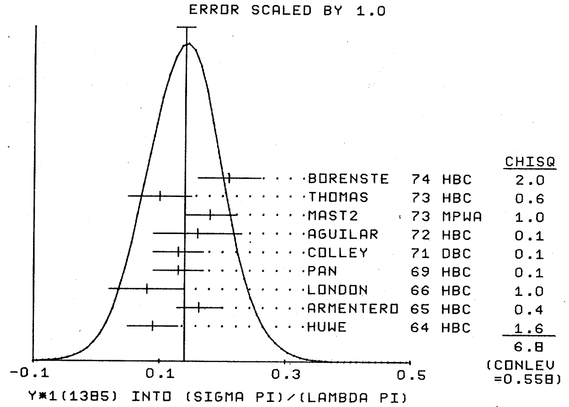
For notation, see key at front of Listings.

Baryons

Σ(1385), Σ(1440), Σ(1480), Σ(1580)

```
                    43  Y*1(1385) BRANCHING RATIOS

R1      Y*1(1385) INTO (SIGMA PI)/(LAMBDA PI)                  (P2)/(P1)
R1           (0.04)    (C.04)           BASTIEN    61 HBC  +-
R1           (0.04) OR LESS             ALSTON     62 HBC  +-0
R1            0.09      0.04            HUWE       64 HBC  +-
R1            0.163     0.035           ARMENTERO  65 HBC  +-                   7/66
R1            0.08      0.06            LONDCN     66 HBC  +                    7/66
R1            0.13      0.04            PAN        69 HBC    PI+ P - K Y PI    12/72
R1            0.13      0.04            COLLEY     71 DBC    K-N 1.5 GEV PROD  10/71
R1             .16       .07            AGUILAR    72 HBC   + K-P TO LAM+PIS   10/74*
R1             .18       .04            MAST2      73 MPWA   K-P TO 2PI SIG     9/73
R1             .10       .05            THOMAS     73 HBC    PI-P TO PI K Y     9/73
R1         .16+/-.03 OR .11+/-.02       BERTHCN    74 HBC   0 QUASI 2 BODY CS  10/74*
R1             .21       .05            BORENSTE   74 HBC  +-OK-P TO(1385)+PIS 10/74*
R1         . . . . . . . . . .
R1  AVG       0.140     0.015   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  STUDENT   0.140     0.017   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                           (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 0.140 ± 0.015
ERROR SCALED BY 1.0

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R2      Y*1(1385) INTO LAMBDA GAMMA                     (P3)
R2        1    (0.17)    (0.17)        MEISNER   72 HBC     1 EVENT ONLY       1/73

R3      Y*1(1385) FROM KBAR N TO LAMBDA PI                SQRT(P1*P4)          4/75*
R3 C           +.586      .319         DEVENISH  74        0 FIXED T DISP REL  4/75*
R3 C     EXTRAPOLATICN OF PARAMETRIZED AMPLITUDE BELOW THRESHOLD                4/75*

R4      Y*1(1385) INTO (LAMBCA GAMMA)/(LAMBDA PI)       (P3)/(P1)              1/76*
R4              LESS THAN .06          COLAS      75 HLBC  0 90 PCT CONF LVL   1/76*

R5      Y*1(1385) INTO (SIGMA GAMMA)/(LAMBCA PI)        (P5)/(P1)              1/76*
R5              LESS THAN .05          COLAS      75 HLBC  0 90 PCT CONF LVL   1/76*

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                                   REFERENCES FOR Y*1(1385)

ALSTON   60 PRL 5 520           +ALVAREZ,EBERHARD,GOCC,GRAZIANO, +     (LRL) I
BASTIEN  61 PRL 6 702           P BASTIEN,M FERRO-LUZZI,A H ROSENFELD (LRL)
BERGE    61 PRL 6 557           +BASTIEN,DAHL,FERRO-LUZZI,KIRZ, +      (LRL)
DAHL     61 PRL 6 142           +HORWITZ,MILLER,MURRAY,WHITE           (LRL)
ELY      61 PRL 7 461           +FUNG,GIDAL,PAN,POWELL,WHITE           (LRL) J
MARTIN   61 PRL 6 283           +LEIPUNER,CHINOWSKY,SHIVELY, +    (BNL,YALE)

ALSTON   62 CERN CCNF 311       +ALVAREZ,FERRO-LUZZI,ROSENFELD, +      (LRL)
COLLEY   62 PR 128 1930         +GELFAND,NAUENBERG, +     (COLUMBIA,RUTGERS) JP
CURTIS   63 PR 132 1771         +COFFIN,MEYER,TERWILLIGER             (MICH) J
COOPER   64 PL 8 365            +FILTHUTH,FRIDMAN,MALAMUD, +     (CERN,AMST)
HUWE     64 UCRL-11291 THESIS D C HUWE                                 (LRL) JP
    ALSO 69 PR 180 1824         D O HUWE                               (LRL)

ARMENTER 65 PL 19 75            ARMENTEROS, +             (CERN,HEIDEL,SACLAY)
BALTAY   65 PR 140 B1027        +SANDWEISS,TAFT,CULWICK,KOPP, +  (YALE,BNL)
MUSGRAVE 65 NC 35 735           +PETMEZAS,+     (BIRM,CERN,EPOL,LOIC,SACLAY)
SMITH    65 THESIS (UCLA)       L T SMITH                              (UCLA)

BIRMINGH 66 PR  152  1148       BIRMINGHAM,GLASGOW,I.C., CXFORDYRUTHERFORD
LONDCN   66 PR 143 1034         +RAU,SAMIOS,YAMAMOTO,GOLDBERG,+  (BNL,SYRA) J
SIEGEL   67 UCRL 18041 THESIS D M SIEGEL                               (LRL)
PAN      69 PRL 23 808          +FCRMAN                               (PENN) I
AGUILAR  70 PRL 25 58           +BARNES, BASSANC, CHUNG, EISNER,+(BNL,SYRA)
ATHERTCN 71 NP B29 477          +CELNIKIER,CLAYTCN,FRENCH,FRISK,+     (CERN)
COLLEY   71 NP  B31 61          +COX,EASTWOOD,FRY+..  (BIRM+EDIN+GLAS+LOIC)

AGUILAR  72 PR D6 29            AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS   (BNL)
MEISNER  72 NC 12A 62           G MEISNER                 (U NC GREENSBORO+LBL)
AMMANN   73 PRD 7 1345          +CARMONY,GARFINKEL,GUTAY,+       (PURD+IUPU)
MAST2    73 PRD 7 3212          +BANGERTER,ALSTCN-GARNJCST,+          (LBL)IJP
    ALSO 73 PRD 7 5             MAST,BANGERTER,ALSTON-GARNJOST,+      (LBL)IJP
HABIBI   73 NEVIS 199(THESIS) M.HABIBI                           (COLUMBIA)
    ALSO 73 PURD73, PG. 387     BALTAY,BRIDGEWATER,COOPER,+ (COLUMBIA+BING)
THOMAS   73 NP B56 15           THOMAS,ENGLER,FISK,KRAEMER            (CARN)IJ

BERTHCN  74 NC 21A 146          BERTHCN,TRISTRAM,+     (CDEF+RHEL+SACL+STRB)   U
BORENSTE 74 PR D9 3006          BORENSTEIN,KALBFLEISCH,STRAND,+  (BNL+MICH)
DEVENISH 74 NP B81 330          DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
LICHTENB 74 PRD 10 3865         D B LICHTENBERG          (INCIANA UNIVERSITY)
    ALSC 74 PRIV. COMM.         D B LICHTENBERG          (INDIANA UNIVERSITY)

ATHERTCN 75 NC 25A 1            ATHERTCN,BAR-NIR,FRENCH               (CERN)
BARDADIN 75 NP B98 418          BARDADIN-OTWINCWSKA+          (SACL+EPOL+RHEL)
COLAS    75 NP B91 253          COLAS,FARWELL,FERRER,SIX              (ORSA)

                                PAPERS NOT REFERRED TO IN CATA CARDS.

MALAMUD  64 PL 10 145           E MALAMUD, P E SCHLEIN          (CERN,UCLA) JP
SHAFER   64 PR 134 B1372        J B SHAFER, D O HUWE                   (LRL) JP
HUNGERBU 74 PRD 10 2051         HUNGERBUHLER,MAJKA,+   (YALE,FNAL,BNL,PITT)
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Σ(1440) BUMPS →

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80  Y*1(1440, JP=     ) I=1           PROCUCTION EXPERIMENTS

SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

CLINE 68 FINC A NARROW PEAK AT 1440 MEV (JUST ABOVE
THE KBAR N THRESHOLD) IN THE LAMBCA PI INVARIANT MASS
FOR K- C TO LAMBDA PI- P EVENTS.  THEY DISCUSS ALTER-
NATE INTERPRETATICNS -- THAT IT IS A RESONANCE OR A KINEMATIC EFFECT.
IN CLINE 68 THE K- BEAM MOMENTUM IS 0.4 GEV/C.  IN A STUDY OF THE SAME
REACTION WITH A MOMENTUM OF 1.1 GEV/C, ALEXANDER 69 FIND NO PEAK.  IN
ADDITION, THEY ARE ABLE TC EXPLAIN THE RESULTS CF BOTH EXPERIMENTS
WITHOUT INVOKING A NEW RESONANCE. A REANALYSIS OF THE CLINE 68
CATA MADE BY BUNNEL 70 SHOW AGREEMENT OF THE DATA WITH THE
ALEXANDER 69 INTERPERTATICN.

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                        REFERENCES FOR Y*1(1440) (PROD. EXP.)

CLINE    68 PRL 21 1372       D CLINE, R LAUMANN, J MAPP       (WISCONSIN) I
ALEXANDE 69 PRL 22 483        ALEXANDER, HALL, JEW, +       (LRL,RIVERSIDE)
BUNNELL  70 LNC 3 224         +CLINE,LAUMANN,MAPP  +        (NWES+WISC+ANL)
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Σ(1480) BUMPS →

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23  Y*1(1480, JP=     ) I=1           PROCUCTION EXPERIMENTS

SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

PEAKS ARE SEEN IN LAMBCA PI ANC SIGMA PI SPECTRA IN
THE REACTION PI+P TO K+ PI Y AT 1.7 GEV/C.  ALSO THE
Y POLARIZATION OSCILLATES IN THE SAME REGION.

   SEE MILLER 70 FOR A CISCUSSION OF THIS STATE.  HE SUGGESTS A POS-
SIBLE ALTERNATE EXPLANATION IN TERMS OF A REFLECTION OF N*1/2(1670)
DECAY TO LAMBDA K. HOWEVER, SUCH AN EXPLANATICN FOR THE K+ SIGMA+ PIO
CHANNEL SEEMS UNLIKELY (SEE PAN 70) IN TERMS OF KNOWN N*3/2(1690)
DECAY INTO SIGMA K. IN ACDITICN SUCH REFLECTIONS WOULD ALSO HAVE
TO ACCOUNT FOR THE OSCILLATICN OF THE Y PCLARIZATION IN THE 1480
MASS REGION.
 HANSON 71, WITH FEWER CATA THAN PAN 70, CAN NEITHER CONFIRM NOR
DENY THE EXISTENCE OF THIS STATE.  MAST 75 SEES NO STRUCTURE IN THIS
MASS REGICN IN K- P TC LAMBCA PIO.

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                 23  Y*1(1480) MASS (MEV) (PRCD. EXP.)

M          1479.      10.             PAN        70 HBC  +  PI+P TO K PI LAM  3/71
M          1465.      15.             PAN        70 HBC  +  PI+P TO K PI SIG  3/71
M          1485.      10.             CLINE      73 MPWA    K- D TO LM PI- P  9/73
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                 23  Y*1(1480) WIDTH (MEV) (PROD. EXP.)

W            31.      15.             PAN        70 HBC  +  PI+P TO K PI LAM  3/71
W            30.      20.             PAN        70 HBC  +  PI+P TO K PI SIG  3/71
W            40.      20.             CLINE      73 MPWA    K- D TO LM PI- P  9/73
W          . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                 23  Y*1(148C) PARTIAL DECAY MODES (FROD. EXP.)

                                                      DECAY MASSES
P1      Y*1(1480) INTO KEAR N                          497+ 939
P2      Y*1(1480) INTO LAMBCA PI                      1115+ 139
P3      Y*1(1480) INTO SIGMA PI                       1189+ 139

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                 23  Y*1(1480) BRANCHING RATIOS (PROD. EXP.)

R1      Y*1(1480) INTO (SIGMA PI)/(LAMBDA PI)          (P3)/(P2)
R1            0.82      0.51          PAN        70 HBC  +                    3/71

R2      Y*1(1480) INTO (PROTON KCBAR)/(LAMBDA PI)      (P1)/(P2)
R2            0.36      0.25          PAN        70 HBC  +                    3/71

R3      Y*1(1480) INTO KBAR N                          (P1)                   9/73
R3          SMALL                     CLINE      73 MPWA    K- D TO LM PI- P  9/73

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                        REFERENCES FOR Y*1(1480) (FROD. EXP.)

PAN      70 PR D2, 49          +FORMAN,KO,HAGOPIAN,SELOVE               (PENN)
CLINE    73 LNC 6 205          CLINE,LAUMANN,MAPP                 (WISCONSIN)IJP

                               PAPERS NOT REFERRED TO IN DATA CARDS

YU-LI PA 69 PRL 23 806         YU-LI PAN, F L FORMAN                 (PENN) I
YU-LI PA 69 PRL 23 808         YU-LI PAN, F L FORMAN                 (PENN) I
MILLER   70 DUKE 229           D H MILLER        (REVIEW TALK)     (PURDUE)
HANSON   71 PR D4 1296         ,KALMUS,LOUIE                          (LBL) I
MAST     75 PRD 11 3078        +ALSTON-GARNJOST,BANGERTER+            (LBL)
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Σ(1580) → D'_{13}

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00  Y*1(1580,JP=3/2-)  I=1                                            4/75*

OBSERVEC IN K- N I=1 TCTAL CS AT BNL(LI 73,CARROLL 73),
AND IN PWA OF K- P --> LAMBDA PI FOR CM ENERGIES=1560-
1600 MEV BY LITCHFIELD 74. LITCHFIELD 74 FINDS JP=3/2-.

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                 00  Y*1(1580) MASS (MEV)                             4/75*

M  L       1582.      4.          LITCHFIEL 74 CPWA  0 K- P TO LAM PI  4/75*

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                 00  Y*1(1580) WIDTH (MEV)                            4/75*

W  L         11.      4.          LITCHFIEL 74 CPWA  0 K- P TO LAM PI  4/75*

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Baryons
Σ(1580), Σ(1620)

Data Card Listings
For notation, see key at front of Listings.

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                    00  Y*1(1580) PARTIAL DECAY MODES                        4/75*

                                                          DECAY MASSES
P1      Y*1(1580) INTO KBAR N                            497+ 939
P2      Y*1(1580) INTO LAMBDA PI                        1115+ 139
P3      Y*1(1580) INTO SIGMA PI                         1197+ 139

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                    00  Y*1(1580) BRANCHING RATIOS                           4/75*

R1      Y*1(1580) INTO KBAR N/TOTAL                     (P1)                 4/75*
R1 L          +.03       .01          LITCHFIEL 74 DPWA    KBAR N MULTICHNL  4/75*
R1 L     MAIN EFFECT OBSERVED BY LITCHFIELD 74 IS IN PI LAMBDA FINAL STATE,  4/75*
R1 L     KBAR N AND SIGMA PI COUPLINGS ALSO ESTIMATED FROM MULTICHANNEL FIT  4/75*
R1 L     INCLUDING TOTAL CROSS SECTION DATA (LI 73).                         4/75*

R2      Y*1(1580) FROM KBAR N TO LAMBDA PI              SQRT(P1*P2)          4/75*
R2 L          +.10       .02          LITCHFIEL 74 DPWA  0 K- P TO LAM PI    4/75*

R3      Y*1(1580) FROM KBAR N TO SIGMA PI               SQRT(P1*P3)          4/75*
R3 L          +.03       .04          LITCHFIEL 74 DPWA    KBAR N MULTICHNL  4/75*

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                               REFERENCES FOR Y*1(1580)

LITCHFIE 74 PL 51B 509         LITCHFIELD                            (CERN)IJP

                               PAPERS NOT REFERRED TO IN DATA CARDS.

CARROLL  73 APS BRKLY MTG 208 CARROLL,CHIANG,KYCIA,LI,MAZUR,MICHAEL+(BNL)I
LI       73 PURDUE CONF. 283  LI                                    (BNL)I

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<u>Note on Σ(1620)</u>

This state was first suggested by the BNL-CCNY collaboration (CRENNELL 68) who presented evidence for it in the reaction $K^- n \to \Sigma(1620)^{\pm}\pi^{\mp}\pi^-$ with $\Sigma(1620)^{\pm}$ decaying into $\Lambda\pi^{\pm}$. Since then there have been conflicting reports about this state.

<u>Total Cross-Section Experiment</u>

A measurement of the K^-p and K^-d total cross sections in the 0.4 to 1.1 GeV/c range has been reported by the BNL group (CARROLL 73, LI 73). A clear bump about 40 MeV wide and 3-4 mb high [corresponding to $(J+1/2)x \sim 0.1$] is seen at a c.m. energy of 1590 MeV in the $I=1$ K^-N cross section.

<u>Formation Experiments</u>

There is evidence from several partial-wave analyses for one or two fairly narrow states within ~ 50 MeV of the effect seen in production; see the entries for $\Sigma(1580,3/2^-)$, $\Sigma(1620,1/2^-)$, and $\Sigma(1660,1/2^+)$. Note however that the various analyses do not agree on the widths and branching ratios of these states.

<u>Production Experiments</u>

A good review of the production experiments has been given by MILLER 70. Here the evidence is only in the $\Lambda\pi$ channel. The BNL-CCNY collaboration, with increased data, CRENNELL 69, still claim the effect in the $\Lambda\pi$ channel (no evidence seen in $\bar{K}N$ or $\bar{K}N\pi$). SABRE 70 studied the same reaction at 3.0 GeV/c with comparable statistics and do not see any evidence for it in the $\Lambda\pi$ channel; on the contrary, they believe it to be a spurious peak resulting from misidentified Σ^0 from the production of $\Sigma(1670)$ decaying into $\Sigma^0\pi^+$. CRENNELL 69 give counter arguments to show that this is not the case in their data and the controversy goes on. AMMANN 70 studied the same reaction at 4.5 GeV/c and report a state at 1640 MeV, again decaying only into $\Lambda\pi$ (no evidence seen in $\Sigma\pi$ or $\bar{K}N$ channels). Upper limits on production cross sections for a 25 GeV/c Σ^- beam are reported by HUNGERBUHLER 74.

In conclusion, for understanding of the Σ(1620) we probably have to wait for more data and for a more complete understanding of the entire mass region from 1600 to 1700 MeV. The closeness of the Σ(1620) mass to 1670 MeV is suggestive that this effect may be related to what goes on in that region (see discussion below).

Σ(1620) → **S'_{11}**

```
        32  Y*1(1620, JP=1/2-) I=1
        THE S11 STATE AT 1697 MEV REPORTED BY VANHORN 75 IS
        INTERMEDIATE IN MASS BETWEEN THE SIGMA(1620) AND
        SIGMA(1750).  WE TENTATIVELY LIST IT UNDER SIGMA(1750).

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                    32  Y*1(1620) MASS (MEV)

M           (1620.)                   KIM        71 DPWA   K-MATRIX ANAL.    3/71
M            1630.0     (10.0)        LANGBEIN   72 IPWA   MULTICHANNEL     12/72

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                    32  Y*1(1620) WIDTH (MEV)

W             (40.)                   KIM        71 DPWA   K-MATRIX ANAL.    3/71
W              65.0     (20.0)        LANGBEIN   72 IPWA   MULTICHANNEL     12/72

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                    32  Y*1(1620) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      Y*1(1620) INTO KBAR N                            497+ 939
P2      Y*1(1620) INTO SIGMA PI                         1197+ 139
P3      Y*1(1620) INTO LAMBDA PI                        1115+ 134

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                    32  Y*1(1620) BRANCHING RATIOS

R1      Y*1(1620) INTO KBAR N                           (P1)
R1           (0.05)                   KIM        71 DPWA   K-MATRIX ANAL.    3/71
R1 A          0.05  OR LESS           WONG       71 DPWA   K-+P--LAM+PI     10/71
R1            0.22     (0.02)         LANGBEIN   72 IPWA   MULTICHANNEL     12/72
R1 A    K-MATRIX FIT(NEGLECTS 3-BODY CHANNELS) REQUIRES NO RESONANCE        10/71

R2      Y*1(1620) FROM KBAR N TO SIGMA PI               SQRT(P1*P2)
R2           (0.08)                   KIM        71 DPWA   K-MATRIX ANAL.    3/71
R2            0.40     (0.06)         LANGBEIN   72 IPWA   MULTICHANNEL     12/72

R3      Y*1(1620) FROM KBAR N TO LAMBDA PI              SQRT(P1*P3)
R3           (0.15)                   KIM        71 DPWA   K-MATRIX ANAL.    3/71
R3          NOT SEEN                  BAILLON    75 IPWA   KBAR N TO LAM PI 11/75*

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                               REFERENCES FOR Y*1(1620)

KIM      71 PRL 27 356         J K KIM                               (HARV)IJP
   ALSO  70 DUKE 161           J. K. KIM                             (HARV)IJP
WONG     71 NC 2A 353          N S WONG                              (YALE)IJP
LANGBEIN 72 NP B47 477         +WAGNER                               (MPIM)IJP
BAILLON  75 NP B94 39          P. BAILLON,P. J. LITCHFIELD      (CERN,RHEL)IJP

                               PAPERS NOT REFERRED TO IN DATA CARDS

VANHORN  75 NP B87 145         A. J. VAN HORN                         (LBL)IJP
   ALSO  75 NP B87 157         A. J. VAN HORN                         (LBL)IJP

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Data Card Listings

For notation, see key at front of Listings.

Baryons

Σ(1620), Σ(1660), Σ(1670)

1620 MEV REGION – PRODUCTION EXPERIMENTS

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                 78  Y*1(1620, JP=    ) I=1      PRODUCTION EXPERIMENTS

                 SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

                 THIS RESONANCE NEEDS CONFIRMATION. THE RESULTS OF
                 CRENNELL 69 AT 3.9 GEV/C ARE NOT CONFIRMED BY THE SABRE
     COLLABORATION AT 3.0 GEV/C (SABRE 70).  HOWEVER IN AN EXPERIMENT AT
     4.5 GEV/C, AMMANN 70 SEE A PEAK AT 1642 MEV WHICH ON THE BASIS OF
     BRANCHING RATIOS THEY DO NOT ASSOCIATE WITH THE Y*1(1670). SEE MILLER
     70 FOR A REVIEW OF THESE CONFLICTS.

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                 78  Y*1(1620) MASS (MEV) (PROD. EXP.)

M  N      (1616.0)    (8.0)          CRENNELL  68 DBC  +- K-D 3.9 BEV/C     11/68
M  N    EVENTS OF CRENNELL 68 ARE IN THE LARGER SAMPLE OF CRENNELL 69.
M      20 1618.0      3.0            BLUMENFEL 69 HBC  +  K0 LONG + PROTON   9/69
M         1619.0      8.0            CRENNELL  69 DBC  +- K-N TO LAM 3 PI    9/69
M         1642.0     12.0            AMMANN    70 DBC     K-N 4.5 GEV/C      9/73
M         . . . . . . . . . .
M  AVG    1619.4      3.8       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
M  STUDENT1619.1      3.0       AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                 78  Y*1(1620) WIDTH (MEV) (PROD. EXP.)

W  N         (66.0)    (16.0)        CRENNELL  68 DBC  +- SEE NOTE N ABOVE 11/68
W      20     30.0      10.0         BLUMENFEL 69 HBC  +                    9/69
W             72.0      22.0    15.0 CRENNELL  69 DBC  +-                   9/69
W             55.0      24.0         AMMANN    70 DBC     K-N 4.5 GEV/C     9/73
W         . . . . . . . . . .
W  AVG        41.3      12.2    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
W  STUDENT    40.7      10.4    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
               SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

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                 78  Y*1(1620) PARTIAL DECAY MODES (PROD. EXP.)

                                                          DECAY MASSES
P1     Y*1(1620) INTO KBAR N                            497+ 939
P2     Y*1(1620) INTO LAMBDA PI                         1115+ 139
P3     Y*1(1620) INTO Y*1(1385) PI                      1384+ 139
P4     Y*1(1620) INTO LAMBDA PI PI                      1115+ 139+ 139
P5     Y*1(1620) INTO SIGMA PI                          1197+ 139
P6     Y*1(1620) INTO Y*0(1405) PI                      1405+ 139

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                 78  Y*1(1620) BRANCHING RATIOS (PROD. EXP.)

R1     Y*1(1620) INTO (LAMBDA PI PI)/(LAMBDA PI)        (P4)/(P3)
R1      14   (2.5)  APPROX           BLUMENFEL 69 HBC  +

R2     Y*1(1620) INTO (KBAR N)/(LAMBDA PI)              (P1)/(P2)
R2          (0.0)     (0.1)          CRENNELL  68 DBC  +
R2           0.4       0.4           AMMANN    70 DBC     K-P 4.5 GEV/C     6/70

R3     Y*1(1620) INTO LAMBDA PI                         (P2)
R3           LARGE                   CRENNELL  68 DBC  +-                  11/68

R4     Y*1(1620) INTO (Y*1(1385) PI)/(LAMBDA PI)        (P3)/(P2)
R4          (0.2)     (0.1)          CRENNELL  68 DBC  +-                  11/68
R4          (0.3)  OR LESS  CL=.95   AMMANN    70 DBC     K-P 4.5 GEV/C     6/70

R5     Y*1(1620) INTO (SIGMA PI)/(LAMBDA PI)            (P5)/(P2)
R5          (1.1)(95 PC UPPER LIMIT) AMMANN    70 DBC     K-N 4.5 GEV/C     9/73

R6     Y*1(1620) INTO (Y*0(1405) PI)/(LAMBDA PI)        (P6)/(P2)
R6           0.7       0.4           AMMANN    70 DBC     K-P 4.5 GEV/C     6/70

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                         REFERENCES FOR Y*1(1620) (PROD. EXP.)

CRENNELL 68 PRL 21 648         +DELANEY, FLAMINIO, KARSHON, +    (BNL,CUNY) I
BLUMENFE 69 PL 29B 58          BLUMENFELD, KALBFLEISCH                (BNL) I
CRENNELL 69 LUND PAPER 183     +KARSHON, LAI, ONEIL, SCARR, +    (BNL,CUNY) I
   RESULTS ARE QUOTED IN LEVI SETTI 69.

AMMANN   70 PRL 24 327         + GARFINKEL, CARMONY, GUTAY,+  (PURDUE,IND)
   ALSO 73 PRD 7 1345          AMMANN,CARMONY,GARFINKEL,        (PURD+IUPU)

                               PAPERS NOT REFERRED TO IN DATA CARDS

ARMENTER 68 NP B8 183          ARMENTEROS,BAILLON +         (CERN+HEID+SACL)
LEVISETT 69 LUND CONF          R LEVI SETTI    (RAPPORTEUR)            EFINS
TRIPP    69 UCRL 19361         R D TRIPP                                (LRL)
ARMENTER 70 DUKE 123           ARMENTEROS,BAILLON +         (CERN+HEID+SACL)
MILLER   70 DUKE 229           D H MILLER    (REVIEW TALK)           (PURDUE)
SABRE    70 NP B16 201         SABRE COLLAB.      (SACL,AMST,BGNA,REHO,EPOL)
HUNGERBU 74 PRD 10 2051        HUNGERBUHLER,MAJKA,+     (YALE,FNAL,BNL,PITT)
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Σ(1660) P'11

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                 79  Y*1(1660, JP=1/2+) I=1

                 SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

                 THE PARTIAL-WAVE ANALYSIS OF K- N TO SIGMA PI BY
                 ARMENTOROS 70 SUGGEST SUCH A RESONANCE. NOW
                 FOUND ALSO IN SOME, BUT NOT ALL, MORE RECENT
                 ANALYSES.

