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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 **33B**, 1 (1970)]. Data are evaluated, listed, averaged, and summarized in Tables. A data booklet is also available.

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I. INTRODUCTION, CREDITS, CONSULTANTS

This review is an updating through January 1971 of our previous review (Particle Data Group, 1970).

In this version of the text we concentrate on topics that are either new or essential. For complementary information on our standard procedures the reader is referred to our 1969 article (Particle Data Group, 1969).

We remind the reader that it is inappropriate to make reference to this compilation instead of to an original work. In our Data Card Listings we provide references to all original data quoted by us.

The responsibilities of the authors of this compilation (who prefer to be quoted as the "Particle Data Group") can roughly be broken down as follows:

Stable Particles: A. Barbaro-Galtieri, N. Barash-Schmidt, T. G. Trippe. Our eta meson consultant is L. R. Price.

Meson Resonances: M. Roos, A. H. Rosenfeld, P. Söding.

Baryon Resonances: A. Barbaro-Galtieri, C. Bricman, T. Lasinski, C. G. Wohl.

General: All Berkeley authors.

Consultants: The three teams just mentioned must come to a consensus on how to treat the data, and must write a number of mini-reviews. It is impractical to spread this responsibility over more than a few people in each team, and still expect to meet publication deadlines. Hence we limit our number of authors (to ten in this edition), but thereby leave gaps in our coverage, both intellectual and geographical. To help us overcome this deficiency, we have solicited the help of consultants:

- Chih-Yung Chien (Johns Hopkins University) and
- LeRoy R. Price (Univ. of California at Irvine).

Mark Sakitt (BNL) has recently agreed to aid us in the future, and we hope to add a few more consultants.

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

II. SELECTION AND ORGANIZATION OF DATA

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

(1) Stable Particles, immune to decay via the strong interaction.
(2) Meson Resonances.
(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 illustrated key thereto.

Data that have not been used in the averages 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 and has not been verified by its authors.
- It involves some assumptions that we do not wish to incorporate.
- It is of poor quality, e.g., bad signal-to-noise ratio.
- Two experiments give contradictory results, so that it is senseless to average the data.

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 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 are 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.

Further details about our selection of data can be found in the text of the 1969 edition, (Particle Data Group, 1969, Sec. III).

III. CRITERIA FOR RESONANCES

An experimentalist who finds some evidence for a peak in a mass spectrum 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 any substantial claim or evidence for a new state.

For the Tables, on the other hand, we wish to be more conservative, and to include only those peaks or resonances that have a $\gtrsim 90\%$ chance of survival. One's betting odds for survival are of course completely subjective; they are influenced mainly by the amount of information available (such as partial-wave analyses), and somewhat by the degree of controversy over interpretation and how long it will be before more information is available.

More details on our acceptance criteria are as follows:

(1) Consider, first, peaks where there is *no* partial-wave information:

(1a) Most mesons and Ξ^* peaks, plus N^* and Y^* peaks above 2200 MeV. Unless the peak is experimentally shaky, we put it in the table.

(1b) Peaks not far above some threshold, e.g., $A1 \rightarrow \rho\pi$ or $A3 \rightarrow f\pi$, and their K^* counterparts Q and L. These are at least partly explained by the "Deck effect," or its more modern version "double-Regge-pole (DRP) exchange." But the notion of duality tells us that "to explain is not to explain away," i.e., the "explanation of a peak" with the DRP model need not contradict its interpretation as an s-channel resonance. So we put these four peaks on the Meson Table, but add comments like "$A1$ interpretation not clear; 160 MeV above $\rho\pi$ threshold." For more discussion of this problem, see the $A1$ mini-review in the listings.

(2) Consider, next, peaks for which there *are* partial-wave analyses. We can then 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 will 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 K^+p peak (near $K\Delta$ threshold) called Z_1 (1900), which is discussed in a mini-review in the listings. The P_{13} Argand plots are displayed there, and most suggest a resonance; however, there is disagreement between the various analyses as to the speed of the amplitude, i.e., as to whether it has a Breit–Wigner type of behavior. In addition, the errors on the amplitudes are still large, and we prefer to wait a bit longer before we put Z_1 on the table.

Approximate Breit–Wigner behavior of a partial-wave amplitude appears to us to be the most satisfactory test for a resonance, since after all a Breit–Wigner amplitude is the Fourier transform of an exponential decay of a state with a finite lifetime. We are aware that this approximate Breit–Wigner behavior could be accidental, but can only hope that such an accident is improbable.

We now ask "How likely is it that peaks of class (1) above (no way to check them with partial-wave analysis) will eventually be confirmed as resonances?" We know of no experimentally convincing peak that has been shown to having *nothing* to do with a resonance. But be warned that broad peaks may be misleading: they may contain several resonances, or they may include a resonance narrower than the peak, plus some other complications.

- Before 1966 we might have tabulated the πp bumps at 1512 and 1688 MeV as single resonances, whereas partial-wave analysis shows that each contains several resonances.

- Abrams *et al.* have reported broad peaks in the $\bar{N}N$ total cross section at 2190, 2345, and 2380 MeV. One of these indeed overlaps our tabulated $U(2375)$ meson, whose width is given as 30 MeV. But $\bar{p}p$ s-channel experiments, which can study all the final states formed at c.m. energies near 2345 MeV, show that the rest of the $\bar{p}p(2345)$ peak, which is 140-MeV wide, must be attributed to a jumble of many different, unresolved effects. So we do not accept as a single resonance the whole $\bar{N}N(2345)$ peak, whose width is measured as 140 MeV.

Despite these cases where a resonance has turned out to be narrower than a bump, and only partly to explain the bump, *most* baryon enhancements have been confirmed by partial-wave analysis. A relevant example is the following:

- Before the $N^*(1470, P11)$ was confirmed in partial-wave analyses, it was seen as a missing mass or $p\pi\pi$ peak produced peripherally in high-energy pp collisions, and (like $A1$, Q, $A3$, and L) was partly explained by the Deck effect and later by double-Regge-pole exchange. Thus nowadays we say that the s-channel resonance *confirms* the production peak, and that this supports one's confidence in duality.

In summary, we enter onto the tables experimentally convincing peaks unless there is contradictory information; and we expect that most of these peaks will eventually be confirmed as one or more resonances.

IV. PARAMETERS AND CONVENTIONS

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.

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* 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 quark spins coupling to give a spin

* 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 Källén (1964).

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

$$C_nP=-(-1)^{S}$$

so all singlets ($^1S_0$, $^1P_1$, $\cdots$) have $C_nP=-1$, and all triplets ($^3S_1$, $\cdots$) have $C_nP=+1$.

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

For proofs see our 1969 text (Particle Data Group, 1969), and Appendix by C. Zemach. We repeat here as the summary Table I that we used in 1969 as Table II.

Baryons and Mesons

Well-established quantum numbers are underlined (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 "?" the ones for which there is almost no evidence.

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 atomic mass number A ($=0$ for mesons), its hypercharge Y, its isospin I, and, for a nonstrange meson, its G parity. We choose

$I=0$;	η	if G is even, ϕ if it is odd;
$I=1$;	ρ	if G is even, π if it is odd;
$I=\frac{1}{2}$;	K	
$I=\frac{3}{2}$;	L	(if ever established).

To crowd even more information onto the symbol, we add a subscript giving J^P. Thus $\eta_{0+}(1070)$. If J^P is not known, but must be "normal" (0^+, 1^-, 2^+, $\cdots$), e.g., because $K\pi$ decays are seen, we use the subscript N. Thus $K_N(1420)$. If such modes are *not* seen (and are not otherwise forbidden), we *guess* that it is because J is "abnormal," and we write, for example, $K_A(1320)$.

For *baryons*, no attempt has been made to attach a subscript about J and P. The symbols are

Z_I	for	$Y=2$,	$I=0, 1$;
N	for	$Y=1$,	$I=\frac{1}{2}$;
Δ	for	$Y=1$,	$I=\frac{3}{2}$;
Λ	for	$Y=0$,	$I=0$;
Σ	for	$Y=0$,	$I=1$;
Ξ	for	$Y=-1$,	$I=\frac{1}{2}$;
Ω	for	$Y=-2$,	$I=0$.

For stable baryons of each Y and I 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 assignment is reported in the 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, $\bar{K}p$, or Kp partial-wave amplitude where the resonant state occurs (the first subscript refers to the isospin state).

When two *baryons* have identical quantum numbers we warn the reader by adding a *prime* to the symbol for the heavier one, e.g., p, $N'(1470, \frac{1}{2}^+)$. In the case of baryon resonances described by Argand diagrams which exhibit more than one resonance, we use one prime for the first, two for the second, $\cdots$; thus the series of which the proton is the stable member becomes: p, $N'(1470, \frac{1}{2}^+)$, $N''(1780, \frac{1}{2}^+)$.

If there is only one resonance on an Argand plot, and thus no need for distinctions, we use no primes.

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

C. Masses and Widths

In the Tables, columns are headed Mass M, and Width Γ. We speak loosely of M as the position of a resonant peak, and of Γ as its full width at half-maximum. We now want to make these statements more precise. Values of M and Γ are extracted from data via *models*, and we cannot average these values if the models are dissimilar. In the next few paragraphs we discuss this point in slightly more detail, using the example of an s-channel resonance.

An *elastic* nonrelativistic Breit–Wigner T-matrix element is usually written

$$T_{11}=\frac{\Gamma/2}{M-m-i\Gamma/2}. \tag{6}$$

Here $\Gamma(m)$ is the width for decay into the channel 1, with angular momentum l. It contains barrier-penetra-

TABLE I. $I^G(J^P)$ of mesons from $\bar{q}q$ model. For the distinction between abnormal J^P and abnormal C, see text. $I=\frac{1}{2}$ states 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 $(J^P)_{N \text{ or } A}\, CP$, is a redundent intermediate step intended to make the Table easier to read.

	$\bar{q}q$ 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' π
		$^3S_1$	$(1^-)_N+$	$0^-(1^-)-$ $1^+(1^-)-$	ω, ϕ ρ
Parity +	$^1P_1$		$(1^+)_A-$	$0^-(1^+)-$ $1^+(1^+)-$	 B
		$^3P_0$	$(0^+)_N+$	$0^+(0^+)+$ $1^-(0^+)+$	$\eta_{0^+}(1060)$ $\pi_N(1016)$
		$^3P_1$	$(1^+)_A+$	$0^+(1^+)+$ $1^-(1^+)+$	 A1
		$^3P_2$	$(2^+)_N+$	$0^+(2^+)+$ $1^-(2^+)+$	f, f' A2
Parity −	$^1D_2$		$(2^-)_A-$	$0^+(2^-)+$ $1^-(2^-)+$	Regge recurrence of $^1S_0$, 0^-
		$^3D_1$	$(1^-)_N+$	same as $^3S_1$	
		$^3D_2$	$(2^-)_A+$	$0^-(2^-)-$ $1^+(2^-)-$	Regge recurrence of top abnormal-C state below: $(J^P)C_n = (0^-)-$
		$^3D_3$	$(3^-)_N+$	$J>2$	
Parity +	$^1F_3$		$(3^+)_A-$	$J>2$	
		$^3F_2$	$(2^+)_N+$	same as $^3P_2$	Another A2?
		$^3F_3$	$(3^+)_A+$	$J>2$	
		$^3F_4$	$(4^+)_N+$	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
	$(1^-)_N-$	$0^+(1^-)+$ $1^-(1^-)+$	
	$(0^+)_N-$	$0^-(0^+)-$ $1^+(0^+)-$	
	$(2^+)_N-$	$0^-(2^+)-$ $1^+(2^+)-$	
	$(3^-)_N-$	$0^+(3^-)+$ $1^-(3^-)+$	

tion factors which can vary rapidly with energy; near threshold $\Gamma(m)$ should start up as q^{2l+1}, and then level off. Various m dependences are used, mostly variants of the general form

$$\Gamma(m) \propto \{q^2/[1+(qR)^2]\}^l (q/m). \qquad (7)$$

For a choice of forms, see Jackson (1967), Pisut and Roos (1968), and Barbaro–Galtieri (1968). Of course the detailed shape of the amplitude will depend on the form chosen. So, although Γ is *related* to the full width, it can be measured in terms of the behavior of T at resonance. It is easy to show (Herndon *et al.*, 1970) that the relation is

$$\text{“Speed” (res)} = \left|\frac{dT}{dm}\right|_{m=M} = \frac{x_e}{\Gamma(M)/2}, \qquad (8)$$

where the elasticity, $x_e = \Gamma_e/\Gamma$, is introduced next. Further properties of “Speed” are discussed in the baryon mini-review at the front of the baryon Data Card Listings.

For an *inelastic* resonance feeding into channel β,

$$T_{1\beta} = \frac{\frac{1}{2}(\Gamma_1\Gamma_\beta)^{1/2}}{M-m-i\Gamma/2} = (x_1 x_\beta)^{1/2}\frac{\Gamma/2}{M-m-i\Gamma/2}, \qquad (9)$$

where

$$\Gamma = \sum_1^N \Gamma_\beta, \qquad x_\beta = \Gamma_\beta/\Gamma, \qquad (10)$$

and x_1 (called the elasticity) is often written x_e.

The channel cross section $\sigma_{1\beta}$ for the reaction $1 \rightarrow \beta$ is

$$\sigma_{1\beta} = 4\pi\lambda\!\!\!^{-2}(J+\tfrac{1}{2}) \mid T_{1\beta} \mid^2, \qquad (11)$$

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

Resonances seen in production are even more complicated. $(\Gamma_1)^{1/2}$ disappears from T, and must be replaced with some model-dependent parametrization of the production process.

In conclusion, we have seen that because of the energy dependence of Γ even the amplitude T for a resonance does not have a full width at half-maximum equal to Γ (but it does peak at or near M). Then kinematic factors enter into the cross section for formation [Eq. (11)] or production, and displace the observed peak away from M. For quantitative examples, see Barbaro–Galtieri (1968).

Most of the useful information on the N, Δ, Λ, and Σ *baryon resonances* with $M < 2000$ MeV has come from partial-wave analysis. Masses and widths of most of these states are dependent on the model, as well as on the data used by the different groups that performed these analyses; therefore, the masses in the main baryon Tables are not averages, but plausible guesses, and the errors are “external errors” based on the consistency among different analyses. For the procedures adopted, different from resonance to resonance, see the appropriate mini-review in the Data Card Listings.

Resonances with mass $M > 2000$ MeV have been detected primarily in total-cross-section experiments.

We can use Eq. (11) to relate the height of the peak at resonance σ_{res} to the elasticity x_e. At resonance, the *channel* cross section is

$$\sigma_{\text{res}}(1 \rightarrow \beta) = 4\pi\lambda\!\!\!^{-2}(J+\tfrac{1}{2})x_e x_\beta, \qquad (12)$$

and the *total* cross section is

$$\sigma_{\text{res}}^{(\text{total})} = 4\pi\lambda\!\!\!^{-2}(J+\tfrac{1}{2})x_e. \qquad (13)$$

If J is known, we can solve for x_e. If J is not known, the product $(J+\frac{1}{2})x_e$ is given in the baryon table.

D. 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 $\mu^\pm \rightarrow e^\pm + \nu + \bar{\nu}$. Assuming a local and lepton-conserving interaction, the matrix element may be written as

$$\sum_i \langle \bar{e} \mid \Gamma_i \mid \mu \rangle \langle \bar{\nu} \mid \Gamma_i (C_i + C_i'\gamma_5) \mid \nu \rangle, \qquad (14)$$

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:

$$\rho = [3g_A^2 + 3g_V^2 + 6g_T^2]/D, \qquad (15)$$

$$\eta = [g_S^2 - g_P^2 + 2g_A^2 - 2g_V^2]/D; \qquad (16)$$

for the asymmetry parameters:

$$\xi = [+6g_S g_P \cos\phi_{SP} - 8g_A g_V \cos\phi_{AV} + 14g_T^2 \cos\phi_{TT}]/D, \qquad (17)$$

$$\delta = [-6g_A g_V \cos\phi_{AV} + 6g_T^2 \cos\phi_{TT}]/D\xi; \qquad (18)$$

and for the parameter describing the helicity of the electron:

$$h = \pm[2g_S g_P \cos\phi_{SP} - 8g_A g_V \cos\phi_{AV} - 6g_T^2 \cos\phi_{TT}]/D. \qquad (19)$$

Here

$$D = g_S^2 + g_P^2 + 4g_A^2 + 4g_V^2 + 6g_T^2, \qquad (20)$$

$$g_i^2 = \mid C_i \mid^2 + \mid C_i' \mid^2, \qquad (21)$$

and

$$\cos\phi_{ij} = Re(C_i^* C_j' + C_i' C_j^*). \qquad (22)$$

The quantities g_i are defined to be real nonnegative 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, listed in the data cards, 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.

E. K-Decay Parameters

1. *Dalitz Plot for $K\rightarrow 3\pi$ 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 parameterize the Dalitz plot distribution by the expression

$$|M|^2\propto 1+g(s_3-s_0)/m_{\pi^+}{}^2+h[(s_3-s_0)/m_{\pi^+}{}^2]^2+j(s_2-s_1)/m_{\pi^+}{}^2+\cdots, \quad (23)$$

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

$$s_i=(\mathbf{p}_K-\mathbf{p}_i)^2=(m_K-m_i)^2-2m_KT_i \qquad i=1, 2, 3, \quad (24)$$

$$s_0=\tfrac{1}{3}\sum_i s_i=\tfrac{1}{3}(m_K{}^2+m_1{}^2+m_2{}^2+m_3{}^2). \quad (25)$$

Here the $\mathbf{p}_i$ are 4-vectors, m_i and T_i are 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 measures the quadratic dependence on s_3. 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.

At present there is no compelling experimental evidence for either the h or the j term [for upper limits on the j term, see Section E.2(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 *listings* for details on this point.

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. *CP Violation in K^0 Decays*

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

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

$$A_S(K_S\rightarrow\pi^+\pi^-\pi^0)/A_L(K_L\rightarrow\pi^+\pi^-\pi^0)\equiv x+iy. \quad (26)$$

If CPT invariance holds and there is no $I=3$ state present, then x is zero, and one measures y, which is the CP-violating part. In the $K_S{}^0$ *listings*, we give the results for (26) under Branching Ratio $R4$. 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 $K_L\rightarrow 3\pi$ decays.* As mentioned above, the presence of a term in (s_2-s_1) in Expression (23) 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. (23), we choose to list $\sigma_\pm$ from the equivalent expression

$$|M|^2\propto 1+\sigma_\pm\tfrac{2}{3}(T_+-T_-)/T_{\pm\max}+(CP\text{ nonviolating terms}), \quad (27)$$

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 (27) 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 $K_L{}^0$ data cards. Note that only upper limits have been reported for this quantity.

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

$$\delta=\frac{\Gamma(K_L\rightarrow\pi^-l^+\nu)-\Gamma(K_L\rightarrow\pi^+l^-\nu)}{\Gamma(K_L\rightarrow\pi^-l^+\nu)+\Gamma(K_L\rightarrow\pi^+l^-\nu)}. \quad (28)$$

This asymmetry violates CP invariance. If CPT is good, for a pure $K_L{}^0$ beam, δ can be written as

$$\delta=2\frac{1-|x|^2}{|1-x|^2}\,\mathrm{Re}\,\epsilon, \quad (29)$$

where x is the $\Delta S=\Delta Q$-violating parameter defined in Sec. E.3, and ϵ is the parameter of the expansion

$$|K_L\rangle=\{[(1+\epsilon)|K\rangle-(1-\epsilon)|\bar{K}\rangle]/[2(1+|\epsilon|^2)]^{1/2}\}, \quad (30a)$$

$$|K_S\rangle=\{[(1+\epsilon)|K\rangle+(1-\epsilon)|\bar{K}\rangle]/[2(1+|\epsilon|^2)]^{1/2}\}. \quad (30b)$$

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

$$\eta_{+-} = A(K_L \to \pi^+\pi^-)/A(K_S \to \pi^+\pi^-) = |\eta_{+-}| \exp(i\phi_{+-}), \tag{31}$$

$$\eta_{00} = A(K_L \to \pi^0\pi^0)/A(K_S \to \pi^0\pi^0) = |\eta_{00}| \exp(i\phi_{00}), \tag{32}$$

ϵ, defined in Eqs. (30) above, and

$$\epsilon' = (i/\sqrt{2}) \exp i(\delta_2 - \delta_0) \,\mathrm{Im}\,(A_2/A_0). \tag{33}$$

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

$$\langle I=0 \mid T \mid K \rangle = \exp(i\delta_0 A_0), \tag{34a}$$

$$\langle I=2 \mid T \mid K \rangle = \exp(i\delta_2 A_2). \tag{34b}$$

Wu and Yang (1964) have derived the relationships

$$\eta_{+-} = \epsilon + \epsilon', \tag{35a}$$

$$\eta_{00} = \epsilon - 2\epsilon'. \tag{35b}$$

At present many models have been proposed to explain the experimental results on CP violation, but more data are needed before the cause of CP violation can be ascertained.

We list η_{+-}, η_{00}, ϕ_{+-}, and ϕ_{00}. 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 $|\eta_{00}|^2$ (Particle Data Group, 1969) in a separate list at the end of the CP-violating parameters section of the $K_L{}^0$ Data Card Listings.

3. $\Delta S = \Delta Q$ *Rule in* K^0 *Decays.*

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

$$x = A(\bar{K}^0 \to \pi^- \ell^+ \nu)/A(K^0 \to \pi^- \ell^+ \nu). \tag{36}$$

We list Re $\{x\}$ and Im $\{x\}$.

4. *Form Factors in* K_{l3} *Leptonic Decays.*

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

$$M \propto f_+(q^2)[(P_K + P_\pi)_\mu \bar{u}_\ell \gamma_\mu (1+\gamma_5) u_\nu] + f_-(q^2)[m_\ell \bar{u}_\ell (1+\gamma_5) u_\nu], \tag{37}$$

where P_K and P_π are the four momenta of K and π mesons, respectively; m_ℓ is the lepton mass; f_+ and f_- are dimensionless form factors which can depend only on $q^2 = (P_K - P_\pi)^2$, the square of the momentum transfer to the leptons. The parameters we list are: $\lambda_\pm$, the energy dependence of the $f_\pm(q^2)$ form factor

$$f_\pm(q^2) = f_\pm(0)[1 + \lambda_\pm (q/m_\pi)^2]; \tag{38}$$

and ξ, the ratio of the two form factors

$$\xi = f_-/f_+. \tag{39}$$

The quantity ξ can be determined in different ways:

(1) by measuring the $K_{\mu 3}/K_{e3}$ branching ratio and comparing it with the theoretical ratio as given in terms of $\xi(0) = f_-(0)/f_+(0)$.

$$\Gamma(K_{\mu 3}{}^\pm)/\Gamma(K_{e3}{}^\pm) = 0.6457 + 0.1264 \,\mathrm{Re}\,\xi + 0.0192 \,|\xi|^2 + 1.4115\lambda_+ + 0.4754\lambda_- \,\mathrm{Re}\,\xi + 0.0080\lambda_+ \,\mathrm{Re}\,\xi,$$

$$\Gamma(K_{\mu 3}{}^0)/\Gamma(K_{e3}{}^0) = 0.6452 + 0.1246 \,\mathrm{Re}\,\xi + 0.0186 \,|\xi|^2 + 1.3162\lambda_+ + 0.4370\lambda_- \,\mathrm{Re}\,\xi + 0.0064\lambda_+ \,\mathrm{Re}\,\xi. \tag{40}$$

See CABIBBO 66 and FEARING 70 (for the charge-dependent formulae) in the card listings. Note that the first constant has been changed to 0.6457; the earlier value was a misprint,* which we copied from CABIBBO 66.

(2) by studying the Dalitz plot of the $K_{\mu 3}$ decay. The K_{e3} Dalitz plot distribution is only dependent upon the λ_+ parameter, whereas the $K_{\mu 3}$ distribution is dependent upon λ_-, λ_+, ξ. Often experimenters have measured only the momentum spectrum of either the π or the lepton and compared it with the predicted spectrum. See note in the K^+ Data Card Listings for a discussion of this method. For a formula relating the Dalitz plot variables to ξ, see for example, BRENE 61 in the $K^\pm$ card listings.

(3) by measuring the muon polarization in $K_{\mu 3}$ decay. In the rest frame of the K, the μ is expected to be polarized in the direction $\mathbf{A}$ with $\mathbf{P} = \mathbf{A}/|\mathbf{A}|$, where $\mathbf{A}$ is given (CABIBBO 64 in K^+ card listings) by

$$A = \alpha_1(\xi)\mathbf{p}_\mu - \alpha_2(\xi)\{(\mathbf{p}_\mu/m_\mu)[(m_k - E_\pi) + (\mathbf{p}_\pi \cdot \mathbf{p}_\mu)(E_\mu - m_\mu)/|\mathbf{p}_\mu|^2)] + \mathbf{p}_\pi\} + m_K \,\mathrm{Im}\,\xi(q^2)(\mathbf{p}_\pi \times \mathbf{p}_\mu). \tag{41}$$

If time-reversal invariance holds, ξ is real, and thus there is no polarization perpendicular to the K-decay plane.

See the note in the Listings, after K^+ decays, for discussions of experimental results.

F. Baryon-Decay Parameters

A/V ratio for baryon leptonic decays. The baryon part of the matrix element for these decays may be written as

$$\langle B_f \mid \gamma_\lambda (g_V - g_A \gamma_5) \mid B_i \rangle, \tag{42}$$

where B_i and B_f represent initial and final baryons, and

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* We thank Drs. H. W. Fearing and J. Smith for calling this mistake to our attention.

g_A and g_V the axial and vector coupling constants. Here the Pauli representation is used for the γ matrices. The definition of g_A/g_V is

$$g_A/g_V = |g_A/g_V| e^{i\delta}, \tag{43}$$

where δ is $0+n\pi$ if time-reversal invariance holds (see JACKSON 57 in neutron card listings).

In neutron beta decay the measurements are consistent with time reversal, so g_A/g_V therefore 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.

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.

Asymmetry parameters in nonleptonic hyperon decays. The transition matrix for the hyperon decay may be written as

$$M = s + p(\boldsymbol{\sigma}\cdot\mathbf{q}), \tag{44}$$

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

The asymmetry parameters are defined by the relations

$$\alpha = 2\,\mathrm{Re}\,(s^*p)/(|s|^2+|p|^2), \tag{45a}$$

$$\beta = 2\,\mathrm{Im}\,(s^*p)/(|s|^2+|p|^2), \tag{45b}$$

$$\gamma = (|s|^2-|p|^2)/(|s|^2+|p|^2). \tag{45c}$$

With the transition matrix (44), the angular distribution of the decay baryon, in the hyperon rest system, is of the form

$$I = 1+\alpha\mathbf{P}_Y\cdot\mathbf{q}, \tag{46}$$

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

In the notation of Lee and Yang (1957), the polarization $\mathbf{P}_B$ of the decay baryon is*

$$\mathbf{P}_B = \frac{[(\alpha+\mathbf{P}_Y\cdot\mathbf{q})\mathbf{q}+\beta(\mathbf{P}_Y\times\mathbf{q})+\gamma\mathbf{q}\times(\mathbf{P}_Y\times\mathbf{q})]}{(1+\alpha\mathbf{P}\boldsymbol{\sigma}\cdot\mathbf{q})}, \tag{47}$$

where $\mathbf{P}_B$ is defined in that rest system of the baryon obtained by a Lorentz transformation along $\mathbf{q}$ from the hyperon rest system in which $\mathbf{q}$ and $\mathbf{P}_Y$ 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

$$\alpha^2+\beta^2+\gamma^2=1. \tag{48}$$

* Note that Ref. 13 contains a misprint. The minus sign in the definition of β should be replaced by a 2. In addition, our unit vector $\mathbf{q}$ is the direction of the baryon, whereas their unit vector $\mathbf{p}$ is the direction of the pion.

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

$$\beta = (1-\alpha^2)^{1/2}\sin\phi, \tag{49a}$$

$$\gamma = (1-\alpha^2)^{1/2}\cos\phi, \tag{49b}$$

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

$$-\tfrac{1}{2}\pi \le \phi \le \tfrac{1}{2}\pi \quad \text{for} \quad \gamma > 0, \tag{50a}$$

$$+\tfrac{1}{2}\pi \le \phi \le \tfrac{3}{2}\pi \quad \text{for} \quad \gamma < 0. \tag{50b}$$

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

$$\alpha = 2|s||p| \quad \cos \quad \Delta/(|s|^2+|p|^2), \tag{51a}$$

$$\beta = -2|s||p| \quad \sin \quad \Delta/(|s|^2+|p|^2); \tag{51b}$$

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

$$-\tfrac{1}{2}\pi \le \Delta \le \tfrac{1}{2}\pi \quad \text{for} \quad \alpha > 0, \tag{52a}$$

$$+\tfrac{1}{2}\pi \le \Delta \le \tfrac{3}{2}\pi \quad \text{for} \quad \alpha < 0. \tag{52b}$$

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

$$\Delta = \delta_s - \delta_p, \tag{53}$$

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,

$$\Delta = \delta_s - \delta_p = (6.8 \pm 2.0)\ \text{deg.}^*$$

On the data cards we list 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 Particles Table we give α, ϕ, and Δ with errors; and for convenience we also give the central value of γ, without an error.

V. STATISTICAL PROCEDURES

This section is a much abbreviated version of Sec. IX in the text of our January 1970 edition (Particle Data Group, 1970), to which the reader is referred details. See also the mini-review on K^* masses and mass differences in the Data Card Listings.

A. Confidence Levels and Errors

Quoted errors represent one standard deviation (σ). Upper and lower limits represent 68.3% confidence bounds (1σ), unless otherwise stated.

* 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.

The errors in the Tables and the errors of the averages in the *listings* often include a scale factor S; see Sec. V.B below.

Quantities that have changed more than 1σ since our January 1970 edition (Particle Data Group, 1970) are italicized in the Tables. For a discussion see Sec. V.B in the text of that edition.

B. Unconstrained Averaging, Scale Factors

In the absence of constraints, we calculate a weighted average

$$\bar{x}\pm\delta\bar{x}=(\sum\omega_i x_i/\sum\omega_i)\pm[1/(\sum\omega_i)^{1/2}];$$
$$\omega_i=[1/(\delta x_i)^2], \tag{54}$$

where the sums run over N experiments. We also calculate χ^2 and compare it with its expectation value of $N-1$.

If $\chi^2>N-1$, we increase the error $\delta\bar{x}$ in Eq. (54) by a factor

$$S=[\chi^2/(N-1)]^{1/2}. \tag{55}$$

It is easy to design statistical tests for determining whether one experiment (or a group of experiments) is consistent with the other experiments. However, statistics do not tell us who is wrong in case of contradictions. When $S\gg1$, one can conclude either that:

(1) some (or all) experiments are wrong or

(2) some (or all) experiments have underestimated their errors, or

(3) the experiments do not measure the same quantity (systematic errors).

We do our best to resolve these cases. If we cannot, we *assume* that *all* experimentalists underestimated their errors by the same scale factor. 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 procedure is straightforward. If, however, there are both precise and imprecise (large errors) measurements of a particular quantity, one must be very careful not to permit the imprecise ones to "dilute" the scale factor. See our January 1970 edition (Particle Data Group, 1970) for the prescription we use to handle this effect.

We often plot an ideogram to guide the reader in deciding which data he might reject before making his own selected average.

For further discussion of ideograms and scale factors, we refer the reader to Sec. IX of our January 1970 edition (Particle Data Group, 1970).

C. Constrained Fits

The information on partial-decay fractions P_i and partial widths $\Gamma_i=P_i\Gamma_{\text{total}}$ is frequently given by branching ratios R_j, say, $R_1=P_1/(P_1+P_2)$, $R_2=P_2/P_3$, $R_3=P_1/P_2$, $R_4=P_3/(P_1+P_2+P_3)$, etc.*

The number of experimental inputs R_j is often greater than the number of decay modes. In these cases we fit all available information on the P_i, Γ_i, and R_j subject to the constraint $\Sigma P_i=1$. When, in addition, the input R_j are contradictory so that scale factors may have to be introduced, one has to resort to iterative procedures.

The Data Card Listings give the values of the fitted R_j, P_i, and Γ_i, together with the error matrices of the P_i and of the Γ_i. For details about this procedure the reader is referred to the text of the January 1970 edition (Particle Data Group, 1970), Sec. IV.B.

VI. PARTICLE DATA GROUP PUBLICATIONS

To obtain a reprint of this report, or any of the items listed below, write either Scientific Information Service, CERN, or Technical Information Division, Lawrence Radiation Laboratory, Berkeley, whichever is closer.

A. Pocket-Sized Particle Data Booklet

In addition to the present version of the Review of Particle Properties available from CERN and LRL, a pocket booklet is available. This contains the tables only, plus some additional useful information, selected for high-energy physicists. The complete pocket version comprises the data booklet, a 16-month diary, a mini-atlas, and a plastic cover. Any of these items that you have requested in the past will automatically be sent to you, but please note that our mailing lists are self-cancelling; unless you return the request card that is sent with each mailing, your name will be removed from our mailing list. If you wish to order any items in bulk we must charge 25 cents (US) for each of the pocket-sized items.

B. Other Compilations

The following reports of the Particle Data Group and of the CERN HERA Group are available from both CERN and LRL:

1. Cross Sections

A Compilation of *K^+N Reactions*, L. R. Price, N. Barash-Schmidt, O. Benary, R. W. Bland, A. H. Rosenfeld, C. G. Wohl, UCRL-20000 K^+N (September 1969).

A Compilation of *YN Reactions*, O. Benary, N. Barash-Schmidt, L. R. Price, A. H. Rosenfeld, G. Alexander, UCRL-20000 *YN* (January 1970).

Compilation of *Elastic Scattering Data*, G. C. Fox and C. Quigg, UCRL-20001 (January 1970).

NN and ND Interactions (above 0.5 GeV/c)—A Compilation, O. Benary, L. R. Price, G. Alexander, UCRL-20000 NN (August 1970).

* We are also able to fit *products* of rates from formation experiments as given in Eq. (12).

A Compilation of *Pion-Nucleon Scattering Data*, G. Giacomelli, P. Pini, and S. Stagni, CERN/HERA 69-1.

Data Compilation of *Antiproton-proton Reactions into Antihyperon-hyperon*, B. Sadoulet, CERN/HERA 69-2.

A Compilation of *Total and Total Elastic Cross Sections*, G. Giacomelli, CERN/HERA 69-3.

A Collection of *Pion Photoproduction Data*. I—From the Threshold to 1.5 GeV, P. Spillantini and V. Valente, CERN/HERA 70-1.

Compilation of Cross Sections. I—*Proton Induced Reactions*, J. D. Hansen, D. R. O. Morrison, N. Tovey, E. Flaminio, CERN/HERA 70-2.

Compilation of Cross Sections. II—*Antiproton Induced Reactions*, E. Flaminio, J. D. Hansen, D. R. O. Morrison, N. Tovey, CERN/HERA 70-3.

Compilation of Cross Sections. III—K^+ *Induced Reactions*, E. Flaminio, J. D. Hansen, D. R. O. Morrison, N. Tovey, CERN/HERA 70-4.

Compilation of Cross Sections. IV—π^+ *Induced Reactions*, E. Flaminio, J. D. Hansen, D. R. O. Morrison, N. Tovey, CERN/HERA 70-5.

2. *Partial-wave amplitudes*

πN Partial-Wave Amplitudes—A Compilation, D. J. Herndon, A. Barbaro-Galtieri, A. H. Rosenfeld, UCRL-20000 πN (February 1970).

Each of these reports in turn lists relevant references. A further list of references can be found in: "Compilation of Coupling Constants and Low-Energy Parameters," by G. Ebel *et al.*, [Nucl. Phys. **B17**, 1 (1970), and Springer Tracts in Modern Physics, Vol. 55, Sept. 1970 edition, edited by G. Höhler.]

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Particle Data Group: A. Barbaro-Galtieri, S. E. Derenzo, L. R. Price, A. Rittenberg, A. H. Rosenfeld, N. Barash-Schmidt, C. Bricman, M. Roos, P. Söding, and C. G. Wohl, Rev. Mod. Phys. **42**, 87 (1970).

PARTICLE PROPERTIES TABLES

April 1971

"Now go, write it before them in a table, and note it in a book, that it may be for the time to come for ever and ever."
Isaiah 30:7-8

". . . or at least until the next edition."
Particle Data Group

N. Barash-Schmidt, A. Barbaro-Galtieri, C. Bricman, T. Lasinski,
A. Rittenberg, M. Roos, A. H. Rosenfeld, P. Söding, T. G. Trippe and C. G. Wohl

(Closing date for data: Feb. 1, 1971)

Stable Particles

For additional parameters, see Addendum to this table.

Quantities in italics have changed by more than one (old) standard deviation since January 1970.

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	$0,1(1^-)^-$	$0(<2.)10^{-21}$	stable	stable		
ν — ν_e	$J=\frac{1}{2}$	0(<60 eV)	stable	stable		
ν_μ		0(<1.6)				
e	$J=\frac{1}{2}$	0.5110041	stable	stable		
		±.0000016	$(>2\times10^{21}y)$			
μ	$J=\frac{1}{2}$	105.6599	2.1983×10^{-6}	$e\nu\bar{\nu}$	100	53
		±.0014	±.0008	$e\gamma\gamma$	$(<1.6\quad)10^{-5}$	53
		$m^2=$ 0.0112	$c\tau=6.590\times10^{4}$	3e	$(<1.3\quad)10^{-7}$	53
		$m_\mu-m_{\pi^\pm}=-33.916$		$e\gamma$	$(<2.2\quad)10^{-8}$	53
		±.011				
$\pi^\pm$	$1^-(0^-)$	139.576	2.6024×10^{-8}	$\mu\nu$	100 %	30
		±.011	±.0024	$e\nu$	$(1.24\pm0.03)10^{-4}$	70
		$m^2=$ 0.0195	$c\tau=780.2$	$\mu\nu\gamma$	[c] $(1.24\pm0.25)10^{-4}$	30
			$(\tau^+-\tau^-)/\bar{\tau}=$	$\pi^0e\nu$	$(1.02\pm0.07)10^{-8}$	5
			(0.05±0.07)%	$e\nu\gamma$	[c] $(3.0\pm0.5)10^{-8}$	70
			(test of CPT)	$e\nu e^+e^-$	$(<3.4\quad)10^{-8}$	70
π^0	$1^-(0^-)^+$	134.972	0.84×10^{-16}	$\gamma\gamma$	(98.84 ± 0.04)%	67
		±.012	±.10 S=2.1*	γe^+e^-	(1.16 ± 0.04)%	67
		$m^2=$ 0.0182	$c\tau=2.5\times10^{-6}$	$\gamma\gamma\gamma$	$(<5\quad)10^{-6}$	67
		$m_{\pi^\pm}-m_{\pi^0}=4.6041$		$e^+e^-e^+e^-$	[d] $(3.47\quad)10^{-5}$	67
		±.0037				

Stable Particles

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)
$K^{\pm}$	$\frac{1}{2}(0^-)$	493.84	1.2371×10^{-8}	$\mu\nu$	$(63.77\pm0.28)\%$ S=1.1*	236
		±0.11	±.0026 S=1.9*	$\pi\pi^0$	$(20.92\pm0.29)\%$ S=1.2*	205
			$c\tau=370.8$	$\pi\pi^-\pi^+$	$(5.58\pm0.03)\%$ S=1.1*	126
		m^2 0.244	$(\tau^+-\tau^-)/\bar{\tau}=$	$\pi\pi^0\pi^0$	$(1.68\pm0.04)\%$	133
			$(.11\pm.09)\%$	$\mu\pi^0\nu$	$(3.20\pm0.11)\%$ S=1.8*	215
			(test of CPT)	$e\pi^0\nu$	$(4.86\pm0.07)\%$ S=1.1*	228
		$m_{K^\pm}-m_{K^0}=-3.95$	S=1.2*	$\pi\pi^\mp e^\pm\nu$	$(3.3\pm0.3)10^{-5}$	204
		±0.13		$\pi\pi^\pm e^\mp\nu$	$(<7)10^{-7}$	204
		S=1.1*		$\pi\pi^\mp\mu^\pm\nu$	$(0.9\pm0.4)10^{-5}$	151
				$\pi\pi^\pm\mu^\mp\nu$	$(<3)10^{-6}$	151
				$e\nu$	$(1.30\pm0.18)10^{-5}$	247
				$\pi\pi^0\gamma$	c$(<1.9)10^{-4}$	205
				$\pi\pi^+\pi^-\gamma$	c$(10\pm4)10^{-5}$	126
				$\pi e\nu\gamma$	c$(6\pm4)10^{-4}$	227
				πe^+e^-	$(<0.4)10^{-6}$	227
				$\pi\mu^+\mu^-$	$(<2.4)10^{-6}$	172
				$\pi\gamma\gamma$	c$(<0.4)10^{-4}$	227
				$\pi\nu\bar{\nu}$	$(<1.2)10^{-6}$	227
				$\pi\gamma$	$(<4)10^{-6}$	227
K^0	$\frac{1}{2}(0^-)$	497.79 ±0.15 S=1.1*	50% K_{Short}, 50% K_{Long}			
K_S^0	$\frac{1}{2}(0^-)$	$m^2=0.248$	0.862×10^{-10}	$\pi^+\pi^-$	$(68.7\pm0.5)\%$ S=1.3*	206
			±.006 S=1.2*	$\pi^0\pi^0$	$(31.3)\%$	209
			$c\tau=2.58$	$\mu^+\mu^-$	$(<.7)10^{-5}$	225
				e^+e^-	$(<35)10^{-5}$	249
				$\pi^+\pi^-\gamma$	c$(2.3\pm0.8)10^{-3}$	206
K_L^0	$\frac{1}{2}(0^-)$		5.172×10^{-8}	$\pi^0\pi^0\pi^0$	$(21.4\pm0.7)\%$ S=1.1*	139
			± 0.043	$\pi^+\pi^-\pi^0$	$(12.6\pm0.3)\%$	133
			$c\tau=1550$	$\pi\mu\nu$	$(26.8\pm0.6)\%$	216
				$\pi e\nu$	$(38.9\pm0.6)\%$ S=1.1*	229
		$m_{K_L}-m_{K_S}=0.5398\times10^{10}\ \hbar\ \mathrm{sec}^{-1}$		$\pi^+\pi^-$	$(0.157\pm.005)\%$	206
		± 0.0033		$\pi^0\pi^0$	$(0.094\pm.019)\%$ S=1.5*	209
				$\pi^+\pi^-\gamma$	c$(<0.4)10^{-3}$	206
			$\frac{\Gamma(K_S\to\pi^+\pi^-\pi^0)}{\Gamma(K_L\to\pi^+\pi^-\pi^0)}<0.45$	$\gamma\gamma$	$(5.6\pm0.5)10^{-4}$	249
			(test of CP)	$e\mu$	$(<1.6)10^{-9}$	238
				$\mu^+\mu^-$	$(<1.9)10^{-9}$	225
				e^+e^-	$(<1.6)10^{-9}$	249
η	$0^+(0^-)^+$	548.8	$\Gamma=(2.63\pm0.59)$ keV	$\gamma\gamma$	$(38.6\pm1.1)\%$	274
		±0.6	Neutral decays 72.2%	$\pi^0\gamma\gamma$	e$(3.3\pm1.1)\%$	258
		S= 1.4*		$3\pi^0$	$(30.3\pm1.1)\%$ S=1.2*	180
		$m^2=0.301$	Charged decays 27.8%	$\pi^+\pi^-\pi^0$	$(23.1\pm1.0)\%$	175
				$\pi^+\pi^-\gamma$	$(4.7\pm0.2)\%$	236
				$\pi^0e^+e^-$	$(<0.03)\%$	258
				$\pi^+\pi^-e^+e^-$	$(0.1\pm0.1)\%$	236
				$\pi^+\pi^-\pi^0\gamma$	$(<0.2)\%$	175
				$\pi^+\pi^-\gamma\gamma$	$(<0.2)\%$	236
				$\mu^+\mu^-$	$(2\pm1)10^{-5}$	253
				$\mu^+\mu^-\pi^0$	$(<5)10^{-4}$	211
p	$\frac{1}{2}(\frac{1}{2}^+)$	938.2592 ±0.0052 $m^2=0.8803$	stable ($>2\times10^{28}$y)			
n	$\frac{1}{2}(\frac{1}{2}^+)$	939.5527 ±0.0052 $m^2=0.8828$	e$(0.932\pm0.014)10^3$	$pe^-\nu$	100 %	1
		$m_p-m_n=-1.29344$ ±0.00007	$c\tau=2.79\times10^{13}$			

Stable Particles

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)
Λ	$0(\frac{1}{2}^+)$	1115.59	2.517×10^{-10}	$p\pi^-$	$(64.0 \pm 0.7)\%$ S=1.1*	100
		±0.06	$\pm.024$ S=1.2*	$n\pi^0$	$(36.0)\%$	104
		S= 1.3*	$c\tau$ = 7.55	$pe\nu$	$(0.80\pm0.06)10^{-3}$	163
		m^2= 1.245		$p\mu\nu$	$(1.35\pm0.60)10^{-4}$	131
Σ^+	$1(\frac{1}{2}^+)$	1189.42	0.800×10^{-10}	$p\pi^0$	$(51.7 \pm 0.8)\%$	189
		±0.11	$\pm.006$	$n\pi^+$	$(48.3)\%$	185
		S= 1.7*	$c\tau$ = 2.40	$p\gamma$	$(1.24\pm0.18)10^{-3}$ S=1.4*	225
		m^2= 1.415		$n\pi^+\gamma$	[c]$(1.30\pm0.24)10^{-4}$	185
		$m_{\Sigma^+}-m_{\Sigma^-}$ = -7.95		$\Lambda e^+\nu$	$(2.02\pm0.47)10^{-5}$	72
		$\pm.12$	$\frac{\Gamma(\Sigma^+\to\ell^+n\nu)}{\Gamma(\Sigma^-\to\ell^-n\nu)}<.035\leftarrow$	$n\mu^+\nu$	$(<2.4)10^{-5}$	202
		S= 1.4*		$ne^+\nu$	$(<1.0)10^{-5}$	224
Σ^0	$1(\frac{1}{2}^+)$	1192.51	$<1.0\times10^{-14}$	$\Lambda\gamma$	100 %	74
		±0.10	$c\tau<3\times10^{-4}$	Λe^+e^-	[d]$(5.45)10^{-3}$	74
		m^2= 1.422				
Σ^-	$1(\frac{1}{2}^+)$	1197.37	[e]1.489×10^{-10}	$n\pi^-$	100 %	193
		±0.07	$\pm.022$ S=1.8*	$ne^-\nu$	$(1.09\pm0.05)10^{-3}$	230
		S= 1.1*	$c\tau$ = 4.46	$n\mu^-\nu$	$(0.45\pm0.04)10^{-3}$	210
		m^2= 1.434		$\Lambda e^-\nu$	$(0.60\pm0.06)10^{-4}$	79
		$m_{\Sigma^0}-m_{\Sigma^-}$=-4.86		$n\pi^-\gamma$	[c]$(1.0 \pm0.2)10^{-4}$	193
		$\pm.06$				
Ξ^0	$\frac{1}{2}(\frac{1}{2}^+)$[f]	1314.7	3.03×10^{-10}	$\Lambda\pi^0$	100 %	135
		±0.7	$\pm.18$	$p\pi^-$	$(<0.9)10^{-3}$	299
		m^2= 1.729	$c\tau$ = 9.08	$pe^-\nu$	$(<1.3)10^{-3}$	323
		$m_{\Xi^0}-m_{\Xi^-}$ =-6.6		$\Sigma^+e^-\nu$	$(<1.5)10^{-3}$	119
		$\pm.7$		$\Sigma^-e^+\nu$	$(<1.5)10^{-3}$	112
				$\Sigma^+\mu^-\nu$	$(<1.5)10^{-3}$	64
				$\Sigma^-\mu^+\nu$	$(<1.5)10^{-3}$	49
				$p\mu^-\nu$	$(<1.3)10^{-3}$	309
Ξ^-	$\frac{1}{2}(\frac{1}{2}^+)$[f]	1321.31	1.660×10^{-10}	$\Lambda\pi^-$	100 %	139
		±0.17	$\pm.037$ S=1.1*	$\Lambda e^-\nu$	[g]$(0.67\pm0.23)10^{-3}$	190
		m^2=1.746	$c\tau$ = 4.98	$\Sigma^0e^-\nu$	$(<0.5)10^{-3}$	123
				$\Lambda\mu^-\nu$	$(<1.3)10^{-3}$	163
				$\Sigma^0\mu^-\nu$	$(<0.5)\%$	70
				$n\pi^-$	$(<1.1)10^{-3}$	303
				$ne^-\nu$	$(<1.0)\%$	327
Ω^-	$0(\frac{3}{2}^+)$[f]	1672.5±.5	$1.3^{+0.4}_{-0.3}\times10^{-10}$	$\Xi^0\pi^-$	Total of 28 events seen	294
		m^2= 2.797	$c\tau$ = 3.9	$\Xi^-\pi^0$		290
				ΛK^-		211

* S = Scale factor = $\sqrt{\chi^2/(N-1)}$, where $N\approx$ number of experiments. S should be $\approx$ 1. If S > 1, we have enlarged the error of the mean, δx, i. e., $\delta x\to S\,\delta x$. 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 ideogram in 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 data card listings for energy limits used in measuring this branching ratio.

d. Theoretical value; see also data card listings.

e. See note in data card listings.

f. P for Ξ and J^P for Ω^- not yet measured. Values reported are SU(3) predictions.

g. Assumes rate for $\Xi^-\to\Sigma^0 e^-\nu$ small compared with $\Xi^-\to\Lambda e^-\nu$.

ADDENDUM TO

Stable Particles

	Magnetic moment	
e	1.001 159 644 ±.000 000 007 $\frac{e\hbar}{2m_e c}$	
μ	1.001 166 16 ±.000 000 31 $\frac{e\hbar}{2m_\mu c}$	μ Decay parameters [a] $\rho = 0.752\pm0.003$ $\eta = -0.12 \pm0.21$ $\xi = 0.972\pm0.013$ $\delta = 0.755\pm0.009$ $h = 1.00\pm0.13$ $\lvert g_A/g_V\rvert = 0.86^{+0.33}_{-0.11}$ $\phi = 180° \pm15°$

$K^\pm$

Mode	Partial rate (sec^{-1})	
$\mu\nu$	$(51.55\pm0.25)10^6$	S=1.2*
$\pi\pi^0$	$(16.91\pm0.24)10^6$	S=1.2*
$\pi\pi^+\pi^-$	$(4.51\pm0.02)10^6$	S=1.1*
$\pi\pi^0\pi^0$	$(1.36\pm0.04)10^6$	
$\mu\pi^0\nu$	$(2.59\pm0.09)10^6$	S=1.8*
$e\pi^0\nu$	$(3.92\pm0.06)10^6$	S=1.2*

$\Delta I = \frac{1}{2}$ rule for $K^\pm \to 3\pi$

$\pi^+\pi^+\pi^-$ $c_g = -.206\pm.007$
$\pi^-\pi^+\pi^-$ $c_g = -.194\pm.007$
$\pi^+\pi^0\pi^0$ $c_g = .527\pm.017$

See also listings and Appendix I

Form factors for leptonic decays

See listings for λ, ξ

K^0_S

Mode	Partial rate	
$\pi^+\pi^-$	$(0.796\pm.007)10^{10}$	S=1.2*
$\pi^0\pi^0$	$(0.364\pm.006)10^{10}$	S=1.3

K^0_L

Mode	Partial rate	
$\pi^0\pi^0\pi^0$	$(4.14 \pm0.13)10^6$	S=1.1*
$\pi^+\pi^-\pi^0$	$(2.44 \pm0.06)10^6$	
$\pi\mu\nu$	$(5.19 \pm0.12)10^6$	
$\pi e\nu$	$(7.52 \pm0.14)10^6$	S=1.1*
$\pi^+\pi^-$	$(3.03 \pm0.10)10^4$	
$\pi^0\pi^0$	$(1.82 \pm0.37)10^4$	S=1.5*

CP violation parameters

$\lvert\eta_{+-}\rvert = (1.95\pm0.03)10^{-3}$, $\phi_{+-} = (44\pm3)°$

$\lvert\eta_{00}\rvert = 2.2\pm0.2)10^{-3}$, $\phi_{00} = (51\pm30)°$ S=1.5*

Charge asymmetry:

$$\delta = \frac{\Gamma(K^0_L \to \ell^+) - \Gamma(K^0_L \to \ell^-)}{\Gamma(K^0_L \to \ell^+) + \Gamma(K^0_L \to \ell^-)} = .33\pm.04$$

$I = \frac{1}{2}$ rule for $K^0_L \to 3\pi$

$\pi^+\pi^-\pi^0$ $c_g = .60\pm.03$ S=3.1*

See also listings & App. I

$\Delta S = -\Delta Q$

Re x = $-.003\pm.031$ S=1.7*
Im x = $-.037\pm.043$ S=1.1*

Form factors for leptonic decays

See listings for λ, ξ

η

Mode	Asymmetry parameter
$\pi^+\pi^-\pi^0$	$(1.2\pm0.5)\%$ S=1.3*
$\pi^+\pi^-\gamma$	$(1.1\pm1.3)\%$

	Magnetic moment ($e\hbar/2m_p c$)		Decay parameters [b] Measured α	Measured ϕ(degree)	Derived γ	Derived Δ (degree)	g_A/g_V [b]	g_V/g_A [b]
p	2.792782 ±.000017							
n	-1.913148 ±.000066	$pe^-\nu$					-1.231±0.010 [δ=(181.1±1.3)°]	
Λ	-0.70 ±.07	$p\pi^-$	0.645±0.016	(-6.3±3.5)°	0.76	$\left(7.4^{+4.0}_{-4.1}\right)°$		
		$n\pi^0$	0.649±0.046					
		$pe\nu$					-0.83 ±0.18 S=1.3*	
Σ^+	2.59 ±.46	$p\pi^0$	-0.991±0.019	(22±90)°	0.12	$\left(183^{+11}_{-12}\right)°$		
		$n\pi^+$	+0.066±0.016	(167±20)° S=1.1*	-0.97	$\left(-73^{+136}_{-10}\right)°$		
		$p\gamma$	$-1.03^{+.52}_{-.42}$					
Σ^-		$n\pi^-$	-0.069±0.008	(10±15)°	0.98	$\left(249^{+12}_{-115}\right)°$		
		$ne^-\nu$					See listings	
		$\Lambda e^-\nu$						0.35±0.18
Ξ^0		$\Lambda\pi^0$	-0.35±0.08	(25±21)° S=1.3*	0.85	$\left(228^{+16}_{-37}\right)°$		
Ξ^-		$\Lambda\pi^-$	-0.40±0.03	(-4±8)° S=1.1*	0.91	$\left(170^{+18}_{-17}\right)°$		

*S = scale factor. Quoted error includes scale factor; see footnote to main Stable Particles Table for definition.

a. $\lvert g_A/g_V\rvert$ defined by $g_A^2 = \lvert C_A\rvert^2 + \lvert C'_A\rvert^2$, $g_V^2 = \lvert C_V\rvert^2 + \lvert C'_V\rvert^2$, and $\Sigma\langle \bar{e}\lvert\Gamma_i\rvert\mu\rangle \langle\bar{\nu}\lvert\Gamma_i(C_i + C'_i\gamma_5)\rvert\nu\rangle$;
ϕ defined by $\cos\phi = -R_e(C^*_A C'_V + C'_A C^*_V)/g_A g_V$ [for more details, see text].

b. The definition of these quantities is as follows [for more details on sign convention, see text]:

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

$$\beta = \frac{-2\lvert s\rvert\lvert p\rvert\sin\Delta}{\lvert s\rvert^2 + \lvert p\rvert^2}. \quad \gamma = \sqrt{1-\alpha^2}\cos\phi. \quad \delta \text{ defined by } g_A/g_V = \lvert g_A/g_V\rvert e^{i\delta}.$$

c. The definition of the slope parameter of the Dalitz plot is as follows: $\lvert M\rvert^2 = 1 + g\left(\frac{s_3 - s_0}{m^2_{\pi^+}}\right)$.

Mesons

April 1971

Quantities in italics have changed by more than one (old) standard deviation since Januaru 1970

Name G\I: 0, 1 −: φ, π +: η, ρ	$I^G(J^P)C_n$ estab.	Mass M (MeV)	Width Γ (MeV)	M^2 $\pm\Gamma M$[a] $(\mathrm{GeV})^2$	Partial decay mode: Mode	Fraction %	p or p_{max}[b] (MeV/c)
$\pi^{\pm}(140)$ $\pi^0(135)$	$1^-(0^-)+$	139.58 134.97	0.0 7.2 eV ±1.2 eV	0.019483 0.018217	See Stable Particles Table		
$\eta(549)$	$0^+(0^-)+$	548.8 ±0.6	2.70 keV ±.67 keV	0.301 ±.000	All neutral $\pi^+\pi^-\pi^0 + \pi^+\pi^-\gamma$	72 28	See Stable Particles Table
η_{0^+}(700-1000) or ε	$0^+(0^+)+$	≳ 750	>> 100	≳ 0.6	ππ	100	
	δ_0^0 seems to stay near 90° from 750 to 1150 MeV; see note in listings						
$\rho(765)$	$1^+(1^-)-$	765 ±10(c)	125 ±20(c)	0.585 ±.095	ππ e^+e^- $\mu^+\mu^-$ For upper limits, see footnote (e)	≈100 .0060±.0008 (d) .0067±.0012 (d)	356 382 368
$\omega(784)$	$0^-(1^-)-$	783.9 ±0.3 S=1.4*	11.4 ±0.9	0.614 ±.009	$\pi^+\pi^-\pi^0$ $\pi^+\pi^-$ $\pi^0\gamma$ e^+e^- For upper limits, see footnote (g)	89.8±4.0 0.93±0.25 (f) 9.3±1.2 0.0066±.0017 S=1.4*	328 366 380 392
$\eta'(958)$ or X^0	$0^+(\;^-)+$ $J^P = 0^-$ or 2^-	957.5 ±0.8	< 4	0.917 <.004	ηππ $\pi^+\pi^-\gamma$ (mainly $\rho^0\gamma$) γγ [note (h)] For upper limits, see footnote (i)	64.0±5.0 S=1.1* 29.4±2.7 S=1.2* 6.6±3.7	231 458 479
$\delta(962)$	≥1 ( )	962 ±5	< 5	0.925 <.005	Observed in missing mass	Widths incompatible	
$\pi_N(975)$	$1^-(0^+)+$	975 ±10§	58 ±11	0.950 ±.056	ηπ possibly seen		315
These three could be related; see note in listings.							
$\pi_N(1016)$ $\to K\bar{K}$	$1^-(0^+)+$	1016 ±10	≈25 if res.	1.032 ±.025	$K^{\pm}K^0$ ηπ	Only mode seen <80	111 342
Resonance, virtual bound state, or antibound state, still not distinguished.							
$\phi(1019)$	$0^-(1^-)-$	*1019.5* *±0.6* *S = 1.5**	4.0 ±0.3	1.039 ±.004	K^+K^- K_LK_S $\pi^+\pi^-\pi^0$ (incl. ρπ) e^+e^- $\mu^+\mu^-$ For upper limits, see footnote (j)	46.4±2.8 S=1.2* 35.4±4.0 S=1.6* 18.2±5.4 S=1.9* .035±.003 .023±.005	125 108 461 509 498
η_{0^+} (1070) or S*	$0^+(0^+)+$	1070 ±30§	150-300 (k) if resonance	1.14	ππ $K\bar{K}$	< 65 > 35	517 201
					Resonance and scattering length both possible (k); see notes in listing on η_{0^+}(700-1000, ππ) and η_N(1080, J>0)		
A1(1070)	$1^-(1^+)+$ $J^P = 2^-$ not excluded	1070 ±20§	50-200 dep. on bgr.	1.14	3π [see note (ℓ) on ρπ] $K\bar{K}$ [$G = (-1)^{\ell+I}$ forbids $K\bar{K}$ for J = 1]	≈ 100 < 0.25	488 201
Resonance interpretation slightly in doubt; only 160 MeV above ρπ threshold. See note (t).							

Mesons

Name (G\I: 0, 1; −: φ, π; +: η, ρ)	$I^G(J^P)C_n$ ⊢⊣ estab.	Mass M (MeV)	Width Γ (MeV)	$M^2 \pm \Gamma M$[a] $(\mathrm{GeV})^2$	Partial decay mode: Mode	Fraction %	p or p_{max}[b] (MeV/c)
B(1235)	$1^+(1^+)-$	1233 ±10§	100 ±20§	1.53 ±.13	ωπ	≈ 100	350
					ππ	< 30 } Absence suggests	602
					$K\bar{K}$	< 2 } J^P = Abnormal	371
					For other upper limits, see footnote (m)		
f(1260)	$0^+(2^+)+$	1269 ±10§	154 ±25§	1.60 ±.20	ππ	≈ 80	618
					$2\pi^+2\pi^-$	7±2	554
					$K\bar{K}$	≈ 5	391
D(1285)	$0^+(A)+$	1286 ±4 S=1.4*	33 ±4	1.65 ±.04	$K\bar{K}\pi$ [mainly $\pi_N(1016)$]	Seen	305
					ππη	Possibly large	484
					$\pi_N(975)\pi$	Possibly seen	244
	$J^P = 0^-, 1^+, 2^-$, with 1^+ favoured				ππρ	Not seen	352
A2 ⟨1310⟩	$1^-(2^+)+$	⟨1310⟩	⟨85⟩	⟨1.72⟩	⟨ ⟩ = unsplit and unresolved avge.		
Either: $A2_{Wide}$ (≈ 1300, Γ ≈ 80) + $A2_{Narrow}$ (≈ 1300, Γ ≈ 10)					ρπ	⟨≈ 76⟩	409
					ηπ	⟨≈ 18⟩	523
or: $A2_{Low}$ (≈ 1290, Γ ≈ 25) + $A2_{High}$ (≈ 1310, Γ ≈ 25)					$\bar{K}K$	⟨≈ 5⟩	420
					η'(958)π	⟨~ 1⟩	271
Existing data can be explained by a pair of resonances which are either narrow-on-wide or possibly side-by-side; three recent high-resolution expts. show no split. See note (n).							
E(1422)	$0^+(0^-)+$	1422 ±4	69 ±8	2.02 ±.10	$K^*\bar{K} + \bar{K}^*K$	50 ± 10	153
					$\pi_N(1016)\pi$	50 ± 10	326
	$J^P = 1^+$ not excluded				ππη	< 60	568
	See note in listings				ππρ	Not seen	457
f'(1514)	$0^+(2^+)+$	1514 ±5	73 ±23 S=1.8*	2.29 ±.11	$K\bar{K}$	72 ± 12 (o)	570
					$K^*\bar{K} + \bar{K}^*K$	10 ± 10 (o)	294
					ππ	< 14 (o)	744
					ηππ	18 ± 10 (o)	624
					ηη	< 40 (o)	521
π/ρ(1540) or F_1	$1(A)$	1540 ±5	40 ±15	2.37 ±.06	$K^*\bar{K} + \bar{K}^*K$	Only mode seen	321
	Evidence based on only one experiment						
$\pi_A(1640)$ or A3	$1^-(A)+$	1640 ±10§	50-200 (t)	2.67 ±.15	fπ	Dominant	310
					3π	Possibly observed	792
	$J^P = 2^-$ preferred				ωππ (p)		597
Resonance interpretation in doubt; only 240 MeV above fπ threshold, see note (t)							
φN(1650)	$0^-(N)-$	1664 ±13 S=1.2*	141 ±17	2.83 ±.23	ρπ	Dominant	639
					3π	Possibly observed	797
					5π	10±10	
$\rho_N(1660)$ or g	$1^+(N)-$	1660 ±20§	≲ 200	2.76	2π	Dominant	818
	$J^P = 1^-, 3^-,\ldots$ with 3^- favoured				$K\bar{K}$	7 ± 3	664
					Nearby peaks in 4π modes have been grouped under ρ(1710) below. This does not imply that $\rho_N(1660)$ and ρ(1710) are different resonances.		
ρ(1710) → 4π	$1^+(\ )-$	1712 ±10§	125 ±25	2.93 ±.21	4π		797
					†[$\pi^\pm A_2^0(\to\pi^+\pi^-\pi^0)$/all$(\pi^\pm\pi^+\pi^-\pi^0)$	40 ± 20]	339
					†[$\pi^\pm\omega(\to\pi^+\pi^-\pi^0)$/all$(\pi^\pm\pi^+\pi^-\pi^0)$	25 ± 10]	667
	See note under $\rho_N(1660)$ above.				†[$\rho^\pm\rho^0$	Seen]	382
	ωπ mode has mass 1633 MeV, see listing.				$\pi^\pm\phi/\pi^\pm\pi^+\pi^-\pi^0$	< 11	539
					$\pi^\pm 2\pi^+2\pi^-\pi^0/\pi^\pm\pi^+\pi^-\pi^0$	< 15	704
					†[ππρ	Seen]	649

← See R-Region Fig. in listings before $\rho_N(1660)$ →

Mesons

Name (G\I: − 0 φ, 1 π; + η, ρ)	$I^G(J^P)C_n$ ⊢ estab.	Mass M (MeV)	Width Γ (MeV)	M^2 $\pm\Gamma M$[a] $(GeV)^2$	Partial decay mode: Mode	Fraction %	p or Pmax[b] (MeV/c)
⇥ See note (q) for states grouped as R(1750), η/ρ(1830), φ/π(1830)							
S(1930)	$1^+(\geq 2)-$	1929 ±14	20 ±15§		$\pi\pi$ $p\bar{p}$	Probably seen Probably seen	955 226
	Seen in $\pi^- p \to (MM)^- p$, appears confirmed in $\bar{p}p \to \bar{p}p$						
⇥ See note (q) for states grouped as ρ(2100), T(2200), ρ(2275), and $N\bar{N}$(2350).							
U(2375)	1 ( )	2371 ±13	30 ±20§	5.57 ±.07	Seen in $\pi^- p \to (MM)^- p$ and $\bar{p}p \to K\bar{K}^*\pi\pi$.		
⇥ See note (q) for heavier states.							
$K^+(494)$ $K^0(498)$	1/2(0⁻)	493.84 497.79		0.244 0.248	See Stable Particles Table		
$K^*(892)$	1/2(1⁻)	*892.6 ±0.5 S=1.3**	50.3 ±1.1 S=1.3*	0.797 ±.045	$K\pi$ $K\pi\pi$	≈ 100 0.2	288 216
		(Charged mode; $m^0 - m^\pm = 8 \pm 3$)					
⇥							
Q: $K_A(1240)$ or C	1/2(1⁺)	1242 ±10	127 ±25	1.54 ±.16	Resonance interpretation unclear; only 270 MeV above $K^*\pi$ threshold; see notes (r) and (t)		
	seen in $\bar{p}p$ at rest and $\pi^- p \to \Lambda K\pi\pi$						
Q: K_A(1280 to 1400)	1/2(1⁺)	1280 to 1400	See note (t)		$K\pi\pi$ †[$K^*\pi$ †[$K\rho$	Only mode seen Large] Seen]	
$K_N(1420)$	1/2(2⁺)	1408 ±10§	*107 ±15 S=2.6**	1.98 ±.15	$K\pi$ $K^*\pi$ $K\rho$ $K\omega$ $K\eta$	*56.9 ± 4.0 S = 1.2** *27.4 ± 3.2 S = 1.1** 9.2 ± 3.5 S = 1.2* 4.5 ± 1.8 2.0 ± 1.8	609 406 311 291 474
	See note (s). $J^P = 3^-$ still possible						
⇥							
L(1770)	1/2(A)	1770 ±10§	50-140 (t)	3.13	$K\pi\pi$ [$K^*(1420)\pi$ $K\pi\pi\pi$	Dominant Large; in K^+p expts. dominant] Possibly seen	791 300 760
	$J^P = 1^+, 2^-$ favoured						

Resonance interpretation unclear; only 215 MeV above $K_N(1420)\pi$ threshold; see note (t).

⇥

Mesons

→ The following bumps, excluded above, are listed among the data cards: $\sigma(410)$; M(953); H(990); $\eta_N(1080)$; A1.5(1170); $\rho\rho(1410)$; $K_SK_S(1440)$; R(1750); η or $\rho(1830) \to 4\pi$; ϕ or $\pi(1830) \to \omega\pi\pi$; $\rho(2100)$; T(2200); $\rho(2275)$; $N\bar{N}_{I=1}(2350)$; $\bar{N}N_{I=0}(2375)$; $X^-(2500)$; $X^-(2620)$; $X^-(2800)$; $X^-(2880)$; $X^-(3030)$; $X^-(3075)$; $X^-(3145)$; $X^-(3475)$; $X^-(3535)$; $K_N(1080\text{-}1260)$; $K_{A(I=3/2)}(1175)$; $K_{A(I=3/2)}(1265)$; $K_N(1660)$; $K^*(2240) \to \bar{Y}N$. (See note (q).)

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

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

§ This is only an educated guess; the error given is larger than the error of the average of the published values (see 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) The values given for $M(\rho)$ and $\Gamma(\rho)$ and their errors are not average values from various experiments, but rather are intended to give the range where we believe the actual values are most likely to fall. Contrast the results tabulated in this note (references in the listings).

	M(MeV)	Γ(MeV)	
ρ^0	774±5	111±5	From $e^+e^- \to \pi^+\pi^-$, fitted to Gounaris-Sakurai formula.
ρ^0	768±10	140±14	
ρ^-	764±2	147±4	From physical region fits to $\pi N \to \pi\pi N$, using energy-dependent width.
ρ^0	775±3	145±9	
ρ^0	768±2	132±13	
ρ^0	759±7	119±20	From pole extrapolation in $\pi N \to \pi\pi N$
ρ^-	760	131	

(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 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 listings. If $e\mu$ universality holds, $\Gamma(\rho^0 \to \mu^+\mu^-) = \Gamma(\rho^0 \to e^+e^-) \times$ phase space correction.

(e) Empirical limits on fractions for other decay modes of $\rho(765)$ are $\pi^\pm\gamma < 0.5\%$, $\pi^\pm\eta < 0.8\%$, $\pi^\pm\pi^+\pi^-\pi^- < 0.15\%$, $\pi^\pm\pi^+\pi^-\pi^0 < 0.2\%$.

(f) Depends mainly on one experiment, $\gamma C \to \pi^+\pi^- C$. Uncertainties about ρ shape and production mechanism could increase error.

(g) Empirical limits on fractions for other decay modes of $\omega(784)$ are $\pi^+\pi^-\gamma < 5\%$, $\pi^0\pi^0\gamma < 1\%$, η + neutral(s) < 1.5%, $\mu^+\mu^- < 0.02\%$, $\pi^0\mu^+\mu^- < 0.2\%$.

(h) This $\eta' \to \gamma\gamma$ value is from a constrained fit under the assumption that $\eta\pi\pi$, $\rho^0\gamma$, and $\gamma\gamma$ are the only existing decay modes. Note that direct measurement of the $\eta' \to \gamma\gamma$ branching fraction gave the slightly different result of $(9.9 {}^{+4.4}_{-3.9})\%$.

(i) Empirical limits on fractions for other decay modes of $\eta'(958)$: $\pi^+\pi^- < 2\%$, $\pi^+\pi^-\pi^0 < 5\%$, $\pi^+\pi^+\pi^-\pi^- < 1\%$, $\pi^+\pi^+\pi^-\pi^-\pi^0 < 1\%$, $6\pi < 1\%$, $\pi^+\pi^-e^+e^- < 0.6\%$, $\pi^0e^+e^- < 1.3\%$, $\eta e^+e^- < 1.1\%$, $\pi^0\rho^0 < 4\%$, $\pi^0\omega < 8\%$.

(j) Empirical limits on fractions for other decay modes of $\phi(1019)$ are $\pi^+\pi^- < 5\%$, $\eta\gamma < 8\%$, η + neutrals < 13%, $\pi^+\pi^-\gamma < 4\%$, $\omega\gamma < 5\%$, $\rho\gamma < 2\%$, $\pi^0\gamma < 0.35\%$.

(k) Width of $\eta_{0+}(1070) \to K_SK_S$ uncertain due to proximity of threshold. The data also allow a fit with scattering length and effective range. See listings and W. Beusch's review, Philadelphia Conference 1970, p. 185.

(ℓ) $\rho\pi$ fraction of 3π mode difficult to distinguish because ρ bands cover most of the Dalitz plot.

(m) Empirical limits on fractions for decay modes of B(1235): $\pi\pi < 30\%$, $K\bar{K} < 2\%$, $4\pi < 50\%$, $\phi\pi < 1.5\%$, $\eta\pi < 25\%$, $(\bar{K}K)^\pm\pi^0 < 8\%$, $K_SK_S\,\pi^\pm < 2\%$, $K_SK_L\,\pi^\pm < 6\%$.

(n) For an up-to-date discussion see K. W. J. Barnham and G. Goldhaber, UCRL-20293. They adjust the absolute mass scale of different expts. by ~10 MeV, and then find that a broad continuum of parameters will fit the data; the values above are typical. Unsplit and unresolved A2 peaks have the following m and Γ: $\rho\pi$ and $\eta\pi$ modes--m = (1300±4) MeV, Γ =(84±4) MeV; $\bar{K}K$ mode--m = (1316±3) MeV, Γ = (60±15)MeV.

(o) There is only a weak indication for a $K^*\bar{K} + \bar{K}^*K$ mode of the f′(1514). If this mode does not exist, the $K\bar{K}$ branching fraction will have to be reported as 80 ± 13% (rather than 72 ± 12% as given in the table), and $\eta\pi\pi$ as 20 ± 13%.

Mesons

(p) The possible $\omega\pi\pi$ decay mode of the A3 has mass 1690 MeV and width 45 MeV, in agreement with R2.

(q) We tabulate here Y = 0 bumps with M ≥ 1700 MeV, for which no satisfactory grouping into particles is yet possible. See listings.

Name	I^G	J^P	M(MeV)	Γ(MeV)	Decay modes observed	Tentative grouping
$K\bar{K}$(1740)	1		1740	≈ 120	$K^0K^{\pm}$	R(1750)
R3(1750)	1,2		1748 ± 15	≤ 38	$(MM)^- \to$1/3/>3 charg.part.>14/<80/15	
$\pi\pi$(1764)			1764 ± 15	87^{+14}_{-20}	$\pi^+\pi^-$	
$K\bar{K}\pi$(1820)	0,1,2		1820 ± 12	50 ± 23	$K_SK^0\pi^0$	1830 region
R4(1830)	1,2		1830 ± 15	≤ 30	$(MM)^-$	
η/ρ(1830)	+		1832 ± 6	42 ± 11	$\pi^+\pi^-\pi^+\pi^-$	
ϕ/π(1830)	-		1848 ± 11	67 ± 27	$\omega\pi^+\pi^-$, possibly $\omega\rho^0$	
X^-(2086)	1,2		2086 ± 38	≈ 150	$(MM)^-$ backward	ρ(2100)
ρ(2120)	1^+	3^-(?)	2120	< 249	$\pi^+\pi^-$, $\bar{p}p$	
$\pi\pi$(2157)	1^+	(odd)-	2157 ± 10	68 ± 22	$\pi^+\pi^0$	T region Seems to require >1 resonance
$N\bar{N}$(2190)	1^-		2190	20-80	$\rho^0\rho^0\pi^0$, $\bar{p}p$	
	1		2190 ± 10	≈ 85	Structure in $N\bar{N}$ total σ	
T(2195)	1,2		2195 ± 15	≤ 13	$(MM)^- \to$ 3 charged particles ≈ 94%	
3π(2207)	≤ 3^-		2207 ± 13	62 ± 52	$\pi^+\pi^-\pi^0$	
4π(2200)	$1^+,2^+,3^+$		2207 ± 22	≈ 130	$\rho^-\pi^+\pi^-$, ω and η antiselected	
$KK\omega$(2176)	$0^-,1^+$		2176 ± 5	20^{+16}_{-2}	$K_SK_S\omega$	
X^-(2260)	1,2		2260 ± 18	≤ 25	$(MM)^-$ backward	ρ(2275)
ρ(2290)	1^+	5^-(?)	2290	< 165	$\pi^+\pi^-$, $\bar{p}p$	
$N\bar{N}$(2350)	1		2350 ± 10	≈ 140	Structure in $N\bar{N}$ total σ	
$N\bar{N}$(2375)	0		2375 ± 10	≈ 190	Structure in $N\bar{N}$ total σ	
X^-(2500)	1,2		2500 ± 32	≈ 87	$(MM)^-$ backward	
X^-(2620)	1,2		2620 ± 20	85 ± 30	$(MM)^-$	2650 region
4π(2676)	(1,2,3)+		2676 ± 27	≈ 150	$\rho^-\pi^+\pi^-$, ω and η antiselected	
X^-(2800)	1,2		2800 ± 20	46 ± 10	$(MM)^-$	
X^-(2880)	1,2		2880 ± 20	≤ 15	$(MM)^-$	
X^-(3025)	1,2		3025 ± 20	≈ 25	$(MM)^-$	3030 region
$N\bar{N}$(3035)	+		3035 ± 25	200 ± 60	4π, 6π	
X^-(3075)	1,2		3075 ± 20	≈ 25	$(MM)^-$	
X^-(3145)	1,2		3145 ± 20	≤ 10	$(MM)^-$	
X^-(3475)	1,2		3475 ± 20	≈ 30	$(MM)^-$	
X^-(3535)	1,2		3535 ± 20	≈ 30	$(MM)^-$	

(r) See Q-region note in listings. Some investigators see a broad enhancement in mass ($K\pi\pi$) from 1250-1400 MeV (the Q region), and others see structure. Only the K_A(1240) or C seems well established, whereas possible structures from 1280 to 1400 MeV cannot be disentangled. For the whole Q region the decay rate into $K^*(892)\pi$ is large, and a $K\rho$ decay is seen. The $K\eta$, $K\omega$, and $K\pi$ are less than a few percent.