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                 79  Y*1(1660) MASS (MEV)

M         1500. -- 1600.             ARMENTERO 70 HDBC -0 K-N TO SIGMA PI   6/70
M        (1670.)                     KIM       71 DPWA    K-MATRIX ANAL.    3/71
M    2   (1621.)                     LEA       73 DPWA    MULTICHNL K-MTRX  9/73
M    2  ONLY UNCONSTRAINED STATES FROM TABLE 1 OF LEA73 ARE IN LISTINGS.    9/73
M         1658.       (4.)           HART      73 DPWA    EL+CX,.7-.8GEV/C  2/74
M   1    (1660.)     (30.)           BAILLON   75 IPWA    KBAR N TO LAM PI 11/75*
M   1  FROM SOLUTION 1 OF BAILLON 75, NOT PRESENT IN SOLUTION 2            11/75*
M   3    (1671.)      (2.)           PONTE     75 DPWA  0 K- P TO LAM PI    1/76*
M   3   FROM SOLUTION 2 OF PONTE 75, NOT PRESENT IN SOLUTION 1.             1/76*
M         1668.      (25.)           VANHORN   75 DPWA  0 K- P TO LAM PI0  11/75*
M         1676.      (15.)           RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

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                 79  Y*1(1660) WIDTH (MEV)

W          (50.0)                    ARMENTERO 70 HDBC -0 K-N TO SIGMA PI   6/70
W          (50.)                     KIM       71 DPWA    K-MATRIX ANAL.    3/71
W    2     (51.8)                    LEA       73 DPWA    MULTICHNL K-MTRX  9/73
W           40.      (10.)           HART      73 DPWA    EL+CX,.7-.8GEV/C  2/74
W   1      (80.)     (40.)           BAILLON   75 IPWA    KBAR N TO LAM PI 11/75*
W   3      (81.)     (10.)           PONTE     75 DPWA  0 K- P TO LAM PI    1/76*
W          230.     (165.)    (60.)  VANHORN   75 DPWA  0 K- P TO LAM PI0  11/75*
W          120.      (20.)           RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

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                 79  Y*1(1660) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1     Y*1(1660) INTO KBAR N                            497+ 939
P2     Y*1(1660) INTO SIGMA PI                          1197+ 139
P3     Y*1(1660) INTO LAMBDA PI                         1115+ 139

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                 79  Y*1(1660) BRANCHING RATIOS

R1     Y*1(1660) FROM KBAR N TO SIGMA PI                SQRT(P1*P2)
R1          (+0.2)                   ARMENTERO 70 HDBC -0 K-N TO SIGMA PI   6/70
R1          (0.24)                   KIM       71 DPWA    K-MATRIX ANAL.    3/71
R1   2      (-.21)                   LEA       73 DPWA    MULTICHNL K-MTRX  9/73
R1           -.16      (.03)         RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

R2     Y*1(1660) INTO KBAR N                            (P1)
R2          (0.14)                   KIM       71 DPWA    K-MATRIX ANAL.    3/71
R2   2       (.10)                   LEA       73 DPWA    MULTICHNL K-MTRX  9/73
R2            .11      (.02)         HART      73 DPWA    EL+CX,.7-.8GEV/C  2/74
R2           LESS THAN .04           RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

R3     Y*1(1660) FROM KBAR N TO LAMBDA PI               SQRT(P1*P3)
R3          (0.0)                    KIM       71 DPWA    K-MATRIX ANAL.    2/73
R3   2      (+.07)                   LEA       73 DPWA    MULTICHNL K-MTRX  9/73
R3  1       (-.04)     (.02)         BAILLON   75 IPWA    KBAR N TO LAM PI 11/75*
R3  3       (+.16)     (.01)         PONTE     75 DPWA  0 K- P TO LAM PI    1/76*
R3            .12      (.12)   (.04) VANHORN   75 DPWA  0 K- P TO LAM PI0  11/75*
R3           LESS THAN .04           RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

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                         REFERENCES FOR Y*1(1660)

ARMENTER 70 DUKE 123           ARMENTEROS, BAILLON, +        (CERN,HEIDEL)IJP
KIM      71 PRL 27 356         J K KIM                              (HARV)IJP
   ALSO 70 DUKE 161            J. K. KIM                            (HARV)IJP
HART     73 PURDUE CONF. 311   +RICE,BACASTOW,FUNG,+  (TENN+UCR+MASA+BUFF)IJP
LEA      73 NP B56 77          +MARTIN,MOORHOUSE+  (RHEL+LOUC+GLAS+AARHUS)IJP

BAILLON  75 NP B94 39          P. BAILLON,P. J. LITCHFIELD      (CERN,RHEL)IJP
PONTE    75 PRD 12 2597        +HERTZBACH,BUTTON-SHAFER+   (MASA+TENN+UCR)IJP
VANHORN  75 NP B87 145         A. J. VAN HORN                        (LBL)IJP
   ALSO 75 NP B87 157          A. J. VAN HORN                        (LBL)IJP

RLIC     76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSON,ROSS+    (RHEL+LOIC)IJP
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Note on Σ(1670)

Production Experiments

The measured $\Sigma\pi/\Sigma\pi\pi$ branching ratio for produced $\Sigma(1670)$'s is strongly dependent on momentum transfer. This was first discovered by EBERHARD 69 who suggested the existence of two Y_1^*'s with the same mass and quantum numbers; one object with a large $\Sigma\pi\pi$ [mainly $\Lambda(1405)\pi$] decay mode produced peripherally, and another one with a large $\Sigma\pi$ decay mode produced at larger angles. This observation has been confirmed by AGUILAR-BENITEZ 70, APSELL 74, ESTES 74, and BLOKZIJL 75. When determined, the most likely quantum numbers are $3/2^-$ [for both $\Sigma\pi$ and $\Lambda(1405)\pi$]. There is also the possibility of a third Y_1^* state, referred to as $\Sigma(1690)$ in the Data Card Listings, with a large $\Lambda\pi/\Sigma\pi$ branching ratio and somewhat larger mass. The large branching ratio is the main justification for this hypothesis and needs confirmation. These problems have been reviewed by EBERHARD 73 and MILLER 70.

Baryons

Σ(1670)

Data Card Listings

For notation, see key at front of Listings.

Formation Experiments

Two states are also observed near this mass in formation. One of these, the Σ(1670, $3/2^-$), has the same quantum numbers as those observed in production and a large Σπ/Σππ branching ratio. It may well correspond to the produced Σ(1670) seen at larger angles. The other, the Σ(1660, $1/2^+$) has different quantum numbers from those seen in production, and its Σπ/Σππ branching ratio is unknown. Thus its relation to the produced Σ(1670) remains obscure. [See also the mini-review on Σ(1620)].

Σ(1670) D''_{13}

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44  Y*1(1670, JP=3/2-) I=1
SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

SEE NOTE ABOVE

WELL ESTABLISHED RESONANCE.  IT HAS BEEN SEEN IN BOTH
FORMATION AND PRODUCTION EXPERIMENTS.  HOWEVER THE
BRANCHING RATIOS OBTAINED BY THESE TWO METHODS SHOW
LARGE INCONSISTENCIES.

SEE LISTING OF PRODUCTION EXPERIMENTS BELOW

AS FOR THE QUANTUM NUMBERS, THE ANALYSES OF LAMBDA PI CHANNEL (IN
FORMATION EXP.) AS WELL AS THE SIGMA PI CHANNEL AGREE ON JP=3/2-.

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                     44  Y*1(1670) MASS (MEV)

M           1660.0                  BERLEY    64 HBC   0 K-P TO LAM PIO     7/66
M           1668.      (5.)         ARMENTER  68 HBC   0 K-P ELAS.+CH.EX   11/68
M          (1661.0)    (2.0)        ARMENTE2  68 HBC   0 K-P TO SIGMA PI   11/68
M           1680.                   ARMENTE4  69 DBC     K-N TO SIG- PIO   12/68
M           1663.0     (2.0)        ARMENT-5  69 HBC   0 K-P TO SIGMPI ED   9/69
M           1672.0                  BERLEY    69 HBC     K-P TO SIG PI      5/70
M           1660.                   ARMENTER  70 HBC   0 K-P TO LAM.PI EI   5/70
M           1681.0     (3.0)        BRUCKER   70 DBC   - K-N TO SIG 2PI    10/71
M           1662.0     (5.0)        GALTIERI  70 HBC   0 SIG PI,EDPWA       7/70
M           1665.     (10.)         GALTIERI  70 HBC   0 LAM. PI, EDPWA     7/70
M           1676.      (2.)         BUDGEN    71 DPWA    LAM PIO,CHS DATA 10/71
M           1670.                   KIM       71 DPWA    K-MATRIX ANAL.     3/71
M           1675.0    (15.0)        LANGBEIN  72 IPWA    MULTICHANNEL      12/72
M           1685.     (20.)         BAILLON   75 IPWA    KBAR N TO LAM PI 11/75*
M   C      (1671.)     (3.)         PONTE     75 DPWA  0 K- P TO LAM PI     1/76*
M   C   FROM SOLUTION 1 OF PONTE 75.                                        1/76*
M   D      (1655.)     (2.)         PONTE     75 DPWA  0 K- P TO LAM PI     1/76*
M   D   FROM SOLUTION 2 OF PONTE 75.                                        1/76*
M           1659.     (12.)   (5.)  VANHORN   75 DPWA  0 K- P TO LAM PIO  11/75*
M           1670.      (5.)         RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

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                     44  Y*1(1670) WIDTH (MEV)

W             60.0                  BERLEY    64 HBC   0                    7/66
W             56.     (18.)         ARMENTER  68 HBC   0 K-P ELAS.+CH.EX   11/68
W            (44.0)    (4.0)        ARMENTE2  68 HBC   0 K-P TO SIGMA PI   11/68
W             47.0                  ARMENTE4  69 DBC     K-N TO SIG- PIO   12/68
W             49.0     (4.0)        ARMENT-5  69 HBC   0 K-P TO SIGMPI ED   9/69
W             34.0                  BERLEY    69 HBC                        5/70
W             50.                   ARMENTER  70 HBC   0 K-P TO LAMB.PI     5/70
W             30.0    (10.0)        BRUCKER   70 DBC   - K-N TO SIG 2PI    10/71
W             48.0     (5.0)        GALTIERI  70 HBC   0 SIG PI,EDPWA       7/70
W             50.     (10.)         GALTIERI  70 HBC   0 LAM. PI, EDPWA     7/70
W             59.      (4.5)        BUDGEN    71 DPWA    LAM PIO           10/71
W             40.                   KIM       71 DPWA    K-MATRIX ANAL.     3/71
W             65.0    (20.0)        LANGBEIN  72 IPWA    MULTICHANNEL      12/72
W             70.     (20.)         BAXTER    73 DPWA  0 K- P TO NEUTRALS 10/74*
W             85.     (25.)         BAILLCN   75 IPWA    KBAR N TO LAM PI 11/75*
W   C        (44.)    (11.)         PONTE     75 DPWA  0 K- P TO LAM PI     1/76*
W   D        (76.)     (5.)         PONTE     75 DPWA  0 K- P TO LAM PI     1/76*
W             32.     (11.)         VANHORN   75 DPWA  0 K- P TO LAM PIO  11/75*
W             50.      (5.)         RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

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                     44  Y*1(1670) PARTIAL DECAY MODES

                                                         DECAY MASSES
P1      Y*1(1670) INTO KBAR N                          497+ 939
P2      Y*1(1670) INTO LAMBDA PI                      1115+ 139
P3      Y*1(1670) INTO SIGMA PI                       1197+ 139
P4      Y*1(1670) INTO LAMBDA PI PI                   1115+ 139+ 139
P5      Y*1(1670) INTO SIGMA PI PI                    1197+ 139+ 139
P6      Y*1(1670) INTO Y*1(1385) PI S-WAVE             139+1384
P7      Y*1(1670) INTO Y*0(1405) PI                   1405+ 139

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                     44  Y*1(1670) BRANCHING RATIOS

R1      Y*1(1670) INTO (KBAR N)/TOTAL                        (P1)
R1           (0.09)    (0.02)       ARMENTER  68 HBC                        9/69
R1            0.08     (0.02)       ARMENT-5  69 HBC   0 ELAS. +CH.EX. ED   9/69
R1            0.07                  KIM       71 DPWA    K-MATRIX ANAL.     3/71
R1            0.10     (0.03)       LANGBEIN  72 IPWA    MULTICHANNEL      12/72
R1            NOT SEEN              HART      73 DPWA    EL+CX,.7-.8GEV/C   2/74
R1             .24      (.03)       RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

R2      Y*1(1670) INTO (LAMBDA PI PI)/TOTAL                  (P4)
R2           (0.11) OR LESS         ARMENTE3  68 HBC     K-P (P1=.09)       9/69

R3      Y*1(1670) INTO (SIGMA PI PI)/TOTAL                   (P5)
R3  A        (0.14) OR LESS         ARMENTE3  68 HBC     K-P AND D-P1=.09 11/68
R3  A    RATIO ONLY FOR (SIG2PI) SYSTEM IN I=1, WHICH CANNOT BE Y*1(1385)     11/68

R4      Y*1(1670) INTO (Y*0(1405) PI)/TOTAL                  (P7)
R4           (0.06) OR LESS         ARMENTE3  68 HBC     K-P AND D-P1=.09 11/68

R5      Y*1(1670) FROM KBAR N TO LAMBDA PI                   SQRT(P1*P2)
R5  2        (+0.1)                 ARMENTER  70HBC      K-P TO LAMB PI     5/70
R5  2   PUBLISHED SIGN CHANGED TO AGREE WITH LUND 1969 CONVENTION (SEE TEXT) 10/74*
R5            +0.09    (0.02)       GALTIERI  70 HBC   0 LAM. PI, EDPWA     7/70
R5             .165    (.01)        BUDGEN    71 DPWA    LAM PIO           10/71
R5            0.08                  KIM       71 DPWA    K-MATRIX ANAL.     3/71
R5            0.13     (0.03)       LANGBEIN  72 IPWA    MULTICHANNEL      12/72
R5            +.10     (.02)        BAXTER    73 DPWA  0 K- P TO NEUTRALS 10/74*
R5            +.018     .060        DEVENISH  74       0 FIXED T DISP REL  4/75*
R5            +.06     (.02)        BAILLON   75 IPWA    KBAR N TO LAM PI 11/75*
R5  C         (.08)    (.01)        PONTE     75 DPWA  0 K- P TO LAM PI     1/76*
R5  D         (.17)    (.01)        PONTE     75 DPWA  0 K- P TO LAM PI     1/76*
R5            +.09     (.02)        VANHORN   75 DPWA  0 K- P TO LAM PIO  11/75*
R5            +.10     (.02)        RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

R6      Y*1(1670) FROM KBAR N TO SIGMA PI                    SQRT(P1*P3)
R6           (+0.21)   (0.01)       ARMENTE2  68 HBC   0 OLD DATA          11/68
R6            +0.19                 ARMENTE4  69 DBC                        9/69
R6            +0.20    (0.01)       ARMENT-5  69 HBC   0 NEW DATA           9/69
R6            +0.18                 BERLEY    69 HBC                        5/70
R6            +0.18    (0.06)       GALTIERI  70 HBC   0 SIG PI,EDPWA       7/70
R6            0.15                  KIM       71 DPWA    K-MATRIX ANAL.     3/71
R6            0.23     (0.05)       LANGBEIN  72 IPWA    MULTICHANNEL      12/72
R6            +.21     (.02)        RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

R7      Y*1(1670) FROM KBAR N TO Y*1(1385) PI S-WAVE         SQRT(P1*P6)
R7  S        (0.17)    (0.02)       SIMS      68 DBC   - LAM 2PI CROS.SEC 10/71
R7  S    SIMS 68 USES ONLY CROSS-SECT. DATA. RESULT USED AS UPPER LIMIT ONLY  3/72
R7            +.11      .03         PREVOST   74 DPWA 0- K-N TO S(1385)PI 10/74*

R8      Y*1(1670) INTO (Y*0(1405)PI)*(KBAR N)/TOTAL**2      (P7*P1)
R8           (0.03) OR LESS         BERLEY    69 HBC   0 K-P .6-.82 BEV/C   5/70
R8   B        0.007    (0.002)      BRUCKER   70 DBC   - K-N TO SIG 2PI    10/71
R8   B   ASSUMING Y*0(1405) PI CROSS SECTION BUMP DUE SOLEY TO 3/2- RESON.   10/71

R9      Y*1(1670) INTO (Y*0(1405) PI)/(Y*1(1385) PI)         (P7)/(P6)
R9            0.23     (0.08)       BRUCKER   70 DBC   - K-N TO SIG 2PI    10/71

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                        REFERENCES FOR Y*1(1670)

BERLEY   64 DUBNA CONF I 565  +CONNOLLY,HART,RAHM,STONEHILL, +       (BNL)IJP

ARMENTER 68 NP B8 195         ARMENTEROS,BAILLON +      (CERN+HEID+SACLAY)IJP
ARMENTE1 68 NP B8 183         ARMENTEROS,BAILLON +      (CERN+HEID+SACLAY)IJP
ARMENTE2 68 NP B8 223         ARMENTEROS+BAILLON +      (CERN+HEID+SACLAY)IJP
ARMENTE3 68 PL 28B 521        ARMENTEROS,BAILLON +      (CERN+HEID+SACLAY)I
SIMS     68 PRL 21 1413       SIMS,ALBRIGHT,BARTLEY,MEER+ (FSU,TUFT,BRAN)

ARMENTE4 69 NP B10 459        ARMENTEROS,BAILLON,MINTEN +   (CERN+SACLAY) J
ARMENT-5 69 NP B14 91         ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
BERLEY   69 PL 30B 430        BERLEY,HART,RAHM,WILLIS,YAMAMOTO        (BNL)

ARMENTER 70 DUKE 123          ARMENTEROS, BAILLON, +             (CERN,HEID)
BRUCKER  70 DUKE 155          +HARRISON,SIMS,ALBRIGHT,CHANDLER++      (FSU)I
GALTIERI 70 DUKE 173          A. BARBARO GALTIERI                    (LRL)IJP
BUDGEN   71 LNC 2  85         D BUDGEN                              (DURH)IJP
KIM      71 PRL 27 356        J K KIM                               (HARV)IJP
    ALSO 70 DUKE 161          J. K. KIM                             (HARV)IJP

LANGBEIN 72 NP B47 477        +WAGNER                               (MPIM)IJP
BAXTER   73 NP B67 125        BAXTER,BUCKINGHAM,CORBETT,DUNN,+    (OXFORD)IJP
HART     73 PURDUE CONF. 311  +RICE,BACASTOW,FUNG,+  (TENN+UCR+MASA+BUFF)IJP
DEVENISH 74 NP B81 330        DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
PREVOST  74 NP B69 246        PREVOST,BARLOUTAUD,+          (SACL+CERN+HEID)

BAILLON  75 NP B94 39         P. BAILLON,P. J. LITCHFIELD      (CERN,RHEL)IJP
PONTE    75 PRD 12 2597       +HERTZBACH,BUTTON-SHAFER+    (MASA+TENN+UCR)IJP
VANHORN  75 NP B87 145        A. J. VAN HORN                         (LBL)IJP
    ALSO 75 NP B87 157        A. J. VAN HORN                         (LBL)IJP

RLIC     76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSON,ROSS+     (RHEL+LOIC)IJP

                              PAPERS NOT REFERRED TO IN DATA CARDS

BASTIEN1 63 PRL 10 188        P L BASTIEN, J P BERGE                  (LRL) IJ
   REPLACED BY BASTIEN 2, BUT SIMILAR AND MORE READILY AVAILABLE.
BASTIEN2 63 UCRL-10779 THESIS P L BASTIEN                             (LRL) IJ
T-ZADEH  63 PRL 11 470        TAHER-ZADEH,PROWSE,SCHLEIN,SLATER,+   (UCLA) JP
   SEE NOTE FOLLOWING SCHLEIN 66.
SCHLEIN 66  UCLA-1016         P.E. SCHLEIN, T.G. TRIPPE              (UCLA) JP
   REANALYSES DATA OF TAHER-ZADEH 63 ,   BASTIEN 63 AND ALL PUBLISHED
   LAMBDA PI CROSS SECTION DATA IN THE LIGHT OF THE NOW KNOWN
   Y*1(1765) .   REVERSES THE MODEL-DEPENDENT CONCLUSION OF TAHER-
   ZADEH ON THE PREFERRED JP ASSIGNMENT (FROM 3 2+ TO 3          (2-).)
SMART    66 PRL 17 556        W M SMART,A KERNAN,G E KALMUS,R P ELY (LRL)IJP
ARMENTER 67 NP B3 592         ARMENTEROS,FERRO-LUZZI+  (CERN,HEID,SACLAY)
PREVOST  71  AMSTERDAM CONF   + CHS COLLABORATION           (CERN+HEID+SACL)
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Σ(1670) BUMPS →

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51  Y*1(1670, JP=    ) I=1          PRODUCTION EXPERIMENTS

SEE NOTE PRECEDING Y*1(1670)
PROBABLY THERE ARE TWO STATES AT SAME MASS WITH SAME
QUANTUM NUMBERS, ONE DECAYING INTO SIGMA PI AND LAMBDA
PI, THE OTHER INTO Y*0(1405) PI.  BRANCHING RATIOS NOT
DISENTANGLED YET, WE LIST THEM TOGETHER FOR NOW.

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                  51  Y*1(1670) MASS (MEV) (PROD. EXP.)

M           (1685.0)                  ALEXANDER 62 HBC  -0 PI-P 2-2.2 BEV/C
M            1660.0     10.0          ALVAREZ   63 HBC  +  K-P 1.51 BEV/C
M           (1665.0)    (5.0)         BUGG      68 CNTR    K-P, D TOTAL C.S
M    P    70(1661.)     (9.)          PRIMER    68 HBC  +  K-P 4.6-5. GEV/C  7/68
M    P       SEE BARNES 69 FOR NEW ANALYSIS OF DATA (3 TIMES MORE DATA)     10/69
M            1670.0      6.0          AGUILAR   70 HBC     SIG.PI K-P 4 GEV  5/70
M            1668.0     10.0          AGUILAR   70 HBC     SIG.2PI K-P 4GEV  5/70
M   B        1665.       1.0          APSELL    74 HBC     K- P 2.87 GEV/C   4/75*
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Data Card Listings

For notation, see key at front of Listings.

Baryons

Σ(1670), Σ(1690)

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M      1200 1688+/-2. OR 1683+/-5.      BERTHON   74 HBC   0 QUASI 2 BODY CS   4/75*
M    3      1665.       3.              BLOKZIJL  75 HBC     K- P AT 4.2 GEV   1/76*
M    3  PARAMETERS DETERMINED FRCM (SIGMAO PI+) PRODUCTICN.                    1/76*
M    4      1657.       3.              BLOKZIJL  75 HBC     K- P AT 4.2 GEV   1/76*
M    4  PARAMETERS DETERMINED FRCM (Y*0(1405) PI+) PRODUCTION.                 1/76*
M           . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.6)

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                     51  Y*1(1670) MASS (MEV) (PROD. EXP.)

W              (45.0)                   ALEXANDER 62 HBC  -0
W               40.0      10.0          ALVAREZ   63 HBC  +
W              (30.0)    (15.0)         BUGG      68 CNTR                     11/66
W     P   70   (60.)     (20.)          PRIMER    68 HBC  + K-P 4.6-5. GEV/C  7/68
W              110.0      12.0          AGUILAR   70 HBC    SIG.PI K-P 4 GEV  5/70
W              135.0      40.0    30.0  AGUILAR   70 HBC    SIG.2PI K-P 4GEV  5/70
W    B          67.        2.4          APSELL    74 HBC    K- P 2.87 GEV/C   4/75*
W      3        64.        9.           BLOKZIJL  75 HBC    K- P AT 4.2 GEV   1/76*
W      4        53.        5.           BLOKZIJL  75 HBC    K- P AT 4.2 GEV   1/76*
W             SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.
W           . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 2.6)

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                     51  Y*1(1670) PARTIAL DECAY MODES (PROD. EXP.)

                                                              DECAY MASSES
P1      Y*1(1670) INTO KBAR N                                 497+ 939
P2      Y*1(1670) INTO LAMBDA PI                             1115+ 139
P3      Y*1(1670) INTO SIGMA PI                              1197+ 139
P4      Y*1(1670) INTO LAMBCA PI PI                          1115+ 139+ 139
P5      Y*1(1670) INTO SIGMA PI PI                           1197+ 139+ 139
P6      Y*1(1670) INTO Y*1(1385) PI                          1384+ 139
P7      Y*1(1670) INTO Y*0(1405) PI                          1405+ 139

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                     51  Y*1(167C) BRANCHING RATIOS (PROC. EXP.)

R1      Y*1(1670) INTO (KBAR N)/(SIGMA PI)                   (P1)/(P3)
R1        0   (0.19) OR LESS            ALVAREZ   63 HBC  + K-P 1.15 BEV/C
R1            (0.5)+- .25 OR MORE       SMITH     63 HBC  -0
R1            (0.6)  OR LESS            LONDON    66 HBC  + K-P 2.25 BEV/C     7/66
R1            (0.025)                   BUGG      68 CNTR 0 ASSUMING J=3/2    11/66
R1        0   (0.24) OR LESS            PRIMER    68 HBC  + K-P 4.6-5. GEV/C   7/68
R1            (0.26) OR LESS            BARNES    69 HBC  + K-P 3.9-5 GEV/C   10/69
R1            (0.2)  OR LESS            AGUILAR   70 HBC                       5/70
R1            (0.10) OR LESS            BERTHON   74 HBC  0 QUASI 2 BODY CS    4/75*
R1             (.03) OR LESS            BLOKZIJL  75 HBC    K- P AT 4.2 GEV    1/76*

R2      Y*1(1670) INTO (LAMB.PI)/(SIG PI)                    (P2)/(P3)
R2      130   (1.20)                    ALVAREZ   63 HBC  + K-P 1.15 BEV/C
R2            (1.2)                     SMITH     63 HBC  -0
R2             0.15      0.07           HUWE      64 HBC  +
R2             0.6    OR LESS           LONDON    66 HBC  + K-P 2.25 BEV/C     7/66
R2       33    0.11      0.06           BUTTON-S  68 HBC  + K-P AT 1.7 GEV/C 10/69
R2   P    0    (0.)                     PRIMER    68 HBC  + K-P 3.9-5 GEV/C   10/69
R2   P   PRIMER 68 ASSUMED THIS CECAY TO BE ALL Y*(1690)- SEE BARNES 69 FOR
R2   P   NEW INTERPRATATION OF CATA.(3 TIMES MORE DATA) -
R2             0.45      0.15           BARNES    69 HBC  + K-P 3.9-5 GEV/C   10/69
R2            (.55)     (.11)           BERTHCN   74 HBC  0 QUASI 2 BODY CS    4/75*
R2    1         .76       .09           ESTES     74 HBC  0 K-P,2.1+2.6GEV/C 11/75*
R2    1       (.46)+/-.07) OR LESS      BLOKZIJL  75 HBC    K- P AT 4.2 GEV    1/76*
R2    1  THIS EXPT. TENDS TO CONFIRM THE INTERPRETATION CF EBERHARD 69.       11/75*
R2          . . . . . . . . . .
R2   AVERAGE MEANINGLESS (SCALE FACTOR = 3.7)

R3      Y*1(1670) INTO (LAMB. PI PI)/(SIG PI)                (P4)/(P3)
R3       90   (0.56)                    ALVAREZ   63 HBC  + K-P 1.15 BEV/C
R3            (0.17)                    SMITH     63 HBC  -0
R3            (0.6)  OR LESS            LONDON    66 HBC  + K-P AT 2.25 BEV/C  7/66

R4      Y*1(1670) INTO (SIGMA PI PI)/(SIG PI)                (P5)/(P3)
R4      180   (0.56)                    ALVAREZ   63 HBC  + K-P 1.15 BEV/C
R4          LARGEST AT SMALL ANGLES     ESTES     74 HBC  0 K-P,2.1+2.6GEV/C 11/75*

R5      Y*1(1670) INTO (Y*0(1405) PI)/(SIG PI)               (P7)/(P3)
R5       50    3.        1.6            LONDCN    66 HBC  + K-P 2.25 BEV/C     7/66
R5   P   17   (0.58)    (0.20)          PRIMER    68 HBC  + K-P 4.6-5. GEV/C   7/68
R5              .88       .13           BLOKZIJL  75 HBC    K- P AT 4.2 GEV    1/76*
R5          . . . . . . . . . .
R5   AVG       0.89      0.13    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R5   STUDENT   0.89      0.14    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R6      Y*1(1670) INTO (SIGMA PI)/(SIGMA PI PI)              (P3)/(P5)
R6              .4    OR LESS           BIRMINGHA 66 HBC  + K-P AT 3.5 GEV/C 11/67
R6             0.30      0.15           LONDCN    66 HBC  + K-P 2.25 GEV/C     7/66
R6   A      BETWEEN 2.5 AND 0.24        EBERHARD  69 HBC    K-P AT 2.6 GEV/C   9/69
R6            (1.39)    (.16)           BERTHCN   74 HBC  0 QUASI 2 BODY CS    4/75*
     A      DEPENDING ON THE PRODUCTION ANGLE

R7      Y*1(1670) INTO (Y*0(1405) PI)/(SIGMA PI PI)          (P7)/(P5)
R7             0.90      0.10     0.16  EBERHARD  65 HBC  + K-P 2.45 BEV/C     7/66
R7 B           1.00       .02           APSELL    74 HBC    K- P 2.87 GEV/C    4/75*
R7 B     APSELL 74 FINDS STRCNG BRANCHING RATIC DEPENDENCE ON PRODUCTION       4/75*
R7 B     ANGLE, AS IN OTHER PRODUCTION EXPERIMENTS. BR RECORDED HERE (AND      4/75*
R7 B     ALSO MASS AND WIDTH ABOVE) ARE FROM EVENTS WITH COS(PRD. ANG.)        4/75*
R7 B     BETWEEN 1.0 AND 0.7.                                                  4/75*
R7          LARGEST AT SMALL ANGLES     ESTES     74 HBC  0 K-P,2.1+2.6GEV/C 11/75*
R7          . . . . . . . . . .
R7   AVG       0.998     0.020   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R7   STUDENT   0.998     0.021   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R8      Y*1(1670) INTO (Y*0(1405) PI)/(Y*1(1385) PI)         (P7)/(P6)
R8            (0.8)  OR LESS            EBERHARD  65 HBC  + K-P 2.45 BEV/C     7/66

R9      Y*1(1670) INTO (LAMBCA PI PI)/(SIGMA PI PI)          (P4)/(P5)
R9             0.35      0.2            BIRMINGHA 66 HBC  + K-P AT 3.5 GEV/C 11/67

R10     Y*1(1670) INTO (LAMBCA PI)/(SIGMA PI PI)             (P2)/(P5)
R10            (.2)  OR LESS            BIRMINGHA 66 HBC  + K-P AT 3.5 GEV/C 11/67

R11     Y*1(1670) INTO (LAMBDA PI)/(LAMBDA PI + SIG PI)      (P2)/(P2+P3)
R11           (0.6)  OR LESS            AGUILAR   70 HBC                       5/70

R12     Y*1(1670) INTO (Y*1(1385) PI)/(SIGMA PI)             (P6)/(P3)         1/76*
R12           (.25)+/-.05) OR LESS      BLCKZIJL  75 HBC    K- P AT 4.2 GEV    1/76*

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                  51  Y*1(1670) QUANTUM NUMBER DETERMINATICN (PROD. EXP.)

Q1               JP=3/2+             LEVEQUE   65 HBC     INTO Y*(1405)+PI 11/68
Q3               JP=3/2-             EBERHARD  67 HBC  +  INTO Y*(1405) PI 11/68
Q4       400     JP=3/2-             BUTTCN-SH 68 HBC  +- INTO SIGZERO+PI  11/68

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                              REFERENCES FOR Y*1(1670) (PROD. EXP.)

ALEXANDE 62 CERN CONF 320      ALEXANDER,JACOBS,KALBFLEISCH,MILLER,+ (LRL) I
ALVAREZ  63 PRL 10 184         +ALSTON,FERRO-LUZZI,HUWE, +           (LRL) I
SMITH    63 ATHENS CONF 67     G A SMITH                             (LRL)
HUWE     64 PR 180 1824(1969)  D O HUWE                              (LRL)
EBERHARD 65 PRL 14 466         +SHIVELY,ROSS,SIEGAL,FICENEC, +   (LRL,ILL) I

BIRMINGH 66 PR  152  1148      BIRMINGHAM,GLASGOW,I.C.Y OXFORD,RUTHERFCRD
LONDON   66 PR 143 1034        +RAU,SAMIOS,YAMAMOTO,GOLDBERG,+  (BNL,SYRA) IJ
BUGG     68 PR 168 1466        +GILMORE,KNIGHT,DAVIES+     (BIRM,CAVE,RHEL)I
BUTTCN-S 68 PRL 21 1123        J BUTTON SHAFER                  (MASA+LRL) JP
PRIMER   68 PRL 20 610         +GCLCBERG,JAEGER,BARNES,DORNAN + (SYRA,BNL)

BARNES   69 BNL 13823          +CHUNG,EISNER,FLAMINIO+           (BNL,SYRA)
EBERHARD 69 PRL 22 200         +FRIEDMAN,PRIPSTEIN,ROSS               (LRL)
AGUILAR  70 PRL 25 58          +BARNES, BASSANC, CHUNG, EISNER,+(BNL,SYRA)

APSELL   74 PRD 10 1419        APSELL,FCRD,GCUREVITCH+(BRAN,UMC,SYRA,TUFT)I
BERTHON  74 NC 21A 146         BERTHON,TRISTRAM,+     (CDEF+RHEL+SACL+STRB)   U
ESTES    74 LBL-3827 (THESIS)  R. D. ESTES                            (LBL)

BLCKZIJL 75 ANL-HEP-CP-75-58   +DEGROOT,HOOGLAND+       (AMST+CERN+NIJM+OXF)
    ALSO 75 PALERMO CONF.      +DEGROOT,HOOGLAND+       (AMST+CERN+NIJM+OXF)

                               PAPERS NOT REFERRED TO IN CATA CARDS

LEVEQUE  65 PL 18 69           +        (SACLAY,EPOL,GLASGCW,LOIC,CXF,RHEL) JP
LEE      66 PRL 17 45          Y Y LEE, D D REEDER, R W HARTUNG       (WISC) JP
EBERHARD 67 PR 163 1446        +PRIPSTEIN,SHIVELY,KRUSE,SWANSCN  (LRL,ILL)IJP
MILLER   70 DUKE 229           D H MILLER   (REVIEW TALK)          (PURDUE)
EBERHARD 73 PURDUE CONF. 247   EBERHARD                               (LBL)IJP
HUNGERBU 74 PRD 10 2051        HUNGERBUHLER,MAJKA,+    (YALE,FNAL,BNL,PITT)

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Σ(1690) BUMPS →

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58  Y*1(1690, JP=     ) I=1          PRODUCTICN EXPERIMENTS

SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

SEE NOTE PRECEDING Y*1(1670) LISTINGS, SEEN IN PRC.
EXPERIMENTS CNLY, MAIN DECAY MODE IS LAMBDA PI.

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                  58  Y*1(1690) MASS (MEV) (PRCD. EXP.)

M       30(1715.0)    (12.0)          COLLEY    67 HBC  + K-P 6 GEV/C        8/67
M    P  60(1694.0)    (24.0)          PRIMER    68 HBC  + K-P 4.6-5 GEV/C    7/68
M     N   (1700.0)     (6.0)          SIMS      68 HBC  - K-N TO LAM PI PI  11/68
M       46(1682.0)     (2.0)          BLUMENFEL 69 HBC  + KO LONG + PROTCN   9/69
M         (1700.0)    (20.0)          MOTT      69 HBC  + K-P 5.5 GEV/C      9/69
M    P   SEE Y*1(1670) LISTING-AGUILAR 70 WITH THREE TIMES THE DATA OF
M    P   PRIMER 68  SHOW THAT THEY HAVE NO EVIDENCE FOR Y*(1690)
M     N   THIS ANALYSIS, WHICH IS DIFFICULT AND REQUIRES SEVERAL ASSUMPTIONS
M       AND SHOWS NO UNAMBIGUOUS Y*1(1690) SIGNAL, SUGGESTS JP=5/2+.  SUCH A
M       Y* WOULD LEAD ALL PREVIOUSLY KNOWN Y* TRAJECTORIES.

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                  58  Y*1(1690) WIDTH (MEV) (PROD. EXP.)

W       30 (100.0)    (35.0)          COLLEY    67 HBC  +                    8/67
W       60 (105.0)    (35.0)          PRIMER    68 HBC  +                    7/68
W     N    (62.0)     (14.0)          SIMS      68 HBC  -  SEE NOTE N ABCVE 11/68
W       46  (25.0)    (10.0)          BLUMENFEL 69 HBC  +                    9/69
W          (130.0)    (25.0)          MOTT      69 HBC  +                    9/69
           SEE THE NOTES ACCOMPANYING THE MASSES QUCTED

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                  58  Y*1(1690) PARTIAL DECAY MODES (PROD. EXP.)

                                                              DECAY MASSES
P1      Y*1(1690) INTO KBAR N                                497+ 939
P2      Y*1(1690) INTO LAMBDA PI                            1115+ 139
P3      Y*1(1690) INTO SIGMA PI                             1197+ 139
P4      Y*1(1690) INTO Y*1(1385) PI                         1384+ 139
P5      Y*1(1690) INTO LAMBDA PI PI (INCLUDING P4)          1115+ 139+ 139

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                  58  Y*1(1690) BRANCHING RATIOS (PROD. EXP.)

R1      Y*1(1690) INTO (KBAR N)/(LAMBDA PI)                 (P1)/(P2)
R1      18    0.4      0.25           COLLEY    67 HBC  + 6/30 EVENTS        8/67
R1           (0.2)  OR LESS           MOTT      69 HBC  +                    9/69

R2      Y*1(1690) INTO (SIGMA PI)/(LAMBDA PI)               (P3)/(P2)
R2            0.3      0.3            COLLEY    67 HBC  + 4/30 EVENTS        8/67
R2           (0.4)  OR LESS CL=.90    MOTT      69 HBC  +                    9/69

R3      Y*1(1690) INTO (Y*1(1385) PI)/(LAMBDA PI)           (P4)/(P2)
R3           (0.5)  OR LESS           MOTT      69 HBC  +                    9/69

R4      Y*1(1690) INTO (LAMBDA PI PI)/(LAMBDA PI)           (P5)/(P2)
R4            0.5      0.25           COLLEY    67 HBC  + 15/30 EVENTS       8/67
R4            2.0      0.6            BLUMENFEL 69 HBC  + 31/15 EVENTS       9/69
R4          . . . . . . . . . .
R4   AVG      0.72     0.53     AVERAGE (ERROR INCLUDES SCALE FACTOR CF 2.5)
R4   STUDENT  0.67     0.28     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R5      Y*1(1690) INTO (Y*1(1385) PI)/(LAMBDA PI PI)        (P4)/(P5)
R5           SMALL                    COLLEY    67 HBC  +                    8/67
R5           LARGE                    SIMS      68 HBC  - K-N TO L2PI       11/68

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Baryons
Σ(1690), Σ(1750), Σ(1765)

Data Card Listings
For notation, see key at front of Listings.

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                              REFERENCES FOR Y*1(1690) (PROD. EXP.)

COLLEY   67 PL 24B 489               (BIRM,GLAS,LOIC,MUNICH,OXFORD,RHEL) I
DERRICK  67 PRL 18 266          +FIELDS, LCKEN, AMMAR,  (ARGONNE,NORTHWEST) I
   REPLACED BY MOTT 69.
PRIMER   68 PRL 20 610          +GOLDBERG, JAEGER, BARNES, + (SYRACUSE,BNL) I
SIMS     68 PRL 21 1413         +ALBRIGHT, +            (FSU,TUFTS,BRANDEIS) I

BLUMENFE 69 PL 29B 58           B J BLUMENFELD, G R KALBFLEISCH       (BNL) I
MOTT     69 PR 177 1966         +AMMAR, DAVIS, KROPAC, +(NCRTHWEST,ARGONNE) I

                                PAPERS NOT REFERRED TO IN CATA CARDS

AGUILAR  70 PRL 25 58           AGUILAR-BENITEZ,BARNES,BASSANO+  (BNL+SYRA)

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Σ(1750) **S''_{11}**

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                57  Y*1(1750, JP=1/2-) I=1

                SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

                THIS STATE CORRESPCNDS TO THE SIGMA ETA THRESHOLD BUMP
                BUT ITS INTERPRETATION IN TERMS OF A RESONANCE IS NOT
                CONCLUSIVE (JONES 74) -- MORE DATA ARE NEEDED.  BY
                ANALOGY WITH THE SIMILAR N ETA AND LAMBDA ETA THRESHOLD
   EFFECTS, WHICH ARE ALMCST CERTAINLY RESCNANCES, IT SEEMS VERY LIKELY
   THAT THIS TOO IS A RESONANCE.
     THERE IS ALSO EVIDENCE FOR THIS STATE IN MANY PARTIAL-WAVE ANALYSES,
   MOSTLY IN THE LAMBDA PI CHANNEL.  THIS EVIDENCE SHOULD BE CONSIDERED
   WITH CAUTION AS THE MASSES AND/OR BRANCHING RATIOS OF THE REPORTED
   STATES ARE OFTEN INCCNSISTENT.

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                57  Y*1(1750) MASS (MEV)

M           NEAR SIGMA ETA THRESHOLD  CLINE     67 DBC  -  K-N TO SIGMA ETA  9/66
M           ABOUT 1750.0              MEYER     67 RVUE                      9/69
M           ABOUT 1730.0              ARMENTERO 70 HDBC -0 K-N TO LAMBDA PI  6/70
M          (1757.0)   (10.0)          CONFORTO  71 DPWA  0 ELASTIC, CH EXCH  6/70
M          (1790.)                    KIM       71 DPWA    K-MATRIX ANAL.    3/71
M          (1790.0)   (15.0)          LANGBEIN  72 IPWA    MULTICHANNEL     12/72
M          (1716.)    (10.)           BAXTER    73 DPWA  0 K- P TO NEUTRALS 10/74*
M          (1785.)    (12.)           CHU       74 DBC   - FIT SIG- ETA CS  10/74*
M    1     (1760.)     (5.)           JONES     74 HBC   0 FIT SIGO ETA CS   1/74
M          (1739.)    (10.)           PREVOST   74 DPWA 0- K-N TO S(1385)PI 10/74*
M    1  S-WAVE BW FIT TO THRSHLD C.S., NO BKGND. ERRORS STATISTICAL ONLY     1/74
M   A      (1780.)    (30.)           BAILLCN   75 IPWA    KBAR N TO LAM PI 11/75*
M   A   FROM SOLUTION 1 OF BAILLCN 75.                                      11/75*
M   B      (1700.)    (30.)           BAILLCN   75 IPWA    KBAR N TO LAM PI  1/76*
M   B   FROM SOLUTION 2 OF BAILLCN 75.                                       1/76*
M          (1697.)    (20.)    (10.)  VANHORN   75 DPWA  0 K- P TO LAM PIO  11/75*
M          (1770.)    (15.)           RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

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                57  Y*1(1750) WIDTH (MEV)

W           ABOUT 50.0                MEYER     67 RVUE                      9/69
W           ABOUT 80.0                ARMENTERO 70 HDBC -0 K-N TO LAMBDA PI  6/70
W            (55.0)   (10.0)          CONFORTO  71 DPWA  0 ELASTIC, CH EXCH  6/70
W            (50.)                    KIM       71 DPWA    K-MATRIX ANAL.    3/71
W           (100.0)   (20.0)          LANGBEIN  72 IPWA    MULTICHANNEL     12/72
W            (60.)    (20.)           BAXTER    73 DPWA  0 K- P TO NEUTRALS 10/74*
W            (89.)    (33.)           CHU       74 DBC   - FIT SIG- ETA CS  10/74*
W    1       (92.)     (7.)           JONES     74 HBC   0 FIT SIG+ETA CS    1/74
W           (108.)    (20.)           PREVOST   74 DPWA 0- K-N TO S(1385)PI 10/74*
W   A       (140.)    (30.)           BAILLCN   75 IPWA    KBAR N TO LAM PI 11/75*
W   B       (160.)    (50.)           BAILLCN   75 IPWA    KBAR N TO LAM PI  1/76*
W            (66.)    (14.)    (12.)  VANHORN   75 DPWA  0 K- P TO LAM PIO  11/75*
W            (60.)    (10.)           RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

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                57  Y*1(1750) PARTIAL DECAY MODES

                                                         DECAY MASSES
P1     Y*1(1750) INTO KBAR N                              497+ 939
P2     Y*1(1750) INTO SIGMA ETA                          1197+ 548
P3     Y*1(1750) INTO LAMBDA PI                          1115+ 134
P4     Y*1(1750) INTO SIGMA PI                           1197+ 139
P5     Y*1(1750) INTO SIGMA(1385) PI                      139+1384

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                57  Y*1(1750) BRANCHING RATIOS

R1     Y*1(1750) INTO (KBAR N)/TOTAL                        (P1)
R1          (0.12)    (0.05)          CONFORTO  71 DPWA  0 ELASTIC, CH EXCH  6/70
R1          (0.8)                     KIM       71 DPWA    K-MATRIX ANAL.    3/71
R1          (0.45)    (0.05)          LANGBEIN  72 IPWA    MULTICHANNEL     12/72
R1           (.15)     (.03)          RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

R2     Y*1(1750) FROM KBAR N INTO SIGMA ETA                 SQRT(P1*P2)
R2          SEEN                      CLINE     69 DBC  -  THRESHOLD BUMP    9/69
R2   1       (.23)     (.01)          JONES     74 HBC   0 FIT SIG+ETA CS    1/74

R3     Y*1(1750) FROM KBAR N INTO LAMBDA PI                 SQRT(P1*P3)
R3   2      (-0.25)                   ARMENTERO 70 IPWA -0 K-N TO LAMBDA PI  6/70
R3   2 PUBLISHED SIGN CHANGED TO AGREE WITH LUND 1969 CCNVENTION (SEE TEXT) 10/74*
R3          (0.09)                    KIM       71 DPWA    K-MATRIX ANAL.    3/71
R3          (0.30)    (0.05)          LANGBEIN  72 IPWA    MULTICHANNEL     12/72
R3          (-.28)     (.05)          BAXTER    73 DPWA  0 K- P TO NEUTRALS 10/74*
R3          (-.120)   (.077)          DEVENISH  74       0 FIXED T DISP REL  4/75*
R3  A       (-.12)     (.02)          BAILLCN   75 IPWA    KBAR N TO LAM PI 11/75*
R3  B       (-.13)     (.03)          BAILLON   75 IPWA    KBAR N TO LAM PI  1/76*
R3          (-.13)     (.04)          VANHORN   75 DPWA  0 K- P TO LAM PIO  11/75*
R3          (-.09)     (.05)          RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

R4     Y*1(1750) FRCM KBAR N TO SIGMA PI                    SQRT(P1*P4)
R4          (0.16)                    KIM       71 DPWA    K-MATRIX ANAL.    3/71
R4          (0.13)    (0.02)          LANGBEIN  72 IPWA    MULTICHANNEL     12/72
R4          (+.04)     (.03)          RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

R5     Y*1(1750) FROM KBAR N TO SIGMA(1385) PI              SQRT(P1*P4)
R5           +.18      .15            PREVOST   74 DPWA 0- K-N TO S(1385)PI 10/74*

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                              REFERENCES FOR Y*1(1750)

CLINE    67 PL 25B 41              CLINE, OLSSON                  (WISCONSIN)IJP
MEYER    67 HEIDELBERG C 117       J MEYER  (RAPPORTEUR)             (SACLAY)IJP
ARMENTER 70 DUKE 123               ARMENTEROS, BAILLON, +      (CERN,HEIDEL)IJP
CONFORTO 71 NP  B34  41            +LEVI SETTI,LASINSKI..OBERLACK++ (EFI+HEID)IJP
KIM      71 PRL 27 356             J K KIM                             (HARV)IJP
   ALSO  70 DUKE 161               J. K. KIM                           (HARV)IJP
LANGBEIN 72 NP B47 477             +WAGNER                             (MPIM)IJP

BAXTER   73 NP B67 125             BAXTER,BUCKINGHAM,CORBETT,CUNN,+  (OXFORD)IJP
CHU      74 NC 20A 35              CHU,BARTLEY,+ (SUNY PLATTSBURGH+TUFTS+BRAN)IJP
JONES    74 NP B73 141             JONES                         (U. CHICAGO)IJP
DEVENISH 74 NP B81 330             DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
PREVCST  74 NP B69 246             PREVOST,BARLOUTAUD,+        (SACL+CERN+HEID)

BAILLCN  75 NP B94 39              P. BAILLON,P. J. LITCHFIELD    (CERN,RHEL)IJP
VANHORN  75 NP B87 145             A. J. VAN HORN                       (LBL)IJP
   ALSO  75 NP B87 157             A. J. VAN HORN                       (LBL)IJP

RLIC     76 RL-75-182 (PRPNT)      GOPAL,KALMUS,MCPHERSCN,ROSS+   (RHEL+LOIC)IJP

                                   PAPERS NOT REFERREC TO IN CATA CARDS

FERRO-LU 66 BERKELEY CONF 183 M FERRO LUZZI  (RAPPORTEUR)              (CERN)
ARMENTER 68 NP B8 183              ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
ARMENTER 69 LUND CCNF PAPER        ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
HARRISCN 70 FSU-HEP 70 3 1         W.C. HARRISON (THESIS)                   (FSU)

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Σ(1765) **D_{15}**

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                45  Y*1(1765, JP=5/2-) I=1

                SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

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                45  Y*1(1765) MASS (MEV)

M          1765.0     10.0           GALTIERI  63 DBC   0 K-D 1.51 BEV/C
M          1755.0     10.0           ARMENTER  65 HBC   0 K-P TO Y*1520 PI   7/66
M          1760.0     10.0           BELL 1    66 DBC   - K-N TO Y*1520 PI   7/66
M    N     1768.0      2.0           ARMENT-1  68 DPWA  0 ELASTIC, CH EXCH  11/68
M    N     1768.0      4.0           BUGG      68 CNTR    K-P, D TOTAL      11/66
M          1775.0      7.0           SMART     68 RVUE -0 K-N TO LAMBDA PI   7/68
M          1770.0     10.0           COOL      70 CNTR    K-P, D TOTAL      10/70
M          1765.0     10.0           GALTIERI  70 DPWA  0 K-P TO LAMBDA PI   7/70
M    N     1770.0      3.0           CONFORTC  71 DPWA  0 ELASTIC, CH EXCH   6/70
M         (1765.)                    KIM       71 DPWA    K-MATRIX ANAL.     3/71
M          1758.7      3.9           BARLETTA  72 DPWA  0 KPPI 0.8-1.2GEV   12/72
M          1765.0      9.0           KANE      72 DPWA  0 K-P TO PI SIG     10/71
M    N     1770.0      5.0           LANGBEIN  72 IPWA    MULTICHANNEL      12/72
M          1775.      10.            BAILLON   75 IPWA    KBAR N TO LAM PI  11/75*
M          1774.      10.            VANHORN   75 DPWA  0 K- P TO LAM PIO   11/75*
M          1774.       5.            RLIC      76 DPWA    KBAR N MULTICHNL   1/76*
M    N  ERROR STATIST. ONLY- NC ERROR DUE TO PARTICULAR P.W.ANAL. INCLUDED   1/71
M         . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                45  Y*1(1765) WIDTH (MEV)

W            60.0     10.0           GALTIERI  63 CBC   0
W            70.0     20.0           BELL 2    66 DBC   -                    7/66
W           128.0      8.0           ARMENT-1  68 DPWA  0 ELASTIC, CH EXCH  11/68
W           110.0      7.0           BUGG      68 CNTR    K-P,D TOTAL        7/68
W           146.0      9.0           SMART     68 RVUE -0                    7/68
W          (100.0)                   COOL      70 CNTR    K-P, D TOTAL      10/70
W           115.0     10.0           GALTIERI  70 DPWA  0 K-P TO LAMBDA PI   7/70
W           132.0     10.0           CONFORTO  71 DPWA  0 ELASTIC, CH EXCH   6/70
W          (100.)                    KIM       71 DPWA    K-MATRIX ANAL.     3/71
W           107.2     10.9           BARLETTA  72 DPWA  0 LAM(1520)PI CH.   12/72
W           120.0     38.0           KANE      72 DPWA  0 K-P TO PI SIG     10/71
W           123.0     10.0           LANGBEIN  72 IPWA    MULTICHANNEL      12/72
W           125.      15.            BAILLON   75 IPWA    KBAR N TO LAM PI  11/75*
W           146.      18.            VANHORN   75 DPWA  0 K- P TO LAM PIO   11/75*
W           130.      10.            RLIC      76 DPWA    KBAR N MULTICHNL   1/76*
W         . . . . . . . . . .
W   AVG     117.5      6.8     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.3)
W   STUDENT 121.0      3.9     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                       (SEE IDEOGRAM BELOW )
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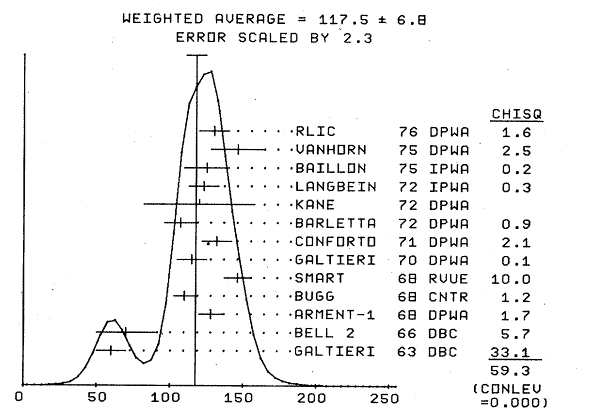


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Data Card Listings

For notation, see key at front of Listings.

Baryons

Σ(1765), Σ(1770)

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                    45  Y*1(1765) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      Y*1(1765) INTO KBAR N                                 497+ 939
P2      Y*1(1765) INTO LAMBDA PI                             1115+ 134
P3      Y*1(1765) INTO Y*0(1520) PI                          1518+ 139
P4      Y*1(1765) INTO Y*1(1385) PI D-WAVE                    139+1384
P5      Y*1(1765) INTO SIGMA PI                              1197+ 139
P6      Y*1(1765) INTO SIGMA ETA                             1197+ 548
P7      Y*1(1765) INTO SIGMA PI PI                           1197+ 139+ 139

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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

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        P 1        P 2        P 3        P 4        P 5        P 6
P 1 .4117+-.0145
P 2   -.0870  .1402+-.0130
P 3    .0877    -.0230  .1567+-.0327
P 4   -.1192     .0104    -.0104  .0984+-.0173
P 5   -.1172     .0102    -.0103      .0140  .0145+-.0043
P 6   -.3298    -.2708    -.8077    -.3718    -.0641  .1784+-.0414

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                    45  Y*1(1765) BRANCHING RATIOS

     ERRORS QUOTED BY EXPERIMENTERS DO NOT INCLUDE UNCERTAINTY CUE
     TO PARAMETRIZATION USED IN THE P.W.A.  THEY SHOULD BE INCREASED.

R1      Y*1(1765) INTO (KBAR N)/TOTAL                       (P1)
R1            (0.6)                 GALTIERI  63 HBC   0 K-P RVUE
R1             0.53     0.09        UHLIG     67 HBC   0                   9/66
R1             0.45     0.01        ARMENT-1  68 DPWA  0 ELASTIC, CH EXCH 11/68
R1            (0.37)                BUGG      68 CNTR                     11/66
R1             0.36     0.02        BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX  1/71
R1            (0.4)                 COOL      70 CNTR    K-P, D TOTAL     10/70
R1             0.36     0.02        CCNFORTO  71 DPWA  0 ELASTIC, CH EXCH  6/70
R1            (0.42)                KIM       71 DPWA    K-MATRIX ANAL.    3/71
R1             0.39     0.01        LANGBEIN  72 IPWA    MULTICHANNEL     12/72
R1              .41      .03        RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
R1           . . . . . . . . .
R1  AVG       0.409     0.018   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.8)
R1  STUDENT   0.3950    0.0099  AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R1  FIT       0.412     0.014  FROM FIT (ERROR INCLUDES SCALE FACTCR OF 2.4)
                        (SEE IDEOGRAM BELOW )
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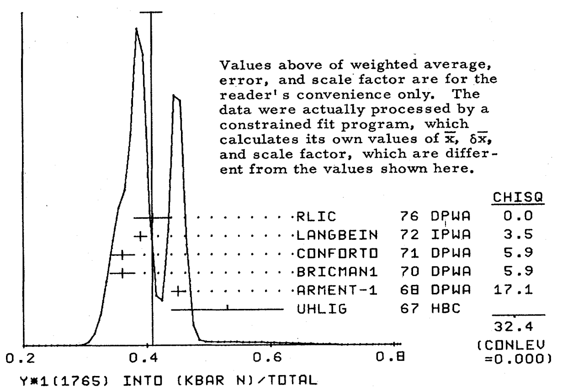
WEIGHTED AVERAGE = 0.409 ± 0.018
ERROR SCALED BY 2.8

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R2      Y*1(1765) FROM KBAR N INTO LAMBDA PI              SQRT(P1*P2)
R2          -0.266     0.017           SMART    68 DPWA -0 K-N TO LAMBDA PI   7/68
R2          -0.22      0.03            GALTIERI 70 DPWA  0 K-P TO LAMBDA PI   7/70
R2          (0.30)                     KIM      71 DPWA    K-MATRIX ANAL.     3/71
R2           0.15      0.04            LANGBEIN 72 IPWA    MULTICHANNEL      12/72
R2           -.259      .048           DEVENISH 74       0 FIXED T DISP REL   4/75*
R2           -.25       .02            BAILLON  75 IPWA    KBAR N TO LAM PI 11/75*
R2           -.28       .04       .05  VANHORN  75 DPWA  0 K- P TO LAM PIO  11/75*
R2           -.28       .03            RLIC     76 DPWA    KBAR N MULTICHNL  1/76*
R2         . . . . . . . . .
R2  AVG MOD  0.251     0.013   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
R2  STUDENT  0.253     0.012   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R2  FIT      0.240     0.012  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R3      Y*1(1765) FROM KBAR N INTO Y*0(1520) PI           SQRT(P1*P3)
R3           0.27      0.03            ARMENTERO 65 HBC   0 K-P TO Y*1520 PI   9/66
R3           0.31      0.02            BARLETTA  72 DPWA  0 K-P TO Y*1520 PI  12/72
R3         . . . . . . . . .
R3  AVG      0.298     0.018   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
R3  STUDENT  0.298     0.019   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R3  FIT      0.254     0.027  FRCM FIT (ERROR INCLUDES SCALE FACTOR OF 2.1)

R4      Y*1(1765) FROM KBAR N TO Y*1(1385) PI D-WAVE      SQRT(P1*P4)
R4  A       (0.24)    (0.03)           ARMENT-2  67 HBC   0 K-P TO LAM PI PI   8/67
R4  S       (0.32)    (0.06)           SIMS      68 CBC   -  K-N TO LAM PI PI 11/68
R4  S   SIMS 68 USES ONLY CROSS-SECT. DATA. RESULT USED AS UPPER LIMIT ONLY  3/72
R4           +.20       .02            PREVOST   74 DPWA 0- K-N TO S(1385)PI 10/74*
R4         . . . . . . . . .
R4  FIT      0.201     0.018  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R5      Y*1(1765) FROM KBAR N INTO SIGMA PI               SQRT(P1*P5)
R5          +0.07      0.02            ARMENTERO 67 DPWA  0 K-P TO SIGMA PI   10/74*
R5          +0.06      0.03            GALTIERI  70 DPWA  0 K-P TO SIGMA PI    7/70
R5          (0.09)                     KIM       71 DPWA    K-MATRIX ANAL.     3/71
R5          +0.074     0.017           KANE      72 DPWA  0 K-P TO PI SIG     10/71
R5           0.09  OR LESS             LANGBEIN  72 IPWA    MULTICHANNEL      12/72
R5           +.13       .02            RLIC      76 DPWA    KBAR N MULTICHNL   1/76*
R5         . . . . . . . . .
R5  AVG      0.086     0.015   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
R5  STUDENT  0.082     0.013   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
R5  FIT      0.077     0.011  FROM FIT (ERROR INCLUDES SCALE FACTCR OF 1.1)

R6      Y*1(1765) INTO (LAMECA PI)/(KBAR N)               (P2)/(P1)
R6           0.33      0.05            UHLIG     67 HBC   0 K-P,.9 GEV/C       9/66
R6         . . . . . . . . .
R6  FIT      0.341     0.035  FRCM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R7      Y*1(1765) INTO (Y*0(1520)PI)/(KBAR N)             (P3)/(P1)
R7           0.28      0.05            UHLIG     67 HBC   0 K-P,.9 GEV/C       9/66
R7         . . . . . . . . .
R7  FIT      0.381     0.079  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.1)

R8      Y*1(1765) INTO (Y*1(1385)PI)/(KBAR N)             (P4)/(P1)
R8           0.25      0.09            UHLIG     67 HBC   0 K-P,.9 GEV/C       9/66
R8         . . . . . . . . .
R8  FIT      0.239     0.044  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R9      Y*1(1765) INTO (SIGMA PI PI)/TOTAL                (P7)
R9   P        (0.12)                   ARMENT-2  68 HDBC -0 K-N TO SIG PI PI 11/68
R9   P   FOR ABOUT 3/4 OF THIS, THE SIGMA PI SYSTEM HAS I=0 AND IS ALMOST
R9   P ENTIRELY Y*0(1520).  FOR THE OTHER 1/4, THE SIGMA PI HAS I=1.  THIS
R9   P IS ABOUT WHAT IS EXPECTED FROM THE KNOWN RATE Y*1(1765) TO Y*1(1385)
R9   P PI, AS SEEN IN LAMBDA PI PI.