(s) The mass comes only from charged $K_N(1420) \to K\pi$ measurements, since it is not well determined in the $K\pi\pi$ system with Q effect present; average of neutral K_N^* mass is 1423, but see typed note under $K^*(892)$ mass in listings.

(t) Four bumps (A1, A3, Q, L) appear, in mass spectra, as broad enhancements (up to 200-400 MeV wide) centred about 200 MeV above threshold; they can be interpreted as either resonances or kinematic effects. Widths and branching ratios are published, and compiled in the listing, but in some cases we do not average them because they are very sensitive to difficult background subtractions. For more discussion, see notes in data card listings.

Mixing angles for SU(3) nonets: the small table which appeared here in earlier editions has been moved to Appendix II.

Baryons

April 1971

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

Particle[a]	I (J^P) estab.	π or K Beam T(GeV) p(GeV/c) $\sigma = 4\pi\lambda\!\!\!^-{}^2$ (mb)	Mass M^b (MeV)	Width Γ^b (MeV)	M^2 $\pm\Gamma M^c$ (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 Particles		
n			939.6		0.883			
N' (1470)	$1/2(1/2^+)$ P'_{11}	T=0.53πp	1435 to	165 to	2.16	Nπ	60	420
		p=0.66	1505	400	±0.34	Nππ	40	368
		σ=27.8						
N' (1520)	$1/2(3/2^-)$ D'_{13}	T=0.61	1510 to	105 to	2.31	Nπ	50	456
		p=0.74	1540	150	±0.18	Nππ	50	410
		σ=23.5				[Δ(1236)π][e]	[dominant][e]	224
						Nη	~0.6	
N' (1535)	$1/2(1/2^-)$ S'_{11}	T=0.64	1500 to	50 to	2.36	Nπ	35	467
		p=0.76	1600	160	±0.18	$N\eta^0$	55	182
		σ=22.5				$N\pi\pi^0$	~10	422
N(1670)[i]	$1/2(5/2^-)$ D_{15}	T=0.87	1655 to	105 to	2.79	Nπ	40	560
		p=1.00	1680	175	±0.24	Nππ	60	525
		σ=15.6				[Δ(1236)π][e]	[44][e]	357
						ΛK	< .3	200
						Nη	< 1[j]	368
N(1688)[i]	$1/2(5/2^+)$ F_{15}	T=0.90	1680 to	105 to	2.85	Nπ	60	572
		p=1.03	1692	180	±0.21	Nππ	40	538
		σ=14.9				[Δ(1236)+π][e]	[26][e]	371
						ΛK	< .2	231
						Nη	< .5[j]	388
N'' (1700)[i]	$1/2(1/2^-)$ S''_{11}	T=0.92	1665 to	100 to	2.89	Nπ	~65	580
		p=1.05	1765	400	±0.42	ΛK	5	250
		σ=14.3				Nη		340
N'' (1780)[i]	$1/2(1/2^+)$ P''_{11}	T=1.07	1650 to	50 to	3.17	Nπ	30	633
		p=1.20	1860	450	±0.51	ΛK	~ 7	353
		σ=12.2				Nη	~10[j]	476
N(1860)	$1/2(3/2^+)$ P_{13}	T=1.22	1770 to	180 to	3.46	Nπ	25	685
		p=1.36	1900	330	±0.57	Nππ		657
		σ=10.4				ΛK	~ 5	437
						Nη	~ 4[j]	545
N(2190)	$1/2(7/2^-)$ G_{17}	T=1.94	2000 to	270 to	4.80	Nπ	25	888
		p=2.07	2260	325	±0.67	Nππ		868
		σ=6.21						
N(2220)	$1/2(9/2^+)$ H_{19}	T=2.00	2200 to	260 to	4.93	Nπ	15	905
		p=2.14	2245	330	±0.65	Nππ		887
		σ=5.97						
N(2650)	$1/2(\ ?^-)$	T=3.12	2650	360	7.02	Nπ	(J+1/2)x	1154
		p=3.26			±0.95	Nππ	=0.45[f]	1140
		σ=3.67						
N(3030)	$1/2(\ ?\ )$	T=4.27	3030	400	9.18	Nπ	(J+1/2)x	1366
		p=4.41			±1.21	Nππ	=0.05[f]	1354
		σ=2.62						
Δ(1236)	$3/2(3/2^+)$ P'_{33}	T=0.195 (++)	1230 to	110 to	1.53	Nπ	99.4	231
		p=0.304	1236	122	±0.14	$N\pi^+\pi^-$	0	89
		σ=91.8				Nγ	~0.6	262
Δ(1650)	$3/2(1/2^-)$ S_{31}	T=0.83	1615 to	130 to	2.72	Nπ	28	547
		p=0.96	1695	200	±0.28	Nππ	72	511
		σ=16.4						

Baryons

	Particle[a]	I (J^P) ⊢⊣ estab.	π or K Beam T(GeV) p(GeV/c) $\sigma = 4\pi\lambda\!\!\!^{-2}$ (mb)	Mass M^b (MeV)	Width Γ^b (MeV)	M^2 $\pm\Gamma M^c$ (GeV^2)	Partial decay mode: Mode	Fraction %	p or p_{max} [d] (MeV/c)
	Δ(1670)	$3/2(3/2^-)\ D_{33}$	T=0.87 p=1.00 σ=15.6	1650 to 1720	175 to 300	2.79 ±0.40	Nπ Nππ	15	560 525
	Δ(1890)	$3/2(5/2^+)\ F_{35}$	T=1.28 p=1.42 σ=9.88	1840 to 1920	135 to 350	3.57 ±0.49	Nπ Nππ	17	704 677
	Δ(1910)	$3/2(1/2^+)\ P_{31}$	T=1.33 p=1.46 σ=9.54	1780 to 1935	230 to 420	3.65 ±0.62	Nπ Nππ	25	716 691
Δ	Δ(1950)	$3/2(7/2^+)\ F_{37}$	T=1.41 p=1.54 σ=8.90	1930 to 1980	140 to 220	3.80 ±0.39	Nπ Δ(1236)π ΣK Σ(1385)K	45 ≈50 ~ 2 1.4	741 571 460 232
	Δ(2420)	$3/2(11/2^+)$	T=2.50 p=2.64 σ=4.68	2320 to 2450	270 to 350	5.86 ±0.75	Nπ Nππ	11 >20	1023 1006
	Δ(2850)	$3/2(\ ?^+\ )$	T=3.71 p=3.85 σ=3.05	2850	400	8.12 ±1.14	Nπ Nππ	(J+1/2)x =0.25 [f]	1266 1254
	Δ(3230)	3/2(?)	T=4.94 p=5.08 σ=2.25	3230	440	10.4 ±1.4	Nπ Nππ	(J+1/2)x =0.05 [f]	1475 1464
Z*	Z^*	Evidence for states with hypercharge 2 is controversial. See listings for discussion and display of data.							
	Λ	$0(1/2^+)$		1115.6		1.24	See Stable Particles		
	Λ(1405)	$0(1/2^-)\ S_{01}$	p< 0 K^-p	1405 ±5 [g]	40 ±10 [g]	1.97 ±0.06	Σπ	100	142
	Λ'(1520)	$0(3/2^-)\ D'_{03}$	p=0.389 σ=84.5	1518 ±2 [g]	16 ±2 [g]	2.30 ±0.02	N$\bar{K}$ Σπ Λππ [Σ(1385)π] [e] Σππ	46±1 41±1 9.6±.7 [39±10] [e] 1.0±.1	237 260 252 75 [n] 144
	Λ'(1670)	$0(1/2^-)\ S'_{01}$	p=0.74 σ=28.5	1670	15 to 38	2.79 ±0.04	N$\bar{K}$ Λη Σπ	~20 ~35 ~45	410 66 393
Λ	Λ''(1690)	$0(3/2^-)\ D''_{03}$	p=0.78 σ=26.1	1690	27 to 85	2.86 0.09	N$\bar{K}$ Σπ Λππ Σππ	~30 [h] ~40 ~20 ~10	429 409 415 352
	Λ(1815)	$0(5/2^+)\ F'_{05}$	p=1.05 σ=16.7	1820 ±5 [g]	64 to 100	3.30 ±0.15	N$\bar{K}$ Σπ Σ(1385)π	62 11 17	537 504 358
	Λ(1830)	$0(5/2^-)\ D_{05}$	p=1.09 σ=15.8	1835	74 to 150	3.37 ±0.20	N$\bar{K}$ Σπ	~10 ~30	550 515
	Λ(2100)	$0(7/2^-)\ G_{07}$	p=1.68 σ=8.68	2100	60 to 140	4.41 ±0.22	N$\bar{K}$ Σπ Λη ΞK Λω	25 ~ 5 < 3 < 10	748 699 617 483 443
	Λ(2350)	0(?)	p=2.29 σ=5.85	2350	140 to 324	5.52 ±0.55	N$\bar{K}$	(J+1/2)x =0.7 [f]	913

Baryons

Particle[a]	I (J^P) ├─┤ estab.	π or K Beam: T(GeV) p(GeV/c) $\sigma = 4\pi\lambda\!\!\!^{-2}$ (mb)	Mass M^b (MeV)	Width Γ^b (MeV)	M^2 $\pm\Gamma M^c$ (GeV^2)	Partial decay mode: Mode	Fraction %	p or p_{max}[d] (MeV/c)
Σ	$1(1/2^+)$		(+)1189.4 (0)1192.5 (-)1197.4		1.41 1.42 1.43	See Stable Particles		
$\Sigma(1385)$	$1(3/2^+)\ P_{13}$	$p<0\ K^-p$	(+)1383±1 S=1.3* (-)1386±2 S=2.2*	(+)36±3 S=1.9* (-)36±6 S=3.5*!	1.92 ±0.05	$\Lambda\pi$ $\Sigma\pi$	90±3 10±3 S=1.4*	208 117
$\Sigma'(1670)$[k]	$1(3/2^-)\ D'_{13}$	p=0.74 σ=28.5	1670	50	2.79 ±0.08	$N\bar{K}$ $\Sigma\pi$ $\Lambda\pi$ $\Sigma\pi\pi$ $[\Lambda(1405)\pi]^e$ $\Lambda\pi\pi$	~8	410 387 447 326 207 397
	Mass, width and elasticity are the values obtained in partial wave analyses for a D_{13} resonance. For more results see the listings and footnote k.							
$\Sigma'(1750)$	$1(1/2^-)\ S''_{11}$	p=0.91 σ=20.7	1750	50 to 80	3.06 ±0.11	$N\bar{K}$ $\Lambda\pi$ $\Sigma\eta$	~15 seen seen	483 507 55
$\Sigma(1765)$	$1(5/2^-)\ D_{15}$	p=0.94 σ=19.6	1765 ±5[g]	~120	3.12 ±0.21	$N\bar{K}$ $\Lambda\pi$ $\Lambda(1520)\pi$ $\Sigma(1385)\pi$ $\Sigma\pi$	~44 ~15 ~14 ~13 ~1	496 518 187 315 461
$\Sigma(1915)$[i]	$1(5/2^+)\ F'_{15}$	p=1.25 σ=13.0	1910	70	3.65 ±0.13	$N\bar{K}$ $\Lambda\pi$ $\Sigma\pi$	~11	613 619 568
	Formation and production experiments do not agree on $\Sigma\pi/\Lambda\pi$ ratio.							
$\Sigma(2030)$	$1(7/2^+)\ F_{17}$	p=1.52 σ=9.93	2030	100 to 170	4.12 ±0.27	$N\bar{K}$ $\Lambda\pi$ $\Sigma\pi$ ΞK	10 to 27 14 to 38 2 to 5 < 2	700 700 652 412
$\Sigma(2250)$	1(?)	p=2.04 σ=6.76	2250	100 to 230	5.06 ±0.37	$N\bar{K}$ $\Sigma\pi$ $\Lambda\pi$	(J+1/2)x =0.3[f]	849 842 799
$\Sigma(2455)$	1(?)	p=2.57 σ=5.09	2455	~120	6.03 ±0.29	$N\bar{K}$	(J+1/2)x =0.2[f]	979
$\Sigma(2620)$	1(?)	p=2.95 σ=4.30	2620	~175	6.86 ±0.46	$N\bar{K}$	(J+1/2)x =0.3[f]	1064
Ξ[ℓ]	$1/2(1/2^+)$		(0)1314.8 (-)1321.3		1.73 1.75	See Stable Particles		
$\Xi(1530)$[ℓ]	$1/2(3/2^+)$ p-wave		(0)1528.9±1.1 (-)1533.8±1.9	7.3 ±1.7	2.34 ±0.01	$\Xi\pi$	100	144
$\Xi(1820)$[ℓ]	1/2(?)		1795 to 1870	12 to 99	3.31 ±0.10	$\Lambda\bar{K}$ $\Xi\pi$ $\Xi(1530)\pi$ $\Sigma\bar{K}$		396 413 234 306
	All four decay modes have been seen. Branching ratios not quoted because there may be more than one state here.							
$\Xi(1940)$[ℓ]	1/2(?)		1894 to 1961	42 to 140	3.72 ±0.18	$\Xi\pi$ $\Xi(1530)\pi$		499 336
	Seen in both final states; not clear if one, or more, states present.							
Ω^-	$0(3/2^+)$		1672.5		2.80	See Stable Particles		

Baryons

* Quoted error includes an S(scale) factor. See footnote to Stable Particles Table.

→ An arrow at the left of the Table indicates a candidate that has been omitted because the evidence for the existence of the effect and (or) for its interpretation as a resonance is open to considerable question. See listings for information on the following: N(1700) D''_{13}, N(1990) F_{17}, N(2040) D'''_{13}, N(3245), N(3690), N(3755), Δ(1690) P''_{33}, Δ(1960) D_{35}, Δ(2160) P'''_{33}, Z_0(1780), Z_0(1865), Z_1(1900), Λ(1330), Λ(1750) P_{01}, Λ(1860) P_{03}, Λ(1870) S''_{01}, Λ(2010) D'''_{03}, Λ(2020) F_{07}, Λ(2100) F''_{05}, Λ(2585), Σ(1440), Σ(1480), Σ(1620) S'_{11}, Σ(1620) P'_{11}, Σ(1660) D'_{13}, Σ(1690), Σ(1880) P''_{11}, Σ(1940) D''_{13}, Σ(2070) F''_{15}, Σ(2080) P_{13}, Σ(2100) G_{17}, Σ(3000), Ξ(1630), Ξ(2030), Ξ(2250), Ξ(2500).

a. For the baryon states, the name [such as N'(1470)] contains the mass, which may be different for each new analysis. The value chosen is the rounded average from Table II of the note on N's and Δ's in the baryon listings. For Y^*'s and Ξ^*'s, the mass is an educated guess obtained by looking at the reported values. The convention for using primes in the names is as follows: when there is more than one resonance on a given Argand diagram, the first has been designated with a prime, the second with a double prime, etc. The <u>name</u> (col. 1) is the same as can be found in large print in the listings.

b. See note on N's and Δ's in baryon listings. 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 here where the spread in parameters arises because different models or procedures have been applied to a common set of data. Where only one value is given it is either because only one experiment reports that state or because the various experiments agree. An error is quoted only when the various experiments averaged have taken into account the systematic errors.

c. For this column M is the rounded average which also appears in the name column. For the N's and Δ's, Γ is the average quoted on Table II of the N's and Δ's note in the baryon listings; for the Y^*'s and Ξ^*'s, Γ is taken as the center of the interval given in the column labeled "Γ".

d. 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 using the averaged central mass values, without taking into account the widths of the resonances.

e. Square brackets indicate a sub-reaction of the previous unbracketed decay mode.

f. This state has been seen only in total cross sections. J is not known; x is Γ_{el}/Γ.

g. This is only an educated guess; the error given is larger than the error of the average of the published values (see listings for the latter).

h. Reported values of elasticity range from .18 to .34, each with a small error; x=.30 is only a guess. All the other branching fractions are dependent upon this choice. The reported values of $x \cdot x_e$ for the other channels favor the large value of x. An x=.25 or lower would violate unitarity.

i. Only information coming from partial-wave analyses has been used here. For the production experiments results see the listings.

j. Value obtained in an energy-dependent partial-wave analysis which uses a t-channel-poles-plus-resonance parametrization. The values of the couplings obtained for the resonances may be affected by double counting.

k. In this energy region the situation is still confused. <u>Formation experiments</u> suggest two states: P_{11}(1620) decaying mainly into Σπ, and D_{13}(1670) with branching fractions Σπ(40%), Λπ(10%), Σππ(< 14%). <u>Production experiments</u> report four states: Σ(1620) seen only in the Λπ mode, Σ_1(1660) with appreciable Λπ and Σπ modes, Σ_2(1660) with main decay mode Λ(1405)+π (that is, Σππ), and Σ(1690) seen in the Λπ mode. Of these four, Σ_1 and Σ_2 seem to be on firmer ground than the other two and both seem to have $J^P = 3/2^-$ like the D_{13}(1670) seen in formation experiments. Two resonances of the same spin and parity have been hypothesized as the origin of much of the complexity observed in production experiments. With the addition of the P_{11}(1620), there are three candidates that eventually might be required to clarify the situation.

ℓ. Only Ξ(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. So Ξ(2030), with main decay mode $\Sigma\bar{K}$, reported as a 3.5-standard-deviation effect, is not tabulated. See the listings for the other states.

m. See note on Δ(1236) in the baryon listings. Values of mass and width are dependent upon resonance shape used to fit the data.

n. This p value is the average value obtained by folding over the two Breit-Wigner shapes.

o. The preliminary results of DIEM 70 quoted in the listings have been revised so that they are now in agreement with the values quoted in the present table (G. Smadja, private communication).

PHYSICAL AND NUMERICAL CONSTANTS*

PHYSICAL CONSTANTS

N	$= 6.022169(40)\times 10^{23}$ mole^{-1} (based on $A_{C^{12}} = 12$)
c	$= 2.9979250(10)\times 10^{10}$ cm sec^{-1}
e	$= 4.803250(21)\times 10^{-10}$ esu $= 1.6021917(70)\times 10^{-19}$ coulomb
1 MeV	$= 1.6021917(70)\times 10^{-6}$ erg
$\hbar$	$= 6.582183(22)\times 10^{-22}$ MeV sec
	$= 1.0545919(80)\times 10^{-27}$ erg sec
$\hbar c$	$= 1.9732891(66)\times 10^{-11}$ MeV cm $= 197.32891(66)$ MeV fermi
	$= 0.6240088(21)$ GeV mb$^{1/2}$
α	$= e^2/\hbar c = 1/137.03602(21)$
$k_{\text{Boltzmann}}$	$= 1.380622(59)\times 10^{-16}$ erg K^{-1}
	$= 8.61708(37)\times 10^{-11}$ MeV K^{-1} $= 1$ eV$/11604.85(49)$K
m_e	$= 0.5110041(16)$ MeV $= 9.109558(54)\times 10^{-31}$ kg
m_p	$= 938.2592(52)$ MeV $= 1836.109(11)\, m_e = 6.72211(63)\, m_{\pi^\pm}$
	$= 1.00727661(8)\, m_1$ (where $m_1 = 1$ amu $= \frac{1}{12} m_{C^{12}} = 931.4812(52)$ MeV)
r_e	$= e^2/m_e c^2 = 2.817939(13)$ fermi (1 fermi $= 10^{-13}$ cm)
$\lambda\!\!\!^{-}_e$	$= \hbar/m_e c = r_e \alpha^{-1} = 3.861592(12)\times 10^{-11}$ cm
$a_{\infty\,\text{Bohr}}$	$= \hbar^2/m_e e^2 = r_e \alpha^{-2} = 0.52917715(81)$ Å (1 Å $= 10^{-8}$ cm)
σ_{Thomson}	$= \frac{8}{3}\pi r_e^2 = 0.6652453(61)\times 10^{-24}$ cm^2 $= 0.6652453(61)$ barns
μ_{Bohr}	$= e\hbar/2m_e c = 0.5788381(18)\times 10^{-14}$ MeV gauss^{-1}
μ_{nucleon}	$= e\hbar/2m_p c = 3.152526(21)\times 10^{-18}$ MeV gauss^{-1}
$\frac{1}{2}\omega^e_{\text{cyclotron}}$	$= e/2m_e c = 8.794014(27)\times 10^{6}$ rad sec^{-1} gauss^{-1}
$\frac{1}{2}\omega^p_{\text{cyclotron}}$	$= e/2m_p c = 4.789484(27)\times 10^{3}$ rad sec^{-1} gauss^{-1}

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

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

$R_\infty = m_e e^4/2\hbar^2 = m_e c^2\alpha^2/2 = 13.605826(45)$ eV (Rydberg)

$pc = 0.3\,H\rho$ (MeV, kilogauss, cm); 0.3 (which is $10^{-11}c$) enters because there are ≈ 300 "volts"/esu volt.

1 year (sidereal)	$= 365.256$ days $= 3.1558\times 10^7$ sec ($\approx \pi\times 10^7$ 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	$= 6.6732(31)\times 10^{-8}$ cm^3 g^{-1} sec^{-2}
1 calorie (thermochemical)	$= 4.184$ joules
1 atmosphere	$= 1033.2275$ g cm^{-2}
1 eV per particle	$= 11604.85(49)$ °K (from $E = kT$)

NUMERICAL CONSTANTS

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

*Compiled by Stanley J. Brodsky, based mainly on the adjustment of the fundamental physical constants by B. N. Taylor, W. H. Parker, and D. N. Langenberg, Rev. Mod. Phys. 41, 375 (1969). The figures in parentheses correspond to the 1 standard deviation uncertainty in the last digits of the main number.

CLEBSCH-GORDAN COEFFICIENTS AND SPHERICAL HARMONICS

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	Coefficients		
m_1	m_2			
.	.			
.	.			

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

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

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

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

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

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

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

1/2 × 1/2

m_1	m_2	J=1, M=+1		
+1/2	+1/2	1		
		J=1, M=0	**J=0, M=0**	
+1/2	-1/2	1/2	1/2	
-1/2	+1/2	1/2	-1/2	
		J=1, M=-1		
-1/2	-1/2	1		

1 × 1/2

m_1	m_2	J=3/2, M=+3/2	
+1	+1/2	1	
		3/2, +1/2	**1/2, +1/2**
+1	-1/2	1/3	2/3
0	+1/2	2/3	-1/3
		3/2, -1/2	**1/2, -1/2**
0	-1/2	2/3	1/3
-1	+1/2	1/3	-2/3
		3/2, -3/2	
-1	-1/2	1	

2 × 1

m_1	m_2	J=3, M=+3		
+2	+1	1		
		3, +2	**2, +2**	
+2	0	1/3	2/3	
+1	+1	2/3	-1/3	
		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
		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
		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
		3, -2	**2, -2**	
-1	-1	2/3	1/3	
-2	0	1/3	-2/3	
		3, -3		
-2	-1	1		

1 × 1

m_1	m_2	J=2, M=+2		
+1	+1	1		
		2, +1	**1, +1**	
+1	0	1/2	1/2	
0	+1	1/2	-1/2	
		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
		2, -1	**1, -1**	
0	-1	1/2	1/2	
-1	0	1/2	-1/2	
		2, -2		
-1	-1	1		

2 × 1/2

m_1	m_2	J=5/2, M=+5/2	
+2	1/2	1	
		5/2, +3/2	**3/2, +3/2**
+2	-1/2	1/5	4/5
+1	+1/2	4/5	-1/5
		5/2, +1/2	**3/2, +1/2**
+1	-1/2	2/5	3/5
0	+1/2	3/5	-2/5
		5/2, -1/2	**3/2, -1/2**
0	-1/2	3/5	2/5
-1	+1/2	2/5	-3/5
		5/2, -3/2	**3/2, -3/2**
-1	-1/2	4/5	1/5
-2	+1/2	1/5	-4/5
		5/2, -5/2	
-2	-1/2	1	

3/2 × 1/2

m_1	m_2	J=2, M=+2	
+3/2	+1/2	1	
		2, +1	**1, +1**
+3/2	-1/2	1/4	3/4
+1/2	+1/2	3/4	-1/4
		2, 0	**1, 0**
+1/2	-1/2	1/2	1/2
-1/2	+1/2	1/2	-1/2
		2, -1	**1, -1**
-1/2	-1/2	3/4	1/4
-3/2	+1/2	1/4	-3/4
		2, -2	
-3/2	-1/2	1	

3/2 × 1

m_1	m_2	J=5/2, M=+5/2		
+3/2	+1	1		
		5/2, +3/2	**3/2, +3/2**	
+3/2	0	2/5	3/5	
+1/2	+1	3/5	-2/5	
		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
		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
		5/2, -3/2	**3/2, -3/2**	
-1/2	-1	3/5	2/5	
-3/2	0	2/5	-3/5	
		5/2, -5/2		
-3/2	-1	1		

SU(3) CONVENTIONS

for Isoscalar Factor Table on next page

Since January 1970 we have used the convention that the first particle shall be a baryon, the second a meson (R. Levi Setti, Proceedings of Lund Conference, 1969, p. 339 and Table II). Note, for comparison, that the de Swart table of 8×8 is merely labeled with symbols like ($I_1 = 1/2$, $Y_1 = 1$, $I_2 = 1$, $Y_2 = 0$), which can be read either as (Nπ) or (KΣ). Since there are no decuplet mesons, however, his 8×10 table is unambiguous; it must be read with the meson first.

The de Swart convention violates the other convention that the N,Nπ coupling shall be D + F (as opposed to -D + F). To get D + F one must use the first line of the "N" table, which reads. . . $3\sqrt{5}/10\,|8_D\rangle + 1/2\,|8_F\rangle$ as opposed to. . . $-3\sqrt{5}/10\,|8_D\rangle + 1/2\,|8_F\rangle$. The first line must then be labeled Nπ rather than KΣ, i.e., with the baryon first.

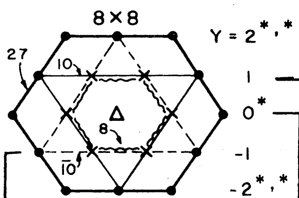
Levi Setti further advocates the convention of writing the baryon first for SU(2) as well as SU(3). For example, the sign of the amplitudes as plotted on his and our Argand plots comes from using our SU(2) Clebsch-Gordan coefficients (Condon Shortley notation) and writing the baryon first. To make it easier to abide by this universal convention we have changed de Swart's 8×10 (SU(3) table to 10×8, with the help of his Eq. (14.3):

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

SU(3) ISOSCALAR FACTORS

Adapted from J. J. de Swart, Rev. Mod. Phys. 35, 916 (1963)
(See note on previous page concerning conventions)

$\{8\} \otimes \{8\} = \{27\} \oplus \{10\} \oplus \{10^*\} \oplus \{8\}_1 \oplus \{8\}_2 \oplus \{1\}$.



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

$\xi_1 \rightarrow$	$\underset{+}{27}$	$\underset{+}{8_D}$	$\underset{-}{8_F}$	$\underset{-}{10^*}$
$N\pi$	$\sqrt{5}/10$	$3\sqrt{5}/10$	$1/2$	$-1/2$
ΣK	$-\sqrt{5}/10$	$-3\sqrt{5}/10$	$1/2$	$-1/2$
$N\eta$	$3\sqrt{5}/10$	$-\sqrt{5}/10$	$1/2$	$1/2$
ΛK	$3\sqrt{5}/10$	$-\sqrt{5}/10$	$-1/2$	$-1/2$

$Y = 1 \quad I = 3/2$ Δ

$\xi_1 \rightarrow$	$\underset{+}{27}$	$\underset{-}{10}$
$N\pi$	$\sqrt{2}/2$	$-\sqrt{2}/2$
ΣK	$\sqrt{2}/2$	$\sqrt{2}/2$

$Y = 0 \quad I = 0$ Λ

$\xi_1 \rightarrow$	$\underset{+}{27}$	$\underset{+}{8_D}$	$\underset{+}{1}$	$\underset{-}{8_F}$
$N\bar{K}$	$\sqrt{15}/10$	$\sqrt{10}/10$	$1/2$	$\sqrt{2}/2$
ΞK	$-\sqrt{15}/10$	$-\sqrt{10}/10$	$-1/2$	$\sqrt{2}/2$
$\Sigma\pi$	$-\sqrt{10}/20$	$-\sqrt{15}/5$	$\sqrt{6}/4$	0
$\Lambda\eta$	$3\sqrt{30}/20$	$-\sqrt{5}/5$	$-\sqrt{2}/4$	0

$Y = 0 \quad I = 1$ Σ

$\xi_1 \rightarrow$	$\underset{+}{27}$	$\underset{+}{8_D}$	$\underset{-}{8_F}$	$\underset{-}{10}$	$\underset{-}{10^*}$
$N\bar{K}$	$\sqrt{5}/5$	$-\sqrt{30}/10$	$\sqrt{6}/6$	$-\sqrt{6}/6$	$\sqrt{6}/6$
ΞK	$\sqrt{5}/5$	$-\sqrt{30}/10$	$-\sqrt{6}/6$	$\sqrt{6}/6$	$-\sqrt{6}/6$
$\Sigma\pi$	0	0	$\sqrt{6}/3$	$\sqrt{6}/6$	$-\sqrt{6}/6$
$\Sigma\eta$	$\sqrt{30}/10$	$\sqrt{5}/5$	0	$1/2$	$1/2$
$\Lambda\pi$	$\sqrt{30}/10$	$\sqrt{5}/5$	0	$-1/2$	$-1/2$

$Y = -1 \quad I = 1/2$ Ξ

$\xi_1 \rightarrow$	$\underset{+}{27}$	$\underset{+}{8_D}$	$\underset{-}{8_F}$	$\underset{-}{10}$
$\Xi\pi$	$-\sqrt{5}/10$	$-3\sqrt{5}/10$	$1/2$	$1/2$
$\Sigma\bar{K}$	$\sqrt{5}/10$	$3\sqrt{5}/10$	$1/2$	$1/2$
$\Xi\eta$	$3\sqrt{5}/10$	$-\sqrt{5}/10$	$-1/2$	$1/2$
$\Lambda\bar{K}$	$3\sqrt{5}/10$	$-\sqrt{5}/10$	$1/2$	$-1/2$

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

$\xi_1 \rightarrow$	$\underset{+}{27}$	$\underset{-}{10^*}$
$\Xi\pi$	$\sqrt{2}/2$	$-\sqrt{2}/2$
$\Sigma\bar{K}$	$\sqrt{2}/2$	$\sqrt{2}/2$

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 $\mu_1 \otimes \mu_2$.

$\{10\} \otimes \{8\} = \{35\} \oplus \{27\} \oplus \{10\} \oplus \{8\}$.

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

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

$\xi_1 \rightarrow$	$\underset{-}{27}$	$\underset{+}{8}$
$\Delta\pi$	$-\sqrt{5}/5$	$-2\sqrt{5}/5$
ΣK	$-2\sqrt{5}/5$	$\sqrt{5}/5$

$Y = 1 \quad I = 3/2$ Δ

$\xi_1 \rightarrow$	$\underset{+}{35}$	$\underset{-}{27}$	$\underset{-}{10}$
$\Delta\pi$	$1/4$	$-\sqrt{5}/4$	$\sqrt{10}/4$
$\Delta\eta$	$\sqrt{5}/4$	$3/4$	$\sqrt{2}/4$
ΣK	$\sqrt{10}/4$	$-\sqrt{2}/4$	$-1/2$

$Y = 0 \quad I = 0$ Λ

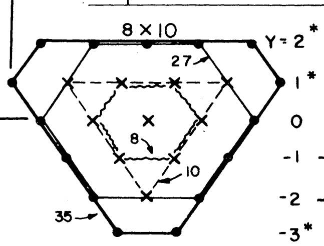
$\xi_1 \rightarrow$	$\underset{-}{27}$	$\underset{+}{8}$
$\Sigma\pi$	$-\sqrt{10}/5$	$-\sqrt{15}/5$
ΞK	$-\sqrt{15}/5$	$\sqrt{10}/5$

$Y = 0 \quad I = 1$ Σ

$\xi_1 \rightarrow$	$\underset{+}{35}$	$\underset{-}{27}$	$\underset{-}{10}$	$\underset{+}{8}$
$\Sigma\pi$	$\sqrt{3}/6$	$-3\sqrt{5}/10$	$\sqrt{3}/3$	$-\sqrt{30}/15$
$\Sigma\eta$	$\sqrt{2}/2$	$\sqrt{30}/10$	0	$-\sqrt{5}/5$
ΞK	$\sqrt{3}/3$	$-\sqrt{5}/5$	$-\sqrt{3}/3$	$\sqrt{30}/15$
$\Delta\bar{K}$	$\sqrt{3}/6$	$\sqrt{5}/10$	$\sqrt{3}/3$	$2\sqrt{30}/15$

$Y = 0 \quad I = 2$

$\xi_1 \rightarrow$	$\underset{+}{35}$	$\underset{-}{27}$
$\Sigma\pi$	$\sqrt{3}/2$	$-1/2$
$\Delta\bar{K}$	$1/2$	$\sqrt{3}/2$



Multiplicity of 35;

● = 1, × = 2

$Y = -1 \quad I = 1/2$ Ξ

$\xi_1 \rightarrow$	$\underset{+}{35}$	$\underset{-}{27}$	$\underset{-}{10}$	$\underset{+}{8}$
$\Xi\pi$	$1/4$	$-7\sqrt{5}/20$	$\sqrt{2}/4$	$-\sqrt{5}/5$
$\Xi\eta$	$3/4$	$3\sqrt{5}/20$	$-\sqrt{2}/4$	$-\sqrt{5}/5$
ΩK	$\sqrt{2}/4$	$-3\sqrt{10}/20$	$-1/2$	$\sqrt{10}/5$
$\Sigma\bar{K}$	$1/2$	$\sqrt{5}/10$	$\sqrt{2}/2$	$\sqrt{5}/5$

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

$\xi_1 \rightarrow$	$\underset{+}{35}$	$\underset{-}{27}$
$\Xi\pi$	$\sqrt{2}/2$	$-\sqrt{2}/2$
$\Sigma\bar{K}$	$\sqrt{2}/2$	$\sqrt{2}/2$

$Y = -2 \quad I = 0$ Ω^-

$\xi_1 \rightarrow$	$\underset{+}{35}$	$\underset{-}{10}$
$\Omega\eta$	$\sqrt{2}/2$	$-\sqrt{2}/2$
$\Xi\bar{K}$	$\sqrt{2}/2$	$\sqrt{2}/2$

$Y = -2 \quad I = 1$

$\xi_1 \rightarrow$	$\underset{+}{35}$	$\underset{-}{27}$
$\Omega\pi$	$1/2$	$-\sqrt{3}/2$
$\Xi\bar{K}$	$\sqrt{3}/2$	$1/2$

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
5.2	3.27	3.31	3.42	1.49	1.48	1.43
5.4	3.32	3.36	3.47	1.53	1.51	1.46
5.6	3.38	3.42	3.52	1.56	1.54	1.49
5.8	3.43	3.47	3.58	1.59	1.57	1.52
		T(PI) = PBEAM - .138 GEV				
6.0	3.49	3.52	3.63	1.61	1.60	1.55
6.2	3.54	3.58	3.68	1.64	1.63	1.58
6.4	3.59	3.63	3.73	1.67	1.65	1.61
6.6	3.65	3.68	3.78	1.70	1.68	1.64
6.8	3.70	3.73	3.83	1.73	1.71	1.67
		T(PI) = PBEAM - .138 GEV				
7.0	3.75	3.78	3.87	1.75	1.74	1.70
7.2	3.80	3.83	3.92	1.78	1.76	1.72
7.4	3.85	3.88	3.97	1.81	1.79	1.75
7.6	3.89	3.93	4.02	1.83	1.82	1.78
7.8	3.94	3.97	4.06	1.86	1.84	1.80
		T(PI) = PBEAM - .138 GEV				
8.0	3.99	4.02	4.11	1.88	1.87	1.83
8.2	4.04	4.07	4.15	1.91	1.89	1.85
8.4	4.08	4.11	4.20	1.93	1.92	1.88
8.6	4.13	4.16	4.24	1.95	1.94	1.90
8.8	4.17	4.20	4.29	1.98	1.96	1.93
		T(PI) = PBEAM - .138 GEV				
9.0	4.22	4.25	4.33	2.00	1.99	1.95
9.2	4.26	4.29	4.37	2.03	2.01	1.97
9.4	4.31	4.33	4.41	2.05	2.03	2.00
9.6	4.35	4.38	4.46	2.07	2.06	2.02
9.8	4.39	4.42	4.50	2.09	2.08	2.04
		T(PI) = PBEAM - .139 GEV				
10.0	4.43	4.46	4.54	2.12	2.10	2.07
10.5	4.54	4.57	4.64	2.17	2.16	2.12
11.0	4.64	4.67	4.74	2.22	2.21	2.18
11.5	4.74	4.77	4.84	2.28	2.26	2.23
12.0	4.84	4.86	4.93	2.33	2.31	2.28
		T(PI) = PBEAM - .139 GEV				
12.5	4.94	4.96	5.03	2.38	2.36	2.33
13.0	5.03	5.05	5.12	2.43	2.41	2.38
13.5	5.12	5.15	5.21	2.47	2.46	2.43
14.0	5.21	5.24	5.30	2.52	2.51	2.48
14.5	5.30	5.32	5.39	2.57	2.56	2.53
		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	2.78	2.77	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				
80.0	12.29	12.30	12.32	6.11	6.10	6.09
90.0	13.03	13.04	13.06	6.48	6.48	6.46
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
500.0	30.65	30.65	30.66	15.31	15.31	15.30
		T(PI) = PBEAM - .140 GEV				

SPECIAL RELATIVITY, PHASE SPACE, AND CROSS SECTIONS

Notation. 4-vector in c.m. $p = (w, \vec{p})$; in lab $P = (W, \vec{P})$, $T = W - m$.
Solid-angle element $d\omega = 2\pi d\cos\theta$; $d\Omega = 2\pi d\cos\Theta$.
$p^2 = w^2 - \vec{p}^2 = m^2$ is an invariant. Cross section σ is invariant.