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                         REFERENCES FOR Y*1(1765)

GALTIERI 63 PL 6 296          A BARBARO-GALTIERI,A HUSSAIN,RD TRIPP (LRL)IJ
ARMENTER 65 PL 19 338         ARMENTEROS, +       (CERN,HEIDELBERG,SACLAY)IJP
BELL 1   66 PRL 16 203        R B BELL, R W BIRGE, Y-L PAN, R T PU  (LRL)IJP
BELL 2   66 UCRL-16936 THESIS R B BELL                              (LRL)IJP
ARMENTER 67 PL 24B 198        ARMENTEROS,FERRO-LUZZI+  (CERN,HEID,SACLAY I)P
ARMENT-2 67 ZEIT.PHYS.202 486 ARMENTEROS,FERRO-LUZZI+  (CERN,HEID,SACLAY)
UHLIG    67 PR 155 1448       +CHARLTCN,CONDON,GLASSER,YCDH,+   (UMD,NRL)

ARMENT-1 68 NP B8 195         ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
ARMENT-2 68 NP B8 216         ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY) I
BUGG     68 PR 168 1466       +GILMORE,KNIGHT,DAVIES+     (BIRM,CAVE,RHEL)I
SIMS     68 PRL 21 1413       SIMS,ALBRIGHT,BARTLEY,MEER+ (FSU,TUFT,BRAN)
SMART    68 PR 169 1330       W M SMART                             (LRL)IJP

BRICMAN1 70 PL 33B 511        +FERRO-LUZZI,LAGNAUX                  (CERN)
COOL     70 PR D1 1887        +GIACOMELLI, KYCIA, LEONTIC, LI, +    (BNL) I
GALTIERI 70 DUKE CONF 173     A BARBARO-GALTIERI                    (LRL)IJP

CONFORTO 71 NP  B34  41       +LEVI SETTI,LASINSKI..OBERLACK++ (EFI+HEID)IJP
KIM      71 PRL 27 356        J K KIM                              (HARV)IJP
    ALSO 70 DUKE 161          J. K. KIM                            (HARV)IJP

BARLETTA 72 NP B40 45         W.A. BARLETTA                         (EFI) IJP
KANE     72 PR D5 1583        D F KANE                              (LBL)IJP
LANGBEIN 72 NP B47 477        +WAGNER                              (MPIM)IJP
DEVENISH 74 NP B81 330        DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
PREVOST  74 NP B69 246        PREVOST,BARLOUTAUD,+        (SACL+CERN+HEID)

BAILLCN  75 NP B94 39         P. BAILLON,P. J. LITCHFIELD     (CERN,RHEL)IJP
VANHORN  75 NP B87 145        A. J. VAN HCRN                        (LBL)IJP
    ALSO 75 NP B87 157        A. J. VAN HORN                        (LBL)IJP

RLIC     76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSCN,ROSS+    (RHEL+LOIC)IJP

                              PAPERS NOT REFERRED TO IN CATA CARDS

FENSTER  66 PRL 17 841        +GELFAND,HARMSEN,L-SETTI,+ (CHIC,ANL(CERN))IJP
     -- FENSTER 66 IS SUPERSEDED BY BARLETTA 72
CONFORTO 68 NP B8 265         +HARMSEN, LASINSKI, +      (CHICAGO,HEIDEL)IJP
    SUPERSEDED BY CONFORTO 71.
HARRISON 70 FSU-HEP 70 3 1    W.C. HARRISCN (THESIS)                (FSU)
PREVOST  71  AMSTERDAM CONF   + CHS COLLABORATION         (CERN+HEID+SACL)
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Σ(1770) 100 Y*1(1770, JP=1/2+) I=1 **P''_{11}**

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                   100  Y*1(1770) MASS  (MEV)

M    1     1770.      20.            BAILLCN   75 IPWA   KBAR N TO PI LAM 11/75*
M    1  FROM SOLUTION 1 OF BAILLON 75, NOT PRESENT IN SCLUTION 2.           1/76*
M          1738.      10.            RLIC      76 DPWA   KBAR N MULTICHNL  1/76*
M        . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.4)

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                   100  Y*1(1770) WIDTH (MEV)

W    1      80.       30.            BAILLCN   75 IPWA   KBAR N TO PI LAM 11/75*
W           72.       10.            RLIC      76 DPWA   KBAR N MULTICHNL  1/76*
W        . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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    \              100  Y*1(1770) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      Y*1(1770) INTO KEAR N                               497+ 939
P2      Y*1(1770) INTO LAMBCA PI                           1115+ 139
P3      Y*1(1770) INTO SIGMA PI                            1197+ 139

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                   100  Y*1(1770) BRANCHING RATICS

R1      Y*1(1770) FROM KBAR N INTC LAMBDA PI                 SQRT(P1*P2)
R1   1         -.08      .02           BAILLCN   75 IPWA   KBAR N TO PI LAM 11/75*
R1           LESS THAN .04             RLIC      76 DPWA   KBAR N MULTICHNL  1/76*
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Baryons
Σ(1770), Σ(1840), Σ(1880), Σ(1915)

Data Card Listings
For notation, see key at front of Listings.

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R2     Y*1(1770) INTO (KBAR N)/TOTAL                       (P1)                1/76*
R2          .14      .04              RLIC       76 DPWA     KBAR N MULTICHNL  1/76*

R3     Y*1(1770) FROM KBAR N INTO SIGMA PI                 SQRT(P1*P3)         1/76*
R3           LESS THAN .04            RLIC       76 DPWA     KBAR N MULTICHNL  1/76*

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REFERENCES FOR Y*1(1770)


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BAILLON  75 NP B94 39         P. BAILLON,P. J. LITCHFIELD        (CERN,RHEL)IJP
RLIC        76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSON,ROSS+    (RHEL+LOIC)IJP
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Σ(1840) — P''_{13}

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       01   Y*1(1840, JP=3/2+) I=1
            SEE THE MINI-REVIEWS PRECEDING THE Y*0'S.

            FOR THE TIME BEING, WE LIST ALL RESONANCE CLAIMS IN THE
     P13 WAVE IN THE 1700-1900 MEV MASS REGION TOGETHER UNDER THIS HEADING.

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                       01  Y*1(1840) MASS (MEV)

M           1840.0    (10.0)             LANGBEIN  72 IPWA     MULTICHANNEL      12/72
M   1      (1720.)    (30.)              BAILLON   75 IPWA     KBAR N TO LAM PI 11/75*
M   1    FROM SOLUTION 1 OF BAILLON 75, NOT PRESENT IN SOLUTION 2.                1/76*
M           1925.     (200.)             VANHORN   75 DPWA   0 K- P TO LAM PIO  11/75*

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                       01  Y*1(1840) WIDTH (MEV)

W           120.0     (10.0)             LANGBEIN  72 IPWA     MULTICHANNEL      12/72
W   1      (120.)     (30.)              BAILLON   75 IPWA     KBAR N TO LAM PI 11/75*
W            65.      (50.)     (20.)    VANHORN   75 DPWA   0 K- P TO LAM PIO  11/75*

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                       01  Y*1(1840) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1     Y*1(1840) INTO KBAR N                                   497+ 939
P2     Y*1(1840) INTO SIGMA PI                                1197+ 139
P3     Y*1(1840) INTO LAMBDA PI                               1115+ 134

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                       01  Y*1(1840) BRANCHING RATIOS

R1     Y*1(1840) INTO (KBAR N)/TOTAL                       (P1)
R1          0.37     (0.13)              LANGBEIN  72 IPWA     MULTICHANNEL      12/72

R2     Y*1(1840) FROM KBAR N INTO SIGMA PI                 SQRT(P1*P2)
R2          0.15     (0.04)              LANGBEIN  72 IPWA     MULTICHANNEL      12/72

R3     Y*1(1840) FROM KBAR N INTO LAMBDA PI                SQRT(P1*P3)
R3          0.20     (0.04)              LANGBEIN  72 IPWA     MULTICHANNEL      12/72
R3          +.122     .078               DEVENISH  74        0 FIXED T DISP REL  4/75*
R3   1     (+.11)    (.02)               BAILLON   75 IPWA     KBAR N TO LAM PI 11/75*
R3          +.06     (.04)               VANHORN   75 DPWA   0 K- P TO LAM PIO  11/75*

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REFERENCES FOR Y*1(1840)


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LANGBEIN 72 NP B47 477        +WAGNER                                   (MPIM)IJP
DEVENISH 74 NP B81 330        DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
BAILLON  75 NP B94 39         P. BAILLON,P. J. LITCHFIELD        (CERN,RHEL)IJP
VANHORN  75 NP B87 145        A. J. VAN HORN                           (LBL)IJP
   ALSO  75 NP B87 157        A. J. VAN HORN                           (LBL)IJP
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Σ(1880) — P'''_{11}

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       67   Y*1(1880, JP=1/2+) I=1
            SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

            SUCH A RESONANCE IS SUGGESTED BY SOME BUT NOT ALL
            PARTIAL-WAVE ANALYSES ACROSS THIS REGION.  UNTIL THERE
            IS MORE EVIDENCE, WE OMIT THIS STATE FROM THE MAIN
            BARYON TABLE.

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                       67  Y*1(1880) MASS (MEV)

M          1882.0      40.0              SMART      68 DPWA -0 K- N TO LAM PI    7/68
M         (1850.0)                       BAILEY     69 DPWA  0 ELASTIC, CH EXCH 10/70
M         ABOUT 1850.0                   ARMENTERO 70 IPWA -0 ELASTIC, CH EXCH  6/70
M          1950.0      50.0              GALTIERI   70 DPWA -0 K- N TO LAM PI    7/70
M          1920.0      30.0              LITCHFIEL 70 DPWA -0 K- N TO LAM PI    6/70
M         (1772.0)                       KANE       72 DPWA    K-P TO SIGMA PI   1/73
M   2     (1898.)                        LEA        73 DPWA    MULTICHNL K-MTRX  9/73
M   2  ONLY UNCONSTRAINED STATES FROM TABLE 1 OF LEA73 ARE IN LISTINGS.         9/73
M   1     (1960.)     (30.)              BAILLON    75 IPWA    KBAR N TO LAM PI 11/75*
M   1   FROM SOLUTION 1 OF BAILLON 75, NOT PRESENT IN SOLUTION 2.                1/76*
M          1985.       50.               VANHORN    75 DPWA  0 K- P TO LAM PIO  11/75*
M          . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                       67  Y*1(1880) WIDTH (MEV)

W          222.0      150.0              SMART      68 DPWA -0 K- N TO LAM PI    7/68
W         (200.0)                        BAILEY     69 DPWA  0 ELASTIC, CH EXCH 10/70
W         ABOUT 30.0                     ARMENTERO 70 IPWA -0 ELASTIC, CH EXCH  6/70
W          200.0       50.0              GALTIERI   70 DPWA -0 K- N TO LAM PI    7/70
W          170.0       40.0              LITCHFIEL 70 DPWA -0 K- N TO LAM PI    6/70
W          (80.0)                        KANE       72 DPWA    K-P TO SIGMA PI   1/73
W   2     (222.2)                        LEA        73 DPWA    MULTICHNL K-MTRX  9/73
W   1     (260.)      (40.)              BAILLON    75 IPWA    KBAR N TO LAM PI 11/75*
W          220.       140.               VANHORN    75 DPWA  0 K- P TO LAM PIO  11/75*
W          . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                       67  Y*1(1880) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1     Y*1(1880) INTO KBAR N                                   497+ 939
P2     Y*1(1880) INTO LAMBDA PI                               1115+ 134
P3     Y*1(1880) INTO SIGMA PI                                1197+ 139

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                       67  Y*1(1880) BRANCHING RATIOS

R1     Y*1(1880) INTO (KBAR N)/TOTAL                       (P1)
R1          (0.22)                       BAILEY     69 DPWA  0 ELASTIC, CH EXCH 10/70
R1          (0.20)                       ARMENTERO 70 IPWA -0 ELASTIC, CH EXCH  6/70
R1   2      (.31)                        LEA        73 DPWA    MULTICHNL K-MTRX  9/73

R2     Y*1(1880) FROM KBAR N INTO LAMBDA PI                SQRT(P1*P2)
R2          -0.11      0.03              SMART      68 DPWA -0 K- N TO LAM PI    7/68
R2          -0.09      0.04              GALTIERI   70 DPWA -0 K- N TO LAM PI    7/70
R2          -0.14      0.03              LITCHFIEL 70 DPWA -0 K- N TO LAM PI    6/70
R2   2     (-.30)                        LEA        73 DPWA    MULTICHNL K-MTRX  9/73
R2          -.169      .119              DEVENISH   74       0 FIXED T DISP REL  4/75*
R2   1     (-.12)     (.02)              BAILLON    75 IPWA    KBAR N TO LAM PI 11/75*
R2          +.05       .07      .02      VANHORN    75 DPWA  0 K- P TO LAM PIO  11/75*
R2          . . . . . . . . .
R2   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R3     Y*1(1880) FROM KBAR N TO SIGMA PI                   SQRT(P1*P3)           9/73
R3         (-.108)                       KANE       72 DPWA    K-P TO SIGMA PI   9/73
R3   2      NOT SEEN                     LEA        73 DPWA    MULTICHNL K-MTRX  9/73

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REFERENCES FOR Y*1(1880)


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SMART     68 PR 169 1330      W M SMART                                 (LRL)IJP
BAILEY    69 THESIS UCRL-50617 DAVID SAAL BAILEY             (LRL LIVERMORE)IJP
ARMENTER 70 DUKE CONF 123     ARMENTEROS, BAILLON, +          (CERN, HEIDEL)IJP
GALTIERI 70 DUKE CONF 173     A BARBARO-GALTIERI                        (LRL)IJP
LITCHFIE 70 NP B22 269        P J LITCHFIELD                    (RUTHERFORD)IJP
KANE      72 PR D5 1583       D F KANE                                  (LBL)

LEA       73 NP B56 77        +MARTIN,MOORHOUSE+ (RHEL+LOUC+GLAS+AARHUS)IJP
DEVENISH 74 NP B81 330        DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
BAILLON  75 NP B94 39         P. BAILLON,P. J. LITCHFIELD        (CERN,RHEL)IJP
VANHORN  75 NP B87 145        A. J. VAN HORN                           (LBL)IJP
   ALSO  75 NP B87 157        A. J. VAN HORN                           (LBL)IJP
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Σ(1915) — F'_{15}

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       46   Y*1(1915, JP=5/2+) I=1
            SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

            THIS RESONANCE WAS FIRST SEEN IN THE TOTAL-CROSS-SEC-
            TION MEASUREMENTS OF COOL 66.  IN THIS ENTRY, HOWEVER,
            WE LIST ONLY THE RESULTS FROM PARTIAL-WAVE ANALYSES.
     SEE THE NEXT ENTRY FOR THE PARAMETERS OF PEAKS SEEN AROUND 1900-1950
     MEV IN CROSS SECTIONS AND INVARIANT-MASS DISTRIBUTIONS.  WE MAKE THIS
     SEPARATION BECAUSE ONLY THE PARTIAL-WAVE ANALYSES ISOLATE THE F15 WAVE
     (OR AT LEAST ATTEMPT TO -- THE SIGNAL IS WEAK).  THIS MASS REGION IS
     COMPLICATED AND POORLY UNDERSTOOD AND THE PEAKS MAY CONTAIN MORE THAN
     JUST THE Y*1(1915).  SEE ALSO THE NOTE TO THE NEXT ENTRY.

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                       46  Y*1(1915) MASS (MEV)

M          1902.0      11.0              SMART      68 DPWA -0 K-N TO LAMBDA PI  7/68
M          1910.0      20.0              BERTHON    70 DPWA  0 K-P TO LAMBDA PI  7/70
M          1900.0      15.0              BERTHON1   70 DPWA  0 K-P TO SIGMA PI  10/70
M   N      1936.0      (3.0)             BRICMAN1   70 DPWA    SIGTOT,ELAS,CHEX  1/71
M          1903.0      10.0              COX        70 DPWA -  K-N TO LAMBDA PI  6/70
M          1905.0      30.0              GALTIERI   70 DPWA  0 K-P TO LAMBDA PI  7/70
M          1895.0      10.0              LITCHFIEL 70 DPWA -0 K-N TO LAMBDA PI  6/70
M   B     (1985.0)    (21.0)             ISLAM      71 DPWA    KN--PI-SIG       12/72
M   B  DISCREPANCY DUE POSSIBLY TO INSUFFICIENT STATISTICS
M          1910.       15.               LITCHFIE   71 DPWA    K-P TO KBAR N    10/71
M          1925.0       8.0              KANE       72 DPWA  0 K-P TO PI SIG    10/71
M          1920.       30.               BAILLON    75 IPWA    KBAR N TO LAM PI 11/75*
M          1914.       10.               HEMINGWA   75 DPWA  0 K- P TO KBAR N   11/75*
M          1920.       15.      20.      VANHORN    75 DPWA  0 K- P TO LAM PIO  11/75*
M          1920.       10.               RLIC       76 DPWA    KBAR N MULTICHNL  1/76*
M   N   ERROR STATIST. ONLY- NO ERROR DUE TO PARTICULAR P.W.ANAL. INCLUDED      1/71
M          . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                       46  Y*1(1915) WIDTH (MEV)

W   A      (50.0)     (20.0)             ARMENTER1 67 DPWA  0 ELASTIC, CH EXCH 11/67
W           52.0       25.0              SMART      68 DPWA -0 K-N TO LAMBDA PI  7/68
W           60.0       20.0              BERTHON    70 DPWA  0 K-P TO LAMBDA PI  7/70
W           75.0       20.0              BERTHON1   70 DPWA  0 K-P TO SIGMA PI  10/70
W          135.0       12.0              BRICMAN1   70 DPWA    SIGTOT,ELAS,CHEX  1/71
W           77.0       27.0              COX        70 DPWA -  K-N TO LAMBDA PI  6/70
W           70.0       20.0              GALTIERI   70 DPWA  0 K-P TO LAMBDA PI  7/70
W           70.0       15.0              LITCHFIEL 70 DPWA -0 K-N TO LAMBDA PI  6/70
W   B     (159.0)     (80.0)             ISLAM      71 DPWA    KN--PI-SIG       12/72
W           70.        15.               LITCHFIE   71 DPWA    K-P TO KBAR N    10/71
W          146.0       22.0              KANE       72 DPWA  0 K-P TO PI SIG    10/71
W           70.        20.               BAILLON    75 IPWA    KBAR N TO LAM PI 11/75*
W           85.        15.               HEMINGWA   75 DPWA  0 K- P TO KBAR N   11/75*
W          102.        18.               VANHORN    75 DPWA  0 K- P TO LAM PIO  11/75*
W          130.        10.               RLIC       76 DPWA    KBAR N MULTICHNL  1/76*
W   A   LACK OF DATA PREVENTS FROM DETERMINING UNAMB. THIS AMPLITUDE             11/67
W          . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.9)

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                       46  Y*1(1915) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1     Y*1(1915) INTO KBAR N                                   497+ 939
P2     Y*1(1915) INTO LAMBDA PI                               1115+ 139
P3     Y*1(1915) INTO SIGMA PI                                1197+ 139

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Data Card Listings

For notation, see key at front of Listings.

Baryons

Σ(1915), Σ(1940)

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                    46  Y*1(1915) BRANCHING RATIOS

R1      Y*1(1915) INTO (KBAR N)/TOTAL                             (P1)
R1   A          (0.12)      (.01)           ARMENTER1 67 DPWA  0 ELASTIC, CH EXCH 11/67
R1               0.18      (0.02)           BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX  1/71
R1               0.11      (0.03)           CONFORTO  71 DPWA  0 ELASTIC, CH EXCH  6/70
R1               0.15      (0.04)           LITCHFIE  71 DPWA    K-P TO KBAR N    10/71
R1                .11       (.04)           HEMINGWA  75 DPWA  0 K- P TO KBAR N   11/75*
R1                .05       (.03)           RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

R2      Y*1(1915) FROM KBAR N INTO LAMBDA PI                      SQRT(P1*P2)
R2             -0.08       (0.02)           SMART     68 DPWA -0 K-N TO LAMBDA PI  7/68
R2             -0.1        (0.02)           BERTHON   70 DPWA  0 K-P TO LAMBDA PI  7/70
R2             -0.09       (0.02)           COX       70 DPWA -  K-N TO LAMBDA PI  6/70
R2             -0.11       (0.03)           GALTIERI  70 DPWA  0 K-P TO LAMBDA PI  7/70
R2             -0.07       (0.015)          LITCHFIEL 70 DPWA -0 K-N TO LAMBDA PI  6/70
R2              -.087       (.056)          DEVENISH  74       0 FIXED T DISP REL  4/75*
R2              -.06        (.02)           BAILLON   75 IPWA    KBAR N TO LAM PI 11/75*
R2              -.09        (.02)           VANHORN   75 DPWA  0 K- P TO LAM PIO  11/75*
R2              -.09        (.03)           RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

R3      Y*1(1915) FROM KBAR N INTO SIGMA PI                       SQRT(P1*P3)
R3   A          (0.00)     (0.01)           ARMENTERO 67 DPWA  0 K-P TO SIGMA PI  11/67
R3             -0.13       (0.03)           BERTHON1  70 DPWA  0 K-P TO SIGMA PI  10/70
R3             -0.06       (0.03)           GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70
R3   B          (0.06)     (0.02)           ISLAM     71 DPWA    KN--PI-SIG       12/72
R3             -0.137      (0.015)          KANE      72 DPWA  0 K-P TO PI SIG    10/71
R3              -.19        (.03)           RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

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                              REFERENCES FOR Y*1(1915)

ARMENTER 67 PL 24B 198          ARMENTEROS,FERRO-LUZZI+  (CERN,HEID,SACLAY)
ARMENTE1 67 NP B3 592           ARMENTEROS,FERRO-LUZZI+  (CERN,HEID,SACLAY)
SMART    68 PR 169 1330         W M SMART                            (LRL)IJP

BERTHON  70 NP B20 476          +RANGAN, VRANA, +(COL FRANCE, RHEL, SACLAY)IJP
BERTHON1 70 NP B24 417          +VRANA, BUTTERWORTH, + (CDEF, RHEL, SACLAY)IJ
BRICMAN1 70 PL 33B 511          +FERRO-LUZZI,LAGNAUX                 (CERN)
COX      70 NP B19 61           +ISLAM, COLLEY, +      (BIRM,EDIN,GLAS,LOIC)IJP
GALTIERI 70 DUKE CONF 173       A BARBARO-GALTIERI                   (LRL)IJP
LITCHFIE 70 NP B22 269          P J LITCHFIELD               (RUTHERFORD)IJP

CONFORTO 71 NP  B34 41          +LEVI SETTI,LASINSKI..OBERLACK++ (EFI+HEID)IJP
ISLAM    71 PJSIR 14 305        +COX,COLLEY,HEATHCOTE                (BIRM) IJP
   PAKISTAN J. SCI. IND. RES.
LITCHFIE 71 NP  B30 125         LITCHFIELD,...+LESQUOY,+.. (RHEL+CDEF+SACL)IJP
KANE     72 PR D5 1583          D F KANE                             (LBL)IJP
DEVENISH 74 NP B81 330          DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LCUC)

BAILLCN  75 NP B94 39           P. BAILLON,P. J. LITCHFIELD     (CERN,RHEL)IJP
HEMINGWA 75 NP B91 12           HEMINGWAY,EADES,HARMSEN+   (CERN,HEID,MPIM)IJP
VANHCRN  75 NP B87 145          A. J. VAN HORN                       (LBL)IJP
   ALSO  75 NP B87 157          A. J. VAN HORN                       (LBL)IJP

RLIC       76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSON,ROSS+     (RHEL+LOIC)IJP

                                PAPERS NOT REFERRED TO IN DATA CARDS

SMART    66 PRL 17 556          W M SMART,A KERNAN,G E KALMUS,R P ELY (LRL)IJP
   SUPERSEDED BY SMART 68.
CONFORTO 68 NP B8 265           +HARMSEN, LASINSKI, +      (CHICAGO, HEIDEL)
   SUPERSEDED BY CONFORTO 71.

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1915 MEV REGION – PRODUCTION AND σ_{TOTAL} EXP'TS

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                    29  Y*1(1915, JP=   ) I=1         PRODUCTION EXPERIMENTS

                    SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

                    SEE THE NOTES TO THE Y*1(1915) AND Y*1(1940), WHICH
                    IMMEDIATELY PRECEDE AND FOLLOW THIS ENTRY.  HERE WE
                    LIST ONLY PARAMETERS OF PEAKS SEEN IN CROSS SECTIONS
     AND INVARIANT-MASS DISTRIBUTIONS.  THE CROSS-SECTION PEAKS ARE ALMOST
     CERTAINLY ASSOCIATED WITH THE F15 Y*1(1915) SEEN IN PARTIAL-WAVE
     ANALYSES.  THE INVARIANT-MASS PEAKS SEEM MORE LIKELY TO BE ASSOCIATED
     WITH THE NOT-COMPLETELY-ESTABLISHED WITH THE D13 Y*(1940).

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                    29  Y*1(1915) MASS (MEV) (PROD. EXP.)

M          CROSS-SECTION PEAKS --
M            1905.0       5.0               BUGG      68 CNTR    K-P, D TOTAL     11/66
M            1906.0       6.0               BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
M            1912.0      10.0               COOL      70 CNTR    K-P, D TOTAL     10/70
M          INVARIANT-MASS-DISTRIBUTION PEAKS --
M           (1942.0)     (9.0)              BOCK      65 HBC     PBAR P 5.7 BEV/C
M            1940.0      11.0               AGUILAR   70 HBC  +  3.9-4.6 GEV/C K-  5/70
M          ELASTIC DCS --                                                          2/73
M    1       1931.       9.                 DADO      72 HBC   0 K-P ELSTC DCS     2/73
M    1   G7 INDICATED BY LEGENDRE COEFFS.,G9 NOT RULED OUT.                        2/73
M                . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 1.9)

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                    29  Y*1(1915) WIDTH (MEV) (PROD. EXP.)

W          CROSS-SECTION PEAKS --
W              60.0      10.0               BUGG      68 CNTR                     11/66
W              50.0      12.0               BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
W             (30.0)                        COOL      70 CNTR    K-P, D TOTAL     10/70
W          INVARIANT-MASS-DISTRIBUTION PEAKS --
W             (36.0)    (20.0)   (36.0)     BOCK      65 HBC
W              90.0      20.0               AGUILAR   70 HBC  +  3.9-4.6 GEV/C K-  5/70
W          ELASTIC DCS --                                                          2/73
W    1         70.       14.                DADO      72 HBC   0 K-P ELSTC DCS     2/73
W                . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 1.1)

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                    29  Y*1(1915) PARTIAL DECAY MODES (PROD. EXP.)

                                                                 DECAY MASSES
P1      Y*1(1915) INTO KBAR N                                  497+ 939
P2      Y*1(1915) INTO LAMBDA PI                              1115+ 134
P3      Y*1(1915) INTO SIGMA PI                               1197+ 139

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                    29  Y*1(1915) BRANCHING RATIOS (PROD. EXP.)

R1      Y*1(1915) INTO (KBAR N)/TOTAL                             (P1)
R1         THESE VALUES OF ELASTICITIES ASSUME J=5/2 --
R1               0.06                       BUGG      68 CNTR    ASSUMING J=5/2    6/68
R1               0.07      0.02             BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
R1               0.07                       COOL      70 CNTR    K-P, D TOTAL     10/70
R1   1  THIS ELASTICITY ASSUMES J=7/2                                              2/73
R1   1           .62        .08             DADO      72 HBC   0 K-P ELSTC DCS     2/73
R1               . . . . . . . . .
R1  AVG          0.10      0.13     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 6.7)
R1  STUDENT      0.077     0.022    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R2      Y*1(1915) INTO (KBAR N)/(SIGMA PI)                        (P1)/(P3)
R2             (.37) OR LESS                BARNES    69 HBC  +  1 STAN. DEV.     10/69

R3      Y*1(1915) INTO (LAMBCA PI)/(SIGMA PI)                     (P2)/(P3)
R3             (.28) OR LESS                BARNES    69 HBC  +  1 STAN. DEV.     10/69

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                              REFERENCES FOR Y*1(1915) (PROD. EXP.)

BOCK     65 PL 17 166           +COOPER,FRENCH,KINSON, +       (CERN,SACLAY) I
COOL     66 PRL 16 1228         +GIACOMELLI,KYCIA,LEONTIC,LI,LUNDBY,+ (BNL) I
   SUPERSEDED BY COOL 70.
BUGG     68 PR 168 1466         +GILMORE,KNIGHT,DAVIES+     (BIRM,CAVE,RHEL)I
BARNES   69 PRL 22 479          +FLAMINIO,MONTANET,SAMIOS +        (BNL+SYRA)

AGUILAR  70 PRL 25 58           AGUILAR-BENITEZ, BARNES, +         (BNL,SYRA)
BRICMAN  70 PL 31B 152          +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
COOL     70 PR D1 1887          +GIACOMELLI, KYCIA, LEONTIC, LI, +    (BNL) I
DADO     72 PRL 29 1695         +BIRMAN,GOLCBERG,WEISS                 (HAIF)JP

                                PAPERS NOT REFERRED TO IN DATA CARDS

PRIMER   68 PRL 20 610          +GCLDBERG,JAEGER,BARNES,DORNAN + (SYRA,BNL)
   SUPERSEDED BY BARNES 69 AND AGUILAR-BENITEZ 70.

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Σ(1940)

D_{13}'''

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                    98  Y*1(1940, JP=3/2-) I=1

                    SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

                    SUCH A RESCNANCE IS SUGGESTED BY SOME BUT NOT ALL
                    PARTIAL-WAVE ANALYSES IN THIS REGION.  THIS
                    EFFECT IS PERHAPS ASSOCIATED WITH THE BUMPS SEEN
                    IN PRODUCTION EXPERIMENTS NEAR THIS MASS.  SEE
                    THE PRECEDING ENTRY.

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                    98  Y*1(1940) MASS (MEV)

M            1940.0      50.0               GALTIERI  70 DPWA    K- N TO LAM PI    7/70
M            1940.0      40.0               GALTIERI  70 DPWA    K-P TO SIGMA PI   7/70
M            1940.0      30.0               LITCHFIEL 70 DPWA    K- N TO LAM PI    7/70
M            1985.0      (5.0)              KANE      72 DPWA  0 K-P TO PI SIG    10/71
M    2      (1865.)                         LEA       73 DPWA    MULTICHNL K-MTRX  9/73
M    2  ONLY UNCONSTRAINED STATES FROM TABLE 1 OF LEA73 ARE IN LISTINGS.           9/73
M            1940.       20.                LITCHFI2  74 DPWA  0 K-P TO L(1520)PI 10/74*
M            1950.       20.                LITCHFI3  74 DPWA  0 K-P TO KBAR DEL  10/74*
M            1950.       30.                BAILLCN   75 IPWA    KBAR N TO LAM PI 11/75*
M            1949.       40.       60.      VANHORN   75 DPWA  0 K- P TO LAM PIO  11/75*
M            1920.       50.                RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
M                . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                    98  Y*1(1940) WIDTH (MEV)

W             200.0      50.0               GALTIERI  70 DPWA    K- N TO LAM PI    7/70
W             200.0      50.0               GALTIERI  70 DPWA    K-P TO SIGMA PI   7/70
W             280.0      40.0               LITCHFIEL 70 DPWA    K- N TO LAM PI    7/70
W             208.0     (22.0)              KANE      72 DPWA  0 K-P TO PI SIG    10/71
W    2       (108.9)                        LEA       73 DPWA    MULTICHNL K-MTRX  9/73
W               60.      20.                LITCHFI2  74 DPWA  0 K-P TO L(1520)PI 10/74*
W               70.      30.       20.      LITCHFI3  74 DPWA  0 K-P TO KBAR DEL  10/74*
W              150.      75.                BAILLON   75 IPWA    KBAR N TO LAM PI 11/75*
W              160.      70.       40.      VANHORN   75 DPWA  0 K- P TO LAM PIO  11/75*
W              300.      80.                RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
W                . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 2.4)

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                    98  Y*1(1940) PARTIAL DECAY MODES

                                                                 DECAY MASSES
P1      Y*1(1940) INTO KBAR N                                  497+ 939
P2      Y*1(1940) INTO LAMBDA PI                              1115+ 139
P3      Y*1(1940) INTO SIGMA PI                               1197+ 139
P4      Y*1(1940) INTO Y*0(1520) PI P-WAVE                     134+1518
P5      Y*1(1940) INTO Y*0(1520) PI F-WAVE                     134+1518
P6      Y*1(1940) INTO KBAR DELTA(1232) S-WAVE                 493+1232
P7      Y*1(1940) INTO KBAR DELTA(1232) D-WAVE                 493+1232

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                    98  Y*1(1940) BRANCHING RATIOS

R1      Y*1(1940) FROM KBAR N INTO LAMBDA PI                      SQRT(P1*P2)
R1             -0.12       0.04             GALTIERI  70 DPWA    K- N TO LAM PI    7/70
R1             -0.14       0.03             LITCHFIEL 70 DPWA    K- N TO LAM PI    7/70
R1   2         (-.11)                       LEA       73 DPWA    MULTICHNL K-MTRX  9/73
R1              -.153       .070            DEVENISH  74       0 FIXED T DISP REL  4/75*
R1              -.04        .02             BAILLCN   75 IPWA    KBAR N TO LAM PI 11/75*
R1              -.05        .03       .02   VANHORN   75 DPWA  0 K-P TO LAM PIO   11/75*
R1              -.06        .03             RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
R1               . . . . . . . . .
R1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.5)

R2      Y*1(1940) FROM KBAR N INTO SIGMA PI                       SQRT(P1*P3)
R2             -0.12       0.03             GALTIERI  70 DPWA    K-P TO SIGMA PI   7/70
R2             -0.093     (0.0C6)           KANE      72 DPWA  0 K-P TO PI SIG    10/71
R2   2          NOT SEEN                    LEA       73 DPWA    MULTICHNL K-MTRX  9/73
R2              -.08        .04             RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
R2               . . . . . . . . .
R2   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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Baryons

Σ(1940), Σ(2000), Σ(2030)

Data Card Listings

For notation, see key at front of Listings.

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R3      Y*1(1940) INTO KBAR N                               (P1)            9/73
R3   2        (.21)                 LEA        73 DPWA    MULTICHNL K-MTRX  9/73
R3            LESS THAN .04         RLIC       76 DPWA    KBAR N MULTICHNL  1/76*
R3     NO SIGNAL FOR THIS STATE WITH X LARGER THAN ABOUT .03 IN THE        11/75*
R3     ANALYSIS OF HEMINGWAY 75.                                           11/75*

R4      Y*1(1940) FROM KBAR N TO Y*0(1520) PI P-WAVE      SQRT(P1*P4)
R4   1        -.11      .04         LITCHFI2  74 DPWA  0 K-P TO L(1520)PI 10/74*
R4   1 ASSUMES LAMBDA(1520) ELASTICITY=.45,SIGN RLTV. TC SIG(2030) DECAY.  10/74*

R5      Y*1(1940) FROM KBAR N TO Y*0(1520) PI F-WAVE      SQRT(P1*P5)
R5   1        -.08      .04         LITCHFI2  74 DPWA  0 K-P TO L(1520)PI 10/74*
R5   1 ASSUMES LAMBCA(1520) ELASTICITY=.45,SIGN RLTV. TC SIG(2030) DECAY.  10/74*

R6      Y*1(1940) FROM KBAR N TO KBAR DELTA(1232) S-WAVE SQRT(P1*P6)
R6   3        -.16      .05         LITCHFI3  74 DPWA  0 K-P TO KBAR DEL  10/74*
R6   3 SIGN RELATIVE TO SIGMA(2030) DECAY                                  10/74*

R7      Y*1(1940) FROM KBAR N TC KBAR CELTA(1232) D-WAVE SQRT(P1*P7)
R7   3        -.14      .05         LITCHFI3  74 DPWA  0 K-P TO KBAR DEL  10/74*
R7   3 SIGN RELATIVE TO SIGMA(2030) DECAY                                  10/74*

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                          REFERENCES FOR Y*1(1940)

GALTIERI 70 DUKE CCNF 173     A BARBARO-GALTIERI                         (LRL)IJP
LITCHFIE 70 NP B22 269        P J LITCHFIELD                       (RUTHERFORD)IJP
KANE     72 PR D5 1583        D F KANE                                   (LBL)IJP
LEA      73 NP B56 77         +MARTIN,MOORHOUSE+  (RHEL+LOUC+GLAS+AARHUS)IJP

DEVENISH 74 NP B81 330        DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
LITCHFI2 74 NP B74 19         LITCHFIELD,HEMINGWAY,BAILLCN,+  (CERN+HEID)IJP
LITCHFI3 74 NP B74 39         LITCHFIELD,HEMINGWAY,BAILLCN,+  (CERN+HEID)IJP

BAILLCN  75 NP B94 39         P. BAILLON,P. J. LITCHFIELC     (CERN,RHEL)IJP
VANHORN  75 NP B87 145        A. J. VAN HORN                         (LBL)IJP
    ALSO 75 NP B87 157        A. J. VAN HORN                         (LBL)IJP

RLIC     76 RL-75-182 (PRPNT) GOPAL,KALMLS,MCPHERSCN,ROSS+     (RHEL+LOIC)IJP

                              PAPERS NOT REFERREC TO IN CATA CARDS.

HEMINGWA 75 NF B91 12         HEMINGWAY,EADES,HARMSEN+   (CERN,HEID,MPIM)IJP

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Σ(2000) 02 Y*1(2000, JP=1/2-) I=1 **S''''_{11}**

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                02  Y*1(2000) MASS (MEV)

M         2004.      40.              VANHORN   75 DPWA  0 K-P TO LAM PIO   11/75*
M         1955.      15.              RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

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                02  Y*1(2000) WIDTH (MEV)

W          116.      40.              VANHORN   75 DPWA  0 K-P TO LAM PIO   11/75*
W          170.      40.              RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

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                02  Y*1(2000) PARTIAL DECAY MCDES

                                                            DECAY MASSES
P1      Y*1(2000) INTO KBAR N                              497+ 939
P2      Y*1(2000) INTO LAMBCA PI                          1115+ 134
P3      Y*1(2000) INTO SIGMA PI                           1197+ 139

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                02  Y*1(2000) BRANCHING RATIOS

R1      Y*1(2000) FROM KBAR N INTO LAMBDA PI               SQRT(P1*P2)
R1            NOT SEEN                BAILLON   75 IPWA    KBAR N TO LAM PI 11/75*
R1              +.07      .02     .01 VANHORN   75 DPWA  0 K-P TO LAM PIO   11/75*
R1               .08      .03         RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

R2      Y*1(2000) INTO (KBAR N)/TOTAL                      (P1)              1/76*
R2               .44      .05         RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

R3      Y*1(2000) FROM KBAR N INTO SIGMA PI                SQRT(P1*P3)       1/76*
R3              +.20      .04         RLIC      76 DPWA    KBAR N MULTICHNL  1/76*

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                          REFERENCES FOR Y*1(2000)

BAILLCN  75 NP B94 39         P. BAILLON,P. J. LITCHFIELD     (CERN,RHEL)IJP
VANHORN  75 NP B87 145        A. J. VAN HCRN                         (LBL)IJP
    ALSO 75 NP B87 157        A. J. VAN HCRN                         (LBL)IJP

RLIC     76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSCN,ROSS+     (RHEL+LOIC)IJP

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Σ(2030) 47 Y*1(2030, JP=7/2+) I=1 **F_{17}**

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                SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

                THIS ENTRY ONLY INCLUDES RESULTS FROM PARTIAL-WAVE
                ANALYSES.  PARAMETERS OF PEAKS SEEN IN CROSS-SECTIONS
                AND INVARIANT-MASS CISTRIBUTIONS ARCUND 2030 MEV ARE
   GIVEN IN THE NEXT ENTRY.  EVENTUALLY THE PARTIAL-WAVE ANALYSES SHOULD
   GIVE THE BEST RESULTS, AS THEY ISOLATE THE F17 WAVE.  THIS SUPERIORITY
   IS, HOWEVER, PROBABLY NCT YET ATTAINED, AND WE RELY CN BOTH ENTRIES
   FOR PARAMETERS GIVEN IN THE MAIN BARYON TABLE.

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                47  Y*1(2030) MASS (MEV)

M        (2030.0)   (20.0)            WOHL      66 HBC   0 K-P TO LAM PIO    7/66
M         2032.0      6.0             SMART     68 DPWA -  K-N TO LAMBDA PI  6/68
M         2030.0     10.0             BERTHON   70 DPWA  0 K-P TO LAMBDA PI  7/70
M         2035.0     10.0             BERTHON1  70 DPWA  0 K-P TO SIGMA PI  10/70
M         2027.0      6.0             COX       70 DPWA -  K-N TO LAMBDA PI  6/70
M         2010.0     15.0             GALTIERI  70 DPWA  0 K-P TO LAMBDA PI  7/70
M         2000.0     20.0             GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70
M         2022.0      4.0             LITCHFIEL 70 DPWA -0 K-N TO LAMBDA PI  6/70
M         2025.      15.              LITCHFIE  71 DPWA    K-P TO KBAR N    10/71
M         2034.0     14.0             KANE      72 DPWA  0 K-P TO PI SIG    10/71
M         2025.      10.              LITCHFI1  74 DPWA  0 K-P TO L(1815)PI 10/74*
M         2035.      10.              LITCHFI2  74 DPWA  0 K-P TO L(1520)PI 10/74*
M         2020.      30.              LITCHFI3  74 DPWA  0 K-P TO KBAR DEL  10/74*
M         2035.      15.              BAILLCN   75 IPWA    KBAR N TO LAM PI 11/75*
M         2038.      10.              HEMINGWA  75 DPWA  0 K- P TO KBAR N   11/75*
M         2042.      11.              VANHORN   75 DPWA  0 K-P TO LAM PIO   11/75*
M         2040.       5.              RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
M             . . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                47  Y*1(2030) WIDTH (MEV)

W         (170.0)                     WOHL      66 HBC   0                   7/66
W          160.0     16.0             SMART     68 DPWA -  K-N TO LAMBDA PI  6/68
W          165.0     30.0      15.0   BERTHON   70 DPWA  0 K-P TO LAMBDA PI  7/70
W          150.0     20.0             BERTHCN1  70 DPWA  0 K-P TO SIGMA PI  10/70
W          158.0     16.0             COX       70 DPWA -  K-N TO LAMBDA PI  6/70
W          115.0     15.0             GALTIERI  70 DPWA  0 K-P TO LAMBDA PI  7/70
W          100.0     40.0             GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70
W          170.0     15.0             LITCHFIEL 70 DPWA -0 K-N TO LAMBDA PI  6/70
W          200.      30.              LITCHFIE  71 DPWA    K-P TO KBAR N    10/71
W          118.0     12.0             KANE      72 DPWA  0 K-P TO PI SIG    10/71
W           70. TO  125.              LITCHFI1  74 DPWA  0 K-P TO L(1815)PI 10/74*
W          160.      20.              LITCHFI2  74 DPWA  0 K-P TO L(1520)PI 10/74*
W          200.      30.              LITCHFI3  74 DPWA  0 K-P TO KBAR DEL  10/74*
W          180.      20.              BAILLON   75 IPWA    KBAR N TO LAM PI 11/75*
W          172.      15.              HEMINGWA  75 DPWA  0 K- P TO KBAR N   11/75*
W          178.      13.              VANHORN   75 DPWA  0 K-P TO LAM PIO   11/75*
W          190.      10.              RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
W             . . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 1.7)

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                47  Y*1(2030) PARTIAL DECAY MODES

                                                            DECAY MASSES
P1      Y*1(2030) INTO KBAR N                              497+ 939
P2      Y*1(2030) INTO LAMBDA PI                          1115+ 134
P3      Y*1(2030) INTO SIGMA PI                           1197+ 139
P4      Y*1(2030) INTO XI K                               1321+ 497
P5      Y*1(2030) INTO Y*0(1815) PI P-WAVE                 134+1820
P6      Y*1(2030) INTO Y*0(1520) PI D-WAVE                 134+1518
P7      Y*1(2030) INTO Y*0(1520) PI G-WAVE                 134+1518
P8      Y*1(2030) INTO KBAR DELTA(1232) F-WAVE             493+1232
P9      Y*1(2030) INTO KBAR CELTA(1232) H-WAVE             493+1232

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                47  Y*1(2030) BRANCHING RATICS

R1      Y*1(2030) INTO (KBAR N)/TCTAL                      (P1)
R1            (0.25)                  WOHL      66 HBC   0 K-P CH EX         7/66
R1   D        (0.11)                  DAUM      68 CNTR    K-P ELA,POL,SIGT  7/70
R1             0.17      0.04         CAMPBELL  71 CBC  -  K- NEUTRON ELAST  1/71
R1             0.18      0.02         LITCHFIE  71 DPWA    K-P TO KBAR N   .10/71
R1              .18       .03         HEMINGWA  75 DPWA  0 K- P TO KBAR N   11/75*
R1              .24       .02         RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
R1   D  DAUM 68 ASSUMES (J+1/2)*P1 VALUE SEEN IN TOTAL CROSS SECTION.
R1            . . . . . . . . . .
R1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.4)

R2      Y*1(2030) FROM KBAR N INTO LAMBCA PI               SQRT(P1*P2)
R2            (0.20)                  WOHL      66 HBC   0 K-P TO LAMBDA PI  7/66
R2            +0.21      0.01         SMART     68 DPWA -  K-N TO LAMBDA PI  6/68
R2            +0.2       0.02         BERTHON   70 DPWA  0 K-P TO LAMBDA PI  7/70
R2            +0.19      0.01         COX       70 DPWA -  K-N TO LAMBDA PI  6/70
R2            +0.16      0.03         GALTIERI  70 DPWA  0 K-P TO LAMBDA PI  7/70
R2            +0.20      0.008        LITCHFIEL 70 DPWA -0 K-N TO LAMBDA PI  6/70
R2             +.195      .053        DEVENISH  74         0 FIXED T DISP REL  4/75*
R2             +.18       .02         BAILLON   75 IPWA    KBAR N TO LAM PI 11/75*
R2             +.20       .01         VANHORN   75 DPWA  0 K-P TO LAM PIO   11/75*
R2             +.18       .02         RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
R2            . . . . . . . . . .
R2   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R3      Y*1(2030) FROM KBAR N INTO SIGMA PI                SQRT(P1*P3)
R3   L        (-0.09)   (0.02)        BERTHON1  70 DPWA  0 K-P TO SIGMA PI  10/70
R3            -0.052     0.010        GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70
R3            -0.10      0.03         LITCHFIE  71 DPWA    K-P TO SIG PI     3/72
R3   L  LITCHFIELD 71 IS AN UPCATE OF BERTHON1 70                            3/72
R3            -0.086     0.014        KANE      72 DPWA  0 K-P TO PI SIG    10/71
R3             -.15       .03         RLIC      76 DPWA    KBAR N MULTICHNL  1/76*
R3            . . . . . . . . . .
R3   AVERAGE MEANINGLESS (SCALE FACTOR = 2.1)

R4      Y*1(2030) FROM KBAR N INTC XI K                    SQRT(P1*P4)
R4            (0.05) OR LESS          TRIPP     67 RVUE  0 K-P TO XI K       8/67
R4            (0.05) OR LESS          BURGUN    68 DPWA  0 K-P TO XI K      10/69
R4            (0.023)                 MULLER    69 DPWA  0                   7/70

R5      Y*1(2030) FROM KBAR N TO Y*0(1815) PI P-WAVE       SQRT(P1*P5)
R5   1         .18       .04          LITCHFI1  74 DPWA  0 K-P TO L(1815)PI 10/74*
R5   1  ASSUMES LAMBDA(1815) ELASTICITY=.6                                  10/74*
R5             .14       .02          CORDEN2   75 DBC   - KBAR PI- NUCLEON 11/75*
R5            . . . . . . . . . .
R5   AVG       0.148     0.018   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R5   STUDENT   0.148     0.020   AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R6      Y*1(2030) FROM KBAR N TO Y*0(1520) PI D-WAVE       SQRT(P1*P6)
R6   2         .14       .03          LITCHFI2  74 DPWA  0 K-P TO L(1520)PI 10/74*
R6   2  ASSUMES LAMBDA(1520) ELASTICITY=.45                                 10/74*
R6   3        (.10)     (.03)         CORDEN2   75 DBC   - KBAR PI- NUCLEON 11/75*
R6   3  UPPER LIMIT                                                         11/75*

R7      Y*1(2030) FROM KBAR N TO Y*0(1520) PI G-WAVE       SQRT(P1*P7)
R7   2         .02       .02          LITCHFI2  74 DPWA  0 K-P TO L(1520)PI 10/74*
R7   2  ASSUMES LAMBDA(1520) ELASTICITY=.45                                 10/74*
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Data Card Listings

For notation, see key at front of Listings.

Baryons

Σ(2030), Σ(2070), Σ(2080)

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R8      Y*1(2030) FRCM KBAR N TO KBAR CELTA(1232) F-WAVE SQRT(P1*P8)
R8             .16        .03           LITCHFI3   74 DPWA  0 K-P TO KBAR DEL   10/74*
R8   3       (.17)      (.03)           CORDEN2    75 DBC   - KBAR PI- NUCLEON 11/75*
R8   3    UPPER LIMIT                                                          11/75*

R9      Y*1(2030) FROM KBAR N TO KBAR DELTA(1232) H-WAVE SQRT(P1*P9)
R9             .00        .02           LITCHFI3   74 DPWA  0 K-P TO KBAR DEL   10/74*

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                         REFERENCES FOR Y*1(2030)

WOHL      66 PRL 17 107          C G WOHL, F T SOLMITZ, M L STEVENSON  (LRL)IJP
TRIPP     67 NP B3 10            + LEITH, +     (LRL,SLAC,CERN,HEIDEL,SACLAY)
BURGUN    68 NP B8 447           +MEYER,PAULI,TALLINI +      (SACL+CDEF+RHEL)
DAUM      68 NP B7 19            +ERNE,LAGNAUX,SENS,STEUER,UDO          (CERN)JP
   CCNFIRMS THE SPIN-PARITY ASSIGNMENT.
SMART     68 PR 169 1336         W M SMART                              (LRL)IJP
MULLER    69 THESIS,UCRL 19372 R A MULLER                               (LRL)

BERTHON   70 NP B20 476          +RANGAN, VRANA, +(COL FRANCE, RHEL, SACLAY)IJP
BERTHON1  70 NP B24 417          +VRANA, BUTTERWORTH, + (CDEF, RHEL, SACLAY)IJP
COX       70 NP B19 61           +ISLAM, COLLEY, +      (BIRM,EDIN,GLAS,LOIC)IJP
GALTIERI  70 DUKE CONF 173       A BARBARO-GALTIERI                     (LRL)IJP
LITCHFIE  70 NP B22 269          P J LITCHFIELD                  (RUTHERFORD)IJP

CAMPBELL  71 NP B25 75           +MORTON, NEGUS, GOYAL, MILLER  (GLAS, LOIC)IJP
LITCHFIE  71 NP  B30 125         LITCHFIELD,...+LESQUOY,+.. (RHEL+CDEF+SACL)IJP
KANE      72 PR D5 1583          D F KANE                               (LBL)IJP

DEVENISH  74 NP B81 330          DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
LITCHFI1  74 NP B74 12           LITCHFIELD,HEMINGWAY,BAILLON,+  (CERN+HEID)IJP
LITCHFI2  74 NP B74 19           LITCHFIELD,HEMINGWAY,BAILLCN,+  (CERN+HEID)IJP
LITCHFI3  74 NP B74 39           LITCHFIELD,HEMINGWAY,BAILLON,+  (CERN+HEID)IJP

BAILLON   75 NP B94 39           P. BAILLON,P. J. LITCHFIELC     (CERN,RHEL)IJP
CORDEN2   75 NP B92 365          +COX,DARTNELL,KENYON,ONEALE,SUMOROK+ (BIRM)IJP
HEMINGWA  75 NP B91 12           HEMINGWAY,EADES,HARMSEN+   (CERN,HEID,MPIM)IJP
VANHORN   75 NP B87 145          A. J. VAN HORN                         (LBL)IJP
    ALSO  75 NP B87 157          A. J. VAN HORN                         (LBL)IJP

RLIC      76 RL-75-182 (PRPNT) GOPAL,KALMUS,MCPHERSCN,ROSS+    (RHEL+LOIC)IJP

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2030 MEV REGION – PRODUCTION AND σ_{TOTAL} EXP'TS

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                28  Y*1(2030, JP=    ) I=1        PRCCUCTION EXPERIMENTS

                SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

                SEE THE NOTE TO THE F17 Y*1(2030), WHICH PRECEDES THIS
                ENTRY.  HERE WE LIST ONLY PARAMETERS OF PEAKS IN CROSS
                SECTIONS AND INVARIANT-MASS DISTRIBUTIONS.  THE CROSS-
   SECTION PEAKS ARE AT LEAST DOMINANTLY ASSOCIATED WITH THE Y*1(2030),
   BUT MAY CONTAIN A SMALL CONTRIBUTION FROM THE SUGGESTED BUT NOT ESTAB-
   LISHED OTHER RESONANCES IN THIS REGION.

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                28  Y*1(2030) MASS (MEV) (PROD. EXP.)

M        (2022.0)   (20.0)            BLANPIED  65 CNTR  0 GAMMA P TO K+ Y*
M         2020.0      7.0             BUGG      68 CNTR    K-P, D TOTAL      6/68
M         2049.0      4.0             BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
M         2025.0     10.0             COOL      70 CNTR    K-P, D TOTAL     10/70
M        (2025.0)   (20.0)            LU        70 CNTR  0 GAMMA P TO K+ Y*  1/71
M          . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 2.8)

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                28  Y*1(2030) WIDTH (MEV) (PROD. EXP.)

W         (120.0)   (20.0)            BLANPIED  65 CNTR  0
W          130.0     10.0             BUGG      68 CNTR                      6/68
W          126.0     11.0             BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
W          165.0                      COOL      70 CNTR    K-P, D TOTAL     10/70
W         (80.0)                      LU        70 CNTR  0 GAMMA P TO K+ Y*  1/71
W          . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                28  Y*1(2030) PARTIAL DECAY MCDES (PROD. EXP.)

                                                          DECAY MASSES
P1      Y*1(2030) INTO KBAR N                           497+ 939
P2      Y*1(2030) INTO KBAR N PI                        497+ 939+ 139

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                28  Y*1(2030) BRANCHING RATICS (PROD. EXP.)

R1      Y*1(2030) INTO (KBAR N)/TOTAL                   (P1)
R1         THESE VALUES OF ELASTICITIES ASSUME J=7/2 --
R1            0.131                    BUGG      68 CNTR                      6/68
R1            0.27     (0.02)          BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
R1            0.12        .            COOL      70 CNTR    K-P, D TOTAL     10/70

R2      Y*1(2030) INTO KBAR N PI                        (P2)
R2               SEEN                  BOCK      HBC

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                         REFERENCES FOR Y*1(2030) (PROD. EXP.)

BLANPIED 65 PRL 14 741          +GREENBERG,HUGHES,KITCHING,LU,+ (YALE(CEA))
COOL     66 PRL 16 1228         +GIACOMELLI,KYCIA,LEONTIC,LI,LUNDBY,+ (BNL) I
   SUPERSEDED BY COOL 7C.
BUGG     68 PR 168 1466         +GILMORE,KNIGHT, +          (RHEL,BIRM,CAVE) I

BRICMAN  70 PL 31B 152          +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
COOL     70 PR D1 1887          +GIACOMELLI, KYCIA, LEONTIC, LI, +    (BNL) I
LU       70 PR D2 1846          +GREENBERG, HUGHES, MINEHART, MORI,+ (YALE)

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Σ(2070) → F′′15

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34  Y*1(2070, JP=5/2+) I=1   F''15

                THIS STATE HAS BEEN SUGGESTED BY ONLY CNE PARTIAL
                WAVE ANALYSIS ACROSS THIS REGION. IT NEEDS CONFIRMATICN
                THE RESCNANCE PROPOSED BY KANE IS TOO BROAD TO
                BE LSED AS EVIDENCE.

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                34  Y*1(2070) MASS (MEV)

M        (2070.)     (10.)            BERTHCN1  70 DPWA -  K- P TO SIG PI     1/71
M        (2057.0)                     KANE      72 DPWA    K-P TO SIGMA PI    1/73

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                34  Y*1(2C70) WIDTH (MEV)

W         (140.)     (20.)            BERTHON1  70 DPWA -  K- P TO SIG PI     1/71
W         (906.0)                     KANE      72 DPWA    K-P TO SIGMA PI    1/73

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                34  Y*1(2070) PARTIAL DECAY MODES

                                                          CECAY MASSES
P1      Y*1(2070) INTO KBAR N                           497+ 939
P2      Y*1(2070) INTO SIGMA PI                        1197+ 139

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                34  Y*1(2C70) BRANCHING RATIOS

R1      Y*1(2070) FROM KBAR N TC SIGMA                 SQRT(P1*P2)
R1           (+.12)     (.02)         BERTHON1  70 DPWA -  K- P TO SIG PI     1/71
R1          (+0.104)                  KANE      72 DPWA    K-P TO SIGMA PI    1/73

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                         REFERENCES FOR Y*1(2070)

BERTHCN1 70 NP B24 417          +VRANA,BUTTERWORTH,+       (CDEF,RHEL,SACLAY)IJP
KANE     72 PR D5 1583          D F KANE                                 (LBL)

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Σ(2080) → P′′′13

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88  Y*1(2080, JP=3/2+) I=1   P'''13

                SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

                SUCH A RESCNANCE IS SUGGESTEC BY SCME BUT NOT ALL
                PARTIAL-WAVE ANALYSES ACROSS THIS REGION.  UNTIL THERE
                IS MORE EVICENCE, WE CMIT THIS STATE FROM THE MAIN
                BARYON TABLE.

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                88  Y*1(2080) MASS (MEV)

M        (2082.0)    (4.0)            COX        70 DPWA -  K- N TC LAM PI    6/70
M        (2070.0)   (30.0)            LITCHFIEL  70 DPWA -0 K- N TO LAM PI    6/70
M    1    2120.      40.              BAILLCN    75 IPWA    KBAR N TC LAM PI 11/75*
M    1  FROM SOLUTION 1 OF EAILLCN 75.                                        1/76*
M    2    2140.      40.              BAILLCN    75 IPWA    KBAR N TO LAM PI  1/76*
M    2  FROM SOLUTION 2 OF BAILLON 75.                                        1/76*
M         2140.      30.              BELLEFO1   75 DPWA  0 K- P TO LAM PIO  11/75*
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                88  Y*1(2080) WIDTH (MEV)

W          (87.0)   (20.0)            COX        70 DPWA -  K- N TO LAM PI    6/70
W         (250.0)   (40.0)            LITCHFIEL  70 DPWA -0 K- N TO LAM PI    6/70
W    1     240.      50.              BAILLCN    75 IPWA    KBAR N TO LAM PI 11/75*
W    2     200.      50.              BAILLON    75 IPWA    KBAR N TO LAM PI  1/76*
W          180.      20.              BELLEFC1   75 DPWA  0 K- P TO LAM PIO  11/75*
W          . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                88  Y*1(2080) PARTIAL DECAY MCDES

                                                          DECAY MASSES
P1      Y*1(2080) INTO KBAR N                           497+ 939
P2      Y*1(2080) INTO LAMBDA PI                       1115+ 139

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                88  Y*1(2080) BRANCHING RATIOS

R1      Y*1(2080) FRCM KBAR N TO LAMBDA PI             SQRT(P1*P2)
R1          (-0.16)   (0.03)          COX        70 DPWA -  K- N TO LAM PI    6/70
R1          (-0.09)   (0.03)          LITCHFIEL  70 DPWA -0 K- N TO LAM PI    6/70
R1   1        -.13      .04           BAILLON    75 IPWA    KBAR N TO LAM PI 11/75*
R1   2        -.13      .04           BAILLCN    75 IPWA    KBAR N TO LAM PI  1/76*
R1            +.19      .03           BELLEFO1   75 DPWA  0 K- P TO LAM PIO  11/75*
R1         . . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                         REFERENCES FOR Y*1(2080)

COX      70 NP B19 61           +ISLAM, CCLLEY, +      (BIRM,EDIN,GLAS,LOIC)IJP
LITCHFIE 70 NP B22 269          P J LITCHFIELD                   (RUTHERFORD)IJP
BAILLON  75 NP B94 39           P. BAILLON,P. J. LITCHFIELC       (CERN,RHEL)IJP
BELLEFO1 75 NP B90 1            DE BELLEFON,BERTHON,BRUNET+       (CDEF,SACL)IJP

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Baryons

Σ(2100), Σ(2250), Σ(2455)

Data Card Listings

For notation, see key at front of Listings.

Σ(2100)

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26  Y*1(2100, JP=7/2-) I=1   G17

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

SUCH A RESCNANCE IS SUGGESTED BY SOME BUT NOT ALL
PARTIAL-WAVE ANALYSES ACROSS THIS REGION.  UNTIL THERE
IS MORE EVIDENCE, WE OMIT THIS STATE FROM THE MAIN
BARYON TABLE.