Lorentz Transformation

$$\begin{pmatrix} w \\ p_x \\ p_y \\ p_z \end{pmatrix} = \begin{pmatrix} \bar{\gamma} & -\bar{\eta} & 0 & 0 \\ -\bar{\eta} & \bar{\gamma} & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} W \\ P_x \\ P_y \\ P_z \end{pmatrix}$$

If θ and Θ are measured with respect to the transformation axis x,

$$\frac{p_\perp}{p_x} = \tan\theta = \frac{|\vec{P}|\sin\Theta}{-\bar{\eta}W + \bar{\gamma}|\vec{P}|\cos\Theta}. \tag{1}$$

If particle 1 is beam, 2 is target, then $(W_2, \vec{P}_2) = (m_2, \vec{0})$ and

$$\bar{\gamma} = (W_1 + m_2)/\sqrt{s},\ \bar{\eta} \equiv \bar{\gamma}\bar{\beta} = |\vec{P}_1|/\sqrt{s},\ |\vec{p}_1| = |\vec{p}_2| = \bar{\eta}m_2 = |\vec{P}_1|m_2/\sqrt{s}. \tag{2}$$

For $m_1 = m_2$, $\bar{\gamma}^2 = 1 + T_1/2m_1$.

General Lorentz Transformation [characterized by $\vec{\beta}$, with $\bar{\gamma} = (1 - \vec{\bar{\beta}}^2)^{-1/2}$ and $\vec{\bar{\eta}} = \bar{\gamma}\vec{\bar{\beta}}$]: $w = \bar{\gamma}W - \vec{\bar{\eta}} \cdot \vec{P}$; $\vec{p} = \vec{P} - \vec{\bar{\eta}}\, \dfrac{W + w}{\bar{\gamma} + 1}$.

A Useful Transformation: Consider two 4-vectors $Q = (E, \vec{Q})$ and $q = (e, \vec{q})$. In the rest frame of Q $[Q' = (M, \vec{0})]$, q becomes $(q \to q')$

$$e' = Q \cdot q/M \quad \text{and} \quad \vec{q}' = \vec{q} - f\vec{Q},$$

where $Q^2 = M^2$ and $f = (e + e')/(E + M)$. These equations follow from example (b), p. 34 of Hagedorn.* They are particularly useful when Q is a sum of four-vectors that correspond to a resonant state.

Invariants. Notation: $1 + 2 \to 1' + 2'$.

$$s = (p_1 + p_2)^2 = m_1^2 + m_2^2 + 2(w_1 w_2 - \vec{p}_1 \cdot \vec{p}_2), \tag{3}$$

$$t = (p_i' - p_i)^2 = m_i^2 + m_i'^2 - 2(w_i w_i' - \vec{p}_i \cdot \vec{p}_i'), \quad (i = 1, 2), \tag{4}$$

$$u = (p_1' - p_2)^2 = (p_2' - p_1)^2 \qquad \text{[use (6), below]}. \tag{5}$$

General relation: $s + t + u = m_1^2 + m_1'^2 + m_2^2 + m_2'^2$. (6)

In lab system $P_2 = (m_2, \vec{0})$, and writing $W = m + T$,

$$s = m_1^2 + m_2^2 + 2W_1 m_2 = (m_1 + m_2)^2 + 2T_1 m_2, \tag{3,lab}$$

$$t = m_2^2 + m_2'^2 - 2W_2' m_2 = (m_2 - m_2')^2 - 2T_2' m_2. \tag{4,lab}$$

In c.m. system $dt = +2|\vec{p}_i|\,|\vec{p}_i'|\, d\cos\theta$. (4,cm)

For elastic scattering $(m_1 = m_1',\ m_2 = m_2')$, (4) and (5) in c.m. become

$$t = -2\vec{p}^2(1 - \cos\theta) = -4\vec{p}^2 \sin^2\theta/2, \tag{4,el}$$

$$u = (m_1^2 - m_2^2)^2/s - 2\vec{p}^2(1 + \cos\theta) = (m_1^2 - m_2^2)^2/s - 4\vec{p}^2\cos^2\theta/2. \tag{5,el}$$

For elastic scattering, using (4,lab), (4,el), and (2),

$$T_2' = \frac{2\vec{P}_1^2 m_2}{s} \sin^2\left(\frac{\theta}{2}\right) \text{ (useful for calculating } \delta\text{-ray energies).} \tag{7}$$

Two-Body States. Energies and momenta in c.m.

$$w_1 = \frac{s + m_1^2 - m_2^2}{2\sqrt{s}},\quad \vec{p}_1^2 = \vec{p}_2^2 = \frac{1}{4s}\left[s - (m_1 + m_2)^2\right]\left[s - (m_1 - m_2)^2\right]. \tag{8}$$

3- and 4-Body States. Let $m_{ij}^2 = (p_i + p_j)^2$, etc.; then

$$\sum_{i<j} m_{ij}^2 = \Sigma m_i^2 + m_{123}^2 = \text{const. } (i, j = 1, 2, 3) \text{ [follows from (6)]} \tag{9}$$

$$\left.\begin{aligned} \sum_{i<j} m_{ij}^2 &= 2\Sigma m_i^2 + m_{1234}^2 = \text{const.} \\ \sum_{i<j<k} m_{ijk}^2 &= \Sigma m_i^2 + 2m_{1234}^2 = \text{const.} \end{aligned}\right\} (i, j, k = 1, 2, 3, 4.) \tag{10}$$

R_n, Invariant Volume in n-Body Momentum Space

A useful invariant is $\int d^4p\, \delta(p^2 - m^2) = \int \dfrac{d^3\vec{p}}{2w} = \int \dfrac{p^2 d|\vec{p}|d\omega}{2w} = \dfrac{1}{2}\int |\vec{p}|dw d\omega$.

$R_2 = \pi|\vec{p}_1|/\sqrt{s}$, $R_3 = \pi^2 \int dw_1 dw_2 = (\pi^2/4s)\int dm_{12}^2 dm_{23}^2$.

Recurrence Relation for Factoring R_n (see e.g., Hagedorn, p. 93*):

Write $N \to 1, 2, \cdots, k,\ k+1, \cdots, n \quad (R_n)$,

as $N \to K, k+1, \cdots, n \quad (R_{n-k+1})$, with $K \to 1, 2, \cdots, k \quad (R_k)$; then $R_n = \int d(m_K^2) R_k R_{n-k+1}$,

or as $N \to K, L$, with $L \to k+1, \cdots, n \quad (R_\ell)$ and $K \to 1, 2, \cdots, k \quad (R_k)$; then $R_n = \int d(m_K^2) d(m_L^2) R_k R_\ell \dfrac{\pi p_{(KL)}}{\sqrt{s}}$

Cross Sections and Decay Rates†

For a system of n particles with overall four-momentum p and final momenta $q_1, \cdots, q_n$ $[q_i = (e_i, \vec{q}_i)]$, define Lorentz Invariant Phase Space

$$d\,\text{LIPS}(s; q_1, \cdots, q_n) = (2\pi)^4 \delta^4(p - \sum_i q_i) \frac{1}{(2\pi)^{3n}} \prod_{i=1}^{n} \frac{d^3\vec{q}_i}{2e_i}. \tag{11}$$

Note that $R_n = (2\pi)^{3n-4} \int d\,\text{LIPS}$.

For $1 + 2 \to n$ particles or $1 \to n$ particles, in general $|i\rangle \to |f\rangle$,

$$\sigma_{if} = \frac{1}{4F} \int |T_{if}|^2\, d\,\text{LIPS}(s; q_1, \cdots, q_n), \tag{12}$$

or

$$\Gamma_{if} = \frac{1}{2m_1} \int |T_{if}|^2\, d\,\text{LIPS}(m_1^2; q_1, \cdots, q_n), \tag{13}$$

where T_{if} is an invariant matrix element. F is Møller's invariant flux factor, $F^2 = (p_1 \cdot p_2)^2 - p_1^2 p_2^2$. In every system where $\vec{p}_1$ and $\vec{p}_2$ are collinear, $F = w_1 w_2 |\vec{v}_1 - \vec{v}_2|$ $(\vec{v} = \vec{p}/w)$. If 1 is beam, 2, target $(\vec{p}_2 = 0)$, then $F = |\vec{P}_1| m_2 = |\vec{p}_1|\sqrt{s}$.

For elastic scattering in c.m., $\dfrac{d\,\text{LIPS}}{d\Omega} = \dfrac{1}{(4\pi)^2} \dfrac{|\vec{p}_1|}{\sqrt{s}}$, and (12) yields

$$\frac{d\sigma}{d\Omega} = \frac{|T|^2}{(8\pi)^2 s} \quad \text{or} \quad \frac{d\sigma}{dt} = \frac{|T|^2}{64\pi|\vec{p}_1|^2 s}. \tag{14}$$

The normalization is such that the optical theorem reads

$$\text{Im}\, T|_{t=0} = 2|\vec{p}_1|\sqrt{s}\,\sigma_{tot}. \tag{15}$$

The choice of Eq. (11) implies a particular normalization of any spinors that may occur in T.† The advantage of this normalization is that it greatly simplifies the structure of T by putting factors such as $\frac{1}{(2\pi)^3}\frac{1}{2E}$ into the phase space where they really belong. In addition, the labels, i, f, refer to specific spin (helicity) states, so that the usual "average and sum" rule is implicit.

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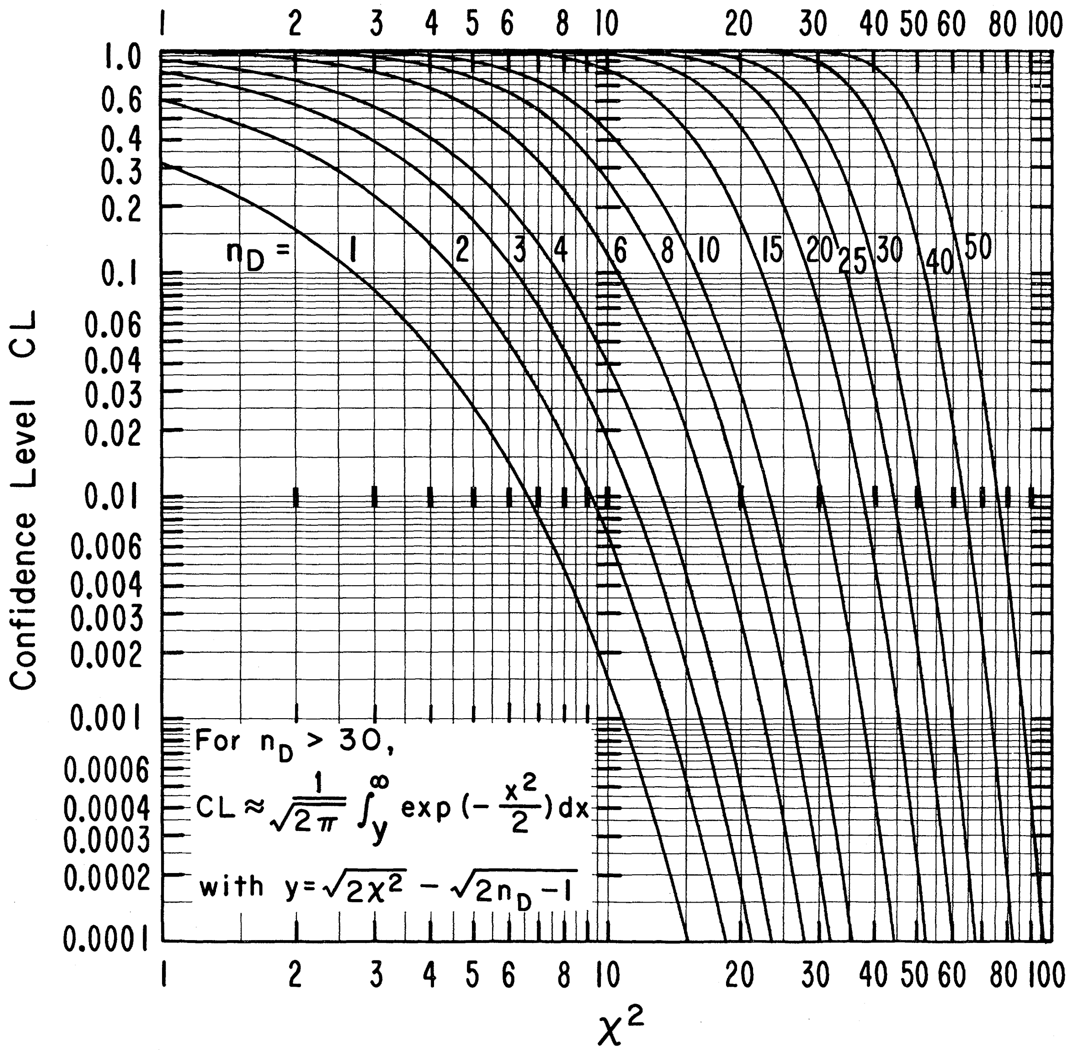
*R. Hagedorn, Relativistic Kinematics, W. A. Benjamin, New York, 1964.

†See, for example, Chaps. 1 and 2 of H. Pilkuhn, The Interactions of Hadrons, John Wiley & Sons, New York, 1967.

CONFIDENCE LEVEL VS. χ^2 FOR n_D DEGREES OF FREEDOM



For any n_D, $\langle \chi^2 \rangle = n_D$, $\delta(\chi^2) = \sqrt{2n_D}$. For large n_D, χ^2 becomes normally distributed about n_D. Thus in the notation of the box in the figure,

$$y_1 = (\chi^2 - n_D)/\sqrt{2n_D} \text{ has unit s.d.}$$

A <u>better</u> approximation, due to Fisher,* is that χ, not χ^2, is normally distributed, specifically

$$y_2 = \sqrt{2\chi^2} - \sqrt{2n_D - 1} \text{ has unit s.d.}$$

One sees then that y_1 underestimates small C.L.'s. Thus for $n = 50$ and $\chi^2 = 80$, $y_1 = 3.0$ and C.L. = 0.13% vs. $y_2 = 2.7$, C.L. = 0.35%.

*R. A. Fisher, <u>Statistical Methods for Research Workers</u>, Oliver and Boyd, Edinburgh.

GAUSSIANLIKE DISTRIBUTIONS

The distribution

$$P_{2n+1}(x) = \frac{1}{2^n n! \sigma^{2n+2}} x^{2n+1} \exp\left[-\frac{x^2}{2\sigma^2}\right]$$

is normalized so that $\int_0^\infty P_{2n+1}(x)dx = 1$; the normalization is valid for $n > -1$ and not necessarily integral $((\frac{1}{2})! = \sqrt{\pi}/2)$. For $n = -1/2$ it reduces to the Gaussian distribution. Through a change of variables it yields the χ^2 distribution for n_D degrees of freedom:

$$P_{n_D}(\chi^2) = \frac{1}{2^{n_D/2}\left(\frac{n_D}{2} - 1\right)!} (\chi^2)^{n_D/2 - 1} \exp\left[-\chi^2/2\right].$$

Relation between standard deviation σ and mean deviation α:

$$2\sigma^2 = \pi\alpha^2; \quad \sigma = 1.4826 \text{ probable error.}$$

Odds against exceeding one standard deviation = 2.15:1; two, 21:1; three, 370:1; four, 16,000:1; five, 1,700.000:1.

ATOMIC AND NUCLEAR PROPERTIES OF MATERIALS

Material	Z	A	Cross Section σ[a] barns	Collision Length L_{coll}[b] g cm^{-2}	Collision Length L_{coll}[b] cm	Minimum $-dE/dx$[c] MeV g^{-1} cm^2	Minimum $-dE/dx$[c] MeV cm^{-1}	Radiation Length L_{rad}[d] g cm^{-2}	Radiation Length L_{rad}[d] cm	Density ρ g cm^{-3}
H_2	1	1.01	0.063	26.5	374[e]	4.13	0.292[e]	58.0	819[e]	0.0708[e]
D_2	1	2.01	0.100	33.4	202[e]	2.07	0.342[e]	116	703[e]	0.165[e]
He	2	4.00	0.16	42.0	336[e]	1.94	0.242[e]	85.4	683[e]	0.125[e]
Li	3	6.94	0.23	50.4	94.3	1.69	0.902	78.7	148	0.534
Be	4	9.01	0.28	55.0	29.9	1.60	2.96	63.7	34.7	1.848
C	6	12.01	0.33	60.4	f	1.78	f	42.4	f	≈1.55[f]
N_2	7	14.01	0.36	63.6	78.9[e]	1.81	1.46[e]	37.8	46.7[e]	0.808[e]
Ne	10	20.18	0.465	72.1	60.1[e]	1.73	2.08[e]	29.1[i]	24.2[e, i]	1.200[e, k]
Al	13	26.98	0.57	79.2	29.3	1.62	4.37	24.0	8.9	2.70
Fe	26	55.85	0.92	101.2	12.8	1.48	11.6	13.9	1.8	7.87
Cu	29	63.54	1.00	105.4	11.8	1.44	12.9	12.0	1.34	8.96
Sn	50	118.69	1.55	129.7	17.8	1.28	9.4	8.89	1.22	7.31
W	74	183.85	2.02	150.8	7.80	1.17	22.6	6.89	0.36	19.3
Pb	82	207.19	2.20	156.2	13.8	1.13	12.8	6.52	0.58	11.35
U	92	238.03	2.42	163.6	≈8.63	1.09	≈20.6	6.13	≈0.32	≈18.95
Air				64.6	53620[g]	1.81	0.0022[g]	36.5	30290[g]	0.001205[g]
Freon (CF_3Br)				87.1	≈58.0	1.52	≈2.3	16.6	≈11	≈1.5
H_2 (bubble chamber, 27°K)				26.5	442[h]	4.13	0.248[h]	58.0	970[h]	≈0.060[h]
H-Ne mixture (bubble chamber)[j]				67.3	96.1	1.83	1.28	29.8[i]	42.5[i]	.70
H_2O				57.2	57.2	2.03	2.03	35.7	35.7	1.00
Ilford Emulsion				103.0	27.0	20.9	5.49	11.2	2.91	3.815
LiF				63.8	24.2	1.69	4.46	39.0	14.8	2.64
Mylar ($C_5H_4O_2$)				59.1	42.8	1.91	2.64	39.6	28.7	1.38
NaI				119.0	32.4	1.32	4.84	9.58	2.61	3.67
Polyethylene (CH_2)				51.0	≈55.5	2.09	≈1.92	44.1	≈48	≈0.92
Polystyrene (CH)[ℓ]				54.9	≈52.3	2.03	≈2.14	43.4	≈41.3	≈1.05
Propane (C_3H_8, bubble chamber)				48.9	119.3	2.28	0.935	44.6	109	0.41

a. $\sigma = \sigma_{natural} = \pi(\hbar/m_\pi c)^2 \times A^{2/3} = 62.8 \text{ mb} \times A^{2/3}$
b. $L_{coll} = A/(N\sigma_{natural}) = 26.5 \text{ g cm}^{-2} \times A^{1/3}$
c. From W. H. Barkas and M. J. Berger, Tables of Energy Losses and Ranges of Heavy Charged Particles, NASA SP-3013 (1964).
d. Mainly from High Energy and Nuclear Physics Data Handbook, W. Galbraith and W. S. C. Williams, Ed. (N. I. R. N. S., Rutherford Lab., Chilton, Didcot, Berks.) 1964.
e. For liquid phase at 1 atm. and boiling temperature.
f. Density variable.
g. At 20°C.
h. May vary by about ±3%, depending on operating conditions.
i. From F. R. Huson, Ionization Loss, Range, Straggling and Multiple Scattering, BNL 11386 (1967).
j. 53.7 atomic percent Ne.
k. Density of gas at STP = 0.900×10^{-3} g cm^{-3}, i.e., 0.75×10^{-3} times the density (1.200) of the boiling liquid.
ℓ. Typical scintillator; e.g., PILOT B has an atomic ratio H/C = 1.1.

MULTIPLE COULOMB SCATTERING*

The rms projected angle θ due to multiple Coulomb scattering (only) of a particle of charge z (in units of electron charge), momentum p (in MeV/c), and velocity v (in units of c) is

$$\theta_{proj} = z \frac{15}{pv} \sqrt{\frac{L}{L_{rad}}} \, (1 + \epsilon) \text{ radians;}$$

where L = length in scatterer.

For $L \geqslant 1/10\ L_{rad}$, ϵ is generally $< 1/10$. The distribution of θ is not truly Gaussian.†

The rms projected displacement y on traversing an absorber of thickness L is

$$y_{rms} = L\theta_{proj}/\sqrt{3}.$$

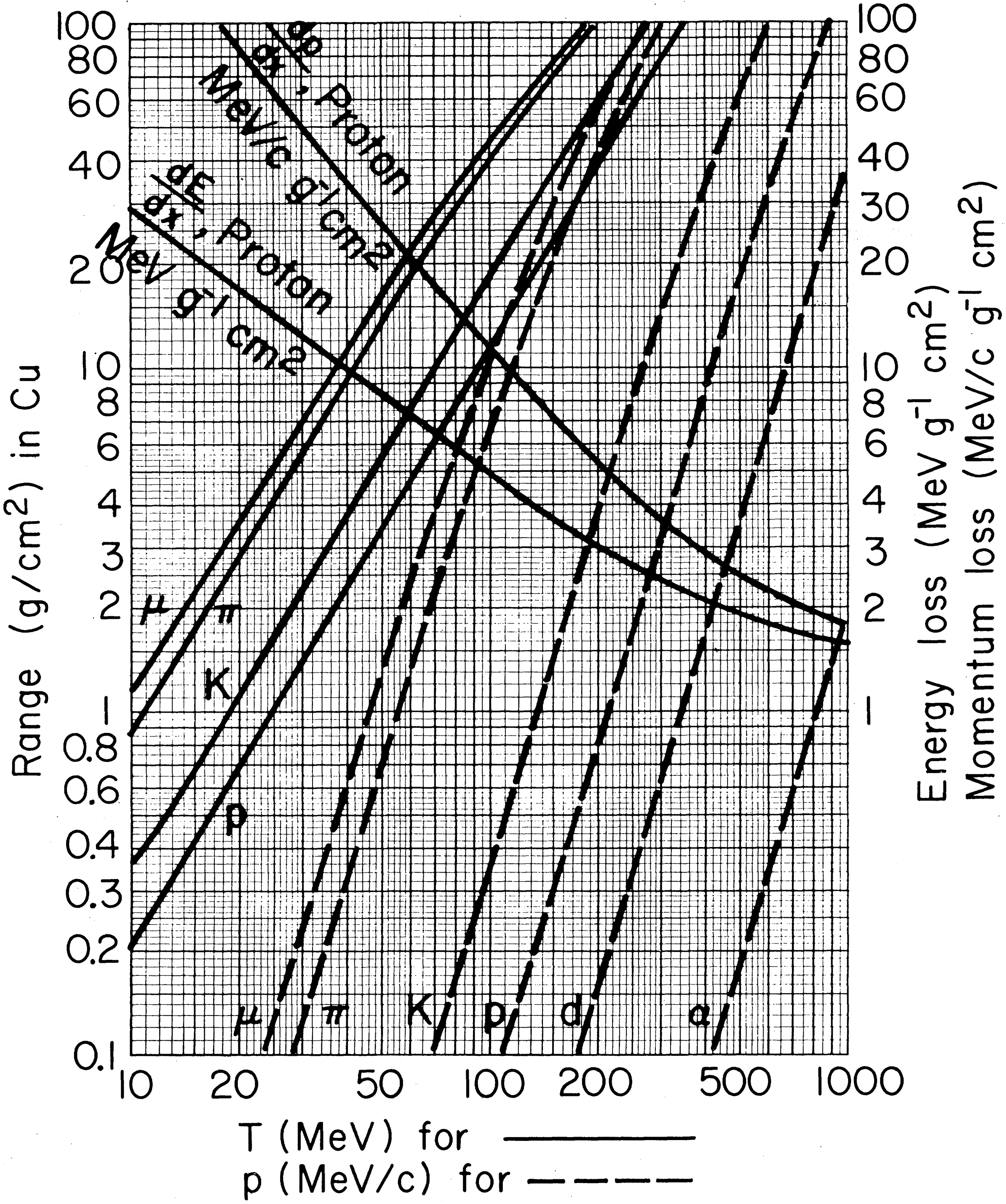
*Mainly from G. Z. Molière, Naturforsch. 3(a), 78 (1948).

†See, for example, the experimental work of A. D. Hansen, L. H. Lanzl, E. M. Lyman, and M. B. Scott, Phys. Rev. 84, 634 (1951).

RADIOACTIVITY AND RADIATION PROTECTION

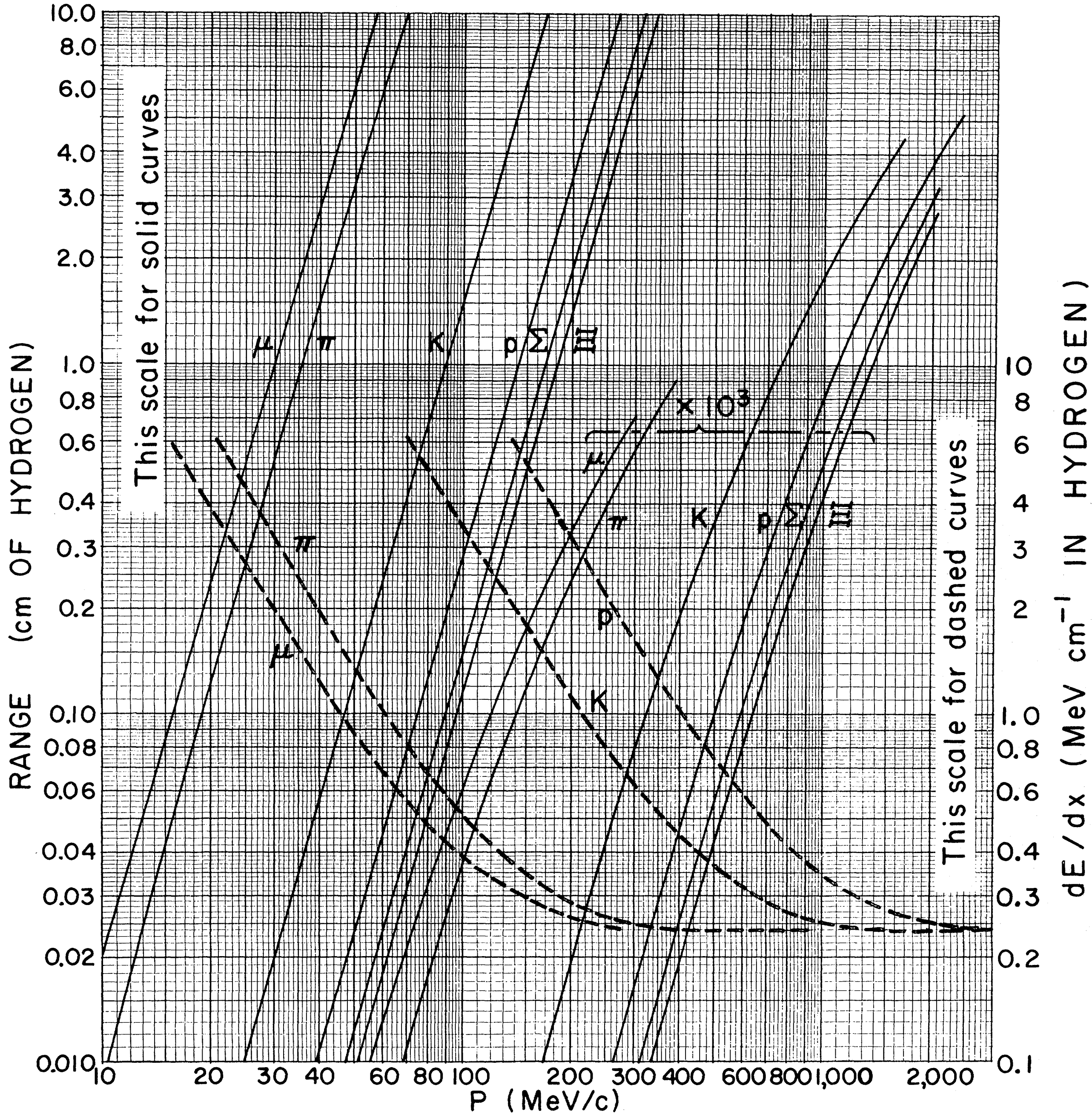
Unit of activity = Curie:
 1 Ci = 3.7×10^{10} disintegrations/sec
Unit of exposure dose for x and γ radiation = Roentgen:
 1 R = 1 esu/cm^3 = 87.8 erg/g (5.49×10^7 MeV/g) of air
Unit of absorbed dose = rad:
 1 rad = 100 erg/g (6.25×10^7 MeV/g) in any material
Unit of dose equivalent (for protection) = rem:
 1 rem (Roentgen equivalent for man) = 1 rad×QF,
where QF (quality factor) depends upon the type of radiation and other factors. For γ rays and HE protons, QF ≈ 1; for thermal neutrons, QF ≈ 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 ≈ 100 millirem/week)
Fluxes (per cm^2) to liberate 1R in carbon:
 3×10^7 minimum ionizing singly charged particles
 0.9×10^9 protons 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/sec/cm^2/ster

RANGE AND ENERGY LOSS IN COPPER



Range and energy/momentum loss in copper, based on a calculation assuming a nominal mean excitation potential of 310 eV. (Calculation by W. A. Aron, UCRL-1325, 1951). The abscissa is to be read as kinetic energy T for the solid curves and momentum p for the dashed curves.

RANGE AND ENERGY LOSS IN LIQUID HYDROGEN



Range and energy loss in liquid hydrogen bubble chamber, determined by a μ^+ range of 1.103 ± 0.003 cm from the $\pi^+ \rightarrow \mu^+\nu$ decay. Liquid hydrogen conditions: $T = 27.6 \pm 0.1$°K; $P = 48 \pm 5$ psia; $\rho = (5.86 \pm 0.06)10^{-2}$ g/cm^3. (Data by Clark and Diehl, UCRL-3789, 1957.) Bubble chamber physicists: note that the number of bubbles per cm is proportional to $1/\beta^2$, not to dE/dx.

DATA CARD LISTINGS

Illustrated Key

Name of particle as it appears in table.

Arrow indicates this particle omitted from table.

XX(1200)

```
74 XX MESON (1200,JPG=  -)  I=1
   ORIGINALLY CALLED XXX
   OMITTED FROM TABLE
------ --------- --------- --------- --------- --------- --------- --------
```

Particle name, and quantum numbers (if known).

Particle code (for internal use only).

General comments on particle.

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.

```
                 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     2/71*
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     2/71*
W                  . . . . . . . . . .
W    AVG           38.4        6.0     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
                              (SEE IDEOGRAM BELOW )
```

Abbreviated reference for this result; full reference given below.

Measurement technique (see abbreviations on next page.)

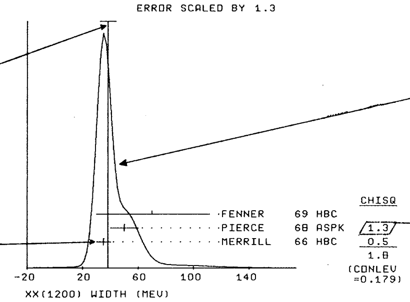
Charge(s) of particle detected.

Reaction producing particle, or comments.

Date this result punched (asterisk indicates result added or changed since previous edition).

Scale factor > 1 indicates inconsistent data.

WEIGHTED AVERAGE = 38.4 ± 6.0
ERROR SCALED BY 1.3



Vertical bar indicates average; width of horizontal bar on top is error (scaled) in average.

Value and error for each experiment.

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)/TOTAL
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)/TOTAL
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     2/71*
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)

****** ********* ********* ********* ********* ********* ********* ********
```

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).

Branching ratio R_j in terms of partial decay modes P_i above (X_i sometimes used for P_i/total).

References listed by year, then author.

Abbreviated reference form used on data cards above.

Journal, report, preprint, etc. (see abbreviations on next page).

```
                          REFERENCES FOR XX(1200)

MERRILL   66 PRL 16 143       A. MERRILL                      (SACLAY+CERN)
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)

****** ********* ********* ********* ********* ********* ********* ********
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Author(s)

Institution(s) of author(s) (see abbreviations on next page).

Illustrated 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 American Physical Society
JETP	English Translation of Soviet Physics JETP
JETPL	Letters to Soviet Physics JETP
LNC	Letters to Nuovo Cimento
NC	Nuovo Cimento
NP	Nuclear Physics
PL	Physics Letters
PPSL	Proceedings of the Physical Society of London
PR	Physical Review
PRL	Physical Review Letters
PRSL	Proceedings of the Royal Society of London
RMP	Reviews of Modern Physics
SJNP	Soviet Journal of Nuclear Physics
ZPHY	Zeitschrift für Physik

Measurement techniques

ASPK	Automatic spark chambers
CC	Cloud chamber
CNTR	Counters, electronics
DBC	Deuterium bubble chamber
DPWA	Energy-dependent partial wave analysis
EMUL	Emulsions
HBC	Hydrogen bubble chamber
HEBC	Helium bubble chamber
HLBC	Heavy liquid bubble chamber
IPWA	Energy-independent partial wave analysis
MMS	Missing mass spectrometer
MPWA	Model-dependent partial wave analysis
OSPK	Optical spark chambers
RVUE	Review of previous experimental data

Conferences

Conferences are referred to by the location in which they were held (e.g., DUBNA, BOULDER, LUND, etc.).

Institutions

Names of institutions are frequently abbreviated. We use mainly the four-letter code proposed by the HERA group at CERN in 1969; however, starting in January 1971 we have revised some of the US entries to follow more closely the abbreviations in common usage, e.g., LSU instead of LOUI for Louisiana State University. Revised and new entries are marked by an asterisk. We have not yet revised the older cards and apologize for the temporarily double entries.