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               26  Y*1(2100) MASS (MEV)

M       (2060.0)   (20.0)           GALTIERI  70 DPWA  0 K-P TO LAMBDA PI  7/70
M       (2120.0)   (30.0)           GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70

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               26  Y*1(2100) WIDTH (MEV)

W         (70.0)   (30.0)           GALTIERI  70 DPWA  0 K-P TO LAMBDA PI  7/70
W        (135.0)   (30.0)           GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70

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               26  Y*1(2100) PARTIAL DECAY MODES

                                                        DECAY MASSES
P1     Y*1(2100) INTO KBAR N                           497+ 939
P2     Y*1(2100) INTO LAMBDA PI                       1115+ 134
P3     Y*1(2100) INTO SIGMA PI                        1197+ 139

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               26  Y*1(2100) BRANCHING RATIOS

R1     Y*1(2100) FROM KBAR N TC LAMBDA PI             SQRT(P1*P2)
R1          (-0.07)   (0.02)        GALTIERI  70 DPWA  0 K-P TO LAMBDA PI  7/70

R2     Y*1(2100) FROM KBAR N TO SIGMA PI              SQRT(P1*P3)
R2          (+0.13)   (0.02)        GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70

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                        REFERENCES FOR Y*1(2100)

GALTIERI 70 DUKE CCNF 173      A BARBARO-GALTIERI                     (LRL)IJP

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Σ(2250) BUMPS

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48  Y*1(2250, JP=     ) I=1        PRCDUCTION EXPERIMENTS

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

THE PARTIAL-WAVE ANALYSIS RESULTS ARE TOO WEAK TO
WARRANT SEPARATING THEM FROM THE PRODUCTION AND CROSS-
SECTION EXPERIMENTS.
   LASINSKI 71 IN KBAR N, USING A POMERON+RESONANCES MODEL, AND
BELLEFON1 75,76 IN DPWA'S OF LAMBDA PI AND SIGMA PI SUGGEST THE
PRESENCE OF TWO RESONANCES AROUND THIS MASS VALUE.

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               48  Y*1(2250) MASS (MEV) (PROD. EXP.)

M         (2245.0)                  BLANPIED  65 CNTR    GAMMA P TO K+ Y*
M         (2299.0)   (6.0)          BOCK      65 HBC     PBAR P 5.7 BEV/C
M          2250.0     7.0           BUGG      68 CNTR    K-P, D TOTAL      6/68
M          2280.     14.0           AGUILAR   70 HBC   + K- 3.9-4.6 GEV/C  5/70
M          2237.0    11.0           BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
M          2255.0    10.0           COOL      70 CNTR    K-P, D TOTAL     10/70
M         (2250.0)  (20.0)          LU        70 CNTR  0 GAMMA P TO K+ Y*  1/71
M   B     (2260.)   (30.)           BELLEFO1  75 DPWA    D5 WAVE          11/75*
M   B     (2215.)   (10.)           BELLEFO1  75 DPWA    G9 OR H11 WAVE   11/75*
M   B   EVIDENCE FOR 2 RESONANCES IN THIS LAMBDA PI DPWA                  11/75*
M    1     2300.     30.            BELLEFO2  75 HBC   0 K- P TO XI*0 KO  11/75*
M    V     2251.     30.      20.   VANHORN   75 DPWA  0 K-P TO LAM PIO   11/75*
M    V    VANHORN72 VALUE FROM A DPWA THAT FINDS JP=5/2+.
M          2270.     10.            BELLEFON  76 DPWA  0 D5 WAVE           1/76*
M          2210.     10.            BELLEFCN  76 DPWA  0 G9 WAVE           1/76*
M             . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 2.0)

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               48  Y*1(2250) WIDTH (MEV) (PROD. EXP.)

W          (150.0)                  BLANPIED  65 CNTR    GAMMA P TO K+ Y*
W           (21.0)  (17.0)  (21.0)  BOCK      65 HBC     PBAR P 5.7 GEV/C
W          230.0     20.0           BUGG      68 CNTR    K-P, D TOTAL      6/68
W          100.0     20.0           AGUILAR   70 HBC   + K- 3.9-4.6 GEV/C  5/70
W          164.0     50.0           BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
W          (170.0)                  COOL      70 CNTR    K-P, D TOTAL     10/70
W          (125.0)                  LU        70 CNTR  0 GAMMA P TO K+ Y*  1/71
W   B      (100.)   (20.)           BELLEFO1  75 DPWA    D5 WAVE          11/75*
W   B       (60.)   (40.)   (20.)   BELLEFO1  75 DPWA    G9 OR H11 WAVE   11/75*
W    1      130.     20.            BELLEFO2  75 HBC   0 K- P TC XI*0 KO  11/75*
W    V      192.     30.            VANHORN   75 DPWA  0 K-P TO LAM PIO   11/75*
W            70.     20.            BELLEFCN  76 DPWA  0 D5 WAVE           1/76*
W            60.     10.            BELLEFCN  76 DPWA  0 G9 WAVE           1/76*
W             . . . . . . . . . .
W   AVG     102.5    23.9   .  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 3.5)
W   STUDENT  96.0    14.4      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
              SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

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               48  Y*1(2250) PARTIAL DECAY MODES (PROD. EXP.)

                                                        DECAY MASSES
P1     Y*1(2250) INTO KBAR N                           497+ 939
P2     Y*1(2250) INTO LAMBDA PI                       1115+ 134
P3     Y*1(2250) INTO SIGMA PI                        1197+ 139
P4     Y*1(2250) INTO KBAR N PI                        497+ 939+ 139
P5     Y*1(2250) INTO XI*1/2(1530) K                  1533+ 497

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               48  Y*1(2250) BRANCHING RATICS (PROD. EXP.)

R1     Y*1(2250) INTO (KEAR N)/TOTAL                  (P1)
R1        J IS NOT DETERMINED.  THE FOLLOWING IS (J+1/2)*P1.
R1          (0.47)                  BUGG      68 CNTR                      6/68
R1          (0.16)   (0.12)         BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
R1          (0.42)                  COOL      70 CNTR    K-P, D TOTAL     10/70

R2     Y*1(2250) FROM KBAR N TO LAMBCA PI             SQRT(P1*P2)
R2          (-0.18)(FOR JP=9/2-)    GALTIERI  70 DPWA    K-P TO LAMBDA PI 10/70
R2  B       (+.12)    (.03)         BELLEFO1  75 DPWA    D5 WAVE          11/75*
R2  B       (-.09)    (.02)         BELLEFO1  75 DPWA    G9 OR H11 WAVE   11/75*
R2   V       -.16      .03          VANHORN   75 DPWA  0 K-P TO LAM PIO   11/75*
              SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

R3     Y*1(2250) FROM KBAR N TO SIGMA PI              SQRT(P1*P3)
R3          (+0.07)(FOR JP=9/2-)    GALTIERI  70 DPWA    K-P TO SIGMA PI  10/70
R3           +.06      .02          BELLEFCN  76 DPWA  0 D5 WAVE           1/76*
R3           -.03      .01          BELLEFON  76 DPWA  0 G9 WAVE           1/76*
R3            . . . . . . . . . .
R3  AVERAGE MEANINGLESS (SCALE FACTOR = 1.3)

R4     Y*1(2250) INTO (KBAR N)/(SIGMA PI)             (P1)/(P3)
R4          (0.18) OR LESS          BARNES    69 HBC   + 1 STAN DEV LIMIT 10/69

R5     Y*1(2250) INTO (LAMBCA PI)/(SIGMA PI)          (P2)/(P3)
R5          (0.18) OR LESS          BARNES    69 HBC   + 1 STAN DEV LIMIT 10/69

R6     Y*1(2250) FRCM K- P TO XI*1/2(1530)0 KO        SQRT(P1*P5)         11/75*
R6  1         .09      .02          BELLEFO2  75 HBC   0 K- P TO XI*0 KO  11/75*
R6  1  SEEN IN DD5 WAVE IN NEUTRAL CHANNEL ONLY, ISOSPIN UNDETERMINED.    11/75*

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                             REFERENCES FOR Y*1(2250) (PROD. EXP.)
BLANPIED 65 PRL 14 741       +GREENBERG,HUGHES,KITCHING, +    (YALE(CEA))
BOCK     65 PL 17 166        +COOPER,FRENCH,KINSON, +       (CERN,SACLAY)
BUGG     68 PR 168 1466      +GILMORE,KNIGHT, +           (RHEL,BIRM,CAVE) I
BARNES   69 PRL 22 479       +FLAMINIO,MONTANET,SAMIOS +        (BNL+SYRA)

AGUILAR  70 PRL 25 58        AGUILAR-BENITEZ, BARNES, +         (BNL,SYRA)
BRICMAN  70 PL 31B 152       +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
COOL     70 PR D1 1887       +GIACOMELLI, KYCIA, LEONTIC, LI, +    (BNL) I
GALTIERI 70 DUKE CONF 173    A BARBARO-GALTIERI                   (LRL)IJP
LU       70 PR D2 1846       +GREENBERG, HUGHES, MINEHART, MORI,+ (YALE)

BELLEFO1 75 NP B90 1         DE BELLEFCN,BERTHON,BRUNET+     (CDEF+SACL)IJP
BELLEFO2 75 NC 28A 289       DE BELLEFON,BERTHON,BILLOIR+    (CDEF,SACL)
VANHORN  75 NP B87 145       A. J. VAN HORN                       (LBL)IJP
    ALSO 75 NP B87 157       A. J. VAN HORN                       (LBL)IJP

BELLEFCN 76 SBMTD. TO NP     DE BELLEFCN,BILLOIR,BERTHON+    (CDEF+SACL)IJP

                             PAPERS NOT REFERRED TO IN DATA CARDS

COOL     66 PRL 16 1228      +GIACOMELLI,KYCIA,LECNTIC,LI,LUNDBY,+ (BNL) I
   SUPEREDED BY COOL 70.
DAUBER   66 PL 23 154        +SCHLEIN, SLATER, STORK, TICHO  (UCLA(LRL)) J
   SUGGESTS J≠9/2 RESONANT BEHAVIOR IN SIGMA- PI+, BUT APPEARS
         INCONSISTENT WITH PARAMETERS OF COOL 66.
DAUM     68 NP B7 19         +ERNE, LAGNAUX, SENS, STEUER, UDO     (CERN)JP
LASINSKI 71 NP  B29  125     T A LASINSKI                          (EFI)IJP
HEMINGWA 75 NP B91 12        HEMINGWAY,EADES,HARMSEN+    (CERN,HEID,MPIM)IJP
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Σ(2455) BUMPS

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53  Y*1(2455, JP=     ) I=1        PROCUCTION EXPERIMENTS

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.
THERE IS ALSO SOME SLIGHT EVIDENCE FOR Y* STATES IN
THIS MASS REGION FROM THE REACTION GAMMA + P TO K+ + MISSING MASS --
SEE GREENBERG 68.

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               53  Y*1(2455) MASS (MEV) (PRCD. EXP.)

M          2455.0     7.0           BUGG      68 CNTR    K-P, D TOTAL      6/68
M          2455.0    10.0           ABRAMS    70 CNTR    K-P, D TOTAL     10/70
M             . . . . . . . . . .
M   AVG    2455.0     5.7     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   STUDENT2455.0     6.1     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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               53  Y*1(2455) WIDTH (MEV) (PROD. EXP.)

W          100.0     20.0           BUGG      68 CNTR                      6/68
W          140.0                    ABRAMS    70 CNTR    K-P, D TOTAL     10/70

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               53  Y*1(2455) PARTIAL DECAY MCDES (PROD. EXP.)

                                                        DECAY MASSES
P1     Y*1(2455) INTO KBAR N                           497+ 939

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               53  Y*1(2455) BRANCHING RATIOS (PROD. EXP.)

R1     Y*1(2455) INTO (KBAR N)/TOTAL                  (P1)
R1        J IS NOT KNOWN.  THE FOLLOWING IS (J+1/2)*P1.
R1          (0.3)                   BUGG      68 CNTR                      6/68
R1           0.39                   ABRAMS    70 CNTR    K-P, D TOTAL     10/70
R1  C       (0.05)   (0.05)         BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
R1  C    FIT OF TOTAL CROSS SECTION GIVEN BY BRICMAN 70 IS POOR IN
R1  C    THIS REGION.

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                             REFERENCES FOR Y*1(2455) (PROD. EXP.)

BUGG     68 PR 168 1466      +GILMORE,KNIGHT, +           (RHEL,BIRM,CAVE) I
ABRAMS   70 PR 1D 1917       +COOL, GIACOMELLI, KYCIA, LEONTIC, +  (BNL) I
BRICMAN  70 PL 31B 152       +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)

                             PAPERS NOT REFERRED TO IN DATA CARDS
ABRAMS   67 PRL 19 678       +COOL,GIACOMELLI,KYCIA,LEONTIC,LI, +  (BNL)
   SUPERSEDED BY ABRAMS 70.
GREENBER 68 PRL 20 221       GREENBERG, HUGHES, LU, MINEHART, +   (YALE)
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Data Card Listings

Baryons

For notation, see key at front of Listings. Σ(2620), Σ(3000), EXOTIC HYPERONS, Ξ's, Ξ^-, Ξ^0

Σ(2620) BUMPS

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54  Y*1(2620, JP=     ) I=1        PRODUCTICN EXPERIMENTS
SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

                54  Y*1(2620) MASS (MEV) (PROD. EXP.)

M          2620.0     15.0            ABRAMS    70 CNTR    K-P, D TOTAL      10/70
M          2542.      22.             DIBIANCA  75 DBC     XI K PI            1/76*
M          . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 2.9)

                54  Y*1(2620) WIDTH (MEV) (PROD. EXP.)

W          (175.0)                    ABRAMS    70 CNTR    K-P, D TOTAL      10/70
W           221.      81.             DIBIANCA  75 DBC     XI K PI            1/76*

                54  Y*1(2620) PARTIAL DECAY MODES (PROD. EXP.)

                                                             DECAY MASSES
P1      Y*1(2620) INTO KBAR N                               497+ 939

                54  Y*1(2620) BRANCHING RATIOS (PROD. EXP.)

R1      Y*1(2620) INTO (KBAR N)/TOTAL                       (P1)
R1          J IS NOT KNOWN.  THE FOLLOWING IS (J+1/2)*P1.
R1          (0.32)                    ABRAMS    70 CNTR    K-P, D TOTAL      10/70
R1            0.36      0.12          BRICMAN   70 CNTR  0 TOTAL AND CH EX    6/70

                          REFERENCES FOR Y*1(2620) (PROD. EXP.)

ABRAMS    67 PRL 19 678        +COOL,GIACOMELLI,KYCIA,LEONTIC,LI, +  (BNL)
    SUPERSEDED BY ABRAMS 70.
ABRAMS    70 PR 1D 1917        +COOL, GIACOMELLI, KYCIA, LEONTIC, +  (BNL) I
BRICMAN   70 PL 31B 152        +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)

DIBIANCA 75 NP B98 137         DIBIANCA,ENDORFR                      (CARN)
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Σ(3000) BUMPS

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59  Y*1(3000, JP=     ) I=1        PRODUCTION EXPERIMENTS
SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

ENHANCEMENT IN LAMBDA PI AND KBAR N INVARIANT MASS
SPECTRA AND IN MISSING MASS OF NEUTRALS RECOILING
AGAINST K0.  EVIDENCE NOT CONCLUSIVE.  OMITTED FROM
TABLE.

                59  Y*1(3000) MASS (MEV) (PROD. EXP.)

M          (3000.0)                   EHRLICH   66 HBC   0 PI-P 7.91 BEV/C    9/66

                59  Y*1(3000) PARTIAL DECAY MODES (PROD. EXP.)

                                                             DECAY MASSES
P1      Y*1(3000) INTO KBAR N                               497+ 939
P2      Y*1(3000) INTO LAMBDA PI                           1115+ 139

                          REFERENCES FOR Y*1(3000) (PROD. EXP.)

EHRLICH  66 PR 152 1194        R EHRLICH, W SELOVE, H YUTA     (PENN(BNL)) I
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EXOTIC HYPERON CROSS SECTION LIMITS

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                THIS IS NOT A COMPLETE LIST.  WE TABULATE
                ONLY FROM 1970 ON.

CS  UNITS MICROBARNS
CS  G       (20.)   OR LESS            GALTIERI  68 DBC     K-N TO SG-PI-PIO  7/70
CS  G   ABOVE LIMIT FOR MASS <  2.15 GEV AND GAMMA <  60 MEV- (2.1 GEV/C K-)  7/70
CS  A       (40.)   OR LESS            GALTIERI  68 DBC  -- K-N TO SG-PI-PIO  7/70
CS  A   ABOVE LIMIT FOR MASS <  2.3 GEV AND GAMMA  < 120 MEV- (2.7 GEV/C K-)  7/70

                          REFERENCES FOR EXOTIC HYPERONS

GALTIERI 68 PRL 21 573         A.BARBARO-GALTIERI,CHADWICK +     (LRL+SLAC)
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Note on Ξ Resonances

The Ξ resonance situation has long been unsettled. This is because 1) they can only be produced as part of a final state, $K^-+p \rightarrow \Xi^* +$ others, and 2) they are so produced with very small cross sections (< 50 μb). Thus the numbers of events available are small, and the analysis is more complicated than if direct formation were possible. Only the Ξ(1530) is really well established. There are apparently at least two Ξ states in the 1800-2000 MeV region, and there are indications of several more above 2000 MeV, but the situation is unclear. Two large bubble chamber experiments reported at the 1975 ANL Symposium on New Directions in Hadron Spectroscopy (BLOKZIJL 75 and MORRIS 75) may be able to clarify the situation. In the meantime, we are forced to group together rather disparate observations and await new results. Figures in the listings point out disagreements among various experiments. The table following this note gives our evaluation of the status of the Ξ resonances, based on the data available at this time.

STATUS OF XI* RESONANCES
THOSE WITH AN OVERALL STATUS OF *** OR **** ARE INCLUDED IN THE MAIN BARYON TABLE. THE OTHERS AWAIT CONFIRMATION.

			STATUS AS SEEN IN --				
PARTICLE	LIJ	OVERALL STATUS	XI PI	LAM K	SIG K	XI* PI	OTHER CHANNELS
XI(1320)	P11	****					WEAK TO LAM PI
XI(1530)	P13	****	****				
XI(1630)		**	**				
XI(1820)		***	***	***	**	***	
XI(1940)		***	***			***	
XI(2030)		**		**	**		3-BODY DECAYS
XI(2250)		*					3-BODY DECAYS
XI(2500)		**		**	**		3-BODY DECAYS

```
****  GOOD, CLEAR, AND UNMISTAKABLE.
 ***  GOOD, BUT IN NEED OF CLARIFICATION OR NOT ABSOLUTELY CERTAIN.
  **  NEEDS CONFIRMATION.
   *  WEAK.
```

S=−2 I=1/2 HYPERON STATES (Ξ)

Ξ^-

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22  XI-(1321, JP=1/2 ) I=1/2
SEE STABLE PARTICLE DATA CARD LISTINGS
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Ξ^0