AACH	TECHNISCHE UNIV. AACHEN	AACHEN, GERMANY
AERE	ATOMIC ENERGY RES. ESTAB.	HARWELL, BERKS., ENGLAND
AMES	IOWA STATE UNIV.	AMES, IOWA, USA
ANL	ARGONNE NAT. LAB.	ARGONNE, ILL., USA
ANNA	UNIV. OF MICHIGAN	ANN ARBOR, MICH., USA
ARIZ	UNIV. OF ARIZONA	TUSCON, ARIZ., USA
ATEN	NUCLEAR RES. CENTRE DEMOKRITOS	ATHENS, GREECE
ATHO	OHIO UNIV.	ATHENS, OHIO, USA
BARI	UNIV. DEGLI STUDI DI BARI	BARI, ITALY
BELG	INST. INTERUNIV. DES SCI. NUC.	BRUXELLES, BELGIUM
BERG	FYSISK INSTITUTT	BERGEN, NORWAY
BERK	UNIV. OF CALIF. AT BERKELEY	BERKELEY, CALIF., USA
BERL	INST. HOCHENERGIEPHYS. DAW	ZEUTHEN/BERLIN, DDR
BERN	UNIV. BERN	BERN, SWITZERLAND
BGNA	UNIV. DI BOLOGNA	BOLOGNA, ITALY
BIRM	BIRMINGHAM UNIV.	BIRMINGHAM, ENGLAND
BNL	BROOKHAVEN NATIONAL LAB.	UPTON, L.I., N. Y., USA
BOHR	NILLS BOHR INSTITUTE	COPENHAGEN, DENMARK
BONN	UNIV. BONN	BONN, GERMANY
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
BUFF	STATE UNIV. OF NEW YORK AT BUFFALO	BUFFALO, N. Y., USA
CAEN	LAB. DE PHYS. CORPUSCULAIRE	CAEN, FRANCE
CALT	CALIF. INSTITUTE OF TECHNOLOGY	PASADENA, CALIF., USA
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
CCNY	CITY COLLEGE OF NEW YORK	NEW YORK, N. Y., 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
*CIT	CALIF. INSTITUTE OF TECHNOLOGY	PASADENA, CALIF., USA
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
CWM	COLLEGE OF WILLIAM AND MARY	WILLIAMSBURG, VA., USA
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
*EFI	ENRICO FERMI INST. FOR NUCL. STUDIES	CHICAGO, ILL., USA
EFIN	ENRICO FERMI INST. FOR NUCL. STUDIES	CHICAGO, ILL., USA
EPOL	ECOLE POLYTECHNIQUE	PARIS, FRANCE
ETHZ	EIDENOSSISCHE TECH. HOCH.	ZURICH, SWITZERLAND
FIRZ	UNIV. DI FIRENZE	FIRENZE, ITALY
FLAS	FLORIDA STATE UNIV.	TALLAHASSEE, FLA., USA
FLOR	UNIV. OF FLORIDA	GAINSVILLE, FLA., USA
FRAS	LAB. NAZIONALI DEL SINCROTRONE	FRASCATI, ITALY
*FSU	FLORIDA STATE UNIV.	TALLAHASSEE, FLA., USA
GENO	UNIV. DI GENOVA	GENOVA, ITALY
GEVA	UNIV. DE GENEVE	GENEVA, SWITZERLAND
GLAS	UNIV. OF GLASGOW	GLASGOW, SCOTLAND
GRAZ	UNIV. GRAZ	GRAZ, AUSTRIA
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
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
INRC	INST. FOR NUCLEAR RESEARCH	CRACOW, POLAND
IOWA	UNIV. OF IOWA	IOWA CITY, IOWA, USA
IPN	INST. DE PHYS. NUCLEAIRE	ORSAY, FRANCE
IPNP	INSTITUT DE PHYSIQUE NUCLEAIRE	PARIS, FRANCE
IPPG	INSTITUTE OF PHYSICS, CSAV	PRAGUE, CZECHOSLOVAKIA
IRAD	INSTITUTE DU RADIUM	PARIS, FRANCE
IRVN	UNIV. OF CALIF. AT IRVINE	IRVINE, CALIF., USA
*ISU	IOWA STATE UNIV.	AMES, IOWA, USA
ITEP	INST. FOR TEOR. AND EXP. PHYS.	MOSCOW, USSR
*JAGL	JAGELLONIAN UNIV.	CRACOW, POLAND
JHOP	JOHNS HOPKINS UNIV.	BALTIMORE, MD., USA
*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
KRAK	JAGELLONIAN UNIV.	KRAKOW, POLAND
LANC	LANCASTER UNIV.	LANCASTER, ENGLAND
LASL	U. C. LOS ALAMOS SCIENTIFIC LAB.	LOS ALAMOS, N. M., USA
LEBD	LEBEDEV PHYSICS INST.	MOSCOW, USSR
LEHI	LEHIGH UNIV.	BETHLEHEM, PA., USA
LEID	INST. LORENTZ	LEIDEN, NETHERLANDS
LHEB	LAB. DES HAUTES ENERGIES	BRUXELLES, BELGIUM
LIVP	LIVERPOOL UNIV.	LIVERPOOL, ENGLAND
LJCP	LABORATOIRE JOLIOT-CURIE	PARIS, FRANCE
LOIC	IMPERIAL COL. OF SCI. AND TECH.	LONDON, ENGLAND
*LOQM	QUEEN MARY COLLEGE	LONDON, ENGLAND
LOUC	UNIVERSITY COLLEGE	LONDON, ENGLAND
LOUI	LOUISIANA STATE UNIV.	BATON ROUGE, LA., USA
LRL	U. C. LAWRENCE RADIATION 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
MANH	MANHATTAN COLLEGE	NEW YORK, N. Y., USA
MANZ	UNIV. MAINZ	MAINZ, GERMANY
*MASA	UNIV. OF MASSACHUSETTS	AMHERST, MASS., USA
*MASB	UNIV. OF MASSACHUSETTS	BOSTON, MASS., USA
MASS	UNIV. OF MASSACHUSETTS	AMHERST, MASS., USA
MCGI	MCGILL UNIV.	MONTREAL, CANADA
MCHS	UNIV. MANCHESTER	MANCHESTER, ENGLAND
MICH	MICHIGAN STATE UNIV.	EAST LANSING, MICH., 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
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
MUOX	MIAMI UNIV.	OXFORD, OHIO, USA
NAGO	NAGOYA UNIV.	NAGOYA, JAPAN
NAL	NATIONAL ACCELERATOR LAB.	BATAVIA, ILL., USA
NAPL	UNIV. DI NAPOLI	NAPOLI, ITALY
NDAM	UNIV. OF NOTRE DAME	NOTRE DAME, IND., USA
NEAS	NORTHEASTERN UNIV.	BOSTON, MASS., USA
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
NWES	NORTHWESTERN UNIV.	EVANSTON, ILL., USA
NYU	NEW YORK UNIV.	NEW YORK, N. Y., USA
OHIO	OHIO STATE UNIV.	COLUMBUS, OHIO, 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
OTTA	NATIONAL RESEARCH COUNCIL	OTTAWA, CANADA
OXF	OXFORD UNIV.	OXFORD, ENGLAND
PADO	UNIV. OF PADOVA	PADOVA, ITALY
PENN	UNIV. OF PENNSYLVANIA	PHILADELPHIA, PA., USA
PISA	UNIV. DI PISA	PISA, ITALY
PITH	PHYSIK. INST. DER TECH. HOCHSCHULE	AACHEN, GERMANY
PITT	UNIV. OF PITTSBURGH	PITTSBURGH, PA., USA
*PPA	PRINCETON-PENN. PROTON ACCEL.	PRINCETON, N. J., USA
PPPA	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
QMCL	QUEEN MARY COLLEGE	LONDON, ENGLAND
REHO	WEIZMANN INST. OF SCI.	REHOVOTH, ISRAEL
RHEL	RUTHERFORD HIGH ENERGY LAB.	CHILTON, DID., BERKS., ENGLAND
RISO	RESEARCH ESTAB. RISO	ROSKILDE, DENMARK
RIVS	UNIV. OF CALIF. AT RIVERSIDE	RIVERSIDE, CALIF., USA
ROCH	UNIV. OF ROCHESTER	ROCHESTER, N. Y., USA
ROMA	UNIV. DEGLI STUDI DI ROMA	ROME, ITALY
RUTG	RUTGERS UNIV.	NEW BRUNSWICK, N. J., USA
SACL	CNTR. D'ETUDES NUC. SACLAY	GIF-SUR-YVETTE, FRANCE
*SEAT	SEATTLE PACIFIC COLLEGE	SEATTLE, WASH., USA
SERP	INST. OF HIGH EN. PHYS.	SERPUKOV, USSR
*SETC	SETON HALL UNIV.	SOUTH ORANGE, N. J., USA
SHAM	UNIV. OF SOUTHAMPTON	SOUTHAMPTON, ENGLAND
SLAC	STANFORD LINEAR ACCEL. CENTER	STANFORD, CALIF., USA
SOFI	BULGARIAN ACAD. OF SCI.	SOFIA, BULGARIA
SPC	SEATTLE PACIFIC COLLEGE	SEATTLE, WASH., USA
STAN	STANFORD UNIV.	STANFORD, CALIF., USA
STEV	STEVENS INST. OF TECH.	HOBOKEN, N. J., USA
STLO	WASHINGTON UNIV.	ST. LOUIS, MO., USA
STOH	STOCKHOLM UNIV.	STOCKHOLM, SWEDEN
STON	STATE UNIV. OF NEW YORK AT STONYBROCK	STONYBROOK, L.I., N. Y., USA
STRB	CENTRE DES RES. NUCLEAIRES	STRASBOURG, FRANCE
SUSS	SUSSEX UNIV.	SUSSEX, ENGLAND
SYR	SYRACUSE UNIV.	SYRACUSE, N. Y., USA
*SYRA	SYRACUSE UNIV.	SYRACUSE, N. Y., USA
TELA	UNIV. OF TEL-AVIV	TEL-AVIV, ISRAEL
TENN	UNIV. OF TENNESSEE	KNOXVILLE, TENN., USA
TNTO	UNIV. OF TORONTO	TORONTO, CANADA
TORI	UNIV. DI TORINO	TORINO, ITALY
TRST	UNIV. OF TRIESTE	TRIESTE, ITALY
TUFT	TUFTS UNIV.	MEDFORD, MASS., USA
*UCB	UNIV. OF CALIF. AT BERKELEY	BERKELEY, CALIF., USA
*UCI	UNIV. OF CALIF. AT IRVINE	IRVINE, CALIF., USA
UCLA	UNIV. OF CALIF. AT LOS ANGELES	LOS ANGELES, CALIF., 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
UPNJ	UPSALA COLLEGE	EAST ORANGE, N. J., USA
UTAH	UNIV. OF UTAH	SALT LAKE CITY, UTAH, USA
UVC	UNIV. OF VIRGINIA	CHARLOTTESVILLE, VA., 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
WPLB	H. H. WILLS PHYS. LAB., U. OF BRISTOL	BRISTOL, ENGLAND
*WUSL	WASHINGTON UNIV.	ST. LOUIS, MO., USA
YALE	YALE UNIV.	NEW HAVEN, CONN., USA
ZEEM	ZEEMAN LAB., UNIV. OF AMSTERDAM	AMSTERDAM, NETHERLANDS

Stable Particles

(Immune to Strong Decay)

For notation, see illustrated key at beginning of data card listings.

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CODE EVENTS QUANTITY  ERROR+  FRROR-  REFERENCE YR TECN SIGN COMMENTS  DATE
    ABOVE                                                           PUNCHED
   BACKGROUND

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$\boxed{\gamma}$

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                     0 GAMMA (0,J=1)

                0  GAMMA MASS  (IN UNITS OF 10**-21 MEV)

M            (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

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                              REFERENCES

                              0  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)

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                 1  E-NEUTRINO  (0,J=1/2)

                 1  E-NEUTRINO  MASS (KEV)

M            (0.25) OR LESS              LANGER    52 CNTR
M            (0.15) OR LESS              HAMILTON  53 CNTR
M            (0.55) OR LESS +OR- 0.28 FRIEDMAN  58 CNTR
M             0.06  OR LESS  CL=.90     BERGKVIS  69 CNTR    EL.STATIC.MAG.SP 11/69

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                              REFERENCES

                              1  E-NEUTRINO  (0,J=1/2)

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)
BERGKVIS 69 CERN 69-7 91      KARL-ERIK BERGKVIST         (UNIV STOCKHOLM)

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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            (2.1)  OR LESS              SHAFER    65 CNTR  CONF LEV = 68PCT  7/66
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            (0.46)    (0.64)    (0.46) FRANK     68 CNTR    PRELIMINARY     9/68

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                              REFERENCES
                              2  MU-NEUTRINO  (0,J=1/2)

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 + (COLUM+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 25 B 376       +LOKEN,PEWITT,MCKENZIE,KEYES+(ARG+CARN+NWU)
FRANK    68  VIENNA ABS.  365 FRANK,GAMET,LAKIN            (SHAM+LIVP+STAN)

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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

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                 3  ELECTRON LIFETIME (UNITS 10**21 YR)

T            OVER                2.0    MOE       65 CNTR                      6/66

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                 3  ELECTRON MAGNETIC MOMENT(E/2ME)

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 R   RICH 68 IS REEVALUATION OF WILKINSON 63
MM         (1.0011596389)+-(31)*10**-10TAYLOR    69 RVUE                     2/71*
MM          1.001159644  +-(7)* 10**-9 WESLEY    70 CNTR  - NEW MEAS.         6/70

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                              REFERENCES
                              3  ELECTRON  (0.5,J=1/2)

SCHUPP   61 PR  121   1       A A SCHUPP,R W PIDD,H R CRANE    (MICHIGAN)
WILKINSO 63 PR 130 852        D T WILKINSON,H R CRANE          (MICHIGAN)
COHEN    65 RMP 37 537        E R COHEN, J W M DUMOND     (NAASC+CALTECH)
MOE      65 PR 140 B 992      M K MOE,F REINES      (CASE INST TECHNOLOGY)
RICH     66 PRL  17  271      A RICH, H R CRANE                (MICHIGAN)
RICH     68 PRL 20 967        A RICH                           (MICHIGAN)
TAYLOR   69 RMP 41 375        +PARKER,LANGENBERG          (PRIN+UCI+PENN)
WESLEY   70 PRL 24 1320       J.C.WESLEY,A.RICH                    (ANNA)

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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   .0014            TAYLOR    69 RVUE    USING NEW E/H     7/70

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                 4  MUON LIFETIME (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    0.002     0.002 MEYER     63 CNTR +
T              2.198    0.002     0.002 MEYER     63 CNTR -                    7/66
T          . . . . . . . . . .
T    AVG       2.1983   0.0008    0.0008 AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)

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                 4  RATIO OF LIFETIME OF MU+ TO MU-

OT             1.000    0.001           MEYER     63 CNTR  LIFETIME MU+/MU-    7/66

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                 4  MUON ANOMALOUS MAGN. MOMENT (10**-6*E/(2*MUON MASS))

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          . . . . . . . . . .
MM   AVG    1166.14     0.31       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                 4  MUON PARTIAL DECAY MODES

                                                         DECAY MASSES
P1      MUON INTO E (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

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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  C.L.= .90  FRANKEL1  63 OSPK

R2      MUON INTO 3E (IN UNITS OF 10**-7)                (P3)/(P1)
R2 F          (5.0)OR LESS  C.L.= .90  PARKER    62 CNTR
R2 F          (1.3)OR LESS  C.L.= .90  ALIKHANOV 62 OSPK
R2 F          (1.5)OR LESS  C.L.= .90  FRANKEL2  63 CNTR
R2 F          (1.25)OR LESS C.L.= .90  BABAEV    63 OSPK
R2 F FOUR ABOVE EXPERIMENTS EVALUATED UPPER LIMITS ASSUMING A SECOND ORDER
R2   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  C.L.= .90  FRANKEL1  63 OSPK
R3             2.2 OR LESS  C.L.= .90  PARKER    64 OSPK
R3             2.9 OR LESS  C.L.= .90  KORENCHEN 70 OSPK  +                    2/71*

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Stable Particles

For notation, see illustrated key at beginning of data card listings.

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                    4    MUON DECAY PARAMETERS

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
RHOP  9213      0.745    0.025             PLANO      60 HBC  +  WHOLE SPECTRUM   10/69
RHOP         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             10/69
RHO C        PARAMETER 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)

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                 10/69
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 SUPERCEEDS GUREVICH 64                                   10/69
XSI          . . . . . . . . . . .
XSI AVG         0.972    0.013   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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)

HEL          HELICITY OF DECAY ELECTRON
HEL          (V-A THEORY PREDICTS HELICITY=+-1 FOR E+-, RESPECIVELY)
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             10/69
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)

GS           SCALAR COUPLING CONSTANT IN MUON DECAY  (IN UNITS OF GV)
GS             (0.33)  OR LESS             DERENZO    69 RVUE                     10/69

GA           AXIALVECTOR 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 AXIALVECTOR 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
                                   4  MUON  (106,J=1/2)

BARDON   59  PRL  2   56         M BARDON, D BERLEY, L LEDERMAN   (COLUMBIA)
DUDZIAK  59  PR 114  336         W DUDZIAK,R SAGANE, J VEDDER          (LRL)
PLANO    60  PR 119 1400         R J PLANO                        (COLUMBIA)
ALI-ZADE 61  JETP 40  452        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                     (EFINS)
PARKER   62 NC  23  485          S PARKER,S PENMAN                   (EFINS)

BABAEV   63 JETP 16 1397         BABAEV,BALATS,KAFTANOV,LANDSBERG +   (ITEP)
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 +       (PENNA)
FRANKEL2 63 PR 130  351          S FRANKEL,W FRATI,J HALPERN +       (PENNA)
MEYER    63 PR  132  2693        S L MEYER,ANDERSON,BLESER,LEDERMAN+ (COLUM)

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         (EFINS)

PEOPLES  66 NEVIS-147 (UNPUB)    J PEOPLES                        (COLUMBIA)
GUREVICH 67  IAE 1297            GUREVICH,MAKARIYNA,MISHAKOVA+   (KURCHATOV)
SCHWARTZ 67  PR 162 1306         D M SCHWARTZ                        (EFINS)
SHERWOOD 67  PR 156 1475         B A SHERWOOD                        (EFINS)
BAILEY   68  PL   28B  287       +BARTL,VON BOCHMANN,BROWN,FARLEY+    (CERN)
FRYBERGE 68  PR 166 1379         D FRYBERGER                         (EFINS)

DERENZO  69  PR 181 1854         S DERENZO                           (EFINS)
TAYLOR   69 RMP 41 375           +PARKER,LANGENBERG            (PRIN+UCI+PENN)
VOSSLER  69 NC 63A 423           C VOSSLER                           (EFINS)
KORENCHE 70 JINR P1-5251         KORENCHENKO,KOSTIN,MICHELMACHER +    (JINR)
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                                   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 +   (EFINS)
LATHROP  60 NC    17 114         J LATHROP,R A LUNDY,S PENMAN +      (EFINS)
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)

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                   8  CHARGED PION  (140,JPG=0--)  I=1

                   8  CHARGED PI  MASS (MEV)

M           139.37     0.20           CROWE     54 CNTR  -
M           139.68     0.15           BARKAS    56 EMUL  +
M           139.577    0.013          SHAFER    67 CNTR    MESONIC ATOMS     6/68
M   M      (139.550)  (0.008)         MALSBURG  71          PRELIMINARY      2/71*
M   M     THIS VALUE DIFFERS CONSIDERABLY FROM PREVIOUS VALUE. THIS DIS-    2/71*
M   M     CREPANCY IS BEING INVESTIGATED . VALUE MOMENTERALY NOT USED.      2/71*
M         . . . . . . . . . . .
M   AVG     139.577    0.013   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   FIT     139.576    0.011 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/71*

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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   FIT       33.916   0.011 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/71*

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                   8  ((MASS PI+)-(MASS PI-))/AVERAGE    (PERCENT)

DM             0.02    0.05           GREENBERG 69 CNTR                      5/70

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                   8  CHAR.PI LIFETIME (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           GREENBERG 69 CNTR                      5/70
T         . . . . . . . . . . .
T   AVG       26.024   0.024    0.024  AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)

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                   8 MEANLIFE DIFFERENCE,(+)-(-)/AVGE. (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   0.055    0.071 AYRES     69 CNTR    NEW EXPERIMENT   10/69
DT        . . . . . . . . . . .
DT  AVG        0.053   0.061   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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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            1.247    0.028          DI CAPUA  64 CNTR
R2        . . . . . . . . . . .
R2  AVG       1.242    0.026   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3     CHAR.PION INTO PIO E NEU     (UNITS 10**-8)       (P4)/(P1)
R3      36    0.97     0.20           BARTLETT  64 OSPK
R3      38    1.07     0.21           BACASTOW  65 OSPK +
R3            1.10     0.26           BERTRAM   65 OSPK                      6/66
R3      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)

R4       CHAR.PION INTO E NEU GAMMA (UNITS 10**-8)       (P5)/(P1)
R4     143    3.0      0.5            DEPOMMIER 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  C.L.= .90   KORENCHEN 70 OSPK  +                   2/71*

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Stable Particles

For notation, see illustrated key at beginning of data card listings.

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                                     REFERENCES
                                     8 CHARGED PION (140,JPG=0--)I=1

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            (ROME I F)

ANDERSON 60 PR 119 2050              H L ANDERSON,T FUJII,R H MILLER +   (EFINS)
ASHKIN   60 NC  16  490              ASHKIN,FAZZINI,FIDECARO,LIPMAN +     (CERN)
DEPOMMIE 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  (COLUM)

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)
  SEE ALSO  PRL 14 923               SHAFER,CROWE,JENKINS                   (LRL)

DEPOMMIE 68 NUC PHYS B4 189          DEPOMMIER,DUCLOS,HEINTZE,KLEINKNECHT+(CERN)
PETRUKHI 68 JINR-P1-3862             PETRUKHIN,RYKALIN,KHAZINS,CISEK     (DUBNA)
AYRES    69  UCRL-18369              DAVID S AYRES (THESIS)                 (LRL)
 ALSO    67 PR  157  1288            AYRES,CALDWELL,GREENBERG,KENNEY,KURZ+ (LRL)
 ALSO    68 PRL 21 261               AYRES,CORMACK,GREENBERG,KENNEY+  (LRL,UCSB)
GREENBER 69 PRL 23 1267              +AYRES,CORMACK,KENNEY,CALDWELL++ (LRL,UCSB)
BOOTH    70 PL 32B 723               +JOHNSON,WILLIAMS,WORMALD             (LIVP)
KORENCHE 70 JINR P1-5250             KORENCHENKO,KOSTIN,MICHELMACHER +     (JINR)
MALSBURG 71 THESIS                   C. VON DER MALSBURG             (HEIDELBERG)

                                     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

                9  PI MASS DIFFERENCE (PI+-)-(PIO)(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            4.6056   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      4.6041   0.0037  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                9  PIO  LIFETIME (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   N  OLD EMULSION MEASUREMENTS NOT USED BECAUSE OF POSSIBLE SYSTEMATIC
T   N      SHIFT TO LARGER LIFETIME VALUES
T   K    INCLUDES EVENTS OF KOLLER 63                                    8/67
T          . . . . . . . . . .
T    AVG      0.839    0.103    0.092  AVERAGE (ERROR INCL. SCALE FACTOR OF 2.1)
                      (SEE IDEOGRAM BELOW )
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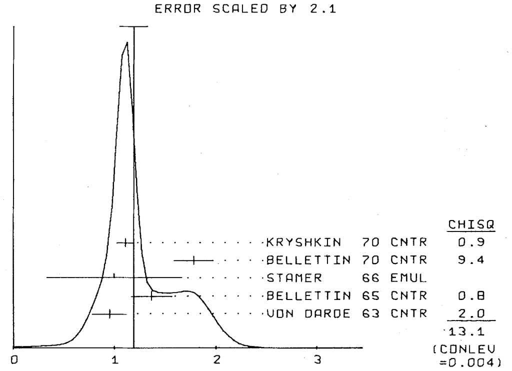
WEIGHTED AVERAGE = 1.19 ± 0.14
ERROR SCALED BY 2.1

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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

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                9  NEUTRAL PION BRANCHING RATIOS

R1      PIO INTO (GAMMA E+ E-)/(2GAMMA)                  (P2)/(P1)
R1            (0.0119) THEORET. CALC.  JOSEPH    60        QUANTUM ELECT.    9/66
R1       27    0.0117   0.0015         BUDAGOV   60 HBC
R1     3071    0.01166  0.00047        SAMIOS    61 HBC    PI-P TO PIO N
R1  S      SAMIOS VALUE USES PANOFSKY RATIO = 1.62
R1         . . . . . . . . . .
R1  AVG        0.0117   0.0004  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2        PIO INTO (3 GAMMA)/(2 GAMMA) (UNITS 10**-6)   (P4)/(P1)
R2        0   (5.0)OR LESS             DUCLOS    65 CNTR   CL=90 PERCENT     6/66
R2            (5.0)  OR LESS           KUTIN     65 CNTR   90 PERCNT  C.L.   3/68

R3        PIO INTO (E+E+E-E-)/(2 GAMMA) (UNITS 10**-5)  (P3)/(P1)
R3            (3.47)  THEORETICAL CAL. KROLL     55        QUANTUM ELECT.    9/66
R3      146    3.18      0.30          SAMIOS    62 HBC    SEE NOTE N BELOW  6/66
R3  N      ABOVE VALUE USES PANOFSKY RATIO=1.62

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                                  REFERENCES
                                  9 NEUTRAL PION (135,JPG=0--)I=1

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)
KROLL    55 PR 98 1355            N KROLL ,W WADA              (COLUMBIA+NRLW)
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)
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)
KOLLER   63    SEE ALSO STAMER 66
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)

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$K^{\pm}$

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                10  CHARGED K  (494,JP=0-)  I=1/2

                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          . . . . . . . . . .
M   AVG     493.81      0.12    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   FIT     493.84      0.11   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/71*

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                 CHARGED K CONSTRAINED FIT
             OVERALL FIT OF LIFETIME, WIDTHS AND BRANCHING
             RATIOS USES 46 DATA POINTS TO DETERMINE SEVEN
             QUANTITIES.  OVERALL FIT HAS  CHISQ=73.9.  MAIN
             CONTRIBUTION (13.5) COMES FROM R19 OF HAIDT
             71 (WE SEE NO REASON TO REJECT THIS EXPERIMENT
             AT THIS TIME)

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                10  CHAR.K  LIFETIME (UNITS 10**-8)

T        CHAR. K LIFETIME
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   FIT        1.2371   0.0026 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.9)
                       (SEE IDEOGRAM BELOW )
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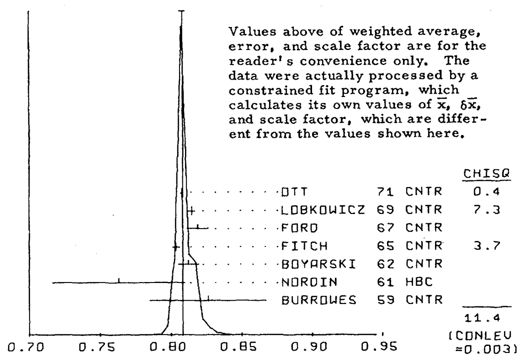
Stable Particles

For notation, see illustrated key at beginning of data card listings.

WEIGHTED AVERAGE = 0.8084 ± 0.0021
ERROR SCALED BY 2.4



CHARGED K DECAY RATE (UNITS 10**8 SEC-1)

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10 LIFETIME DIFFERENCE,(+)-(-)/AVGE. (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)

10  DECAY RATES DIFF.,(+)-(-)/AV.  (PERCENT)

D1      DIFFERENCE IN K MU2 RATES ((W1+)-(W1-))/W1
D1            -0.54       0.41             FORD       67 CNTR                     8/67

D2      DIFFERENCE IN TAU RATES   ((W2+)-(W2-))/W2
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   2M    (0.10)     (0.14)            FORD       70 ASPK    SEE NOTE F       11/70*
D2             0.08       0.12             FORD       70 ASPK    SEE NOTE F       11/70*
D2  F THE LAST IS THE COMBINED RESULT OF FORD 67 AND FORD 70
D2           . . . . . . . . . .
D2  AVG        0.07       0.12    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

D3      DIFFERENCE IN TAU PRIME RATES ((W4+)-(W4-))/AVERAGE
D3     1802   -1.1        1.8              HERZO      69 OSPK                     5/70

D4      DIFFERENCE IN K PI2 RATES  ((W2+)-(W2-))/AVERAGE
D4             0.8        1.2              HERZO      69 OSPK                     5/70

10  CHARGED K PARTIAL DECAY MODES

                                                          DECAY MASSES
P1    CHAR. K INTO MU (NFU)                 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    POSIT.K INTO PI+ PI- E+NEU            K E+ 4        139+ 139+  .5+   0
P8    POSIT.K INTO PI+ PI+ E-NEU            K E- 4        139+ 139+  .5+   0
P9     POSIT.K INTO PI+ PI- MU+ NEU         K+MU+ 4       139+ 139+ 105+   0
P10    POSIT.K INTO PI+ PI+ MU- NEU         K+MU- 4       139+ 139+ 105+   0
P11    CHAR. K INTO E NEU                   K E 2          .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 PI E NEUTRINO GAMMA     PI E NEU GAM  139+  .5+   0+   0
P19     NEG.  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

10  CHARGED K DECAY RATES

W1      CHAR. K INTO MU NEU (K MU)       (UN. 10**6 SEC-1) (P1)
W1             51.2       0.8              FORD       67 CNTR +-                  8/67
W1           . . . . . . . . . .
W1  FIT        51.55      0.25    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

W2      CHARG. K INTO PI PI+ PI- (TAU) (UN. 10**6 SEC-1) (P3)
W2  F         (4.496)    (0.030)           FORD       67 CNTR +- SEE NOTE F       8/67
W2  F   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        4.513      0.023   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

W3      CHAR. K INTO (TAU) - (TAU PRIME)  (UNITS 10**6 SEC-1)  (P3-P4)
W3      USED FOR DELTA I=1/2 TEST
W3           . . . . . . . . . .
W3  FIT        3.158      0.039   FROM FIT

W4      CHAR. K INTO (MU PIO NEU) + (E PIO NEU)  (UNITS 10**6 SEC-1) (P5+P6)
W4      USED FOR DELTA I=1/2 TEST
W4           . . . . . . . . . .
W4  FIT        6.51       0.12    FROM FIT
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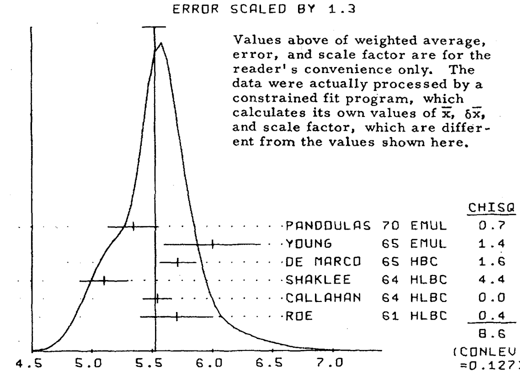
```
10  CHARGED K BRANCHING RATIOS

R   0       OLD DATA EXCLUDED

R1      CHAR. K INTO MU NEU (MU2)      (UNITS 10**-2)      (P1)/TOTAL
R1  0       (58.5)     (3.0)          BIRGE      56 EMUL +
R1  0       (56.9)     (2.6)          ALEXANDER 57 EMUL +
R1  0    OLD EXPERIMENTS NOT INCLUDED IN AVERAGING                              1/71*
R1        . . . . . . . . . .
R1  FIT      63.77      0.28    FROM FIT

R2      CHAR. K INTO PI PIO (PI2)      (UNITS 10**-2)      (P2)/TOTAL
R2  0       (27.7)     (2.7)          BIRGE      56 EMUL +
R2  0       (23.2)     (2.2)          ALEXANDER 57 EMUL +
R2  0   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        . . . . . . . . . .
R2  FIT      20.92      0.29    FROM FIT

R3      CHAR. K INTO PI PI+ PI-(TAU)  (UNITS 10**-2)      (P3)/TOTAL
R3  0        (5.6)     (0.4)          BIRGE      56 EMUL +
R3  0        (6.8)     (0.4)          ALEXANDER 57 EMUL +
R3  0        (5.2)     (0.3)          TAYLOR     59 EMUL +
R3  0   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 P  INCLUDES EVENTS OF TAYLOR 59
R3        . . . . . . . . . .
R3  AVG       5.521     0.098   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
R3  FIT       5.583     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



CHARGED K TAU B.F. PI+PI-PIO (UN 10**-2)

```
R4      CHAR. K INTO PI 2PIO (TAU PRIME)(UNITS 10**-2)    (P4)/TOTAL
R4  0        (2.1)     (0.5)          BIRGE      56 EMUL +
R4  0        (2.2)     (0.4)          ALEXANDER 57 EMUL +
R4  0        (1.5)     (0.2)          TAYLOR     59 EMUL +
R4  0   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 P  INCLUDES EVENTS OF TAYLOR 59
R4        . . . . . . . . . .
R4  AVG       1.613     0.087   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R4  FIT       1.677     0.044  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R5      CHAR. K INTO MU PIO NEU (MU3) (UNITS 10**-2)      (P5)/TOTAL
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        . . . . . . . . . .
R5  FIT       3.20      0.11    FROM FIT

R6      CHAR. K INTO E PIO NEU (E3)   (UNITS 10**-2)      (P6)/TOTAL
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        . . . . . . . . . .
R6  AVG       4.78      0.26    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R6  FIT       4.855     0.070  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R7       CHAR. K INTO (PI2 + MU3)/(TOTAL)                 (P2+P5)/TOTAL     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  FIT      24.12      0.29   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R8      POSIT.K INTO PI+ PI+ E- NEU   (UNITS 10**-7)      (P8)/TOTAL
R8        (20.)     OR LESS           BIRGE       65 FBC  + 95 PER CT CONF       8/66
R8     0  (6.9)     OR LESS           ELY         69 HLBC + 95 PER CT CONF      10/69

R9       POSIT.K INTO PI+ PI- MU+ NEU (UNITS 10**-5)      (P9)/TOTAL
R9     1   0.77      0.54      0.50  CLINE       65 FBC  +                       8/66

R10      POSIT.K INTO PI+ PI+ MU- NEU (UNITS 10**-6)      (P10)/TOTAL
R10    0  (3.0)OR LESS                BIRGE       65 FBC  + 95 PER CT CONF       8/66
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Stable Particles

For notation, see illustrated key at beginning of data card listings.

```
R11      CHAR. K INTO E NEU           (UNITS 10**-5)       (P11)/TOTAL
R11         (160.0)  OR LESS           BORREANI  64 HBC   +  CONLEV=0.95      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) (P17)/TOTAL
R12            (1.1)  OR LESS           CHEN      68 OSPK +  T(PI)60 TO 90MEV  5/68
R12            (0.4)  OR LESS           KLEMS2    70 OSPK +  T(PI)GT 117 MEV  12/70*

R13      CHAR. K INTO PI PIO GAMMA     (UNITS 10**-4)       (P13)/TOTAL
R13      18   (2.2)    (0.7)            CLINE     64 FBC  +  PI+ KE 55-80 MEV  8/66
R13 E     0   (1.9)   OR LESS           EMMERSON  69 OSPK    PI+  55-80 MEV   10/69
R13 F       90 PER CENT CONFIDENCE                                            10/69

R14      CHAR. K INTO PI PI+ PI- GAMMA(UNITS 10**-4)       (P14)/TOTAL
R14            1.0        0.4           STAMER    65 EMUL +                    8/66

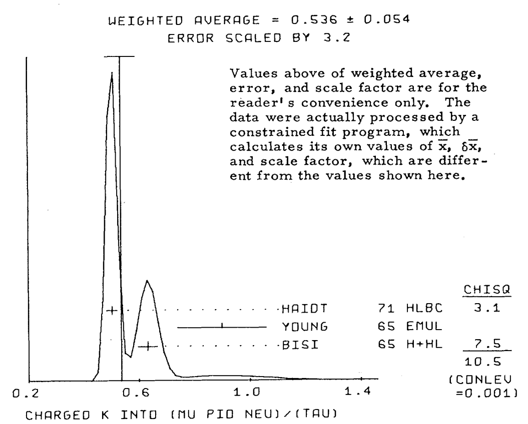
R15      CHAR. K INTO PI E+ E-         (UNITS 10**-6)       (P15)/TOTAL
R15       1    (1.1)  OR LESS           CAMERINI  64 FBC  +                    8/66
R15            (0.4)  OR LESS           CLINE     67 FBC  +                   11/67
R15            (4.4)  OR LESS           BISI      67 DBC  +  90 PER CT CONF   11/67

R16      CHAR. K INTO PI MU+ MU-       (UNITS 10**-6)       (P16)/TOTAL
R16            (3.0)  OR LESS           CAMERINI  65 FBC  +  90 PER CT CONF    8/66
R16            (2.4)  OR LESS           BISI      67 DBC  +  90 PER CT CONF   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 FIT         3.746     0.058  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

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 FIT         0.3004    0.0078 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R19      CHAR. K INTO (MU PIO NEU)/TAU                     (P5)/(P3)
R19    2175     0.632     0.035         BISI      65 H+HL +                  . 8/66
R19      39     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 FIT         0.573     0.019  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.8)
                         (SEE IDEOGRAM BELOW )
```

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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  H         HAIDT 71 IS A REANALYSIS OF EICHTEN 68
R20           . . . . . . . . . .
R20 AVG         0.858     0.018    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R20 FIT         0.870     0.013  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R21      POSIT.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           . . . . . . . . . .
R21 AVG         5.96      0.58     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R22      POSIT.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 FIT         5.733     0.090  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R24      CHAR. K INTO (PI PIO)/(MU NEU)                    (P2)/(P1)
R24             0.3253    0.0065        AUERBACH  67 OSPK +                    8/67
R24    1600     0.305     0.018         ZELLER    69 ASPK +                   10/69
R24           . . . . . . . . . .
R24 AVG         0.3230    0.0065   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
R24 FIT         0.3280    0.0059 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R25      CHAR. K INTO (E PIO NEU)/(MU NEU)                 (P6)/(P1)
R25     472     0.0797    0.0054        AUERBACH  67 OSPK +                    8/67
R25      THE VALUE .0785+-.0025 GIVEN IN THE ABOVE REF IS AN AVERAGE OF
R25      AUERBACH 67 R25 AND CESTER 66 R23.
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           . . . . . . . . . .
R25 AVG         0.0753    0.0025   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
R25 FIT         0.0761    0.0011 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R26      CHAR. K INTO (MU PIO NEU)/(MU NEU)                (P5)/(P1)
R26     310     0.0602    0.0046        AUERBACH  67 OSPK +                    8/67
R26     424     0.055     0.004         GARLAND   68 OSPK +                    4/68
R26     240     0.054     0.009         ZELLER    69 ASPK +                   10/69
R26           . . . . . . . . . .
R26 AVG         0.0569    0.0029   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R26 FIT         0.0502    0.0018 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.8)

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        11.421     0.085  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      66     2.15      0.35           CLARK     70 OSPK                    11/70*
R28           . . . . . . . . . .
R28 AVG         2.04      0.28     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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 A 1398     (0.604)   (0.022)        EICHTEN   68 HLBC                     10/68
R29 A          (0.596)   (0.025)        HAIDT     71 HLBC +                   12/70*
R29                   COMMENTS
R29  H        HAIDT 71 IS A REANALYSIS OF EICHTEN 68
R29 A      ONLY INDIVIDUAL RATIOS INCLUDED IN FIT--SEE R19 AND R20--          11/68
R29  C FROM THIS EXPERIMENT 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
R29  C SHOW LARGE DISAGREEMENTS WITH THE REST OF THE DATA.
R29           . . . . . . . . . .
R29 AVG         0.670     0.016    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R29 FIT         0.659     0.022  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.8)

R30      CHAR. K INTO PI E NEU GAMMA/PI E NEU              (P18)/(P6)
R30  B          0.012     0.008         BELLOTT1  67 HLBC +                   11/67
R30  B  GAMMA ENERGY GREATER THAN 30 MEV

R31      K- INTO PI+ E- E-/TOTAL (UNITS 10**-5)            (P19)/TOTAL
R31        TEST OF LEPTON NUMBER CONSERVATION
R31            (1.5)  OR LESS           CHANG     68 HBC   - CL=               3/68

R32      CHAR. K INTO PI NEU NEU/ TOTAL  (UNITS 10**-6)   (P20)/TOTAL
R32          (100.0)  OR LESS  CL=.90   CAMERINI  69 HLBC +  TEST NEUTR.CURR.  5/70
R32  K         1.2 OR LESS              KLEMS     70 OSPK                      5/70
R32  K  ASSUMES PI+ SPECTRUM SAME AS PIO SPECTRUM IN KE3 DECAY

R33      CHAR. K INTO E NEU GAMMA / TOTAL (UNITS 10**-5)  (P21)/TOTAL
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)/TOTAL
R34            4.       OR LESS, CL=.90 KLEMS     70 OSPK +                    1/71*

R35      CHAR. K INTO (TAU)/(TAU PRIME)                    (P3/P4)
R35      USED FOR DELTA I=1/2 TEST
R35           . . . . . . . . . .
R35 FIT         3.329     0.086  FROM FIT
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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 6
P 1	.638+-.003					
P 2	-.850	.209+-.003				
P 3	-.138	-.062	.056+-.000			
P 4	-.127	-.051	.145	.017+-.000		
P 5	-.257	-.188	.083	.002	.032+-.001	
P 6	-.230	-.198	.168	.009	.481	.049+-.001

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 5	G 6
G 1	.515+-.003					
G 2	-.669	.169+-.002				
G 3	-.106	-.038	.045+-.000			
G 4	-.099	-.041	.139	.014+-.000		
G 5	-.213	-.176	.083	.002	.026+-.001	
G 6	-.166	-.173	.165	.010	.482	.039+-.001

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Slope Parameter for $K \to 3\pi$ Decays

For the 3π decays of the K mesons we list the slope parameter "g" which is defined by

$$|M|^2 \propto 1 + g \frac{(s_3 - s_0)}{m_{\pi^+}^2} \qquad (1)$$

where

$$s_i = (\underline{p}_K - \underline{p}_i)^2 = (m_K - m_i)^2 - 2\, m_K T_i \qquad (2)$$

$$s_0 = \frac{1}{3}\sum s_i = \frac{1}{3}(m_K^2 + m_1^2 + m_2^2 + m_3^2) \qquad (3)$$

$\underline{p}_K, \underline{p}_i$ are the four-vectors for the K and the i^{th} pion, and the index 3 refers to the odd pion. (4)

We refer to the three possible charged decays as τ, τ', τ^0

$\tau^{\pm}$	$K^{\pm} \to \pi^+\pi^-\pi^{\pm}$
$\tau'^{\pm}$	$K^{\pm} \to \pi^0\pi^0\pi^{\pm}$
τ^0	$K_2^0 \to \pi^+\pi^-\pi^0$

where the odd pion is the third one.

There is no strong evidence so far that a second order term is needed in Eq. (1). Most of the experimenters have fitted their data with a second order term, which turned out to be consistent with zero. We use the value of g obtained when the second order term was dropped from the fit. 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.

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 two of 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

$$Y = \frac{3T_3 - Q}{Q}, \quad Q = m_K - \sum m_i .$$

The relevant formulae are:

$$Y = -\frac{3}{2}\frac{s_3 - s_0}{m_K Q} + \Delta, \text{with } \Delta = \frac{m_{12} - m_3}{Q}\left(2 - \frac{m_3 + m_{12}}{m_K}\right)$$

and

$$\boxed{g = \frac{-c_y a_y}{1 + a_y \Delta}}, \quad \text{with } c_y = \frac{3}{2}\frac{m_{\pi^+}^2}{m_K Q} .$$

(b) For the analysis of K^0 decay the expression often used is:

$$|M|^2 = 1 + 2a_t \frac{m_K}{m_{\pi^+}^2}(2T_3 - T_{3\,max})$$

with

$$T_{3\,max} = \frac{m_K^2 + m_3^2 - 4m_{12}^2}{2m_K} - m_3 .$$

The relevant transformations are

$$T_3 = -\frac{s_3 - s_0}{2m_K} + \frac{Q}{3}(1 + \Delta)$$

and

$$\boxed{g = \frac{-2a_t}{1 + a_t c_t}}, \text{ with } c_t = \frac{2m_K}{m_{\pi^+}^2}\left[\frac{2}{3}Q(1+\Delta) - T_{3\,max}\right] .$$

For the reader's convenience we give a table of numerical values for Q, $T_{3\,max}$, Δ, c_y and c_t, obtained using the masses from our August 1970 edition.

	Q	$T_{3\,max}$	Δ	c_y	c_t
$\tau^{\pm}$	74.96	48.15	0	0.7894	0.0924
$\tau'^{\pm}$	84.24	53.27	-0.0789	0.7025	-0.0778
τ^0	83.54	53.92	0.0798	0.7028	0.3176

Some K^0 authors use the above form of matrix element:

$$|M|^2 = 1 + 2a_u \frac{m_K}{m_{\pi^+}^2}(2T_3 - T_{3\,max}) ,$$

but define

$$T_{3\,max} = \frac{2}{3}Q .$$

The relevant transformation is then

$$g = \frac{-2a_u}{1 + a_u c_u}, \text{ with } c_u = \frac{2m_K}{m_{\pi^+}^2}\Delta = 0.2272.$$

Older K^0 analyses were done using

$$|M|^2 = 1 + a_v \frac{T_3}{m_K} .$$

The relevant transformation is then

$$g = \frac{-c_v a_v}{1 + d_v a_v}$$

with

$$c_v = \frac{m_{\pi^+}^2}{2m_K^2} = 0.0393$$

and $d_v = \frac{Q}{3m_K}(1+\Delta) = 0.0604$.

```
                10  CHARGED K  ENERGY DEPENDENCE OF DALITZ PLOT

      MATRIX ELEMENT SQUARED =  1 + G (S3-S0)/(MPI+**2)

GT+  LINEAR ENERGY DEPENDENCE (G) FOR TAU DECAYS  CHARGED K INTO PI PI+PI-
          THESE EXPTS FIT M**2=1+AY*Y. WE LIST G IN THE MAIN LISTING AND
          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+     2M  (-0.223)   (0.004)           FORD      70 ASPK    PRELIMINARY         1/71*
GT+ G17898  (-0.196)   (0.012)           GRAUMAN   70 HLBC +  AY=0.228+-.030      8/70*
GT+  39819   -0.201     0.008            HOFFMASTE 70 HLBC +  INCLUDES GRAUMAN    1/71*
GT+ G        EMULS. DATA ADDED - ALL EVENTS INCLUDED BY HOFFMASTER 70             1/71*
GT+ Z  ALSO INCLUDES DBC EVENTS
GT+          . . . . . . . . .
GT+ AVG       -0.2057   0.0069  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

GT-  LINEAR ENERGY DEPENDENCE (G) FOR TAU DECAYS  CHARGED K INTO PI PI+PI-
          FOR DEFINITION OF AY SEE NOTE UNDER S10GT+
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- F  NO RADIATIVE CORRECTIONS INCLUDED
GT- M  ALSO INCLUDES DBC EVENTS
GT-          . . . . . . . . .
GT- AVG       -0.1937   0.0067  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

DG  ((GT+)-(GT-))/((GT+)+(GT-)) IN PERCENT
DG      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   1157    0.602     0.049            AUBERT    70 HLBC +  USES PI+ SPECT.     1/71*
GTP   1527    0.602     0.061            AUBERT    70 HLBC +  USES GAMMAS ALSO.   1/71*
GTP    198    0.516     0.074            PANDOULAS 70 EMUL +                     10/70*
GTP          . . . . . . . . .
GTP AVG        0.527    0.017   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)

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Note on K^+ and K^0 Form Factors

The definition of all the variables listed in this section can be found in the text. As in the past we keep the values of ξ as obtained in μ polarization measurements (ξ_B) separated from the values obtained from branching ratios and spectra (ξ_A), but combine them in order to display in an ideogram the discrepancies in Re ξ.

Many approximations are usually made to extract these parameters from the experimental data:

1) Scalar and tensor currents. There is no evidence for scalar or tensor currents so pure vector current is usually assumed.

2) Im ξ so far is consistent with 0, and this is usually assumed in most of the experiments.

3) The q^2 dependence of the $f_\pm$ form factors is assumed to be linear, as in Eq. (38) in the main text.

4) Radiative corrections are not serious; they change λ_+ by about 0.005 (GINSBERG 67 and 70).

5) Momentum transfer dependence of ξ. From Eq. (38) and Eq. (39) in the main text, it is clear that in the first approximation one has

$$\xi(q^2) = \xi(0)[1 + (\lambda_- - \lambda_+)t],$$

where $t = q^2/m_\pi^2$. This shows that the three parameters $\xi(0)$, λ_-, and λ_+ can be highly correlated. Many of the old experiments have assumed $\lambda_+ = \lambda_- = 0$; however, recently it has become clear that in order to eliminate the discrepancies between ξ_A and ξ_B, λ_+ and λ_- should be included in the fits. We discuss each method of determining ξ separately.

a) Branching ratio analysis. From Eq. (40) in the main text it is clear that $\frac{d\xi}{d\lambda_+} \approx -\frac{1.4}{0.125} \approx -11$. Therefore for $\lambda_+ = 0.05$, $\Delta\xi = -0.55$. The old hypothesis $\lambda_+ = 0$ certainly is not very good.

b) Dalitz plot analysis. From Eq. (37) in the main text, it appears that the Dalitz plot distribution of the K_{e3} decay is essentially dependent only upon λ_+ and independent from ξ; therefore, the values of λ_+ obtained from K_{e3} data can be directly averaged.

On the other hand for the $K_{\mu 3}$ Dalitz plot, all three parameters are involved and they are correlated. For example, CHIEN 70 (in a neutral K experiment) find that λ_+ is not sensitive to ξ and λ_- variations, whereas ξ and λ_- are highly correlated. HAIDT 71 (in a K^+ experiment) find that the uncorrelated parameters are $\xi(0)$ and $\xi(6.8)$. Because of these correlations, we list the values of λ_+ from $K_{\mu 3}$ decays separately from those obtained from K_{e3} decays and do not list λ_- at all. We refer the reader to the original papers for discussion of the λ_- parameter.

c) Muon polarization analysis. The μ polarization depends only on $\xi(q^2)$; the λ_+ and λ_- parameters do not appear explicitly in Eq. (41) in the main text. For large statistics one could determine $\xi(q^2)$ and then derive $\xi(0)$, λ_+, and λ_-. This has not been possible with the statistics available so far.

In addition to the most common correlation among ξ, λ_+, and λ_-, there are many experimental difficulties. For example, in the Dalitz plot both ξ and λ_+ are most sensitive to the low E_π region, which happens to be the least populated area; hence, the parameters are determined with a very small fraction of the data. Many experiments are sensitive only to part of the Dalitz plot. Others fit only one projection of it, which may yield more than one solution.

In conclusion, due to various experimental difficulties and inhomogeneous treatment of the data by the various experiments, in this edition we continue our past policy of not quoting average values, and limit our review to a listing of experimental data. Again, as in the past, the table does not include any values for λ and ξ.

For a recent review on $K_{\ell 3}$ form factors, see Gaillard and Chounet.[1]

For notation, see illustrated key at beginning of data card listings.

Reference

1. M. K. Gaillard and L. M. Chounet, $K_{\ell 3}$ Form Factors, CERN 70-14 (May 1970), and Phys. Letters 32B, 505 (1970).

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              10  CHARGED K FORM FACTORS                                    8/67

         F+ AND F- ARE FORM FACTORS FOR THE VECTOR MATRIX ELEMENT
         FS AND FT REFER TO THE SCALAR AND TENSOR TERM

XIA     XIA = F-/F+ (DETERMINED FROM SPECTRA AND KMU3/KE3)  ---------------
XIA
XIA      SOME OF THE OLDER EXPERIMENTS HAVE EVALUATED XI ASSUMING THAT IT IS
XIA      INDEPENDENT OF THE MOMENTUM TRANSFER (T), I.E., THEY SET L+=L-=0.
XIA      OTHERS HAVE ASSUMED A VALUE FOR L+ AND USED L-=0. ONLY RECENTLY
XIA      BOTH L+,L- AND XI(0) (OR THREE RELATED PARAMETERS) HAVE BEEN INCLU-
XIA      DED IN THE FITS . SEE HAIDT 71. (OR CHIEN 70 FOR KOL) .

XIA L   76  (+1.8)     (1.6)              BROWN     62 XEBC +  MU+,PIO SPECTRA   8/67
XIA L   87  (+0.7)     (0.5)              GIACOMELL 64 EMUL +  MU+ SPECTRUM      8/67
XIA L       (-0.1)     (0.7)              JENSEN    64 XEBC +  MU+,PIO SPECTRN   8/67
XIA L       (-0.17)    (0.75)    (0.99)   SHAKLEE   64 XEBC +  KMU3/KE3          8/67
XIA L       (+0.6)     (0.5)              BISI 1    65 HBC  +  KMU3/KE3          8/67
XIA          BTWN +0.2 AND +1.4           CUTTS     65 OSPK +  MU+ SPECTRUM      8/67
XIA L 1509  (+0.4)     (0.4)              CALLAHA1  66 FRBC +  KMU3/KE3          8/67
XIA   2648   0.0        1.1       0.9     CALLAHA1  66 FRBC +  MU+ SPECTRUM      8/67
XIA    444  +0.72       0.80              CALLAHA1  66 FRBC +  P+0 SPEC,FIX MU   8/67
XIA L       (+0.75)    (0.50)             AUERBACH  67 OSPK +  KMU3/KE3          8/67
XIA E 1398  (-0.60)    (0.20)             EICHTEN   68 HLBC +  KMU3/KE3 T=4.    10/68
XIA E          EICHTEN 68 REPLACED BY HAIDT 71
XIA B 5501  (-0.08)    (0.15)             BOTTERIL2 68 ASPK +  KM3/KE3,LM+=.023  6/68
XIA L   78  (-0.5)     (0.9)              EISLER    68 HLBC +  PIO SPECT,LM+-=0  6/68
XIA L  976  (+1.0)     (0.6)              GARLAND   68 OSPK +  KMU3/KE3,LM+-=0   4/68
XIA           0.91      0.82              ZELLER    69 ASPK +  KM3/KE3 NOTE Z   10/69
XIA  B       -0.35      0.22              BOTTERIL  70 OSPK    KM3/KE3,LM+=.045 10/69
XIA Q 3240  (-0.80)    (0.50)             HAIDT     71 HLBC  + D.P. L+=.055,T=7  2/71*
XIA   3240   -0.50      1.5               HAIDT     71 HLBC  + D.P. L+=.055,T=0  2/71*
XIA   1505   -0.72      0.21              HAIDT     71 HLBC  + KM3/KE3, L+=.029  2/71*
XIA Q   VALUES AT T=0 AND AT T=6.8 ARE UNCORRELATED                              2/71*
XIA  B  T=0  BOTTERIL 69 IS REEVALUATION OF BOTTERIL2 68 WITH DIFF. L+          10/69
XIA  E  T=4  ASSUMES  L+=.023+-.008 - INSENSITIVE TO L-
XIA L   L+ AND  L-  ASSUMED TO BE ZERO - NOT AVERAGED
XIA Z   T=0 ZELLER 69 ASSUMES L+=0.023 ,L-=0
XIA          . . . . . . . . . .
XIA AVERAGE MEANINGLESS (SCALE FACTOR = 1.3)

XIB     XIB = F-/F+ (DETERMINED FROM MU POLARIZATION IN KMU3)  ------------

XIB     THE MU POLARIZATION IS A MEASURE OF XI(T). NO ASSUMPTIONS ON L+-
XIB     NECESSARY, T SHOULD BE SPECIFIED.

XIB   2100   +1.2      2.4       1.8    BORREANI  65 HLBC +  POLARIZATION       8/67
XIB    397   -1.4      1.8              CALLAHA1  66 FRBC +  TOTAL POLA-.       8/67
XIB   2950   -0.7      0.9       3.3    CALLAHA1  66 FRBC +  LONG. POLAR.       8/67
XIB  86000   -0.6      1.1              BETTELS   68 FRBC +  TOTAL POL. T=0    11/69
XIB  86000   -1.0      0.3              BETTELS   68 FRBC +  TOTAL POL. T=4.9  11/69
XIB   3133   -0.95     0.3              CUTTS     68 OSPK +  TOTAL POL. T=3     6/68
XIB B   BETTELS 68 VALUES AT T=0 AND T=4.9 ARE UNCORRELATED.
XIB          . . . . . . . . . .
XIB AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

RXI        REAL PART OF XI    (COMBINED XIA AND XIB)
RXI   2100   +1.2      2.4       1.8    BORREANI  65 HLBC +  MU POL
RXI   2648    0.0      1.1       0.9    CALLAHA1  66 FRBC +  MU+ SP.
RXI    444   +0.72     0.37             CALLAHAN  66 FRBC +  PIO SP.
RXI    397   -1.4      1.9              CALLAHAN  66 FRBC +  MU POL (TOT.)
RXI   2950   -0.7      0.9       3.3    CALLAHAN  66 FRBC +  MU POL (LONG.)
RXI  86000   -0.6      1.1              BETTELS   68 FRBC +  MU POL T=0
RXI   3133   -0.95     0.3              CUTTS     68 OSPK +  MU POL T=3
RXI           0.91     0.82             ZELLER    69 ASPK +  B.R.
RXI  B       -0.35     0.22             BOTTERIL  70 OSPK    KM3/KE3,LM+=.045 10/69
RXI   3240   -0.50     1.50             HAIDT     71 HLBC  + D.P. L+=.055,T=0  2/71*
RXI   1505   -0.72     0.21             HAIDT     71 HLBC  + KM3/KE3, L+=.029  2/71*
RXI          . . . . . . . . . .
RXI AVERAGE MEANINGLESS (SCALE FACTOR = 1.7)
                        (SEE IDEOGRAM BELOW )
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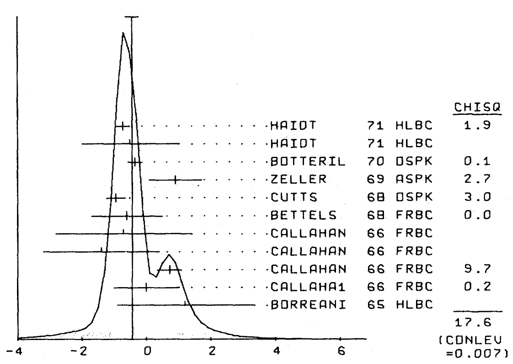

COMBINED F-/F+ USING BOTH XIA AND XIB

```
IXI        IMAGINARY PART OF XI (TEST OF T REVERSAL)   ------------------
IXI           0.1       0.4       0.3   BETTELS   68 HLBC    POLARIZATION      10/69

FS      FS/F+  RATIO OF SCALAR TO F+ COUPLINGS  (ABS. VALUE)   ------------

FS          (.18) OR LESS               BELLOTT2  67 HLBC    90 PERC. CONFLEV 10/69
FS          (.30) OR LESS               KALMUS    67 HLBC  + 95 PERC. CONFLEV 10/69
FS         (0.23)  OR LESS              BOTTERIL1 68 ASPK     CL=90 PERCENT    8/66

FT      FT/F+  RATIO OF TENSOR TO F+ COUPLINGS  (ABS. VALUE)   ------------

FT          (.58) OR LESS               BELLOTT2  67 HLBC    90 PERC. CONFLEV 10/69
FT         (1.1)  OR LESS               KALMUS    67 HLBC  + 95 PERC. CONFLEV 10/69
FT         (0.58)  OR LESS              BOTTERIL1 68 ASPK     CL=90 PERCENT    8/66

L+E      LAMBDA +  (LINEAR ENERGY DEPENDENCE OF F+ IN KE3 DECAY)   ---------
L+E      FOR RAD. CORR. TO THE DALITZ PLOT, SEE GINSBERG 67.

L+E    217   +0.036     .045            BROWN     62 XEBC +  PIO SPEC,NO R.C.
L+E    407   -0.010     .029            JENSEN    64 XEBC +  PIO SPEC,NO R.C.   8/67
L+E    230   -0.04      .05             BORREANI  64 HBC  +  F+ SPEC,NO R.C.    8/67
L+E    854    0.045    0.017     0.018  BELLOTT2  67 FBC  +  DLTZ PLT, R.C.    11/67
L+E   1393   +0.016     .016            IMLAY     67 OSPK + DLTZ PLT,NO R.C.    8/67
L+E    515   +0.028     .013      .014  KALMUS    67 FBC  + E,PI SPEC,NO R.C.   8/67
L+E    960    (.09)    (.04)            BOTTERIL1 68 ASPK + E SPEC  USES R.C.   6/68
L+E     90   -0.02     0.08      0.12   EISLER    68 HLBC + PIO SPEC,NO R.C.    6/68
L+E   1458     .045     .015            BOTTERIL  70 OSPK    PIO SPECTRUM RC   10/69
L+E        . . . . . . . . . .
L+E AVG        0.0286   0.0074  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

L+M     LAMBDA +  (LINEAR ENERGY DEPENDENCE OF F+ IN KMU3 DECAY)
L+M      FOR RAD. CORR. TO DALITZ PLOT OF KMU3  SEE GINSBERG 70

L+M            0.055    0.025           HAIDT     71 HLBC    KMU3 DAL. PLOT    2/71*

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                              REFERENCES
                              10 CHARGED K (494,JP=0-)I=1/2

BIRGE     56 NC   4   834     BIRGE,PERKINS,PETERSON,STORK,WHITEHEA (LRL)
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.  E R COHEN,K M CROWE,J DUMOND   (AI+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      (MICHIGAN)
KALMUS    64 PRL    13   99   +KERNAN,PU,POWELL,DOWD           (LRL,WISC)
SHAKLEE   64 PR   136 B 1423  SHAKLEE,JENSEN,ROE,SINCLAIR      (MICHIGAN)

BIRGE     65 PR 139 B 1600    BIRGE,ELY,GIDAL,CAMERINI,CLINE +  (LRL+WIS)
BISI      65 NC    35  768    BISI,BORREANI,CESTER,FERRARO +      (TURIN)
BISI 1    65 PR 139 B 1068    BISI,MARZARI-CHIESA,RINAUDO   (TURINO,INFN)
BORREANI  65 PR 140 B1686     BORREANI,GIDAL,RINAUDO,CAFORIO+(BARI,TURIN)
CALLAHAN  65 PRL   15  129    A CALLAHAN,D CLINE              (WISCONSIN)
CAMERINI  65 NC    37 1795    CAMERINI,CLINE,GIDAL,KALMUS,KERNAN(WIS+LRL)
CLINE     65 PL    15  293    A CLINE,W F FRY                 (WISCONSIN)

DE MARCO  65 PR 140 B 1430    DE MARCO,GROSSO,RINAUDO        (TURINO+CERN)
    ALSO  68 PR 169 1045      SAYER,BEALL,DEVLIN,SHEPHARD+(MD+PPA+PALMER)
FITCH     65 PR 140 B 1088    FITCH,QUARLES,WILKINS  (PRINCETON+MT HOLYK)
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)
TRILLING  65   IS 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)
CESTER    66   SEE ALSO FOOTNOTE L OF AUERBACH 67

AUERBACH  67 PR 155  1505     +DOBBS,MANN,MCFARLANE,WHITE+     (PENN,PRIN)
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)
BOTTERIL  67   SEE ALSO BOTTERILL 68
BOWEN     67 PR 154 1314      BOWEN,MANN,MCFARLANE,HUGHES+(PENN-PRINCETO)

CLINE     67 HEIDELBERG CONF  CLINE,HAGGERTY,SINGLETON,FRY+   (WISCONSIN)
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+
BOTTERIL  68 PR 171 1402      BOTTERILL,BROWN,CORBETT,CULLIGAN+  (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,PLANO+(MARYLAND,RUTGERS)

CHEN      68 PRL 20 73        CHEN,CUTTS,KIJEWSKI,STIENING +    (LRL,MIT)
CUTTS     68 PRL 20 955       CUTTS,STIENING,WIEGAND,DEUTSCH    (LRL,MIT)
  ALSO    65 PR 138 B969      CUTTS,ELIOFF,STIENING                 (LRL)
  ALSO    69 PR 184 1380      +STIENING,WIEGAND,DEUTSCH         (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)

CAMERINI  69 PRL 23 326       +LJUNG,SHEAFF,CLINE              (WISCONSIN)
DAVISON   69 PR   180 1333    +BACASTOW,BARKAS,EVANS,FUNG,PORTER+  (RIVS)
ELY       69 PR   180 1319    ELY,GIDAL,HAGOPIAN,KALMUS+     (UCL,WIS,LRL)
EMMERSON  69 PRL 23 393       EMMERSON,QUIRK                      (OXFORD)
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For notation, see illustrated key at beginning of data card listings.

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HERZO     69 PR 186 1403        +BANNER,BEIER,BERTRAM,EDWARDS +          (ILL)
LOBKOWIC  69 PR 185 1676        +MELISSINOS,NAGASHIMA,TEWKSBURY+ (ROCH,BNL)
  ALSO    66 PRL 17 548         LOBKOWICZ +                                 ()
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)

AUBERT    70  LAL-1238 (KIEV)   +HEUSSE,PASCAUD,VIALLE,VILAIN+  (ORSA+BRUX)
BOTTFRIL  70 PL 31B 325         +BROWN,CLEGG,CORBETT,CULLIGAN+         (OXF)
CLARK     70 UCRL 20079         +CORK,ELIOFF,KERTH,MCREYNOLDS+         (LRL)
FORD      70 PRL 25 1370        +PIROUE,REMMEL,SMITH,SOUDER           (PRIN)
GRAUMAN   70 PR D1 1277         +KOLLER,TAYLOR,PANDOULAS+ (STEV,SETON,LEHI)
  ALSO    69 PRL 23 737         +KOLLER,TAYLOR,PANDOULAS+ (STEV,SETON,LEHI)

HOFFMAST  70  SIT-P256          HOFFMASTER,KOLLER,TAYLOR+    (STEV+SHU+LEHI)
KLEMS     70 PRL 24 1086        +HILDEBRAND,STIENING               (LRL,CHIC)
KLEMS2    70 PRL 25 473         KLEMS,HILDEBRAND,STIENING          (LRL,CHIC)
MACEK     70 PR D1 1249         +MANN,MCFARLANE,ROBERTS                (PENN)
PANDOULA  70 PR D2 1205         +TAYLOR,KOLLER,GRAUMAN +          (STEV,SETO)

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)
OTT       71 PR 3D 52           OTT,PRITCHARD                          (QMCL)

          QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN THE DATA CARDS

BLOCK     62 CFRN CONF 371      BLOCK,LENDINARA,MONARI           (NWU+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+WIS+BARI)
ADAIR     64 PL 12  67          ADAIR,LEIPUNER                     (YALE,BNL)
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         +STEIN+(AACH+BARI+CERN+EPOL+NIJM+ORS+PA+TO)
FEARING   70 PR D3 542          +FISCHBACK,SMITH                  (SUNY+BOHR)
GINSBERG  70 PR D1 229          E S GINSBERG                      (IIT HAIFA)

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K^0

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              11   NEUTRAL K  (JP=0-)  I=1/2

              11   KO 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    FIT         497.79     0.15    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)  2/71*
                           (SEE IDEOGRAM BELOW )
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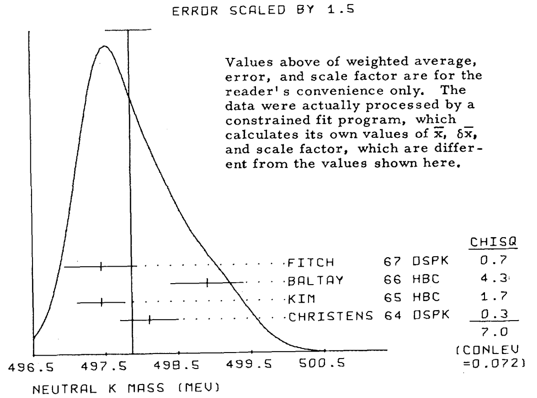
WEIGHTED AVERAGE = 497.87 ± 0.32
ERROR SCALED BY 1.5

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              11   KO-K CH. 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    FIT        3.95     0.13   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)  2/71*

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                                REFERENCES
                                11 NEUTRAL K (JP=0-)I=1/2

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_S^0

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              12   SHORT-LIVED NEUTRAL K (498, JP=0-)  I=1/2

              12   KOS LIFETIME (UNITS 10**-10 SEC)
T        KOS LIFETIME
T   0   90   (1.07)   (0.13)   (0.13) BOLDT     58 CC
T      512    0.94     0.05     0.05  CRAWFORD  59 HBC
T   0   63   (1.09)   (0.18)   (0.15) BOWEN     60 CC
T   0  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    20000    0.865    0.009          HILL      68 DBC                     6/68
T   B  KOS LIFETIME NOT THE PRIMARY QUANTITY MEASURED IN THIS EXPT.        6/68
T   H   HILL 68 GIVES A DETAILED DISCUSSION OF SYSTEMATICS ENCOUNTERED
T   H   IN THIS TYPE OF EXPERIMENT.
T            . . . . . . . . .
T   AVG       0.8619   0.0062   0.0062 AVERAGE (ERROR INCL. SCALE FACTOR OF 1.2)
T   FIT       0.8619   0.0058 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)
                      (SEE IDEOGRAM BELOW )
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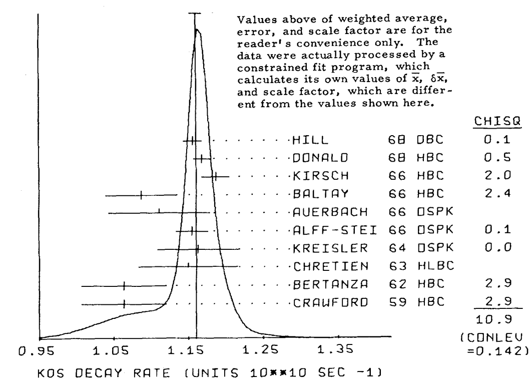
WEIGHTED AVERAGE = 1.1602 ± 0.0084
ERROR SCALED BY 1.2

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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

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              12   KOS  BRANCHING RATIOS

R1      KOS INTO (PI+ PI-)/TOTAL                          (P1)/TOTAL
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      0.684     0.011        DOYLE     69 HBC     PI-P TO LAM,KO    2/71*
R1  U        ANDERSON RESULT NOT PUBLISHED, EVENTS ADDED TO DOYLE SAMPLE      2/71*
R1           . . . . . . . . .
R1  AVG         0.684     0.011   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  FIT         0.6865    0.0045 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R2      KOS INTO (PIO PIO)/TOTAL                          (P2)/TOTAL
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  FIT         0.3135    0.0045 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)
                         (SEE IDEOGRAM BELOW )
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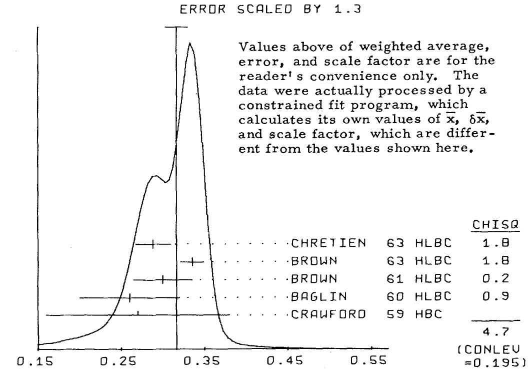
WEIGHTED AVERAGE = 0.316 ± 0.014
ERROR SCALED BY 1.3



Stable Particles

For notation, see illustrated key at beginning of data card listings.

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R3        KOS INTO (PI+ PI-)/(PIO PIO)                  (P1/P2)
R3    267    2.12     0.17            BOZOKI    69 HLBC                       5/70
R3   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          . . . . . . . . .
R3  AVG      2.196    0.065   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.6)
R3  FIT      2.189    0.046  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)
                      (SEE IDEOGRAM BELOW )
```
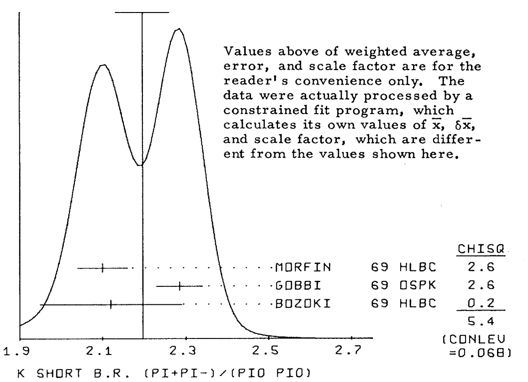

WEIGHTED AVERAGE = 2.196 ± 0.065
ERROR SCALED BY 1.6

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R4      (KOS INTO PI+ PI- PIO)/(KOL INTO PI+ PI- PIO)
        TEST OF CP VIOLATION - SEE TEXT FOR DEFINITIONS
        CPT ASSUMED VALID - (I.E. RE(A)=0) - ONLY (IMA)**2 QUOTED HERE
R4      18   (3.8) OR LESS            ANDERSON  65 HBC      90 PERCENT CL    10/69
R4            0.45 OR LESS            BEHR      66 HLBC     90 PER CT CONF    8/66
R4      53   (1.7) OR LESS            WEBBER    70 HBC      90 PERCENT CL     8/70*
R4 C    71    0.8  OR LESS            WEBBER    70 HBC      90 PERCENT CL     8/70*
R4 C         THIS IS THE COMBINED RESULT OF ANDERSON 65 AND WEBBER 70
R4  M   50   (1.2)  OR LESS  CL=.95   MEISNER   71 HBC     0 CL=.9 NOT AVAIL.  2/71*
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           BOTT-BODE 67 OSPK      90 PER CT CONF    8/67
R5          (20.0)  OR LESS           BOHM      69 OSPK     90 PER CT CONF    2/71*
R5           (1.07) OR LESS           HYAMS     69 OSPK     90 PER CT CONF   10/69
R5   S      (32.6)  OR LESS           STUTZKE   69 OSPK     90 PER CT CONF    5/69
R5   S     VALUE CALCULATED BY US,USING 2.3 INSTEAD OF 1 EVENT, 90 PERC.CL   10/69

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

R7     KOS INTO (E+ E-)/CHARGED  (UNITS 10**-5)            (P4)/(P1)
R7          (50.0)  OR LESS           BOHM      69 OSPK     90 PER CT CONF    2/71*
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REFERENCES
12 SHORT-LIVED NEUTRAL K (498, JP=0-) I=1/2

```
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 +  (PARIS EP)
BOWEN    60 PR   119 2030      BOWEN,HARDY,REYNOLDS,SUN,MOORE+(PRINCE+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)
         (BERTANZA UNPUBLISHED,BUT RECERTIFIED BY AUTHORS,AUGUST 66)

BROWN    63 PR   130  769      BROWN,KADYK,TRILLING,ROE +   (LRL+MICHIGAN)
CHRETIEN 63 PR   131 2208      CHRETIEN+      (BRANDEIS+BROWN+HARVARD+ MIT)
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)
             SEE ALSO AUERBACH 65
BALTAY   66 PR 142   932       BALTAY,SANDWEISS,STONEHILL +     (YALE+BNL)
BEHR     66 PL   22  540       BEHR,BRISSON,PETIAU+ (EP,MILAN,PADUA,ORSAY)
BELLOTTI 66 NC 45A 737         +PULLIA,BALDO-CEOLIN +         (MILAN+PADUA)
BOTT-BOD 66 PL   23 277        BOTT-BUDENHAUSEN,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+(LIVERPOOL,CERN,PARIS)
HILL     68 PR 171 1418        HILL,ROBINSON,SAKITT +        (BNL,CARNEGIE)

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)
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                  (ANN ARBOR)
STUTZKE  69  PR   177  2009    +ABASHIAN,JONES,MANTSCH,ORR,SMITH(ILLINOIS)

WEBBER   70 PR D1 1967         +SOLMITZ,CRAWFORD,ALSTON-GARNJOST     (LRL)
 ALSO    69 UCRL 19226 THESIS  B R WEBBER                            (LRL)
MEISNER  71 PR 3D 59           +MANN,HERTZBACH,KOFLER +     (MASA+BNL+YALE)
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PAPERS NOT REFERRED TO IN DATA CARDS

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BIRGE    60 ROCH CONF 601      R W BIRGE,P P FLY +          (LRL+WISCONSIN)
MULLER   60 PRL    4  418      MULLER,BIRGE,FOWLER,GOOD,PICCIOMI+(LRL+BNL)
FITCH    61 NC    22 1160      V FITCH,P PIROUE,R PERKINS    (PRINCE+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)
TRILLING 65    IS UPDATED FROM 1965 ARGONNE CONF , PAGE 115
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$\boxed{K_L^0}$ 13 LONG-LIVED NEUTRAL K (498, JP=0-) I=1/2

Note on K_L^0-K_S^0 Mass Difference

Because the mass difference is now known almost as precisely as the K_S^0 lifetime, we no longer give the mass difference in units of inverse K_S^0 lifetimes. Following the convention of recent mass difference experiments (FAISSNER 69, CULLEN 70, ARONSON 70), we now give $\Delta M/\hbar$ in units of 10^{10} sec^{-1}. For ease of comparison, older experiments have been converted to these units by dividing by the K_S^0 lifetime. We have used the value of the K_S^0 lifetime given in this review (0.862×10^{-10} sec) in those cases where the author's value is not given.

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                    13  KOL-KOS  MASS DIFFERENCE
      WE GIVE (KOL-KOS MASS DIFFERENCE / HBAR) IN UNITS OF 10**10 SEC-1

D  T        (2.20)   (0.35)          FITCH     61 CNTR
D            0.84     0.29     0.22 GOOD       61 HLBC
D  T         1.02     0.23          CAMERINI   62 HLBC     SEE NOTE C BELOW  8/67
D   C  VALUE CHANGED FROM 1.7 (SEE TABLE 1 OF CAMERINI 66)                   8/67
D  T         0.55     0.24          AUBERT     65 HLBC                       6/66
D            0.26     0.36     0.26 BALDO-CEO  65 HLBC     ASS.CP CONS.
D  T A       0.64     0.12          CHRISTENS  65 OSPK                       6/66
D    A CHRISTENSON 65 HAS BEEN CORRECTED FOR INTERFERENCE BY FITCH 65 FTNOT  1/71*
D  T        (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   V  VISHNEVSKY 65 NOT CORRECTED FOR INTERFERENCE EFFECTS                  3/68
D            0.514    0.039         ALFF-STEI  66 OSPK                       6/66
D       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  T    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   N     ERROR IGNORES UNCERTAINTY OF PHASE SHIFTS
D       95   0.62     0.10     0.16 CHANG      66 HBC      KO+P INTO HYPER.  8/67
D            0.81     0.17          FUJII      66 OSPK     IRON REGENERATOR  9/66
D       59   0.74     0.34          MEISNER1   66 HBC      SEE NOTE M1       6/66
D   M1     + SIGN FAVORED           MEISNER2   66 HBC                        9/66
D            0.38     0.16          JOVANOVIC  66 OSPK     C+URANIUM REGEN. 11/66
D  T   136 + 0.64     0.19          CANTER     67 DBC      KO+D INTO HYPER. 11/67
D            0.65     0.11          MISCHKE    67 OSPK                     .11/67
D      590   0.59     0.13          BALATZ     68 OSPK     AL REGENERATOR    3/68
D            0.520    0.044         CARNEGIE   68 HBC      GAP METHOD        3/68
D  T        +0.487    0.046         MELHOP     68 OSPK     ST.STEEL REGEN    6/68
D  B         0.547    0.024         BOTT-BOD   69 OSPK     C REGEN           1/71*
D  B   BOTT-BOD 69 IS A REEVALUATION OF BOTT-BOD 66                          1/71*
D  F         0.555    0.020         FAISSNER   69 ASPK     REGEN IN CU      10/69
D  F   ESTIMATED ADDITIONAL SYSTEMATIC UNCERTIANTY LESS THAN TWO PERCENT     1/71*
D            0.542    0.006         CULLEN     70 CNTR                       1/71*
D            0.542    0.006         ARONSON    70 ASPK     GAP METHOD        1/71*
D  D         0.534    0.006         CARNEGIE   70 CNTR                       2/71*
D  D   CHANGED FROM KIEV CONF.VALUE BY AUTHORS                               3/71*
D  T   A KOS LIFETIME OF 0.862 10**-10 SEC WAS USED IN CONVERTING THE MASS   1/71*
D  T   DIFFERENCE FROM UNITS OF INVERSE KOS LIFETIMES TO ABSOLUTE UNITS.     1/71*
D  T   VALUES NOT BEARING THIS FOOTNOTE EITHER WERE GIVEN IN ABSOLUTE UNITS  1/71*
D  T   OR WERE CONVERTED USING THE AUTHORS VALUE OF THE KOS LIFETIME.        1/71*
D          . . . . . . . . .
D   AVG      0.5398   0.0033  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
                      (SEE IDEOGRAM BELOW )
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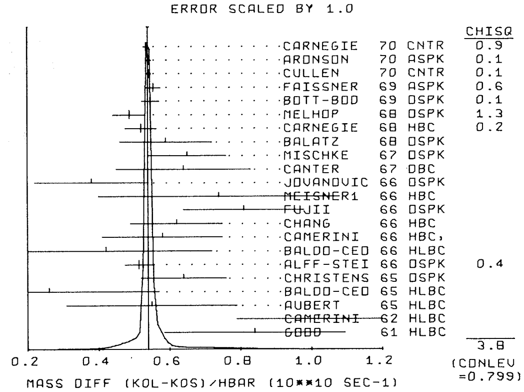
WEIGHTED AVERAGE = 0.5398 ± 0.0033
ERROR SCALED BY 1.0



Stable Particles

For notation, see illustrated key at beginning of data card listings.