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23  XI0(1314, JP=1/2 ) I=1/2
SEE STABLE PARTICLE DATA CARD LISTINGS
```

Baryons

Ξ(1530), Ξ(1630)

Data Card Listings

For notation, see key at front of Listings.

Ξ(1530) P13

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49  XI*1/2(1530, JP=3/2+) I=1/2

THIS IS THE ONLY REALLY WELL-ESTABLISHED XI*.  THE
QUANTUM NUMBERS 3/2+ ARE FAVORED BY THE DATA.

   WE DO NOT USE   DETERMINATIONS OF THE MASS AND THE WIDTH OF THIS
STATE UNLESS THEY ARE ACCOMPANIED BY SOME DISCUSSION OF SYSTEMATICS
AND RESOLUTION.

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                    49  XI*1/2(1530) MASS (MEV)

M        55(1529.0)    (5.0)           PJERROU   62 HBC  -0 K-P 1.8 GEV/C
M          (1532.0)    (2.0)           BADIER    64 HBC  -0 K-P 3 GEV/C
M-       38 1535.7      3.2            LONDON    66 HBC  -  K-P 2.24 GEV/C     7/66
M-      334(1534.7)    (1.1)           BALTAY    72 HBC  -  K-P 1.75 GEV       1/73
M-      185 1536.2      1.6            KIRSCH    72 HBC  -  K-P 2.87GEV/C      2/72
M-          1535.3      2.0            ROSS2     73         XI KBAR PI (PI)    2/74
M-       48(1540.)     (3.)            BERTHON   74 HBC   0 QUASI 2 BODY CS   10/74*
M-          1534.5      1.2            BELLEFO2  75 HBC   0 K-P TO XI- K PI   11/75*
M-           . . . . . . . . .
M-  AVG     1535.18     0.84     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M-  STUDENT1535.18      0.92     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
M-  FIT     1534.97     0.63    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
MO       76 1528.7      1.1            LONDON    66 HBC   0 K-P 2.24 GEV/C     7/66
MO       59 1531.4      0.8            BADIER    72 HBC   0 K-P AT 3.95GEV/C 10/71
MO     1262 1532.0      0.4            BALTAY    72 HBC   0 K-P 1.75 GEV       1/73
MO      324 1531.3      0.6            BORENSTEI 72 HBC   0 K-P 2.2GEV/C       2/72
MO      286 1532.3      0.7            KIRSCH    72 HBC   0 K-P 2.87GEV/C      2/72
MO          1533.0      1.0            ROSS2     73         XI KBAR PI (PI)    2/74
MO       97(1533.6)    (1.4)           BERTHON   74 HBC   0 QUASI 2 BODY CS   10/74*
MO          1532.2       .7            BELLEFO2  75 HBC   0 K-P TO XI- K PI   11/75*
MO           . . . . . . . . .
MO  AVG     1531.78     0.34     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
MO  STUDENT1531.84      0.28     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
MO  FIT     1531.80     0.31    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

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                    49  (XI*-) - (XI*0) MASS DIFFERENCE (MEV)

D              5.7      3.0            PJERRCU   65 HBC  -0 1.8-1.95 GEV/C     7/66
D    R        (7.0)    (4.0)           LONDON    66 HBC  -0 2.24 GEV/C         7/66
D              2.0      3.2            MERRILL   66 HBC  -0 1.7-2.7 GEV/C      7/66
D              2.7      1.0            BALTAY    72 HBC  -0 K-P 1.75 GEV       1/73
D    R        (3.9)    (1.8)           KIRSCH    72 HBC  -0 K- P 2.8 GEV/C     2/72
D    R    REDUNDANT WITH DATA IN MASS LISTING.
D            . . . . . . . . .
D   AVG        2.92     0.91     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D   STUDENT    2.90     0.99     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
D   FIT        3.17     0.64    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                    49  XI*1/2(1530) WIDTH (MEV)

WO             7.0      2.0            SCHLEIN   63 HBC   0 1.8, 1.95 GEV/C
WO             7.0      7.0            BERGE     66 HBC   0 1.5-1.7 GEV/C      7/66
WO             8.5      3.5            LONDON    66 HBC   0 2.24 GEV/C         7/66
WO            11.0      2.0            BADIER    72 HBC   0 K-P AT 3.95GEV/C 10/71
WO             9.0      0.7            BALTAY    72 HBC   0 K-P 1.75 GEV       1/73
WO             8.4      1.4            BORENSTEI 72 HBC   0 XI- PI+ MODE       2/72
WO            11.0      1.8            KIRSCH    72 HBC   0 XI- PI+            2/72
WO             9.1      2.4            ROSS2     73         XI KBAR PI (PI)    2/74
WO             9.5      1.2            BELLEFO2  75 HBC   0 K-P TO XI- K PI   11/75*
WO           . . . . . . . . .
WO  AVG        9.14     0.48     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
WO  STUDENT    9.13     0.53     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT
                                 (SEE IDEOGRAM BELOW )
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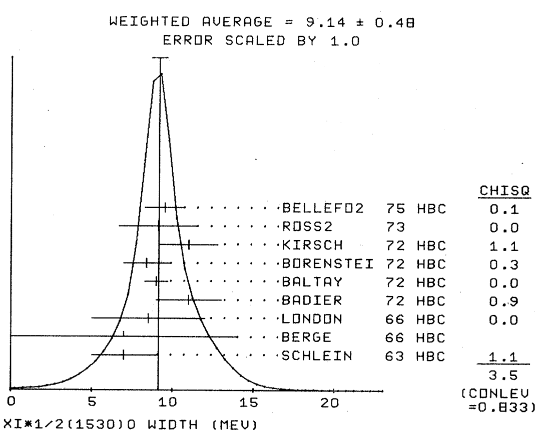


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W-             7.8      3.5      7.8   BALTAY    72 HBC  -  K-P 1.75 GEV       1/73
W-            16.2      4.6            KIRSCH    72 HBC  -  XI- PIO,XIO PI-    2/72
W-             8.3      3.6            ROSS2     73         XI KBAR PI (PI)    2/74
W-             9.6      2.8            BELLEFO2  75 HBC   0 K-P TO XI- K PI   11/75*
W-           . . . . . . . . .
W-  AVG       10.1      1.9      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W-  STUDENT   10.0      2.1      AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    49  XI*1/2(1530) REAL PART OF POLE POSITION              4/75*

REO         1531.6      0.4            LICHTENB  74       0 EXTRAP HABIBI73    4/75*
RE-         1534.4      1.1            LICHTENB  74       - EXTRAP HABIBI73    4/75*

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                    49  XI*1/2(1530) IMAGINARY PART OF POLE POSITION         4/75*

IMO         4.45      0.35             LICHTENB  74       0 EXTRAP HABIBI73    4/75*
IM-         3.9       1.75      3.9    LICHTENB  74       - EXTRAP HABIBI73    4/75*

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                    49  XI*1/2(1530) PARTIAL DECAY MODES

                                                               DECAY MASSES
P1      XI*1/2(1530) INTO XI PI                               1321+ 139
        OTHER STRONG DECAYS ARE FORBIDDEN BY ENERGY CONSERVATION.
P2      XI*1/2(1530) INTO XI GAMMA                            1321+   0

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                    49  XI*1/2(1530) BRANCHING RATIOS (MEV)

R1      XI*1/2(1530) INTO (XI GAMMA)/TOTAL                    (P2)              1/76*
R1            LESS THAN 0.04             KALBFLEI  75 HBC  -  90 PCT CFDNC LVL  1/76*

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                               REFERENCES FOR XI*1/2(1530)

PJERRCU  62 PRL 9 114          +PROWSE,SCHLEIN,SLATER,STORK,TICHO    (UCLA) I
SCHLEIN  63 PRL 11 167         +CARMONY,PJERROU,SLATER,STORK,TICHO   (UCLA)IJP
BADIER   64 DUBNA I 593        +DEMOULIN,GOLDBERG, +     (EPOL,SACLAY,AMST) I
PJERRCU  65 PRL 14 275         +SCHLEIN,SLATER,SMITH,STORK,TICHO     (UCLA)

BERGE    66 PR 147 945         +EBERHARD,HUBBARD,MERRILL,B-SHAFER,+   (LRL) I
LONDCN   66 PR 143 1034        +RAU,SAMIOS,YAMAMOTO,GOLDBERG,+  (BNL,SYRA) IJ
MERRILL  66 UCRL-16455 THESIS D W MERRILL                             (LRL) JP

BADIER   72 NP B37 429         +BARRELET,CHARLTCN,VIDEAU              (EPOL)
BALTAY   72 PL 42B 129         +BRIDGEWATER,COOPER,GERSHWIN,+  (COLU+BING)
    ALSO 73 NEVIS 199(THESIS) HABIBI                              (CCLUMBIA)
BORENSTE 72 PR D5 1559         BORENSTEIN,CANBURG,KALBFLEISCH++ (BNL,MICH) I
KIRSCH   72 NP B40 349         SCHMIDT+CHANG,HEMINGWAY(BRAN,UMD,SYRA,TUFT) I

ROSS2    73 PURDUE CCNF. 355  RCSS,LLCYD,RADCJICIC                 (OXFORD)
BERTHON  74 NC 21A 146         BERTHON,TRISTRAM,+     (CDEF+RHEL+SACL+STRB)   U
LICHTENB 74 PRD 10 3865        D B LICHTENBERG        (INDIANA UNIVERSITY)
    ALSO 74 PRIV. COMM.        D B LICHTENBERG        (INDIANA UNIVERSITY)
BELLEFG2 75 NC 28A 289         DE BELLEFON,BERTHON,BILLOIR+      (CDEF,SACL)
KALBFLEI 75 PRD 11 987         KALBFLEISCH,STRAND,CHAPMAN         (BNL+MICH)

                               PAPERS NOT REFERRED TO IN DATA CARDS

SHAFER   66 PR 142 883         BLTTCN-SHAFER,LINDSEY,MURRAY,SMITH     (LRL) JP
   A SPIN-PARITY DETERMINATION.
HABIBI   73 NEVIS 199(THESIS) HABIBI                                  (COLU)
HUNGERBU 74 PRD 10 2051        HUNGERBUHLER,MAJKA,+   (YALE,FNAL,BNL,PITT)
BRIEFEL  75 PRD 12 1859        +GOUREVITCH,KIRSCH+    (BRAN+UMD+SYRA+TUFT)

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Ξ(1630)

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21  XI*1/2(1630, JP=     ) I=1/2

THIS EFFECT NEEDS CCNFIRMATICN.
BARTSCH 69 SEE A SMALL, BROAD ENHANCEMENT NEAR
1650 MEV - IT IS NOT CLEAR THAT IT IS THE SAME
PHENOMENON AS BMST 70, WHO FIND CS=3.6+-1.6
MICROBARNS AT 2.87 GEV/C INCIDENT K- MOMENTUM.
   BORENSTEIN 72 SEE NO EFFECT IN THIS REGION.  THEY FIND
   CS<2 MICROBARNS AT 2.18.
      ROSS 72 ARGUE THAT THE EFFECT THEY SEE IS NOT THE SAME AS THAT
   SEEN BY BMST 70, AND FIND CS=2+-1 MICROBARNS AT 3.3 GEV/C.
   BELLEFON 75B FIND A CS OF AROUND 10 MICROBARNS NEAR 2 GEV/C,
   BUT LESS THAN 3 MICROBARNS ARCUND 2.3 GEV/C.

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                    21  XI*1/2(1630) MASS (MEV)

M        40 1635.       10.            BMST      70 HBC   0 INTO  XI- PI+      7/70
M        29 1606.        6.            ROSS      72 HBC   0 K-P AT 3.1-3.7     3/72
M        34 1633.       12.            BELLEFO2  75 HBC   0 K-P TO XI- K PI   11/75*
M            . . . . . . . . .
M   AVG      1616.7      9.7     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.0)
M   STUDENT1617.0        7.2     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    21  XI*1/2(1630) WIDTH (MEV)

W        40   57.       18.            BMST      70 HBC   0 K-P AT 2.87
W        29   21.        7.            ROSS      72 HBC   0 XI-PI+ K*0(890)    3/72
W        34   40.       15.            BELLEFC2  75 HBC   0 K-P TO XI- K PI   11/75*
W            . . . . . . . . .
W   AVG        28.0      8.7     AVERAGE (ERRCR INCLUDES SCALE FACTOR OF 1.5)
W   STUDENT    27.7      7.3     AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

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                    21  XI*1/2(1630) PARTIAL DECAY MODES

                                                               DECAY MASSES
P1      XI*1/2(1630) INTO XI PI                               1321+ 139

        SEEN IN K- P TO XI- PI+ KO AND XI- PIO K+.

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                               REFERENCES FOR XI*1/2(1630)

BMST     70 DUKE 317           BRANDEIS+MARYLAND+SYRACUSE+TUFTS COLLABOR.
ROSS     72 PL 38B 177         ,BURAN,LLOYD,MULVEY,RADOJICIC          (OXF) I
BELLEFO2 75 NC 28A 289         DE BELLEFCN,BERTHCN,BILLOIR+     (CDEF,SACL)

                               PAPERS NOT REFERRED TO IN DATA CARDS

APSELL   69 PRL 23 884         +      (BRANDEIS, MARYLAND, SYRACUSE, TUFTS)
   SUPERSEDED BY BMST 70.
BARTSCH  69 PL 28B 439         +       (AACHEN, BERLIN, CERN, LOIC, VIENNA)
KALBFLEI 70 DUKE CONF 331      G R KALBFLEISCH                        (BNL) I
   SUMMARIZES EVIDENCE FOR ISCSPIN 1                                 (2.    )
BORENSTE 72 PR D5 1559         BORENSTEIN,DANBURG,KALBFLEISCH++ (BNL,MICH) I
SCHMIDT  73 PURDUE CONF. 363   SCHMIDT                           (BRANDEIS)
HUNGERBU 74 PRD 10 2051        HUNGERBUHLER,MAJKA,+   (YALE,FNAL,BNL,PITT)
BRIEFEL  75 PRD 12 1859        +GOUREVITCH,KIRSCH+    (BRAN+UMD+SYRA+TUFT)

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Data Card Listings

For notation, see key at front of Listings.

Ξ(1820)

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50  XI*1/2(1820, JP=    ) I=1/2

AS THE ACCOMPANYING IDEOGRAMS ILLUSTRATE, THE SITUATICN
IS CONFUSED.  UNTIL SOME FUTURE CLARIFICATICN, WE LIST
UNDER XI(1820) EVERYTHING REPORTED IN THE MASS RANGE
1750-1875 MEV.  WHEN BRANCHING RATICS ARE REPORTED, WE
QUOTE THEM, BUT ONLY THE MOST QUALITATIVE CONCLUSIONS ARE JUSTIFIED.

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                50  XI*1/2(1820) MASS (MEV)

M          (1770.0)                     HALSTEINS 63 FBC  -0 K-FR 3.5 GEV/C
M        30 1814.0      4.0             BADIER    65 HBC   0 LAMBDA KBAR
M        29 1817.0      7.0             SMITH 1   65 HBC  -0 LAMBDA KBAR
M        40 1830.0     10.0             ALITTI    69 HBC  -  LAM, SIG KBAR     9/69
M        65 1795.      10.              BMST      70 HBC   0 XI-PI+ (2.9 K-P)  7/70
M        55 1820.      12.              BMST      70 HBC     XI(1530) PI       7/70
M        35 1854.      12.              BMST      70 HBC  -  SIGMA- KOBAR      7/70
M        65 1871.      11.              BMST      70 HBC   0 LAMBDA  KOBAR     7/70
M        25 1830.0     10.0             CRENNELL  70 DBC  -0 3.6, 3.9 GEV/C   10/70
M  B     28 1762.0      8.0             BADIER    72 HBC     XI PI,XI2PI,K Y  10/71
M  B     38 1838.0      5.0             BADIER    72 HBC     XI PI,XI2PI,K Y  10/71
M  B     BADIER 72 ADDS ALL CHANNELS AND DIVIDES PEAK IN LOWER AND HIGHER M
M    1   30 1821.       5.              ROSS1     73         LAMBDA K-/KBARO   2/74
M    1   LESS SIGNIFICANT ENHANCEMENT (M=1825,W=100) SEEN IN XI(1530)+PI       2/74
M       100 1823.       3.              BLOKZIJL  75 HBC     K- P AT 4.2 GEV   1/76*
M           1807.      27.              DIBIANCA  75 DBC     XI 2PI, XI* PI    1/76*
M           . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 3.1)
                    (SEE IDEOGRAM BELOW )
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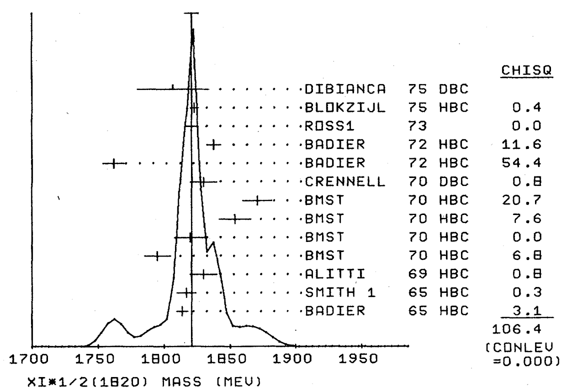


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                50  XI*1/2(1820) WIDTH (MEV)

W           (80.0)  OR LESS              HALSTEINS 63 FBC  -0 K-FR 3.5 GEV/C
W           (12.0)    (4.0)              BADIER    65 HBC   0 LAMBDA KBAR
W             30.0     7.0               SMITH 2   65 HBC  -0
W             55.0    40.0     20.0      ALITTI    69 HBC  -  LAM, SIG KBAR     9/69
W       65    99.     31.                BMST      70 HBC     XI-PI+ (2.9 K-P)  7/70
W       55    82.     42.                BMST      70 HBC     XI(1530) PI       7/70
W       35    56.     14.                BMST      70 HBC  -  SIGMA- KOBAR      7/70
W       65    58.     39.                BMST      70 HBC   0 LAMBDA  KOBAR     7/70
W            103.0    38.0     24.0      CRENNELL  70 DBC  -0 3.6, 3.9 GEV/C   10/70
W  B          51.0    13.0               BADIER    72 HBC     LOWER MASS       10/71
W  B          58.0    13.0               BADIER    72 HBC     HIGHER MASS      10/71
W    1  30    12.      4.                ROSS1     73         LAMBDA K-/KBARO   2/74
W      100    19.      4.                BLOKZIJL  75 HBC     K- P AT 4.2 GEV   1/76*
W             85.     58.                DIBIANCA  75 DBC     XI 2PI, XI* PI    1/76*
W                   SEE THE NOTES ACCOMPANYING THE MASSES QUOTED
W             . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 2.3)
                    (SEE IDEOGRAM BELOW )
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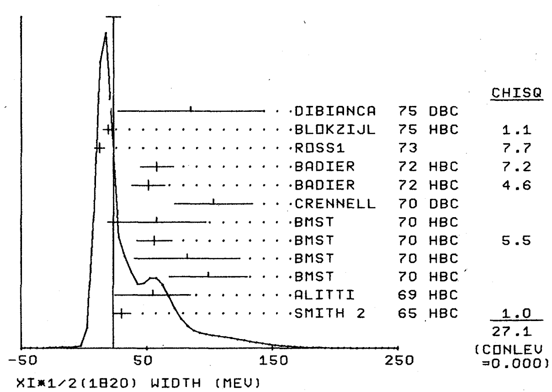


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                50  XI*1/2(1820) PARTIAL DECAY MODES

                                                             DECAY MASSES
P1      XI*1/2(1820) INTO LAMBDA KBAR                       1115+ 497
P2      XI*1/2(1820) INTO XI PI                             1321+ 139
P3      XI*1/2(1820) INTO SIGMA KBAR                        1197+ 497
P4      XI*1/2(1820) INTO XI*1/2(1530) PI                   1533+ 139
P5      XI*1/2(1820) INTO XI PI PI (EXCLUDING P4)           1321+ 139+ 139

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                50  XI*1/2(1820) BRANCHING RATIOS

R1      XI*1/2(1820) INTO (LAMBCA KBAR)/TOTAL               (P1)
R1            0.3       0.15           ALITTI    69 HBC  -                      9/69

R2      XI*1/2(1820) INTO (XI PI)/TOTAL                     (P2)
R2            0.1       0.1            ALITTI    69 HBC  -                      9/69

R3      XI*1/2(1820) INTO (SIGMA KBAR)/TOTAL                (P3)
R3          (0.02) OR LESS             TRIPP     67 RVUE                        8/67
R3            0.3       0.15           ALITTI    69 HBC  -                      9/69

R4      XI*1/2(182C) INTC (XI*1/2(1530) PI)/TOTAL           (P4)
R4            0.3       0.15           ALITTI    69 HBC  -                      9/69
R4          (0.25) OR LESS             DAUBER    69 HBC     K-P 2.7 BEV/C       9/69

R5      XI*1/2(182C) INTO (XI PI)/(LAMBDA KBAR)             (P2)/(P1)
R5            0.20      0.20           BADIER    65 HBC                         7/66
R5          (.42)+/-.02) OR LESS       BLOKZIJL  75 HBC     K- P AT 4.2 GEV     1/76*

R6      XI*1/2(1820) INTO (XI*(1530) PI)/(LAM KBAR)         (P4)/(P1)
R6            0.26      0.13           SMITH 1   65 HBC
R6             .77       .20           BLOKZIJL  75 HBC     K- P AT 4.2 GEV     1/76*
R6            . . . . . . . . . .
R6  AVG       0.41      0.23    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.1)
R6  STUDENT   0.39      0.14    AVERAGE USING STUDENT10(H/1.11) -- SEE TEXT

R7      XI*1/2(1820) INTO (XI PI PI)/(LAMBCA KBAR)          (P5)/(P1)
R7          (0.1)  OR MORE             SMITH 1   65 HBC

R8      XI*1/2(182C) INTO (XI PI)/(XI*1/2(1530) PI)         (P2)/(P4)
R8            1.5       0.6      0.4   APSELL    70 HBC   0                     6/70

R9      XI*1/2(1820) INTO (XI PI PI)/(XI*1/2(1530) PI)      (P5)/(P4)
R9            0.3       0.5            APSELL    70 HBC   0                     6/70

R10     XI*1/2(1820) INTO (SIGMA KBAR)/(LAMBDA KBAR)        (P3)/(P1)           1/76*
R10            .23       .06           BLCKZIJL  75 HBC     K- P AT 4.2 GEV     1/76*

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                    REFERENCES FOR XI*1/2(1820)

HALSTEIN 63 SIENA CONF 173    HALSTEINSLID,+ (BERGEN,CERN,EPOL,RHEL,LOUC) I
BADIER   65 PL 16 171         +DEMOULIN,GOLDBERG, +    (EPOL,SACLAY,AMST) I
SMITH 1  65 PRL 14 25         +LINDSEY,BUTTCN-SHAFER,MURRAY          (LRL)IJP
SMITH 2  65 ATHENS CONF 251   G A SMITH, J S LINDSEY                 (LRL)
TRIPP    67 NP B3 10          + LEITH, +    (LRL,SLAC,CERN,HEIDEL,SACLAY)
    LSES DATA OF SMITH 1.

ALITTI   69 PRL 22 79         +BARNES,FLAMINIO,METZGER, +  (BNL,SYRACUSE) I
DAUBER   69 PR 179 1262       +BERGE, HUBBARD, MERRILL, MULLER       (LRL)
APSELL   70 PRL 24 777        +     (BRANDEIS, MARYLAND, SYRACUSE, TUFTS) I
BMST     70 DUKE 317          BRANDEIS+MARYLAND+SYRACUSE+TUFTS COLLABOR.
CRENNELL 70 PR 1D 847         +KARSHON, LAI, ONEALL, SCARR, SCHUMANN(BNL)
BADIER   72 NP B37 429        +BARRELET,CHARLTON,VIDEAU             (EPOL)
ROSS1    73 PURDUE CONF. 345  ROSS,LLCYD,RADOJICIC                (OXFORD)

BLOKZIJL 75 ANL-HEP-CP-75-58  +DEGROOT,HOOGLAND+      (AMST+CERN+NIJM+OXF)
    ALSO 75 PALERMO CONF.     +DEGROOT,HOOGLAND+      (AMST+CERN+NIJM+OXF)
DIBIANCA 75 NP B98 137        DIBIANCA,ENDORFR                      (CARN)

                    PAPERS NOT REFERRED TO IN CATA CARDS

MERRILL  68 PR 167 1202       D W MERRILL, J BUTTON-SHAFER           (LRL)
    WEAK EVIDENCE CONCERNING JP.
APSELL   69 PRL 23 884        +      (BRANDEIS, MARYLAND, SYRACUSE, TUFTS)
    SUPERSEDED BY BMST  70.
SCHMIDT  73 PURDUE CONF. 363  SCHMIDT                           (BRANDEIS)
BRIEFEL  75 PRD 12 1859       +GOUREVITCH,KIRSCH+    (BRAN+UMD+SYRA+TUFT)
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Ξ(1940)

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52  XI*1/2(1940, JP=    ) I=1/2

WE LIST UNDER XI(1940) EVERYTHING REPORTED IN THE MASS
RANGE 1875-2000 MEV.

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                52  XI*1/2(1940) MASS (MEV)

M        35 1933.0     16.0             BADIER    65 HBC   0 XI- PI+
M        27 1930.0     20.0             ALITTI    68 HBC   0 XI- PI+          11/68
M        66 1894.0     18.0             DAUBER    69 HBC  -  XI PI            11/68
M       110 1954.       9.              BMST      70 HBC   0 XI-PI+ (2.9 K-P)  7/70
M        40 1961.       8.              BMST      70 HBC     XI(1530) PI       7/70
M        21 1955.0     14.0             GOLDWASSE 70 HBC  -  XI PI            10/70
M        29 1956.0      6.0             BADIER    72 HBC     XI PI,XI2PI,K Y  10/71
M        25 1952.      11.              ROSS1     73         (XI PI)-          2/74
M           1900.      12.              DIBIANCA  75 DBC     XI PI             1/76*
M           . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 2.0)
                    (SEE IDEOGRAM BELOW )
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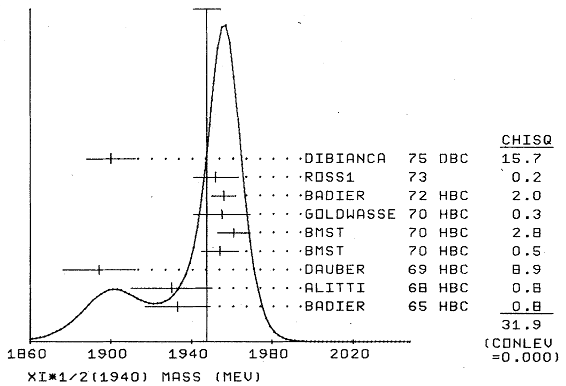
Baryons

Ξ(1940), Ξ(2030), Ξ(2250)

Data Card Listings

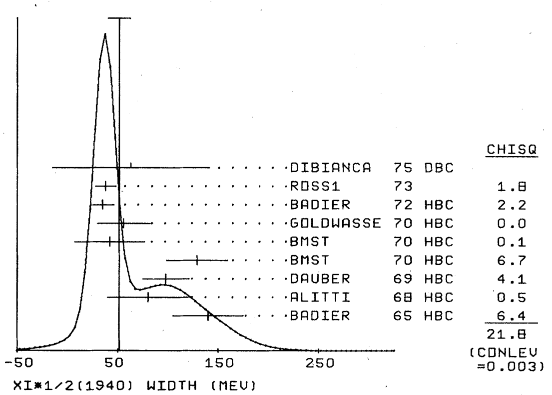
For notation, see key at front of Listings.



52 XI*1/2(1940) WIDTH (MEV)

W	35	140.0	35.0	BADIER	65	HBC	0	XI- PI+	
W	27	80.0	40.0	ALITTI	68	HBC	0	XI- PI+	11/68
W	66	98.0	23.0	DAUBER	69	HBC	-	XI PI	11/68
W	110	129.	30.	BMST	70	HBC	0	XI-PI+ (2.9 K-P)	7/70
W	40	42.	35.	BMST	70	HBC		XI(1530) PI	7/70
W	21	56.0	26.0	GOLDWASSE	70	HBC	-	XI PI	10/70
W	29	35.0	11.0	BADIER	72	HBC		XI PI,XI2PI,K Y	10/71
W		38.	10.	ROSS1	73			(XI PI)-	2/74
W		63.	78.	DIBIANCA	75	DBC		XI PI	1/76*

W AVERAGE MEANINGLESS (SCALE FACTOR = 1.8)
(SEE IDECGRAM BELOW)



52 XI*1/2(1940) PARTIAL DECAY MODES

		DECAY MASSES
P1	XI*1/2(1940) INTO XI PI	1321+ 139
P2	XI*1/2(1940) INTO XI*(1530) PI	1533+ 139
P3	XI*1/2(1940) INTO XI PI PI (EXCLUDING P2)	1321+ 139+ 139
P4	XI*1/2(1940) INTO XIO PI-	1314+ 139
P5	XI*1/2(1940) INTO XI- PIO	1321+ 134

52 XI*1/2(1940) BRANCHING RATIOS

THE XI(1940) IS SEEN MAINLY IN XI PI AND SOME IN XI(1530) PI. IT HAS BEEN LOOKED FOR IN OTHER CHANNELS BUT NOT SEEN.

R1 XI*1/2(1940) INTO (XI PI)/(XI*1/2(1530) PI) (P1)/(P2)
R1 2.8 0.7 0.6 APSELL 70 HBC 0 6/70

R2 XI*1/2(1940) INTO (XI PI PI)/(XI*1/2(1530) PI) (P3)/(P2)
R2 0.0 0.3 APSELL 70 HBC 0 6/70

R3 XI*1/2(1940) INTO (XIO PI-)/(XI- PIO) (P4)/(P5) 2/74
R3 1 25 2.6 6. 1.6 ROSS1 73 (XI PI)- 2/74
R3 1 THIS BR IS 2.0(0.5) FOR AN I=1/2(I=3/2) XI*(1940). 2/74

REFERENCES FOR XI*1/2(1940)

BADIER 65 PL 16 171 +DEMOULIN,GOLDBERG, + (EPOL,SACLAY,AMST) I
ALITTI 68 PRL 21 1119 +FLAMINIO,METZGER,RADOJICIC,+(BNL,SYRACUSE) I
DAUBER 69 PR 179 1262 +BERGE, HUBBARD, MERRILL, MULLER (LRL) I
APSELL 70 PRL 24 777 + (BRANDEIS, MARYLAND, SYRACUSE, TUFTS) I
BMST 70 DUKE 317 BRANDEIS+MARYLAND+SYRACUSE+TUFTS COLLABOR.
GOLDWASS 70 PR 1D 1960 E L GOLDWASSER, P F SCHULTZ (ILLINOIS)
BADIER 72 NP B37,429 +BARRELET,CHARLTON,VIDEAU (EPOL)
ROSS1 73 PURDUE CONF. 345 ROSS,LLOYD,RADOJICIC (OXFORD)

DIBIANCA 75 NP B98 137 DIBIANCA,ENDORFR (CARN)

PAPERS NOT REFERRED TO IN DATA CARDS

APSELL 69 PRL 23 884 + (BRANDEIS, MARYLAND, SYRACUSE, TUFTS)
SUPERSEDED BY BMST 70.
SCHMIDT 73 PURDUE CONF. 363 SCHMIDT (BRANDEIS)
BRIEFEL 75 PRD 12 1859 +GOUREVITCH,KIRSCH+ (BRAN+UMD+SYRA+TUFT)

Ξ(2030)

68 XI*1/2(2030, JP=) I=1/2

THE STATE AT 2129 MEV REPORTED BY BLOKZIJL 75 IS REALLY INTERMEDIATE BETWEEN XI*(2130) AND XI*(2250). WE LIST IT HERE TEMPORARILY.

68 XI*1/2(2030) MASS (MEV)

M	42	2030.0	10.0	ALITTI	69	HBC	-	K-P 3.9-5 BEV/C	9/69
M	40	2058.0	17.0	BARTSCH	69	HBC		K-P 10GEV/C	9/69
M	15	2019.	7.	ROSS1	73			SIGMA KBAR	2/74
M	25	2129.	5.	BLOKZIJL	75	HBC		K- P AT 4.2 GEV	1/76*
M		2044.	8.	DIBIANCA	75	DBC		XI 2PI, XI* PI	1/76*

M AVERAGE MEANINGLESS (SCALE FACTOR = 7.4)

68 XI*1/2(2030) WIDTH (MEV)

W		45.0	40.0	20.0	ALITTI	69	HBC	-		9/69
W		57.0	30.0		BARTSCH	69	HBC			9/69
W	15	33.	17.		ROSS1	73			SIGMA KBAR	2/74
W	25	21.	8.		BLOKZIJL	75	HBC		K- P AT 4.2 GEV	1/76*
W		60.	24.		DIBIANCA	75	DBC		XI 2PI, XI* PI	1/76*

W AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

68 XI*1/2(2030) PARTIAL DECAY MODES

		DECAY MASSES
P1	XI*1/2(2030) INTO XI PI	1321+ 139
P2	XI*1/2(2030) INTO LAMBDA KBAR	1115+ 497
P3	XI*1/2(2030) INTO SIGMA KBAR	1197+ 497
P4	XI*1/2(2030) INTO XI*1/2(1530) PI	1533+ 139
P5	XI*1/2(2030) INTO LAMBDA (OR SIGMA) KBAR PI	1115+ 497+ 139

68 XI*1/2(2030) BRANCHING RATIOS

R1 XI*1/2(2030) INTO (XI PI)/(MODES P1 TO P4) (P1)/(P1+P2+P3+P4)
R1 (0.30) OR LESS ALITTI 69 HBC - 1 STD DEV LIMIT 9/69

R2 XI*1/2(2030) INTO (LAM KBAR)/(MODES P1 TO P4) (P2)/(P1+P2+P3+P4)
R2 0.25 0.15 ALITTI 69 HBC - 9/69

R3 XI*1/2(2030) INTO (SIG KBAR)/(MODES P1 TO P4) (P3)/(P1+P2+P3+P4)
R3 0.75 0.20 ALITTI 69 HBC - 9/69

R4 XI*1/2(2030) INTO (XI* PI)/(MODES P1 THRU P4) (P4)/(P1+P2+P3+P4)
R4 (0.15) OR LESS ALITTI 69 HBC - 1 STD DEV LIMIT 9/69

R5 XI*1/2(2030) INTO LAMBDA (OR SIGMA) KBAR PI (P5)
R5 SEEN BARTSCH 69 HBC 9/69

REFERENCES FOR XI*1/2(2030)

ALITTI 69 PRL 22 79 +BARNES,FLAMINIO,METZGER, + (BNL,SYRACUSE) I
BARTSCH 69 PL 28B 439 + (AACHEN, BERLIN, CERN, LOIC, VIENNA)
ROSS1 73 PURDUE CONF. 345 ROSS,LLOYD,RADOJICIC (OXFORD)

BLOKZIJL 75 ANL-HEP-CP-75-58 +DEGROOT,HOOGLAND+ (AMST+CERN+NIJM+OXF)
ALSO 75 PALERMO CONF. +DEGROOT,HOOGLAND+ (AMST+CERN+NIJM+OXF)
DIBIANCA 75 NP B98 137 DIBIANCA,ENDORFR (CARN)

Ξ(2250)

22 XI*1/2(2250, JP=)

THE EVIDENCE FOR THIS STATE IS WEAK. BARTSCH 69 SEE A BUMP OF NOT MUCH STATISTICAL SIGNIFICANCE IN LAMBDA-KBAR-PI, SIGMA-KBAR-PI, AND XI-PI-PI MASS SPECTRA. GOLDWASSER 70 SEE A NARROWER BUMP IN XI-PI-PI AT A HIGHER MASS. PERHAPS THEY ARE THE SAME STATE, PERHAPS THEY ARE NOT, BUT SEE ALSO MORRIS 75.

22 XI*1/2(2250) MASS (MEV)

M	35	2244.0	52.0	BARTSCH	69	HBC		K-P 10 GEV/C	9/69
M	18	2295.0	15.0	GOLDWASSE	70	HBC	-	K-P 5.5 GEV/C	10/70

M AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

22 XI*1/2(2250) WIDTH (MEV)

W	130.0	80.0	BARTSCH	69	HBC			9/69
W	LESS THAN	30.0	GOLDWASSE	70	HBC	-	K-P 5.5 GEV/C	10/70

22 XI*1/2(2250) PARTIAL DECAY MODES

		DECAY MASSES
P1	XI*1/2(2250) INTO XI PI PI	1321+ 139+ 139
P2	XI*1/2(2250) INTO LAMBDA KBAR PI	1115+ 497+ 139
P3	XI*1/2(2250) INTO SIGMA KBAR PI	1197+ 497+ 139

Data Card Listings

For notation, see key at front of Listings.

Baryons

Ξ(2250), Ξ(2500), Ω^-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                        REFERENCES FOR XI*1/2(2250)

BARTSCH  69 PL 28B 439         +     (AACHEN, BERLIN, CERN, LOIC, VIENNA)
GOLDWASS 70 PR 1D 1960         E L GOLDWASSER, P F SCHULTZ      (ILLINOIS)

                               PAPERS NOT REFERRED TO IN CATA CARDS.

MORRIS   75 ANL-HEP-CP-75-58   MORRIS,CH,PARKER,SMITH,WHITMORE         (MSU)
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Ξ(2500)

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                99  XI*1/2(2500, JP=    ) I=1/2

                IT IS QUITE POSSIBLE THAT THE REASON THE EXPERIMENTS
                DISAGREE ABOUT THE MASS AND WIDTH IS THAT THEY ARE
                SEEING DIFFERENT XI*S.  FOR NOW, HOWEVER, WE GROUP
   THEM TOGETHER.

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                99  XI*1/2(2500) MASS (MEV)

M       30 2430.0     20.0                ALITTI    69 HBC  -  K-P 4.6-5 GEV/C   9/69
M       45 2500.0     10.0                BARTSCH   69 HBC  -0 K-P 10 GEV/C      9/69
M          2392.      27.                 DIBIANCA  75 DBC     XI 2PI            1/76*
M          . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 3.2)

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                99  XI*1/2(2500) WIDTH (MEV)

W          150.0      60.0      40.0      ALITTI    69 HBC  -                    9/69
W           59.0      27.0                BARTSCH   69 HBC  -0                   9/69
W           75.       69.                 DIBIANCA  75 CBC     XI 2PI            1/76*
W          . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.1)