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              NEUTRAL K CONSTRAINED FIT
          OVERALL FIT OF LIFETIME, WIDTHS AND BRANCHING
          RATIOS USES 56 DATA POINTS TO DETERMINE SEVEN
          QUANTITITES.  OVERALL FIT HAS CHISQ=49.5.
          VALUES OF WIDTHS AND LIFETIME CHANGED MAINLY
          BECAUSE OF NEW T MEASUREMENT (VOSBURG 71).

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              13  KOL LIFETIME  (UNITS 10**-8 SEC)

T        KOL LIFETIME
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    5.151     0.044           VOSBURG    71 CNTR  0           2/71*
T   L  SUM OF PARTIAL DECAY RATES
T            . . . . . . . . . .
T   AVG       5.156     0.042     0.042 AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)
T   FIT       5.172     0.043  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

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              13  KOL DECAY RATES

W1     KOL INTO PIO PIO PIO          (UNITS 10**6 SEC-1)  (P1)
W1      54    5.22   1.03        0.84  BEHR       66 HLBC    ASSUMES CP     8/66
W1            . . . . . . . . . .
W1  FIT       4.14      0.13   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

W2     KOL INTO PI+ PI- PO           (UNITS 10**6 SEC-1)  (P2)
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            2.54      0.43           HILL      66 DBC                     9/66
W2      IN THE OVERALL FIT THIS RATE IS WELL DETERMINED BY THE LIFETIME AND
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            . . . . . . . . . .
W2  AVG       2.36      0.32    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)
W2  FIT       2.435     0.057  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
                        (SEE IDEOGRAM BELOW )
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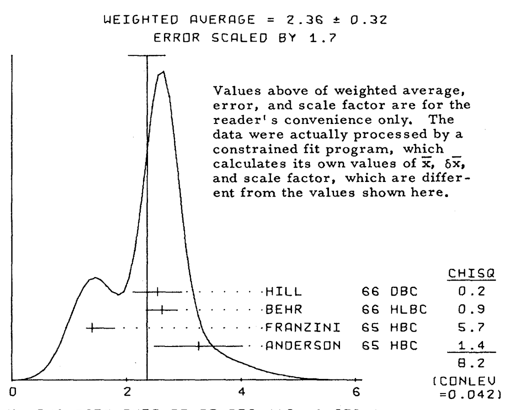


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W3     KOL INTO PI E NEUTRINO        (UNITS 10**6 SEC-1)  (P4)
W3            7.52      0.85     0.72  AUBERT    65 HLBC   DS=DQ,CP ASSUMED  8/67
W3            . . . . . . . . . .
W3  FIT       7.52      0.14   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

W4     KOL INTO CHARGED (3-BODY)     (UNITS 10**6 SEC-1)  (P2+P3+P4)
W4      98   15.1       1.9            AUERBACH  66 OSPK                    8/67
W4            . . . . . . . . . .
W4  FIT      15.14      0.18   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

W5     KOL INTO LEPTONIC (KMU3+KE3) (UNITS 10**6 SEC-1) (P3+P4)
W5     109    9.4       1.3            FRANZINI  65 HBC                     6/66
W5      54   11.3       1.9            GOLDEN    66 HBC                     9/66
W5  C  335  (10.3)     (0.8)           HILL      67 DBC     K+N TO KO P     8/67
W5     393   11.6       0.9            CHO       70 DBC     K+N TO KOP     10/70*
W5  C  CHO 70 INCLUDES EVENTS OF HILL 67
W5            . . . . . . . . . .
W5  AVG      10.94      0.69    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W5  FIT      12.71      0.16   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

W6     KOL INTO PI MU NEUTRINO       UNITS 10**6 SEC-1)    (P3)
W6      19    4.54      1.24     1.08  LOWYS     67 HLBC                    8/67
W6            . . . . . . . . . .
W6  FIT       5.19      0.12   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  FIT       0.274     0.011  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

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                       6/65
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     558    0.157     0.010          EVANS     69 HLBC                     10/69
R2            . . . . . . . . . .
R2  AVG       0.1612    0.0038  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2  FIT       0.1608    0.0035 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

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 MEASURED INDEPENDENTLY FROM R2 AND R4
R3            . . . . . . . . . .
R3  FIT       0.3425    0.0066 FROM FIT

R4     KOL INTO (PI E NEUTRINO)/CHARGED                     (P4)/(P2+P3+P4)
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       0.488     0.033   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R4  FIT       0.4968    0.0067 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       0.5919    0.0076 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R6     KOL INTO(PI+ PI- PIO)/TOTAL                          (P2)/TOTAL
R6
R6            . . . . . . . . . .
R6  FIT       0.1259    0.0028 FROM FIT

R7     KOL INTO(LEPTON PI NEUTRINO)/TOTAL                   (P3+P4)/TOTAL
R7
R7            . . . . . . . . . .
R7  FIT       0.6573    0.0066 FROM FIT

R8      KOL INTO (2 GAMMA)/TOTAL     (UN. 10**-4)           (P9)/TOTAL
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   70 OSPK    KOL 1.5-9 GEV/C   2/71*
R8  C     CRIEGEE 66 REPLACED BY TODOROFF 67                                 11/68
R8  K     CRONIN1 67 REPLACED BY KUNZ 68.                                     2/71*
R8            . . . . . . . . . .
R8  AVG       5.13      0.70    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R9     KOL INTO (PI+ PI-)/CHARGED    (UNIT 10**-3)          (P5)/(P2+P3+P4)
R9      45    2.0       0.4            CHRISTENS 64 OSPK ETA +- = 1.94
R9      54    2.08      0.35           GALBRAITH 65 OSPK ETA +- = 2.02
R9            1.93      0.26           BASILE    66 OSPK ETA +- = 1.86        9/66
R9            1.993     0.080          BOTT-BODE 66 OSPK ETA +- = 1.935       9/66
R9            . . . . . . . . . .
R9  AVG       1.992     0.073   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R9  FIT       2.001     0.063  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

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           0.67      0.13           KULYUKINA 68 CC                        2/71*
R10 B        (0.71)    (0.04)          BEILLIERE 69 HLBC                     10/69
R10 B  BEILLIERE 69 IS A SCANNING EXPT USING SAME EXPOSURE AS BUDAGOV 68
R10   1309    0.648     0.030          EVANS     69 HLBC                     10/69
R10   3548    0.68      0.08           BASILE    70 OSPK                     10/70*
R10           . . . . . . . . . .
R10 AVG       0.687     0.024   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
R10 FIT       0.689     0.022  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
                        (SEE IDEOGRAM BELOW )
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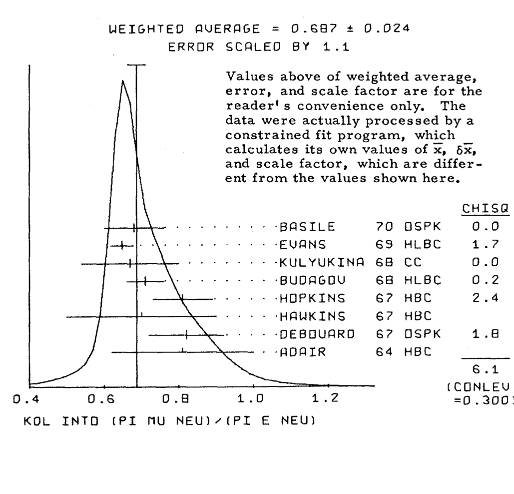

For notation, see illustrated key at beginning of data card listings.

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R11     KOL INTO (MU+MU-)/CHARGED    (UNITS 10**-6)          (P6)/(P2+P3+P4)
R11         (100.0)OR LESS                ANIKINA    65 CC                              6/66
R11          (50.0)    OR LESS            ABASHIAN   66 OSPK     90 PER CT CONF         8/66
R11         (250.0)   OR LFSS             ALFF-STEI  66 OSPK     0.90 CONF. LFVEL       9/66
R11           (2.0)   OR LESS             BOTT-BODE  67 OSPK      90 PER CT CONF        8/67
R11          (35.0)   OR LESS             FITCH      67 OSPK     90 PER CT CONF         3/68

R12       KOL INTO (PI+ PI- GAMMA)/TOTAL (UNITS 10**-3)  (P10)/TOTAL
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 MFV         6/66
R12          (0.4)OR LESS  CL=.90         THATCHER   68 OSPK     GAM KE 20-170 MV       2/71*

R13       KOL INTO (E+ E-)/CHARGED     (UNITS 10**-6)        (P7)/(P2+P3+P4)
R13        (1000.0)OR LESS                ANIKINA    65 CC                              6/66
R13          (50.0) OR LESS               ABASHIAN   66 OSPK      90 PRCT CONF          6/66
R13         (200.0) OR LFSS               ALFF-STEI  66 OSPK     90 PRCT CONF           6/66
R13          (23.0)   OR LESS             BOTT-BODE  67 OSPK      90 PER CT CONF        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 LFSS            CARPENTER  66 OSPK     90 PER CT CONF         8/66
R14           (0.107)OR LESS              BOTT-BODE  67 OSPK      90 PER CT CONF        8/67
R14           (0.08) OR LFSS              FITCH      67 OSPK     90 PER CT CONF         3/68

R15      KOL INTO(E+ PI- NEU)/(E- PI+ NEU)
R15 0    97   (0.90)    (0.18)            NEAGU      61 CC
R15 0         (1.01)    (0.16)            LUERS      64 HBC                             8/66
R15 0  894    (0.99)    (0.023)           KULYUKINA  66 CC                              9/66
R15 0 1539    (1.06)    (0.05)            VERHEY     66 OSPK                            8/67
R15 0    LOW PRECISION EXPTS NOT AVERAGED.  FOR MORE PRECISE VALUE,
R15 0    SEE S13A2 (BENNETT 70, MARX 70)

R16      KOL INTO(MU+ PI- NEU)/(MU- PI+ NEU)
R16   3200     1.02    0.04               ABASHIAN   66 OSPK                            8/66
R16     1M     1.0081   0.0027            DORFAN     67 OSPK                           11/67
R16      SEE ALSO S13A2 AND S13AL IN THE CP VIOLATION SECTION                           2/71*
R16          . . . . . . . . . .
R16 AVG        1.0082   0.0027  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R17         KOL INTO (PIO PIO)/TOTAL  (UNITS 10**-3)      (P11)/TOTAL
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          . . . . . . . . . .
R18 AVG        1.81       0.13    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R18 FIT        1.701      0.072  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      58    0.46       0.11            BANNER2    69 OSPK     ETA00=2.3+-0.3        10/68
R19      NO EVENTS SEEN                   BARTLETT   68 OSPK     SEE E00 BELOW         11/68
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 FIT        0.439      0.089  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.6)
                          (SEE IDEOGRAM BELOW )
```

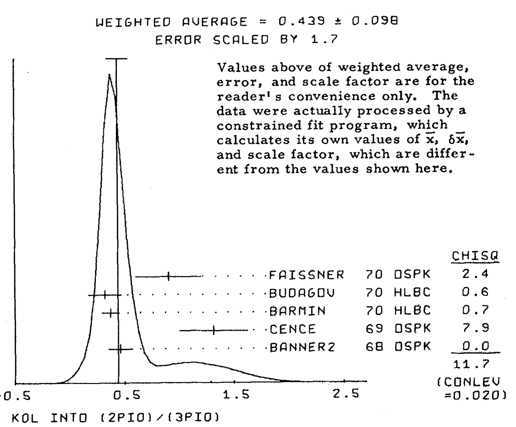

Values above of weighted average, error, and scale factor are for the reader's convenience only. The data were actually processed by a constrained fit program, which calculates its own values of $\bar{x}$, $\delta\bar{x}$, and scale factor, which are different from the values shown here.

```
R20     KOL INTO (PI+ PI-)/(KE3 + KMU3)  (UNITS 10**-3)  (P5)/(P3+P4)
R20     309     2.51      0.23            DEBOUARD   67 OSPK                            6/68
R20     525     2.35      0.19            FITCH      67 OSPK     ETA+-=1.91+-.06        6/68
R20          . . . . . . . . . .
R20 AVG         2.41      0.15    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R20 FIT         2.385     0.076  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

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   B 115     2.24      0.28            BANNER1    68 OSPK     SEE NOTE B            11/68
R21 B  THIS IS NEW EXPER. -NOT TO BE CONF. WITH  R8 OF CRONIN1 67-                     11/68
R21          . . . . . . . . . .
R21 AVG         2.28      0.26    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R22     KOL INTO (MU+MU-)/(PI+PI-)    (UNITS 10**-5)         (P6)/(P5)
R22       0    14.0    OR LESS  CL = .9   FOETH      69 ASPK     90 PCENT CONF          5/70
R22       0     0.12   OR LESS  CL = .9   CLARK      70 ASPK                           11/70*
R22       0     1.8    OR LESS            DARRIULAT  70 ASPK     90 PCENT CONF         11/70*

R23     KOL INTO (E+ E- )/(PI+PI-)     (UNITS 10**-5)        (P7)/(P5)
R23       0  (10.0)   OR LESS  CL = .9   FOETH      69 ASPK    90 PCENT CONF           5/70
R23       0     0.10  OR LESS  CL = .9   CLARK      70 ASPK                            11/70*

R24     KOL INTO (EMU)/(PI+PI-)        (UNITS 10**-5)        (P8)/(P5)
R24          (0.10) OR LESS  CL = .9     CLARK      70 ASPK                            11/70*

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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	P11
P 1	.214+-.007					
P 2	-.226	.126+-.003				
P 3	-.439	-.101	.268+-.006			
P 4	-.560	-.108	-.397	.389+-.006		
P 5	-.267	.026	.121	.154	.002+-.000	
P11	.148	-.043	-.076	-.098	-.047	.001+-.000

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 5	G11
G 1	.041+-.001					
G 2	-.113	.024+-.001				
G 3	-.293	.028	.052+-.001			
G 4	-.360	.052	-.175	.075+-.001		
G 5	-.183	.102	.196	.239	.000+-.000	
G11	.155	-.025	-.055	-.067	-.034	.000+-.000

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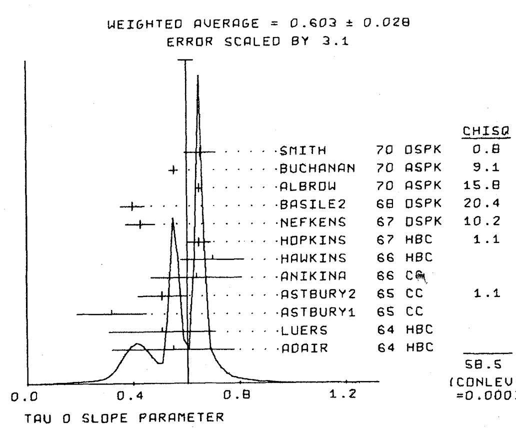
                    13  NEUTRAL K  ENERGY DEPENDENCE OF DALITZ PLOT

        MATRIX ELEMENT SQUARED =  1 + G (S3-SO)/(MPI+**2)

GTO  LINEAR ENERGY DEPENDENCE (G) FOR TAU DECAYS  KLONG INTO PI+ PI- PIO
              SEE NOTE ABOVE FOR DEFINITIONS OF AT, AU, AND AV.

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    0.555     0.016          BUCHANAN   70 ASPK AU=-0.261 +- .007       3/71*
GTO     4400    0.656     0.058          SMITH      70 OSPK AT=-0.297 +- .024       3/71*
GTO    B     BUCHANAN 70 GIVES A=0.257 +- .005 FOR A QUADRATIC FIT WITH             3/71*
GTO    B     STATISTICAL ERRORS ONLY.  THE A VALUE USED HERE IS FOR A LINEAR        3/71*
GTO    B     FIT AND INCLUDES SYSTEMATIC ERRORS.                                    3/71*
GTO            . . . . . . . . . .
GTO AVG         0.603     0.028    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 3.1)
                          (SEE IDEOGRAM BELOW )
```



For notation, see illustrated key at beginning of data card listings.

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                13  CP VIOLATION PARAMETERS IN KOL DECAYS

             SEE TEXT FOR DEFINITIONS OF CP VIOLATION PARAMETERS

--------------------13 CHARGE ASYMMETRY IN TAU DECAYS---------------------
TEXT SECTION IV E.2

     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- PIO   (UNITS 10**-2)
A       .3M    1.8     OR LESS  CL=.90  BLANPIED  68 CNTR  0 CAL. BY SCRIBANO. 1/71*
A        3M    0.6     OR LESS  CL=.90  SCRIBANO  70 CNTR  0                 . 1/71*
A      4400    8.2     OR LESS  CL=.90  SMITH     70 OSPK  0 CALCULATED BY US. 1/71*

--------------------13  CHARGE ASYMMETRY IN LEPTONIC DECAYS (PERCENT)------
TEXT SECTION IV F.2

       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)
A1  D    1M    (0.403)  (0.134)          DORFAN    67 OSPK    DERIVED FROM R16 11/67
A1 D     1M     0.490    0.160           DORFAN    67 OSPK                     10/70*
A1 D THE 2ND VALUE LISTED FOR DORFAN 67 RESULTS FROM A REANALYSIS OF THAT
A1    EXPT. SEE M.A.PACIOTTA,THESIS,U C BERKELEY.

A2     KOL INTO (E+PI-NU)-(E-PI+NU)/(E+PI-NU)+(E-PI+NU)
A2  B  10M     (0.224)  (0.036)          BENNETT   67 CNTR    SEE NOTE B       11/67
A2 B    10M     0.246    0.059           BENNETT   67 CNTR                     10/70*
A2      10M     0.346    0.033           MARX      70 CNTR                     10/70*
A2 B THE 2ND VALUE LISTED FOR BENNETT 67 RESULTS FROM A REANALYSIS OF
A2    THAT EXPT. SEE H.SAAL,THESIS,COLUMBIA UNIV.
A2             . . . . . . . . .
A2  AVG         0.322    0.043   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)

AL      KOL INTO ((L+)-(L-))/((L+)+(L-))  (COMBINED A1 AND A2)
AL      10M    0.246    0.059           BENNETT   67 CNTR                      2/71*
AL D     1M    0.49     0.16            DORFAN    67 OSPK                      2/71*
AL      10M    0.346    0.033           MARX      70 CNTR                      2/71*
AL             . . . . . . . . .
AL  AVG         0.327    0.042   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
                         (SEE IDEOGRAM BELOW )
```
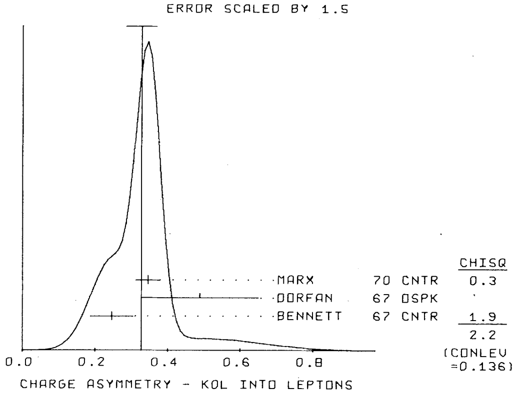

WEIGHTED AVERAGE = 0.327 ± 0.042
ERROR SCALED BY 1.5

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--------------------13  PARAMETERS FOR KOL INTO 2PI DECAY------------------
TEXT SECTION IV E.2

     ETA+- = A(KL TO PI+PI-)/A(KS TO PI+PI-)
     ETA00 = A(KL TO PIOPIO)/A(KS TO PIOPIO)

     THE MAGNITUDES OF ETA+- AND OF ETA00 ARE DERIVED FROM BR. RATIOS.
     FOR THE QUANTITIES MEASURED BY THE INDIVIDUAL EXPERIMENTS SEE LISTINGS
     OF S13R9 AND S13R2 (ETA+-) AND OF S13R17 AND S13R19 (ETA00).
     FOR THE READER'S CONVENIENCE WE LIST HERE THE DERIVED QUANTITIES ETA+-
   (CALLED E+- BELOW) AND (ETA00)**2 (CALLED EOS BELOW)

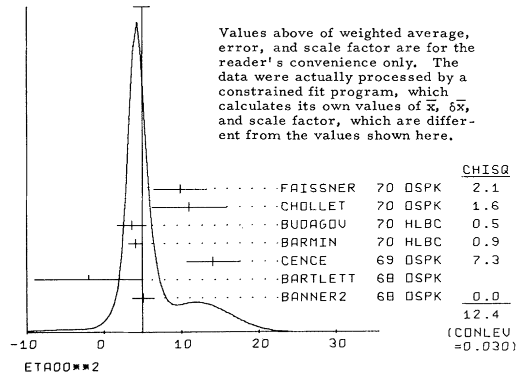
EOS     (ETA00)**2 = (A(KL TO 2PIO)/A(KS TO 2PIO))**2  (UNITS 10**-6)    ---
EOS      58    5.06      1.4               BANNER2   68 OSPK                  10/69
EOS       0   -2.        7.0               BARTLETT  68 OSPK                  10/69
EOS F   180   (13.)     (4.)               GAILLARD  69 OSPK                  10/69
EOS     133   14.1       3.4               CENCE     69 OSPK                  10/69
EOS      29    4.08      0.9               BARMIN    70 HLBC                  12/70*
EOS      30    3.61      1.9               BUDAGOV   70 HLBC                  10/70*
EOS           11.03      4.3               CHOLLET   70 OSPK   CU REG.,4 GAMMAS 10/70*
EOS  F 172     9.9       3.4               FAISSNER  70 OSPK                  12/70*
EOS  F FAISSNER 7) CONTAINS SAME 2PIO EVENTS AS GAILLARD 69
EOS          . . . . . . . . . .
EOS AVG        4.9       1.0     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.6)
EOS FIT        5.0       1.0    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.5)  2/71*
                        (SEE IDEOGRAM BELOW )

E+-     ETA+-  = A(KL TO PI+PI-)/A(KS TO PI+PI-) UNITS 10**-3  ------------
E+-      45   (1.94)                       CHRISTENS 64 OSPK                  10/69
E+-      54   (2.02)                       GALBRAITH 65 OSPK                  10/69
E+-           (1.86)                       BASILE    66 OSPK                  10/69
E+-           (1.935)                      BOTT-BODE 66 OSPK                  10/69
E+-     525    1.91       .06              FITCH     67 OSPK                  10/69
E+-          . . . . . . . . . .
E+- FIT        1.95      0.03   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/71*

ER      RATIO OF ETA00 OVER ETA+-
ER             1.09      0.09              RUBBIA    70 CNTR   PRELIMINARY     2/71*

F00      PHASE OF ETA 00    (DEGREES)      ----------------------------------
F00     FIRST QUADRANT PREFERRED           GOBBI     69 OSPK                  11/69
F00            51.       30.               CHOLLET   70 OSPK   CU REG.,4 GAMMAS 10/70*
```

WEIGHTED AVERAGE = 4.9 ± 1.0
ERROR SCALED BY 1.6

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F+-     PHASE OF ETA +-          (DEGREES)   ------------------------------
F+-      DM IS (KOL-KOS MASS DIFFERENCE / HBAR) IN UNITS OF 10**10 SEC-1      2/71*
F+-            SEE SECTION D OF KOL LISTINGS FOR LATEST VALUE
F+-      WE HAVE ADDED THE MASS DEPENDENCE AND PROPAGATED THE ERROR IN DM     2/71*
F+-      USING DM=0.5398+-0.0033 FOR BENNETT 69, BOHM 69, FAISSNER 69, AND    2/71*
F+-      JENSEN 70.                                                           2/71*

F+-           45.0      50.0             FITCH     65 OSPK    BE REGEN         11/67
F+-           30.0      45.0             FIRESTONE 66 HBC                      11/67
F+-           70.0      21.0             BOTT-BODE 67 OSPK    C REGEN          11/67
F+-           25.0      35.0             MISCHKE   67 OSPK    CU REGEN          7/68
F+-  N       (51.0)    (11.0)            BENNETT2  68 CNTR    CU REG. USES      8/68
F+-   C       34.5      10.0             BENNETT   69 CNTR    CU REGEN          2/71*
F+-   B       47.6      12.1             BOHM      69 OSPK    VACUUM REGEN      2/71*
F+-   F       46.2       7.4             FAISSNER  69 ASPK    CU REGEN          2/71*
F+-   J       43.2       4.4             JENSEN    70 ASPK    VACUUM REGEN      2/71*
F+-         . . . . . . . . . .
F+-  AVG      43.6       3.3      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
                      COMMENTS
F+-   C     BENNETT 69 USES MEASUREMENT OF (F+-)-(PHIF) OF ALFF-STEI 66        2/71*
F+-   C     BENNETT 69 F+-= 34.9+-10.0, NOT INCLUDING ERROR IN DM              2/71*
F+-   C     DM DEPENDENCE OF BENNETT 69 IS 69*(DM-0.545) DEG                   2/71*
F+-   B     BOHM 69 F+-=41+-12, NOT INCLUDING ERROR IN DM                      2/71*
F+-   B     DM DEPENDENCE OF BOHM 69 IS 479*(DM-0.526) 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, NOT INCLUDING ERROR IN DM               2/71*
F+-   F     DM DEPENDENCE OF FAISSNER 69 IS 205*(DM-0.555) DEG                 2/71*
F+-   J     JENSEN 70 F+-=42.2+-4.0, NOT INCLUDING ERROR IN DM                 2/71*
F+-   J     DM DEPENDENCE OF JENSEN 70 IS 576*(DM-0.538) DEG                   2/71*
F+-   N     BENNETT 69 IS A REEVALUATION OF BENNETT2 68                       11/69
```

Superweak Model Predictions

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

$$\mathrm{Re}\,\epsilon = |\eta_{+-}| \left[1 + \left(\frac{2\Delta m\, \tau_S}{\hbar}\right)^2\right]^{-1/2} .$$

The K_L^0-K_S^0 mass difference, the K_S lifetime, and $|\eta_{+-}|$ given in these tables result in the predictions that

$$\phi_{+-} = \phi_{00} = (42.94 \pm 0.26)°$$

and

$$\mathrm{Re}\,\epsilon = (1.428 \pm 0.023) \times 10^{-3} .$$

These can be compared with the experimental values

$$\phi_{+-} = (43.6 \pm 3.3)°$$
$$\phi_{00} = (51 \pm 30)°$$
$$\mathrm{Re}\,\epsilon = (1.64 \pm 0.24) \times 10^{-3}$$

where ϵ has been computed from δ, the charge asymmetry parameter for leptonic K_L^0 decays, and (Re x, Im x), the $\Delta S = -\Delta Q$ amplitude, using Eq. (29) of the text.

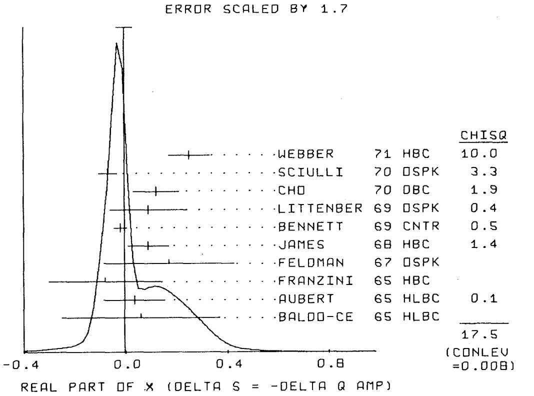
Stable Particles

For notation, see illustrated key at beginning of data card listings.

```
                    13 X =(DS=-DQ AMPLITUDE /DS=+DQ AMPLITUDE)

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     215     0.12      0.09            CHO        70 DBC     K+D TO KOPP      10/70*
REX    1079    -0.069     0.036           SCIULLI    70 OSPK    PI-P             11/70*
REX     252     0.25       .07       .09  WEBBER     71 HBC     K-P TO KBAR N    10/69
REX   B     BENNETT 69 IS A REANALYSIS OF BENNETT1 68
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 REANALYSIS OF HILL 67, USING ONLY UNAMBIGUOUS EVENTS         2/71*
REX            . . . . . . . . .
REX AVG        -0.003     0.031   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)
                          (SEE IDEOGRAM BELOW )
```

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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     586    -0.11      0.10      0.11  LITTENBER  69 OSPK    K+N TO KOP        4/69
IMX     215    -0.08      0.07            CHO        70 DBC     K+D TO KOPP      10/70*
IMX    1079     0.108     0.092    0.074  SCIULLI    70 OSPK    PI-P             11/70*
IMX     252     0.0        .08            WEBBER     71 HBC     K-P TO KBAR N    10/69
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 REANALYSIS OF HILL 67, USING ONLY UNAMBIGUOUS EVENTS         2/71*
IMX            . . . . . . . . .
IMX AVG        -0.037     0.043   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
                          (SEE IDEOGRAM BELOW )
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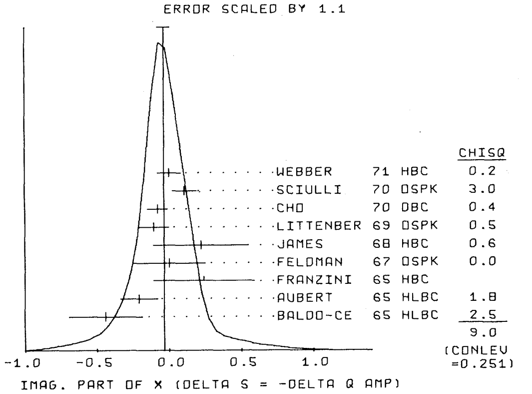


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                    13  KOL  FORM FACTORS

     FOR DISCUSSION OF FORM FACTORS SEE NOTE PRECEDING K+ FORM FACTORS

XIA     XIA = F-/F+ (DETERMINED FROM SPECTRA AND KMU3/KE3)   ---------------
XIA
XIA    SOME OF THE OLDER EXPERIMENTS HAVE EVALUATED XI ASSUMING THAT IT IS
XIA      INDEPENDENT OF THE MOMENTUM TRANSFER (T), I.E., THEY SET L+=L-=0.
XIA      OTHERS HAVE ASSUMED A VALUE FOR L+ AND USED L-=0. ONLY RECENTLY
XIA      BOTH L+,L- AND XI(0) (OR THREE RELATED PARAMETERS) HAVE BEEN INCLU-
XIA      DED IN THE FITS. SEE CHIEN 70.

XIA L   389   (+1.1)     (0.9)     (1.3)  ADAIR      64 HBC     KMU3/KE3            8/67
XIA L         (+0.66)    (0.9)     (1.3)  LUERS      64 HBC     KMU3/KE3            8/67
XIA L  1371   (+1.2)     (0.8)            CARPENTER  66 OSPK    MU,PI SPECTRA       8/67
XIA   C1371    -0.82      0.6             CARPENTER  66 OSPK    MU,PI SPECTRA.C.    8/67
XIA            -0.2       0.8       1.2   KULYUKINA  68 CC      MU,PI SPECTRA       2/71*
XIA     770    +0.3      +0.4             BUDAGOV    68 HLBC    KM3/KE3,LM+=.023   11/68
XIA    1309    -0.22      0.30            EVANS      69 HLBC    KM3/KE3,LM+=.02    10/69
XIA    3140    -3.9       0.4             BASILE     70 OSPK +  DLTZ PLOT L+=.02   10/70*
XIA    3548    -0.50      0.5             BASILE     70 OSPK +  KM3/KE3,LM+=.02    10/70*
XIA   H 26K    -0.680     0.12      0.20  CHIEN      70 ASPK    DAL.PLT. L+=.08     2/71*
XIA   C      2ND CARPENTER VALUE ALLOWS ENERGY DEP OF F+,F-
XIA   H   CHIEN 70 VALUE AT L-=0 . L- AND XI(0) ARE HIGHLY CORRELATED               2/71*
XIA L     LM+ AND LM- ASSUMED TO BE ZERO - NOT AVERAGED
XIA            . . . . . . . . .
XIA AVERAGE MEANINGLESS (SCALE FACTOR = 3.8)

XIB     XIB = F-/F+ (DETERMINED FROM MU POLARIZATION IN KMU3)   ------------
XIB     THE MU POLARIZATION IS A MEASURE OF XI(T). NO ASSUMPTIONS ON L+-
XIB     NECESSARY, T SHOULD BE SPECIFIED.

XIB    2608    -1.2       0.5             AUERBACH   66 OSPK    POLARIZATION        8/67
XIB     638    -1.6       0.5             ABRAMS     68 OSPK    POLARIZATION        5/69
XIB            -1.81      0.50      0.26  LONGO      69 CNTR    POL. T=2.65        11/69
XIB            . . . . . . . . .
XIB AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

RXI       REAL PART OF XI    (COMBINED XIA AND XIB)
RXI    1371    -0.82      0.6             CARPENTER  66 OSPK    MU PI, SP.
RXI            -0.2       0.8       1.2   KULYUKINA  68 CC      MU PI, SP.
RXI     770    +0.3      +0.4             BUDAGOV    68 HLBC    B.R.
RXI    2608    -1.2       0.5             AUERBACH   66 OSPK    POL.
RXI     638    -1.6       0.5             ABRAMS     68 OSPK    POL.
RXI    1309    -0.22      0.30            EVANS      69 HLBC    B.R.
RXI            -1.81      0.50      0.26  LONGO      69 CNTR    POL. T=2.65
RXI    3140    -3.9       0.4             BASILE     70 OSPK +  DLTZ T=0           10/70*
RXI    3548    -0.50      0.5             BASILE     70 OSPK +  B.R.               10/70*
RXI   H 26K    -0.680     0.12      0.20  CHIEN      70 ASPK    DAL.PLT. T=0        2/71*
RXI            . . . . . . . . .
RXI AVERAGE MEANINGLESS (SCALE FACTOR = 3.0)
                          (SEE IDEOGRAM BELOW )
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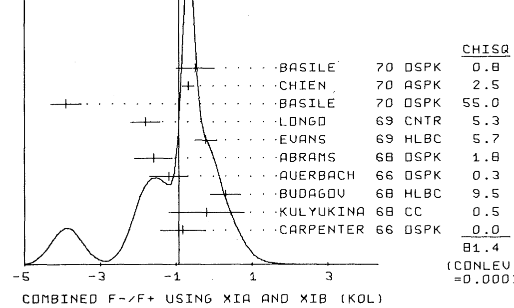


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IXI       IMAGINARY PART OF XI   (TEST OF T REVERSAL)   --------------------
IXI            -0.2       0.6             ABRAMS     68 OSPK    MU POLARIZATION    10/69
IXI            -0.02      0.08            LONGO      69 CNTR    POL. T=2.65        11/69
IXI            . . . . . . . . .
IXI AVG        -0.023     0.079   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

FS      FS/F+  RATIO OF SCALAR TO F+ COUPLINGS  (ABS. VALUE)   -------------
FS            (0.15)   OR LESS            KULYUKINA 67 CC       68 PERCENT CO.LE 10/69

FT      FT/F+  RATIO OF TENSOR TO F+ COUPLINGS  (ABS. VALUE)   -------------
FT            (1.0)    OR LESS            KULYUKINA 67 CC       68 PERCENT CO.LE 10/69

L+E      LAMBDA +  (LINEAR ENERGY DEPENDENCE OF F+ IN KO E3 DECAY)    ------
L+E      FOR RAD. CORR. TO THE DALITZ PLOT OF KE3, SEE GINSBERG 67.

L+E     153    +0.07       .06            LUERS      64 HBC     DLTZ PLOT,NO R.C
L+E     577    +0.15       .08            FISHER     65 OSPK    DLTZ PLT,NO R.C.   8/67
L+E     762    -0.01       .02            FIRESTONE  67 HBC     DLTZ PLT,NO R.C.   8/67
L+E     531    +0.01       .015           KADYK      67 HBC     E,PI SPEC,NO R.C   8/67
L+E     240    +0.08       .10       .08  LOWYS      67 FBC     PI SPEC, RAD COR   8/67
L+E    1000     0.02      0.013           ARONSON    68 OSPK    PI SPECTRUM        5/69
L+E    4800    +0.023     0.012           BASILE     68 OSPK    DLTZ PLT,NO R.C.   3/68
L+E            . . . . . . . . .
L+E AVG         0.0172    0.0070  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

L+M     LAMBDA +  (LINEAR ENERGY DEPENDENCE OF F+ IN KMU3 DECAY)
L+M      FOR RAD. CORR. TO DALITZ PLOT OF KMU3  SEE GINSBERG 70

L+M  C 26K      0.07      0.02            CHIEN      70 ASPK  0 KMU3 DALITZ PLOT   3/71*
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.                                                3/71*

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Stable Particles

For notation, see illustrated key at beginning of data card listings.