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                99  XI*1/2(2500) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      XI*1/2(2500) INTO XI PI                          1321+ 139
P2      XI*1/2(2500) INTO LAMBCA KBAR                    1115+ 497
P3      XI*1/2(2500) INTO SIGMA KBAR                     1197+ 497
P4      XI*1/2(2500) INTO XI*1/2(1530) PI                1533+ 139
P5      XI*1/2(2500) INTO LAMBCA (OR SIGMA) KBAR PI      1115+ 497+ 139
P6      XI*1/2(2500) INTO XI PI PI                       1321+ 139+ 139

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                99  XI*1/2(2500) BRANCHING RATIOS

R1      XI*1/2(2500) INTO (XI PI)/(MODES P1 THRU P4)      (P1)/(P1+P2+P3+P4)
R1            (0.5)  OR LESS           ALITTI    69 HBC     1 STD DEV LIMIT    9/69

R2      XI*1/2(2500) INTO (LAM KBAR)/(MODES P1 THRU P4)   (P2)/(P1+P2+P3+P4)
R2             0.5       0.2           ALITTI    69 HBC   -                    9/69

R3      XI*1/2(2500) INTO (SIG KBAR)/(MODES P1 THRU P4)   (P3)/(P1+P2+P3+P4)
R3             0.5       0.2           ALITTI    69 HBC   -                    9/69

R4      XI*1/2(2500) INTO (XI* PI)/(MODES P1 THRU P4)     (P4)/(P1+P2+P3+P4)
R4            (0.2)  OR LESS           ALITTI    69 HBC     1 STD DEV LIMIT    9/69

R5      XI*1/2(2500) INTO (LAMBCA (OR SIGMA) KBAR PI)/TOTAL
R5                                                        (P5)
R5             SEEN                    BARTSCH   69 HBC   -0                   9/69

R6      XI*1/2(2500) INTO (XI PI PI)/TOTAL                (P6)
R6             SEEN                    BARTSCH   69 HBC   -0                   9/69

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                        REFERENCES FOR XI*1/2(2500)

ALITTI   69 PRL 22 79          +BARNES,FLAMINIO,METZGER, +  (BNL,SYRACUSE) I
BARTSCH  69 PL 28B 439         +      (AACHEN, BERLIN, CERN, LOIC, VIENNA)

DIBIANCA 75 NP B98 137         DIBIANCA,ENDORFR                       (CARN)
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S=−3 I=0 HYPERON STATE (Ω)

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Ω^-

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                24  OMEGA-(1675, JP=3/2+) I=0

                SEE STABLE PARTICLE DATA CARD LISTINGS

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Appendix I

TEST OF $\Delta I=1/2$ RULE FOR K DECAYS

The quantities of interest for making tests of theoretical predictions regarding the $\Delta I=1/2$ rule for K decay are usually partial decay rates for single channels or special sums of channels. It is not possible to compute the errors on sums, differences, and ratios of partial decay rates from the information given in the Table of Stable Particles because of the presence of off-diagonal terms in the error matrix. For this reason we give some of these quantities in Table I. Throughout this Appendix, italics are used to indicate that a quantity has changed by more than one (old) standard deviation since our previous edition, and S gives the scale factor included in the quoted error because of inconsistencies in the data (see footnote at end of Stable Particle Table for definition of S).

Table I. (000) and (+−0) refer to the sign of the pions into which the K_L decays.

$\Gamma_{K^+_{\ell 3}}=\Gamma_{K^+_{e3}}+\Gamma_{K^+_{\mu 3}}$	$=(6.483\pm0.090)10^6\ \text{sec}^{-1}$	
$\Gamma_{K^+_{\mu 3}}/\Gamma_{K^+_{e3}}$	$=0.663\pm0.018$	S=1.7*
$\Gamma_{K^+_{\tau}}/\Gamma_{K^+_{\tau'}}$	$=3.227\pm0.083$	
$\Gamma_{K^0_{\ell 3}}=\Gamma_{K^0_{e3}}+\Gamma_{K^0_{\mu 3}}$	$=(12.75\pm0.15)10^6\ \text{sec}^{-1}$	S=1.1*
$\Gamma_{K^0_{\mu 3}}/\Gamma_{K^0_{e3}}$	$=0.696\pm0.017$	
$\Gamma_{K^0(000)}/\Gamma_{K^0(+-0)}$	$=1.747\pm0.070$	S=1.1*

1. Leptonic decay rates

The $\Gamma_{K_{\ell 3}}$ rates are useful in testing the leptonic $\Delta I=1/2$ rule in the way suggested by Trilling.[1] The predictions are

$$\Gamma_{K^0_{\ell 3}}/2\Gamma_{K^+_{\ell 3}}=1.012,\ \text{a phase-space factor,}^2$$

and

$$\Gamma_{K^0_{\mu 3}}/\Gamma_{K^0_{e3}}=\Gamma_{K^+_{\mu 3}}/\Gamma_{K^+_{e3}}\ .$$

From Table 1,

$$\Gamma_{K^0_{\ell 3}}/2\Gamma_{K^+_{\ell 3}}=0.983\pm0.018$$

and

$$\frac{\Gamma_{K^0_{\mu 3}}}{\Gamma_{K^0_{e3}}}\left[\frac{\Gamma_{K^+_{\mu 3}}}{\Gamma_{K^+_{e3}}}\right]^{-1}=1.050\pm0.038\ .$$

These results seem to show a less than 2σ disagreement with the predictions, but the errors should be regarded with caution in view of the internal disagreements in the data. (Note the ideograms in the Data Listings for the charged K meson.)

2. Three-pion decays

We follow here the tests done by Mast et al.,[3] based on the general analysis of K decays suggested by Zemach.[4] Both decay rates (Γ) and slopes (g, the energy dependence of the Dalitz plot distributions) are used. The $\Delta I=1/2$ rule predicts that the following test quantities are all equal to zero:

$$\text{Test 1}=\frac{2}{3}\ \frac{\Gamma_{K^0(000)}}{\phi_1}\left[\frac{\Gamma_{K^0(+-0)}}{\phi_2}\right]^{-1}-1\ ,$$

$$\text{Test 2}=\frac{1}{4}\ \frac{\Gamma_{K^+_\tau}}{\phi_3}\left[\frac{\Gamma_{K^+_{\tau'}}}{\phi_4}\right]^{-1}-1\ ,$$

$$\text{Test 3}=\frac{1}{2}\ \frac{\Gamma_{K^+_\tau}}{\phi_3}\left[\frac{\Gamma_{K^0(+-0)}}{\phi_2}\right]^{-1}-1\ ,$$

$$\text{Test 4}=\frac{1}{2}g_{K^+_{\tau'}}+g_{K^+_\tau}\ ,$$

$$\text{Test 5}=g_{K^0(+-0)}+g_{K^+_\tau}-\frac{1}{2}g_{K^+_{\tau'}}\ .$$

The ϕ_i are phase-space factors which have been calculated as described in Mast et al.[3] by use of a relativistic formulation and the masses and slopes from this edition. The factors labeled UDP are the relative areas of the Dalitz plots, assuming a uniform distribution. The NUDP include the observed slopes (see below). The CNUDP have been calculated by including the final-state Coulomb interaction.
The values are:

	Method		
	UDP	NUDP	CNUDP
$\phi_1(000)=$	1.489	1.489	1.444
$\phi_2(+-0)=$	1.221	1.300	1.284
$\phi_3(++-)=$	1.000	1.000	1.000
$\phi_4(+00)=$	1.247	1.180	1.144

For convenience, we repeat the slope parameters tabulated in the Stable Particle Table. They are as follows:

$g_{K^+_\tau}$	$=-0.214\pm0.005$	S=1.7*
$g_{K^-_\tau}$	$=-0.214\pm0.007$	S=2.7*
$\bar{g}_{K^\pm_\tau}$	$=-0.214\pm0.004$	
$g_{K^+_{\tau'}}$	$=$ *0.550±0.020*	*S=1.6**
$g_{K^0(+-0)}$	$=$ *0.646±0.014*	*S=2.5**

A difference in the τ^+ and τ^- slopes would be an indication of CP violation in this decay. Since no difference is observed at this time, we average he two and use this value in Test 4 and Test 5.

We use the CNUDP factors and the rates and slopes reported in this edition to compute the five test quantities which the $\Delta I=1/2$ rule predicts to be zero. The results are:

Test 1 =	0.036±0.042
Test 2 =	−0.077±0.024
Test 3 =	0.227±0.021
Test 4 =	*0.061±0.011*
Test 5 =	0.157±0.018

The three-pion final state can be in isospin states I = 1,2,3. Tests 1 and 2 test the existence of isospin I = 3 in the final state. Since the rate tests (Tests 1, 2, and 3) could differ from zero by as much as 0.1 owing to the mass differences and the occurrence of big slopes[5], no evidence for I=3 is found. Test 4 is related to the I=2 amplitude in the final state and indicates the presence of I=2. Tests 3 and 5 give information on the $\Delta I=3/2$ part of the I=1 amplitude relative to the $\Delta I=1/2$ part. Both tests indicate the presence of $\Delta I=3/2$.

References

1. G. Trilling, K−Meson Decays, UCRL−16473, (updated from Argonne Conference Proceedings, 1965, p. 115).
2. N. Brene (CERN), private communication. In our Jan. 1968 edition we had erroneously used 1.04.
3. T. S. Mast, L. K. Gershwin, M. Alston−Garnjost, R. O. Bangerter, A. Barbaro−Galtieri, J. J. Murray, F. T. Solmitz, and R. D. Tripp, Phys. Rev. 183, 1200 (1969).
4. C. Zemach, Phys. Rev. 133, B1201 (1964).
5. C. Bouchiat and M. Veltman, Topical Conference on Weak Interactions, CERN 69−7 (1969), p. 225.

Appendix II

A. SU(3) CLASSIFICATION OF BARYON RESONANCES

It is established that a symmetry higher than SU(3) is necessary to classify the known baryon resonances. However, many higher−symmetry schemes have been proposed, and even for SU(6) various versions exist (for a review see Dalitz[1]). Since it is not clear which one of these schemes best fits the data, we do not review them here, but we report once again fits of baryon states into SU(3) multiplets.

For the reader's convenience, we collect here the relevant formulae.

Exact SU(3) symmetry predicts that all the members of a multiplet should have the same mass and the same couplings for decays into other multiplets. It has been found, however, that the members of the octet of stable baryons lie within 20% of their mean mass; therefore a symmetry−breaking interaction has been introduced by Gell−Mann and Okubo independently.[2] In addition, for the isospin−0 vector mesons (ω and ϕ), an additional symmetry−breaking interaction has been introduced by Sakurai[3] to take care of octet−singlet mixing. The relevant formulae for masses and decay rates are given below.

Mass Formulae

Broken SU(3) gives:

Decuplet	$\Delta - \Sigma = \Sigma - \Xi^* = \Xi^* - \Omega$	GMO	(1)
Octet	$2(N + \Xi) = 3\Lambda + \Sigma$	GMO	(2)
Octet−Singlet mixing	$\sin^2\theta = \dfrac{\Lambda - M_8}{\Lambda - \Lambda'}$	Mixing angle[18]	(3)
	$M_8 = \dfrac{2(N + \Xi) - \Sigma}{3}$	GMO	(4)

Here GMO stands for the Gell−Mann−Okubo formula; the particle symbol indicates its mass. The formulae would be the same if squared masses were used. For the nonet case, Λ is the "mostly−octet" particle, Λ' is the "mostly−singlet" particle.

Decay Rates

In terms of a relativistically invariant matrix element T, the decay rate for two−body decay of a resonance of mass M_R is

$$\Gamma \propto \frac{|T|^2 R_2}{M_R}\,, \qquad (5)$$

where $R_2 = k/M_R$ is the two-body phase space factor. Since the numerator is an invariant, and since Γ must transform as $1/E$, we introduce the denominator M_R.[4]

For meson decays (see below) the rates are calculated according to Eq. (5); for baryon resonance decays into $1/2^+$ baryons and 0^- mesons, one next takes into account the fact that spin sums in $|T|^2$ introduce another factore M_R, cancelling the $1/M_R$. We are then left with

$$\Gamma = \frac{|T|^2 k}{M_R} M_N\,, \text{ for baryons} \qquad (5')$$

$$= \frac{|T|^2 k}{M_R^2} M_N^2\,, \text{ for mesons.} \qquad (5'')$$

The powers of the nucleon mass M_N or M_N^2 have been introduced so that we can treat $|T|$ as dimensionless.

$|T|^2$ contains centrifugal barrier factors, which we call B_ℓ. We then have

Decuplet, Singlet: $$\Gamma = (cg)^2 B_\ell(k) \frac{M_N}{M_R} k \qquad (6)$$

Octet: $$\Gamma = (c_D g_D + c_F g_F)^2 B_\ell(k) \frac{M_N}{M_R} k \qquad (7)$$

Octet–Singlet mixing: $$\Lambda = G_8 \cos\theta + G_1 \sin\theta$$ $$\Lambda' = -G_8 \sin\theta + G_1 \cos\theta \qquad (8)$$

with $$G_8 = c_D g_D + c_F g_F$$ $$G_1 = c_1 g_1\,. \qquad (9)$$

Here c_i are the SU(3) coefficients with the sign convention adopted in this article [see note in the Table of SU(3) Iscoscalar Factors and Fig. 2 in the text]. M_N is the nucleon mass, M_R is the resonance mass for which Γ is calculated, k is the center-of-mass momentum for the channel being considered, and g_i are the relevant couplings. For the case of singlet–octet mixing, formula (8) has to be used in conjuction with (6) and (7). G_8 and G_1 represent the couplings for the multiplet, and Λ and Λ' represent the couplings for the physical states.

The relation between g_D, g_F, and the parameter α is

$$\alpha = \left[1 + \frac{\sqrt{5}}{3}\frac{g_F}{g_D}\right]^{-1}. \qquad (10)$$

Exact SU(3) predicts that the couplings g_i for all the members of a multiplet are the same; however, since the symmetry is broken for the masses, it is probably broken for the widths. In the case of the $3/2^+$ decuplet, for broken SU(3) a sum rule has been derived by Becchi[5] and by Gupta[6] independently. It relates the g_i for the members of the decuplet by the relation

$$2(\Delta + \Xi) = 3\Sigma^*(\Lambda\pi) + \Sigma^*(\Sigma\pi), \qquad (11)$$

where $\Sigma^*(\Lambda\pi)$ is the coupling for the $\Sigma(1385) \to \Lambda\pi$ decay and $\Sigma^*(\Sigma\pi)$ is the coupling for the decay $\Sigma(1385) \to \Sigma\pi$.

As mentioned in the text (Sec. IV B) the determination of the relative signs of resonant amplitudes can be useful in making an SU(3) assignment of resonances. In fact the resonant amplitude $T \propto \sqrt{x_e x_i} \propto G_e G_i$, where the subscript e refers to the elastic channel and the G_e, G_i are the couplings of Eqs. (6) through (9). Assuming that all g_i are positive, the sign of the G_i are dependent upon the sign of the Clebsh–Gordon coefficients c_i. Once a sign convention is adopted (we use the Levi–Setti[7] convention, see Fig. 2 in the text) and the signs for a Σ state (I=1) and a Λ state (I=0) of known SU(3) assignment have been chosen for reference, the signs of all the other amplitudes can be useful in determining multiplet assignments. For exact SU(3) all the decays of members of a decuplet have the same sign. For octets the relative sign depends upon the value of g_D/g_F and the mixing angle, as seen from Eqs.(7) through (9).

Fits to the Data

Fits of baryon decay rates within SU(3) can be found in, among others, papers by Tripp,[8,9] Levi–Setti,[7] Samios,[10] and Plane.[11] The most recent fits were made by Barbaro–Galtieri[12] and Samios.[13]

In fitting the data a choice for B_ℓ has to be made. Plane[11] tried two forms for B_ℓ:

(a) The form $B_\ell = (kr)^{2\ell} D_\ell(kr)$, r being the radius of interaction and D_ℓ the polynomials in kr given by Blatt and Weisskopf.[14] Usually r is taken to be 1 fermi.[8]

(b) The form $B_\ell = k^{2\ell}$.

However, for final results form (b) was chosen. A discussion of the differences among these two forms has been given by Barbaro-Galtieri.[15] It turns out that not only the values of the couplings, g_i, depend upon the form used for B_ℓ, but also the value obtained for the mixing angle. For the $3/2^-$ singlet, Λ(1520), and the isospin-0 member of the octet, Λ(1690), the mixing angles obtained in the two cases are

$$\theta_a = (-16.1^{+1.4}_{-1.3})^\circ \ , \ \theta_b = (-27.5^{+3.6}_{-3.4})^\circ \ ,$$

in disagreement by a few standard deviations. It turns out that if a radius of interaction of r = 0.15 fermi is used for form (a), the two values of θ agree. This value of r does not fit resonance shapes when used in the Breit-Wigner resonant form.

Samios[13] used form (b) for B_ℓ.

Table I is a summary of the fits made by us (update of Barbaro-Galtieri[12]) using the barrier factor form (a) and exact SU(3). A few comments follow.

<u>1/2⁻ Nonet (Baryon-Eta Resonances)</u>

For this nonet Eq. (7) was multiplied by the factor

$$\left[\frac{M_R - M_B}{\overline{M}_R - \overline{M}_B}\right]^2 ,$$

where M_B is the decay baryon and $\overline{M}_R - \overline{M}_B$=564 MeV is the difference of the mean $1/2^-$ and $1/2^+$ baryon octet masses. This kinematic factor comes from PCAC arguments (i.e., the assumption that the axial vector current remains an octet in the presence of symmetry breaking) and it was advocated by Graham.[16] For the $1/2^-$ nonet it was used in this form first by Gell-Mann.[17]

<u>3/2⁺ Decuplet</u>

The agreement among the coupling constants obtained for the four rates in this decuplet is very bad. The fit made using form (b) for B_ℓ has χ^2=50 for 3 degrees of freedom; the one made with form (a) for B_ℓ has χ^2/DF=24/3. The broken SU(3) relation (11), however, is very well satisified.

B. SU(3) CLASSIFICATION OF MESON RESONANCES

All of the discussion above applies, except that for bosons the GMO formula is usually applied to the <u>square</u> of the masses, as opposed to the first power for fermions. Thus for example, Eq. (2) becomes

$$4\hat{K} = 3\hat{\eta} + \hat{\pi}. \qquad (2')$$

The symbol $\hat{K}$ was introduced by Glashow and Socolow[18] for the <u>square</u> of the K mass, etc.

Because of the difference between Eqs. (5') and (5"), there is also an extra factor of (M_N/M_R) in Eqs. (6) and (7). The three established nonets (0^-, 1^-, 2^+) and their mixing angles are listed at the bottom of the Meson Table.

Table I. SU(3) baryon multiplets with two or more known members. Values of θ and α [defined by Eqs. (8) and (10)] are the result of fits made to all the measured two-body decay rates of each mutiplet.

J^P	Octet members[a]				Singlet	θ(deg)[b]	α
$1/2^-$	N(1535)	Λ(1670)	Σ(1750)	[Ξ(1825)]	Λ(1405)	3±5	0.93±.11
$3/2^-$	N(1520)	Λ(1690)	Σ(1670)	[Ξ(1815)]	Λ(1520)	−23±4	0.31±.05
$5/2^-$	N(1670)	Λ(1830)	Σ(1765)				1.17±.04
$5/2^+$	N(1688)	Λ(1815)	Σ(1915)				0.65±.03
	Decuplet members[c]				g_{10}		
$3/2^+$	Δ(1232)	Σ(1385)	Ξ(1530)	Ω⁻	1.78−2.29	χ^2/DF=50/3	
$7/2^+$	Δ(1950)	Σ(2030)					

[a]Masses in parentheses are the nominal masses used in the Baryon Table. The Ξ members have masses as calculated by using formulae (1) and (2) with the mixing angle θ derived from the decay widths.
[b]See text for a discussion of the $3/2^-$ mixing angle.
[c]Coupling constants from Ref. 12.

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Appendix III

TEST OF $\Delta I=1/2$ RULE FOR HYPERON DECAYS

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1. Nonleptonic decay Amplitudes

In this edition we again use the new convention for the amplitudes A and B adopted in 1973. Some theorists have suggested that dimensionless amplitudes are more useful to them than the ones appearing in the literature. Berge[1] used a convention with A and B in units of $\sec^{-1/2}$. Samios[2] used a convention which gave A and B in units of $(\text{MeV-sec})^{-1/2}$. Following is the convention suggested by Jackson[3], which gives dimensionless A and B.

The effective Lagrangian density for nonleptonic hyperon decays ($B_1 \rightarrow B_2 + \pi$) can be written

$$\mathcal{L}_{\text{eff}} = G\mu_c^2[\bar{\psi}_2(A+B\gamma_5)\psi_1]\phi_\pi,$$

where $G=10^{-5}m_p^{-2}$ is a coupling constant characteristic of first-order weak decays, μ_c is the charged pion mass, and A and B are dimensionless complex numbers giving the relative amplitudes of the parity-violating and parity-conserving decays, respectively. The matrix γ_5 is to be taken in the Pauli form, $\gamma_5=\begin{pmatrix} 0 & -I \\ -I & 0 \end{pmatrix}$. The invariant amplitude for the decay is

$$\mathcal{M} = G\mu_c^2[\bar{u}(p)(A+B\gamma_5)u(P)],$$

where P is the 4-momentum of the decaying hyperon of mass M, and p is the 4-momentum of the baryon decay product of mass m. With the normalization convention, $\bar{u}_i u_i = 2m_i$, the Pauli form of the matrix element in the rest frame of the decaying hyperon is

$$\mathcal{M} = G\mu_c^2\langle\chi_2|\sqrt{2M(E+m)}A + \sqrt{2M(E-m)}\,B\vec{\sigma}\cdot\hat{q}|\chi_1\rangle,$$

where E is the total energy of the final baryon and $\hat{q}$ is a unit vector in the direction of motion of the final baryon. Comparison with Sec. VI D of the text shows that the amplitudes s and p defined there are proportional to A and B:

$$\frac{p}{s} = \left(\frac{E-m}{E+m}\right)^{1/2}\frac{B}{A} = \left[\frac{(M-m)^2-\mu^2}{(M+m)^2-\mu^2}\right]^{1/2}\frac{B}{A}.$$

Here μ is the mass of the pion entering the decay. The parameters α, β, and γ can therefore be expressed in terms of A and B, rather than s and p, if desired.

The decay rate for $B_1 \rightarrow B_2 + \pi$ is

$$\Gamma=\frac{G^2\mu_c^4}{8\pi}q\left\{\left[\frac{(M+m)^2-\mu^2}{M^2}\right]|A|^2+\left[\frac{(M-m)^2-\mu^2}{M^2}\right]|B|^2\right\},$$

where q is the c.m. momentum of the decay products. For reference, the dimensionless constant in this expression has the value $(G^2\mu_c^4/8\pi) = 1.9488\times10^{-15}$.

Table I summarizes the amplitudes A and B for the nonleptonic decays of the Λ, Σ, and Ξ hyperons. These amplitudes have been calculated by using the experimental data for mean lives, branching ratios, and the decay asymmetry α given in the Stable Particle Table of this Review. Time-reversal invariance is assumed and final-state interactions are neglected, so A and B are taken to be relatively real. The subscript on the hyperon refers to the sign of the decaying pion. The statistical correlation coefficient

$$C_{AB} = \frac{\langle \Delta A \Delta B\rangle}{\sqrt{\langle \Delta A^2\rangle\langle \Delta B^2\rangle}}$$

is also given. The absolute signs of A and B have been assigned, using the following convention. Taking $A(\Lambda^0_-)$ as positive, the other S-wave decay amplitudes are chosen to give an approximate fit to the triangular relationships

$$\sqrt{2}A(\Sigma^+_0) + A(\Sigma^+_+) = A(\Sigma^-_-) \text{ and } \sqrt{3}A(\Sigma^+_0) + A(\Lambda^0_-) = 2A(\Xi^-_-).$$

The signs of the B amplitudes relative to those of the corresponding A amplitudes are determined by the sign of the appropriate α decay parameter.

Table I

M → m + μ	A	B	C_{AB}
$\Lambda^0_- \to p + \pi^-$	1.48±0.01	10.17±0.24	−0.272
$\Lambda^0_0 \to n + \pi^0$	−1.08±0.02	−7.28±0.59	−0.747
$\Sigma^+_+ \to n + \pi^+$	0.06±0.02	19.06±0.16	0.003
$\Sigma^+_0 \to p + \pi^0$	1.48±0.05	−12.04±0.59	0.918
$\Sigma^-_- \to n + \pi^-$	1.93±0.01	−0.65±0.08	−0.024
$\Xi^0_0 \to \Lambda + \pi^0$	1.53±0.03	−5.90±1.11	0.347
$\Xi^-_- \to \Lambda + \pi^-$	2.04±0.02	−6.71±0.38	0.198

2. Tests of the ΔI=1/2 Rule

(a) Λ Decay

For Λ decay the ΔI=1/2 rule predicts that $\Gamma_0/\Gamma_- = 0.50$ and $\alpha_0 = \alpha_-$. In order to determine the magnitude of possible ΔI=3/2 amplitudes present we write the linear expressions[4] for the ΔI=3/2 A- and B-wave amplitudes in terms of Δα, where Δα is the measured value of α_0/α_- minus the predicted value, and in terms of ΔΓ similarly defined. Evaluating these we find

$$\Delta\alpha = -1.53\,(A_3/A_1) + 1.60\,(B_3/B_1),$$
$$\Delta\Gamma = 1.83\,(A_3/A_1) + 0.26\,(B_3/B_1).$$

Here the ΔI=3/2 amplitudes are expressed relative to the ΔI=1/2 amplitudes. The numerical values of the coefficients depend on the ratio B/A. The uncertainties in the coefficients are small compared to the uncertainties in Δα and ΔΓ. Final-state πN interactions have been included in these relations but have a very small effect. From the Stable Particle Table,

$$\Delta\alpha = 0.006\pm0.066, \quad \Delta\Gamma = 0.058\pm0.012,$$

and hence

$$(A_3/A_1) = 0.027\pm0.008$$

and

$$(B_3/B_1) = 0.030\pm0.037.$$

The possible 3% ΔI=3/2 A-wave amplitude is due to the disagreement of decay rates with prediction. At this level the results are sensitive to electromagnetic corrections. However, in Λ decay the phase space correction and the other radiative corrections appear to be about equal in magnitude and have opposite signs,[5,6] and hence cancel each other in the correction to the decay rates.

(b) Ξ Decay

The analysis for Ξ decay is very similar to that for Λ decay. If the ΔI=1/2 rule is valid, $\Gamma_0(\Xi^0)/\Gamma_-(\Xi^-) = 0.50$ and $\alpha_0 = \alpha_-$. For this case the expressions linear in ΔI=3/2 A- and B-wave amplitudes are[4]

$$\Delta\alpha = 1.38\,(A_3/A_1) - 1.38\,(B_3/B_1),$$
$$\Delta\Gamma = -1.44\,(A_3/A_1) - 0.06\,(B_3/B_1).$$

From the Stable Particle Table,

$$\Delta\alpha = 0.12\pm0.21, \quad \Delta\Gamma = 0.058\pm0.024,$$

and we find

$$(A_3/A_1) = -0.035\pm0.017$$

and

$$(B_3/B_1) = -0.13\pm0.15.$$

(c) Σ Decay

The traditional test of the ΔI=1/2 rule in Σ decay is that the amplitudes satisfy the relationship

$$\sqrt{2}\,\Sigma^+_0 + \Sigma^+_+ - \Sigma^-_- = 0\ .$$

Graphically this is equivalent to closing the Σ triangle when the amplitudes are plotted on A, B axes. Including ΔI≥3/2 amplitudes in Σ decay analysis, the "Σ triangle" relationship becomes

$$\sqrt{2}\,A_0 + A_+ - A_- = -3\sqrt{2/5}\,A_3 + \frac{2}{\sqrt{15}}A_5\ ,$$

where A_3 and A_5 are ΔI=3/2 and ΔI=5/2 amplitudes, respectively. There is a similar equation for the B amplitudes. From Table I,

$$\sqrt{2}A_0 + A_+ - A_- = 0.22\pm0.09$$

and

$$\sqrt{2}B_0 + B_+ - B_- = 2.7 \pm 1.1 \ .$$

If we neglect the $\Delta I=5/2$ amplitudes and assume all amplitudes to be real we can solve for possible $\Delta I=3/2$ amplitudes. The result is

$$\frac{A_3}{A_-} = -0.060 \pm 0.026$$

and

$$\frac{B_3}{B_+} = -0.074 \pm 0.030 \ .$$

Thus for hyperon decay, present experimental data limit $\Delta I=3/2$ amplitudes to less than about 5%.

3. The Lee–Sugawara Relation

From Table I the Lee–Sugawara relation,[7,8] $\sqrt{3}\Sigma_0^+ + \Lambda_-^0 - 2\Xi_-^- = 0$, is satisfied to -0.05 ± 0.12 for the A amplitudes, and to 2.7 ± 2.0 for the B amplitudes.

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$$\frac{\Gamma_0}{\Gamma_-} \approx \frac{1}{2} \left\{ 1+3\sqrt{2} \times \left[\frac{S_{11}S_{33}\cos(\delta_1-\delta_3)+P_{11}P_{33}\cos(\delta_{11}-\delta_{31})}{S_{11}^2+P_{11}^2} \right] \right\} .$$

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Appendix IV

GROWTH OF INFORMATION

From time to time we have presented figures demonstrating the amount of experimental work which has gone into spectroscopy, and the amount of new information available as a result. The 1976 versions of these figures are shown as Figs. 1, 2, and 3.

Figure 1 is a simple count of the number of meson resonances listed in the Tables, categorized as those "understood" -- i.e., all quantum numbers are believed known -- and those simply "listed". For the 1976 edition, there is an increase in both of these categories because of the discovery of the J/ψ and related particles.

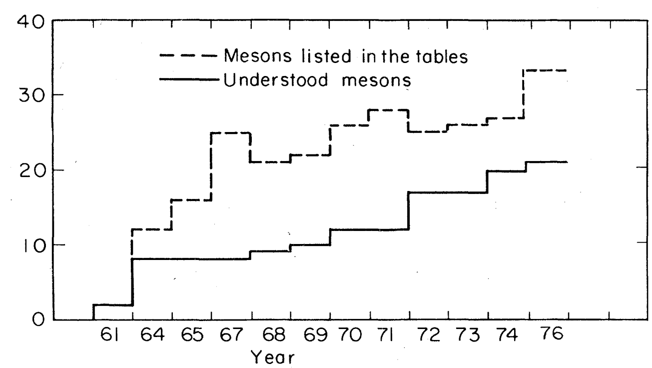

Fig. 1. Number of meson resonances listed in the Tables (dashed line) and those for which all quantum numbers are known (solid line), as a function of year of publication of the Review of Particle Properties. Note abscissa omits years in which no publication occurred.

In Figure 2 we present similar information for the baryon resonances, but concentrating here on the "growth of understanding". That is, the <u>number</u> of known baryons (we include for this figure only those with known J^P) has grown only very slowly with time (dashed line); the real progress has been in the measurement of the <u>properties</u> of those baryons. Therefore we show as the solid curve a count of the number of baryonic properties –– mass, width, and branching ratios. Most of these results are from partial–wave analyses.

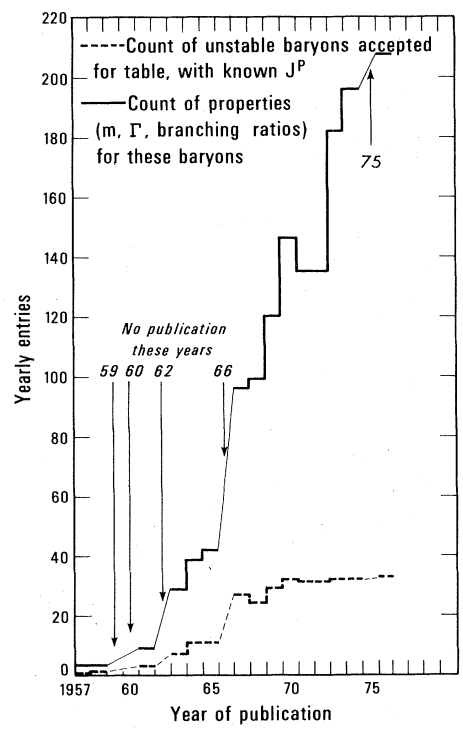

Fig. 2. Total amount of information (mass + width + branching ratios) on baryon resonances listed in the Tables, restricted to those with well–established J^P (solid line). Dashed line shows numbers of such resonances listed. Abscissa shows year of publication of Review of Particle Properties.

Finally, in Figure 3 we show a count of the number of new results put in the Listings each year, shown according to the type of detector that was used in obtaining the result, and according to the type of particle. N^* and Z^* particles have been omitted from this figure, because for these we use mainly the results of partial–wave analyses, rather than the primary data.

The fall in productivity in recent years doubtless reflects the tight budget situation and the declining emphasis on spectroscopy. Intense activity on the J/ψ and related particles is evident in the curve for meson resonances.

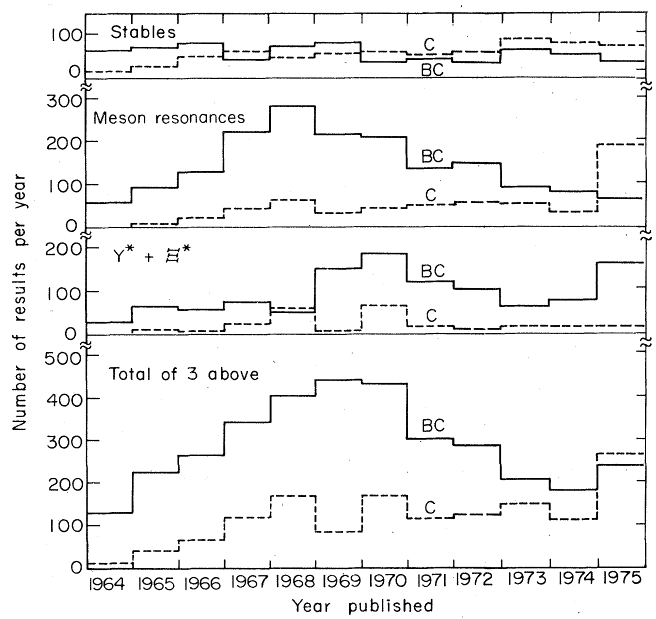

Fig. 3. The rate of production of data on particle properties, as a function of year of publication of the original result, based on data cards added to the Listings. Solid line shows bubble chamber results, dashed line counter or other electronic systems results.