REFERENCES
13 LONG-LIVED NEUTRAL K (498, JP=0-) I=1/2


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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 +   (PARIS+EP)
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)

CAMERINI 62 PR 128 362           CAMERINI,FRY,GAIDOS,BIRGE,ELY +  (WISC+LRL)
DARMON   62 PL 3 57              J DARMON,A ROUSSET,J SIX          (PARIS+EP)

ADAIR    64 PL 12 67             R K ADAIR,L B LEIPUNER            (YALE+BNL)
ALEKSANY 64 DUBNA 2 102          ALEKSANYAN,ALIKHANYAN,VARTAZARYAN+ (EREVAN)
  SEE ALSO  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  (PRINCETN)
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)
ASTBURY1 65  SEE ALSO M PEPIN    HELV.PHYS. ACTA 39 523
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+  (PARIS+ORSAY)
AUBERT   65  SEE ALSO LOWYS 67
BALDO-CE 65 NC 38 684            BALDO-CEOLIN,CALIMANI,CIAMPOLILLO + (PADVA)

CHRISTEN 65 PR 140 B 74          CHRISTENSON,CRONIN,FITCH,TURLAY (PRINCETON)
FISHER   65 ANL 7130 83         FISHER,ABASHIAN,ABRAMS,CARPENTER+ (ILLINOIS)
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+BRIST+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 +        (MOSCOW)

ABASHIAN 66 BERKELEY 28          ABASHIAN,ABRAMS,VERHEY+            (URBANA)
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)
AUERBACH 66   SEE ALSO PRL 14 192
BALDO-CE 66 NC  45A  733         BALDO-CEOLIN,CALIMANI,CIAMPOLILLO+  (PADUA)
BASILE   66  BALATON CONF        BASILE,CRONIN,THEVENET +           (SACLAY)

BEHR     66 PL   22  540         BEHR,BRISSON,BALDO-CEOLIN,AUBERT+(PADUA,EP)
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)
GOLDEN   66  BERKELEY 28         R.GOLDEN,F.CRAWFORD,D.STERN           (LRL)
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+MD+MIT)
KULYUKIN 66  BERKELEY 28         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+           (URBANA)

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+ORSAY+MPI)

DEVLIN   67 PRL 18 54            DEVLIN,SOLOMON,SHEPARD,BEALL+ (PRINC+MARY.)
DORFAN   67 PRL  19  987         DORFAN,ENSTROM,RAYMOND,SCHWARTZ +(SLAC+LRL)
FELDMAN  67 PR  155  1611        FELDMAN,FRANKEL,HIGHLAND,SLOAN  (U OF PENN)
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+    (EP,ORSAY)
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+(MOSCOW)
BANNER1  68 PRL 21 1103          BANNER,CRONIN,LIV,PILCHER       (PRINCETON)

BANNER2  68 PRL 21 1107          BANNER,CRONIN,LIV,PILCHER       (PRINCETON)
  ALSO   69 PR 188 2033
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,ORSAY,PARIS)
  ALSO   68 PL   28B 215         +CUNDY,MYATT,NEZRICK+        (CERN,ORSAY,EP)
CARNEGIE 68 PRINC TR44 THESIS    R.K.CARNEGIE                    (PRINCETON)
JAMES    68 NP   B8 365          F JAMES, H BRIAND             (PARIS,CERN)
    ALSO 68 PRL  21 257          HELLAND,LONGO,YOUNG        (UCLA,MICHIGAN)
KULYUKIN 68 JETP 26 20           KULYUKINA,MESTVIRISHVILI,NEAGU+      (JINR)
KUNZ     68 THESIS (PU 46)       P F KUNZ                             (PRIN)
MELHOP   68 PR 172 1613          MELHOP MURTY BOWLES,BURNETT+    (LA JOLLA)
THATCHER 68 PR 174 1674          THATCHER,ABASHIAN,ABRAMS,CARPENTER +  (ILL)

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,RUTH,AACHEN)
    ALSO 67 PRL 18 20            +KRIENEN,GALBRAITH,HUSSRI+ (CERN+RUTH+AACH)
GOBBI    69 PRL 22 685           +GREEN,HAKEL,MOFFETT,ROSEN,GOZ+ (ROCH+RUTG)

LITTENBE 69 PRL 22 654           LITTENBERG,FIELD,PICCIONI,MEHLHOP+   (USCD)
LONGO    69 PR 181  1808         M J LONGO,K K YOUNG,J A HELLAND (ANNA,UCLA)

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,JHOP,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,ORSAY,EP)

CARNEGIE 70 KIEV CONF            +CESTER,FITCH,STROVINK,SULAK    (PRINCETON)
  ALSO PRIVATE COMMUNICATION,    V. FITCH, FEB. 71.
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)
 SEE ALSO   CERN 69-7 309        +GAILLARD,JANE,RATCLIFFE,REPELLIN +  (CERN)
CLARK    70 UCRL 20289           +ELIOFF,FIELD,FRISCH,JOHNSON,KERTH +  (LRL)
  ALSO   71 UCRL 20264-THESIS    HENRY FRISCH                          (LRL)
  ALSO   70 UCRL 19709-THESIS    ROLLAND JOHNSON                       (LRL)
CULLEN   70 PL 32B 523           +DARRIULAT,DEUTSCH,FOETH + (AACH,CERN,TORI)

DARRIULA 70 PL 33B 249           +FERRERO,GROSSO,HOLDER +   (AACH,CERN,TORI)
ENSTROM  70 SLAC 125 (THESIS)    J E ENSTROM                          (SLAC)
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+(EFIN,ILL)
MARX     70 PL 32B 219           +NYGREN,PEOPLES,STEINBERGER+(COL,HARV,CERN)
 ALSO    70 THESIS,NEVIS 179     JAY MARX                         (COLUMBIA)
RUBBIA   70 BAPS 15 1587         RUBBIA+                              (CERN)
SCIULLI  70 PRL 25 1214          +GALLIVAN,BINNIE,GOMEZ,MALLARY,PECK+ (CALT)
SCRIBANO 70 PL 32B 224           +MANNELLI,PIERAZZINI,MARX+ (PISA,COLU,HARV)
SMITH    70 PL 32B 133           +WANG,WHATLEY,ZORN,HORNBOSTEL     (UMD,BNL)

VOSBURG  71 PREPRINT (RUTG)      +DEVLIN,ESTERLING,GOZ,BRYMAN+   (RUTG+MASA)
WEBBER   71 PR 3D 64             +SOLMITZ,CRAWFORD,GARNJOST            (LRL)
    ALSO 68 PRL 21 498           WEBBER,SOLMITZ,CRAWFORD,ALSTONGARNJOST(LRL)
    ALSO 69 UCRL 19266-THESIS    B R WEBBER                            (LRL)

                                 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+    (EP+MILANO+PADOVA)
MESTVIRI 65 JINR P 2449          MESTVIRISHVILI,NYAGU,PETROV,RUSAKOV+ (JINR)
TRILLING 65 UCRL 16473           GEORGE H TRILLING                     (LRL)
TRILLING 65   IS 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+COL)
  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+COL)
SCHMIDT  67 NEVIS 160(THESIS)    P. SCHMIDT                       (COLUMBIA)
CRONIN   68 VIENNA CONF P.281    CRONIN,RAPPORTEURS TALK         (PRINCETON)
GINSBERG 70 PR D1 229            E S GINSBERG                    (IIT HAIFA)
HEUSSE   70 LNC  3 449           +AUBERT,PASCAUD,VIALLE              (ORSAY)
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$\boxed{\eta}$

14 ETA (549,JPG=0-+) I=0

FOR C. BALTAYS REVIEW OF THE ETA MESON, SEE PROC. UNIV.OF PENN. CONF. ON MESON SPECTROSCOPY (W.A.BENJAMIN, N.Y., 1968)

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)				
			(SEE IDEOGRAM BELOW)					

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14 ETA WIDTH (MEV)

W	91	(10.0)	OR LESS	ALFF	62	HBC		
W	149	(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	JONES	66	CNTR	.95 CONF.LEVEL	8/67

ALSO SEE ETA DECAY RATES (BELOW).

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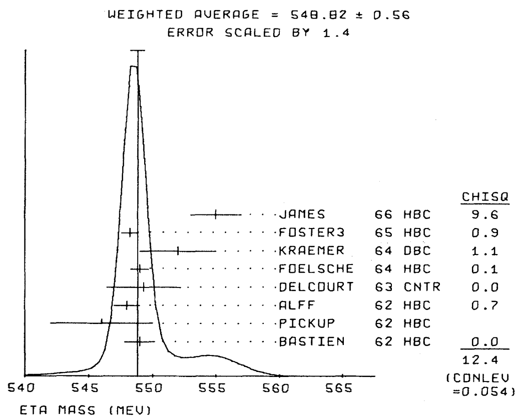


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                    14  ETA PARTIAL DECAY MODES

                                                          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

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                    14 ETA DECAY RATES

W1     ETA INTO 2GAMMA (UNITS KEV)                       (P1)
W1          (0.93)   (0.2)          BEMPORAD  67 CNTR    PRIMAKOFF EFFECT 11/67
```

The above value for $\Gamma_{\gamma\gamma}$ assumes that $\Gamma_{\gamma\gamma}/\Gamma_{total}$ = 31.4%. However, the results of that experiment may be stated more generally than is given in the paper, as

$$\Gamma_{\gamma\gamma} \times \frac{\Gamma_{\gamma\gamma}}{\Gamma_{total}} = 0.380 \pm 0.083 \text{ keV}$$

(private communication from C. Bemporad). Thus our new value of

$$\Gamma_{\gamma\gamma}/\Gamma_{total} = 38.6 \pm 1.1\%$$

would give

$$\Gamma_{\gamma\gamma} = 0.99 \pm 0.22 \text{ keV}$$

and

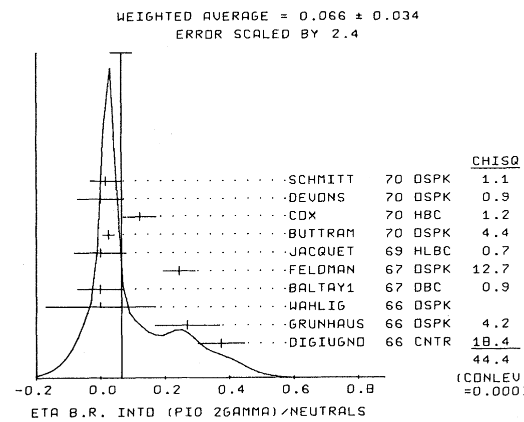
$$\Gamma_{total} = 2.63 \pm 0.59 \text{ keV}.$$

ETA DECAY INTO NEUTRALS

As is well known, there are great inconsistencies among the various experiments that report etas decaying into neutrals. The controversy is over whether the mode $\eta \rightarrow \pi^0\gamma\gamma$ is ≈ 0 (as some experiments indicate) or $\gtrsim 20\%$ (as other experiments indicate).

The discrepancies are displayed in the ideogram below, in which all ten relevant experiments have been converted to a common ratio, $\pi^0\gamma\gamma$/neutrals. Also upper limits, < x, have been converted to 0 ± x. The confidence level for consistency of all ten is $< 10^{-5}$!

In previous editions we were able to point out that it was the older experiments which gave the > 20% values, whereas the more recent experiments had been giving $\lesssim 1\%$. However, the recent experiment of COX 70 gives about 8 ± 3%, so the controversy is not yet settled.



We feel that we should consider all ten experiments on an a priori equal basis, and then follow the prescription of deleting large χ^2 experiments until the confidence level rises to some reasonable value. If we remove the Feldman and DiGiugno experiments, χ^2 decreases from 45 (for all ten) to about 9 (for the remaining 8). Accordingly we have removed those 2 experiments and used the remaining eight experiments in our overall fit.

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                    14 ETA   BRANCHING RATIOS

R1        ETA INTO NEUTRALS/CHARGED                          (P1+P2+P7)/(P3+P4)
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 CLEARLY SEPARATE 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  FIT       2.59      0.15    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R2      ETA INTO 2GAMMA/CHARGED                              (P1)/(P3+P4)
R2            0.99      0.48            CRAWFORD  63 HBC
R2         . . . . . . . . .
R2  FIT       1.387     0.084   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
```

Stable Particles

For notation, see illustrated key at beginning of data card listings.

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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            DEVONS    70 OSPK    .9 CONF.LEVEL     12/70*
R3 R      16      .016     .047           SCHMITT   70 OSPK                      12/70*
R3 R    SCHMITT 70 IS A REANALYSIS BUNIATOV 67
R3   F          (0.11)   (0.03)           STRUGALSK 70 HLBC                       2/71*
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   FIT        0.045     0.017  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

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
R4   M   IT IS 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 DBC                        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             • • • • • • • • •
R4   AVG        0.2041    0.0079  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
R4   FIT        0.2040    0.0076 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)
                          (SEE IDEOGRAM BELOW )
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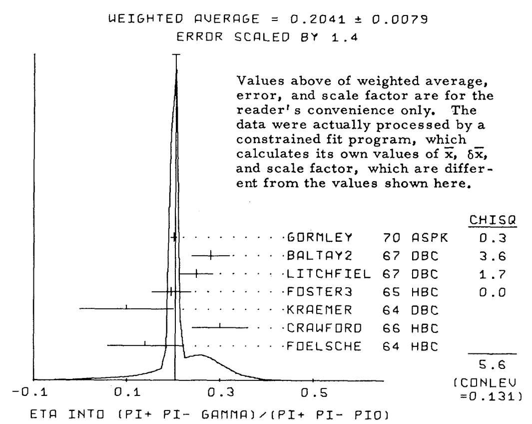


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R5      ETA INTO (3PIO)+ 2/3(PIO 2GAMMA)/ PI+PI-PIO    (P2+2/3P7)/P3
R5              0.83      0.32            CRAWFORD  63 HBC                        7/66
R5              2.0       1.0             FOELSCHE  64 HBC                        7/66
R5              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   FIT        1.406     0.091  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

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   FIT        0.785     0.040  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

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   FIT        1.67      0.10   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R8      ETA INTO NEUTRAL/(PI+ PI- PIO)                         (P1+P2+P7)/(P3)
R8     280      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             • • • • • • • • •
R8   AVG        3.35      0.35     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R8   FIT        3.12      0.18   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R9      FTA INTO  (E+E-PIO)/(PI+PI-PIO)  (UNITS 10**-2) (P5)/(P3)
R9             (1.1)  OR LESS             PRICE     65 HBC
R9       0     (0.77) OR LESS             FOSTER2   65 HBC
R9             (.42)  OR LESS             BAGLIN1   67 HLBC    .9 CONF.LEVEL      8/67
R9       0     (.16)  OR LESS             BILLING   67 HLBC    .9 CONF.LEVEL     11/67

R10     ETA INTO (E+E-PI+PI-)/TOTAL  (UNITS 10**-2)    (P6)/TOTAL
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
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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 70 HLBC                      2/71*
R12           • • • • • • • • •
R12 AVG         0.535    0.018    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
R12 FIT         0.535    0.013  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

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 70 HLBC                      2/71*
R13           • • • • • • • • •
R13 AVG         0.397    0.025    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R13 FIT         0.420    0.016  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R14         ETA INTO PIO (2GAMMA)/2GAMMA                    (P7)/(P1)
R14            (.5)   OR LESS           WAHLIG    66 SPRK   .9 CONF LEVL       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         0.085    0.033  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R15         ETA INTO (E+E-PIO)/TOTAL (UNITS 10**-2)         (P5)/TOTAL
R15           (0.7)OR LESS              RITTENBER 65 HBC                       6/66
R15           (0.084)OR LESS            BAZIN     68 DBC  .9 CONF LEVL         6/68

R16       ETA INTO 2GAMMA/(3PIO + PIO 2GAMMA)               (P1)/(P2+P7)
R16             0.80      .25           BACCI     63 CNTR                      7/66
R16           • • • • • • • • •
R16 FIT         1.149    0.062  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R17       ETA INTO (PI+PI-PIO GAMMA)/(PI+PI-PIO)            (P10)/(P3)
R17            (.07) OR LESS            FLATTE    67 HBC                       8/67
R17            (.009)OR LESS            PRICE     67 HBC                       8/67
R17            (.016)OR LESS            BALTAY2   67 DBC     .95 CONF LEVL    11/67
R17           (0.017)OR LESS            ARNOLD    68 HLBC     .9 CONF LEVEL    9/68

R18       ETA INTO (PI+PI- 2GAMMA)/(PI+PI-PIO)              (P11)/(P3)
R18            (.009)OR LESS            PRICE     67 HBC                       8/67
R18            (.016)OR LESS            BALTAY2   67 DBC     .95 CONF LEVL    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 FIT         1.312    0.083  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

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         1.188    0.059  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R21     ETA INTO NEUTRALS/TOTAL                             (P1+P2+P7)/TOTAL
R21              .79      .08           BUNIATOV  67 OSPK                     11/67
R21           • • • • • • • • •
R21 FIT         0.722    0.012  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R22     ETA INTO (PIZRO 2GAMMA)/TOTAL                       (P7)/TOTAL
R22            (.12) OR LESS            JACQUET   69 HLBC   .95 CONF.LEVEL     6/70
R22           • • • • • • • • •
R22 FIT         0.033    0.012  FROM FIT

R23     FTA INTO MU+MU-/TOTAL        (UNITS 10**-5)         (P12)/TOTAL
R23       0    (2.)    OR LESS          WEHMANN   68 OSPK   .95 CONF.LEVEL     4/68

R24     ETA INTO MU+MU-PIO/TOTAL  (UNITS 10**-4)            (P14)/TOTAL
R24            (5.)    OR LESS          WEHMANN   68 OSPK                      4/68

R25     ETA INTO MU+MU-/2GAMMA       (UNITS 10**-5)         P(12)/(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         2/71*
R26  N       THE ARTICLE THAT A CENTRAL VALUE OF 0.0 IS ABOUT AS PROBABLE      2/71*
R26  N       AS THE QUOTED VALUE OF 0.1                                        2/71*
R26           • • • • • • • • •
R26 FIT         0.097    0.035  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)
```

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 1  .386+-.011
 P 2   -.200       .303+-.011
 P 3   -.464        -.234       .231+-.010
 P 4   -.378        -.202         .700      .047+-.002
 P 7   -.351        -.554        -.179        -.135      .033+-.011
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Stable Particles

For notation, see illustrated key at beginning of data card listings.

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              14  ETA C-NONCONSERVING DECAY PARAMETER

A   DECAY ASYMMETRY PARAMETER FOR PI+ PI- PIO   (UNITS 10**-2)
A    1351    7.2      2.8              BALTAY    66 DBC                 8/66
A     705   -6.1      4.0              LARRIBE   66 HBC                 8/67
A   10665    0.3      1.0              CNOPS     66 OSPK                8/67
A    1300    5.8      3.4              CLPWY     66 HBC                 8/66
A   36800    1.5       .5              GORMLEY3  68 ASPK                6/68
A   10709     .3      1.1              MULLER    69 OSPK                9/69
A    1138   -1.4      3.               CARPENTR  70 HBC                 6/70
A     349    3.2      5.4              DANBURG   70 DBC                 2/71*
A            . . . . . . . . .
A   AVG      1.21     0.54    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
                      (SEE IDEOGRAM BELOW )
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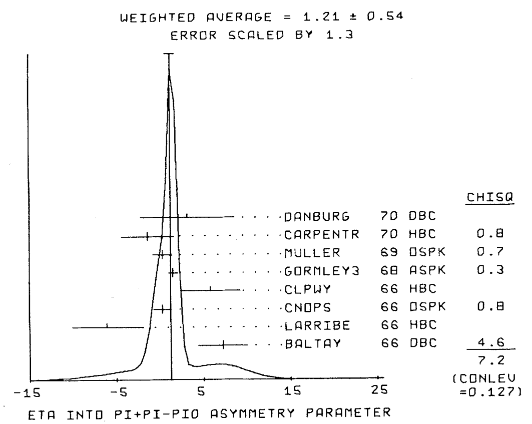

H. Yuta and S. Okubo [Phys. Rev. Letters 21, 781 (1968)] have pointed out that an asymmetry in the decay $\eta \to \pi^+\pi^-\pi^0$ of about 2% need not imply a breakdown of C invariance, since an asymmetry of this amount could be caused by an interference between the η and the 3π background. Gormley et al. [Phys. Rev. Letters 22, 198 (1969)], however, believe that this effect can account for only $\leq 0.23\%$ in their experiment (above). Also see: A. Frenkel and G. Vesztergombi, "C-Violation in η-Decay," Nucl. Phys. B15, 429 (1970) and K. Taggart, "Asymmetry and Background in $\eta \to 3\pi$," Phys. Rev. D 2, 1960 (1970).

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B   DECAY ASYMMETRY PARAMETER FOR PI+ PI- GAMMA (UNITS 10**-2)
B      33   -2.      17.            CRAWFORD  66 HBC                  11/66
B           -4.       8.            LITCHFIEL 67 OBC                   8/67
B  N 1620    1.5      2.5           MULLER    69 OSPK                  9/69
B  N ABOVE EXPERIMENT IS SENSITIVE ONLY TO UPPER .4 OF GAMMA-RAY SPECTRUM
B    7257    1.22     1.56          GORMLEY   70 ASPK                  6/70
B          . . . . . . . . .
B   AVG      1.1      1.3    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                                 REFERENCES
                                 14 ETA(549,JPG=0-+)I=0

PEVSNER   61 PRL 7 421           PEVSNER,KRAEMER,NUSSBAUM,RICHARDSON + (JHU)

ALFF      62 PRL 9 322           ALFF,BERLEY,COLLEY,BRUGGER +  (COL+RUTGERS)
BASTIEN   62 PRL 8 114           BASTIEN,BERGE,DAHL,FERRO-LUZZI +      (LRL)
CHRETIEN  62 PRL 9 127           CHRETIEN+  (BRAND+BROWN+HARVARD+MIT+PADOVA)
PICKUP    62 PRL 8 329           F PICKUP,ROBINSON,SALANT       (NRC+CAN+BNL)
SHAFER    62 CERN CONF 307       J SHAFER,FERRO-LUZZI,MURRAY +      (UC+LRL)

BACCI     63 PRL 11 37           BACCI,PENSO,SALVINI +  (ROME U+CNEN FRASCA)
BUSCHBEC  63 SIENA CONF 1 166    BUSCHBECK-CZAPP,COOPER +  (VIENNA+CERN+AMS)
CRAWFORD  63 PRL 10 546          F S CRAWFORD,LLOYD,FOWLER        (LRL+DUKE)
   AND       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 +  (LPCHE+SACLAY IF+ROME+INFN)

FOELSCHE  64 PR 134 B 1138       H W FOELSCHE,H L KRAYBILL            (YALE)
KRAEMER   64 PR 136 B 496        KRAEMER,MADANSKY,FIELDS +   (JHU+NW U+WOOD)
PAULI     64 PL 13 351           E PAULI,A MULLER              (LPCHE+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)
CRAWFORD 66 PRL  16  333      F.S.CRAWFORD,L.R.PRICE                 (LRL)
DIGIUGNO 66 PRL 16 767        DIGIUGNO,GIORGI,SILVESTRI+ (NAP+TRST+FRASC)
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,+(ICL+RUTH)
WAHLIG   66 PRL  17  221      WAHLIG,SHIBATA,MANNELLI           (MIT+PISA)

BAGLIN1  67 PL 24B 637        BAGLIN,BEZAGUET,DEGRANGE,+       (E.POLY+UC)
BAGLIN2  67 BAPS 12 567       BAGLIN,BEZAGUET,DEGRANGE,+       (E.POLY+UC)
BALTAY1  67 PRL 19 1495       BALTAY,FRANZINI,KIM,NEWMAN+    (COLUM+BRAND)
BALTAY2  67 PRL 19 1498       BALTAY,FRANZINI,KIM,NEWMAN+(COLUM+STONY BK)
BEMPORAD 67 PL 25B 380        BEMPORAD,BRACCINI,FOA,LUBELSMEY+(PISA,BONN)
   AND      PRIVATE COMMUNICATION
BILLING  67 PL 25B 435        BILLIG,BULLOCK,ESTEN,GOVAN,+        (UCL,OXF)
BONAMY   67 HEIDELBERG CONF.  BONAMY,SONDEREGGER                  (SACLAY)
BUNIATOV 67 PL 25B 560        BUNIATOV,ZAVATTINI,DEINET,+     (CERN,KARLS)
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+(RUTH+SACLAY)
PRICE    67 PRL 18 1207       L.R.PRICE,F.S.CRAWFORD                 (LRL)

ARNOLD   68 PL 27B 466        +PATY,BAGLIN,BINGHAM+ (STRB+MADR+EPOL+BERK)
BAZIN    68 PRL 20 895        BAZIN,GOSHAW,ZACHER,+     (PRINCETON,QUEENS)
BULLOCK  68 PL 27B 402        +ESTEN,FLEMING,GOVAN,HENDERSON,OWEN+ (LOUC)
WEHMANN  68 PRL 20 748        WEHMANN,ENGELS,+(HARV+CASE+SLAC+COR+MCGILL)

BAGLIN   69 PL 29B 445        BAGLIN,BEZAGUET,+      (EPOL,BERK,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)

BUTTRAM  70 PRL 25 1358       +KREISLER,MISCHKE                     (PRIN)
COX      70 PRL 24 534        COX,FORTNEY,GOLSON                    (DUKE)
DEVONS   70 PR(D) 1 1936      +GRUNHAUS,KOZLOWSKI,NEMETHY +     (COLU,SYR)
GORMLEY  70 PR 2D 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)
STRUGALS 70 JINR-E1-5256      STRUGALSKI,CHUVILO,GEMESY,+           (JINR)

        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)

             REFERENCES ON ETA ASYMMETRY PARAMETERS

BALTAY   66 PRL  16  1224     BALTAY,FRANZINI,KIM,KIRSCH+(COLUM+STONY BK)
CNOPS    66 PL 22 546         CNOPS,FINOCCHIARS,LASSALLE,+(CERN+ZUR+SACL)
CRAWFORD 66 PRL  16  333      F.S.CRAWFORD,L.R.PRICE                 (LRL)
LARRIBE  66 PL 23 600         LARPIBE,LEVEQUE,MULLER,PAULI,+  (SACL+RUTH)
CLPWY    66 PR 149  1044      COLUMBIA,LRL,PURDUE,WISCONSIN,YALE

BOWEN    67 PL 24B 206        BOWEN,CNOPS ,FINOCCHIARO,+  (CERN+ZUR+SACL)
LITCHFIE 67 PL 24B 486        LITCHFIELD,RANGAN, SEGAR,SMITH+(RUTH+SACLAY)
GORMLEY3 68 PRL 21 402        GORMLEY,HYMAN,LEE,NASH,PEOPLES+  (COLU+BNL)
MULLER   69 THESIS            ARMAND MULLER                         (STRB)
CARPENTR 70 PR(D) 1 1303      CARPENTER, BINKLEY,CHAPMAN,COX,DAGAN+(DUKE)
DANBURG  70 PR(D) 2 2565      +ABOLINS,DAHL,DAVIES,HOCH,KIRZ,+       (LRL)
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                16  PROTON  (938,J=1/2)  I=1/2

                16  PROTON  MASS (MEV)

M        (938.256)  (0.005)        COHEN     65 RVUE                    7/66
M         938.2592   .0052         TAYLOR    69 RVUE    USING NEW E/H   7/70

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                16  PROTON LIFETIME  (UNITS 10**26 YR)

T        10**20 YRS 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   B    KROPP AND BACKENSTOSS SENSITIVE TO PARTICULAR DECAY MODES OF PROT

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                16 PROTON MAGNET. MOMENT(E/2MP)

MM       (2.792763(0.000030)       COHEN     65 RVUE
MM        2.792782  .000017        TAYLOR    69 RVUE    USING NEW E/H   7/70

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     16   PROTON ELECTRIC DIPOLE MOMENT  (IN UNITS OF 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
                              16 PROTON (938,J=1/2) I=1/2

GOLDHABE 54 PR 96 1157 FNOTE2 GOLDHABER,F REINES+        (LOS ALAMOS,BNL)
FLEROV   57 SOV PHYS DOK 3 78 FLEROV,KLOCHKOV,SKOBKIN,TERENTEV      (USSR)
BACKENST 60 NC   16  749      BACKENSTOSS,FRAUENFELDER,HYAMS +      (CERN)
COHEN    65 RMP 37 537        E R COHEN, J W M DUMOND      (NAASC+CALTECH)
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)
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                17  NEUTRON (939,J=1/2)  I=1/2

                17  NEUTRON-PROTON MASS DIF.(MEV)

D  M        1.29344  0.00007        MATTAUCH  65 RVUE                   3/71*
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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Stable Particles

For notation, see illustrated key at beginning of data card listings.

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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  ( IN UNITS OF 10**-23 E CM)
                   TEST OF C VIOLATION IN THE EM INTERACTION

FDM           (5.)   OR LESS             BAIRD      69 MBR                      10/69

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                    17  NEUTRON LIFETIME (UNITS 10**3 SEC)

              THE MEASUREMENT OF THE NEUTRON LIFETIME 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 LIFETIME 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
    E  ERROR CHANGED BECAUSE ERROR IN CROSS SECTION FOR NEUTRON ABSORPTION
    E  IN GOLD HAS BEEN REDUCED
T              0.932    0.014            CHRISTENS 67 PILE                       3/68

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                    17  BETA DECAY COUPLING CONSTANTS

AV       GA/GV  (SEE TEXT FOR SIGN CONVENTION)
AV  B      (-1.18)   (0.02)              BHALLA     66 RVUF                     11/67
AV          -1.250    0.044              CONFORTO  67 RVUE  SEE NOTE C BELOW
AV          -1.23     0.01               CHRISTENS 67 CNTR  SEE NOTE D BELOW    11/68
AV  B   THIS VALUE NOT USED SINCE CORRESPONDING  LIFETIME HAS BEEN DISCARDE
AV  C      CONFORTO VALUE COMBINES ALL FREE NEUTRON DECAY DATA
AV  D      CHRISTENSON MEASUREMENT NOT SENSITIVE TO SIGN OF GA/GV
AV         . . . . . . . . .
AV  AVG     -1.2310   0.0098  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

F        PHASE ANGLE OF GA RELATIVE TO GV  (DEGREES)
F  C       176.1      6.4               CONFORTO  67 RVUE                       11/68
F  S       181.3      1.3               EROZOLIMS 70 CNTR   POLAR. NEUTRON      10/69
F   C                        VALUE DERIVED FROM FREE NEUTRON DECAY ONLY
F   S    ONLY STATISTICAL ERROR QUOTED
F          . . . . . . . . .
F  AVG     181.1      1.3     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                                   REFERENCES
                                   17 NEUTRON (939,J=1/2) I=1/2

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   (M. PLANCK INST. CHEM.,+)
BHALLA   66 PL 19  691             C P BHALLA                        (ALABAMA)
CHRISTEN 67 PL 26B 11              +NIELSEN,BAHNSEN,BROWN,RUSTAD(RISO-DENMARK)
CONFORTO 67 APAH 22 15             G. CONFORTO                          (CERN)
BAIRD    69 PR  179  1285          +MILLER,DRESS,RAMSEY              (ORNL,HARV)
TAYLOR   69 RMP 41 375             +PARKER,LANGENBERG            (PRIN+UCI+PENN)
EROZOLIM 70 SJNP 11 583            EROZOLIMSKI,BONDARENKO,  +     (KURC MOSCOW)
  ALSO   68 PL 27B 557             EROZOLIMSKY,BONDARENKO  +  (KURC IN MOSCOW)

                                   PAPERS NOT REFERRED TO IN DATA CARDS

JACKSON  57 PR 106 517             JACKSON,TREIMAN,WYLD             (PRINCETON)
COHEN    65 RMP 37 537             E R COHEN,DUMOND        (NAASC+CAL INST TECH)
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                    18  LAMBDA (1115,JP=1/2+)  I=0

                    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.

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 1115.63    0.07              SCHMIDT    65 HBC  SEE NOTE N           6/68
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   S      ERROR PURELY STATISTICAL
M          . . . . . . . . .
M   AVG    1115.544    0.075   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
M   FIT    1115.586    0.063  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)   2/71*
                      (SEE IDEOGRAM BELOW )

                 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)

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                 18  LAMBDA LIFETIME (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
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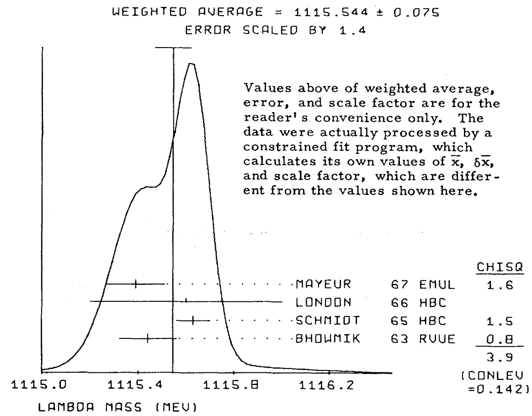


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T   S 1147  (2.50)   (0.14)           CHIEN      66 HBC      6.9 PBAR P         9/67
T   S  972  (2.70)   (0.20)           CHIEN      66 HBC      6.9 PBAR P,ANTI    9/67
T     2213   2.452    0.056    0.054 ENGELMANN 66 HBC                           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   S      ERROR PURELY STATISTICAL
T          . . . . . . . . .
T   AVG      2.517    0.024    0.023  AVERAGE (ERROR INCL. SCALE FACTOR OF 1.2)
                     (SEE IDEOGRAM BELOW )
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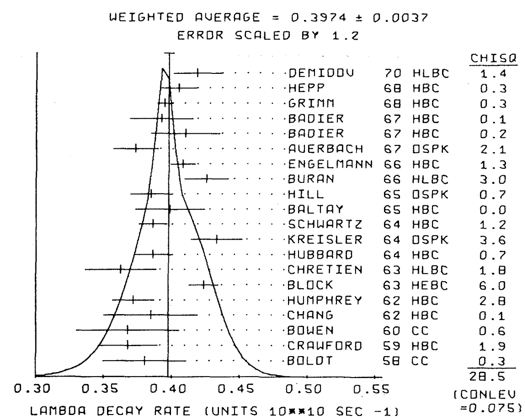


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              18  LIFETIME DIFFERENCE,(LAMBDA-ANTILAMDA)/AVERAGE

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             -0.77     0.27           HILL       65 OSPK                       9/66
MM      900    -0.70     0.07           DAHL-JENS  70 EMUL    PULSED MAGNET      2/71*
MM          . . . . . . . . .
MM  AVG        -0.704    0.065   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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              18  LAMBDA PARTIAL DECAY MODES

                                                          DECAY MASSES
P1     LAMBDA INTO PROTON PI-                            938+ 139
P2     LAMBDA INTO NEUTRON PI0                           939+ 134
P3     LAMBDA INTO PROTON MU- NEUTRINO                   938+ 105+    0
P4     LAMBDA INTO PROTON E- NEUTRINO                    938+  .5+    0

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Stable Particles

For notation, see illustrated key at beginning of data card listings.

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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  U       ANDERSON RESULT NOT PUBLISHED, EVENTS ADDED TO DOYLE SAMPLE      2/71*
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             . . . . . . . . . .
R1  AVG         0.6361    0.0062  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  FIT         0.6396    0.0067 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

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  FIT         0.3604    0.0067 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R3      LAMBDA INTO (P E- NEU)/TOTAL     (UNITS  10**-3)   (P4)/(P1+P2)
R3  0    15    (2.0)     (0.5)            HUMPHREY  61 RVUE
R3  0     8    (2.9)     (1.5)      (1.2) AUBERT    62 FBC
R3      150     0.82      0.12       0.13 ELY       63 FBC
R3  0    20    (1.55)    (0.34)           LIND      64 HBC
R3      102     0.78      0.12            BAGLIN    64 FBC
R3      143     0.80      0.08            MALONEY   69 HBC                    10/69
R3  0       LOW STATISTICS EXPERIMENTS . NOT AVERAGED                          7/70
R3             . . . . . . . . . .
R3  AVG         0.800     0.059   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4      LAMBDA INTO (P MU- NEU)/TOTAL    (UNITS  10**-4)   (P3)/(P1+P2)
R4       1    (0.2)   OR GREATER          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             . . . . . . . . . .
R4  AVG         1.35      0.60    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                    18  LAMBDA DECAY PARAMETERS

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-             . . . . . . . . . .
A-  AVG         0.645     0.016   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

A0      ALPHAO /ALPHA- FOR LAMBDA (L INTO PIO N/L INTO PI- P)
A0              1.10      0.27            CORK      60 CNTR
A0 0  4760      1.000     0.068           OLSEN     70 OSPK PI+N TO K+ LAMBDA   5/70
A0 0  DONE BY COMPARING PROT DISTRIB WITH N DISTRIB FROM LAMBDA DECAY
A0             . . . . . . . . . .
A0  AVG         1.006     0.066   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

F-       PHI ANGLE (SIN(PHI)/COS(PHI)=BETA/GAMMA)  (DEGRESS)
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   REP BY ANDERSSON 11/68
F-             -6.7       4.5             ANDERSSON 68 OSPK                    11/68
F-             . . . . . . . . . .
F-  AVG        -6.3       3.5     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

AL          ASYMMETRY PARAMETER IN ELECTRON - LAMBDASPIN CORRELATION
AL              0.06      0.19            BARLOW    65 OSPK                    7/66


AV       GA/GV FOR LAMBDA BETA DECAY (SEE TEXT FOR SIGN CONVENTION)
AV  C    22  (-1.03)                      LIND      64 HBC                     6/68
AV  C   102    (0.6) OR GREATER (ABS.V) 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 GREATER (ABS.V) ELY         65 HLBC     CL= .95        1/71*
AV             -1.14      0.23       0.33 CONFORTO  65 RVUE                   11/67
AV M    149    -0.72      0.14       0.19 MALONEY   69 HBC                    10/69
AV  B   270   (-0.71)    (0.11)    (0.14) BAGGETT   70 HBC    STOP.K-,PRELIM. 11/70*
AV  B         (+0.61)    (0.13)    (0.11) BAGGETT   70 HBC    STOP.K-,PRELIM. 11/70*
AV      110    (0.35)    (0.27)           CHU       70 OSPK    PRELIMINARY    11/70*
AV  B  BAGGETT 70 CANNOT DETERMINE THE SIGN,AND GETS 2 SOLUTIONS
AV M                       MALONEY 69 MEASURES THE ABSOLUTE VALUE OF A/V
AV  C          EXPTS INCLUDED IN CONFORTO 65, RVUE                             6/68
AV             . . . . . . . . . .
AV  AVG        -0.83      0.18    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)

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                                 REFERENCES
                                 18 LAMBDA (1115,JP=1/2+) I=0

EISLER    57 NC      5 1700      EISLER,PLANO,SAMIOS,SCHWARTZ +  (COLUM+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 +  (PARIS-EP)
BOWEN     60 PR    119 2030      BOWEN,HARDY,REYNOLDS,SUN +       (PRINCETON)
CORK      60 PR    120 1000      CORK,KERTH,WENZEL,CRONIN,COOL  (LRL+PR+BNL)
COLUMBIA 60 ROCH CONF 726        M SCHWARTZ +                      (COLUMBIA)
HUMPHREY 61 PRL      6  478      HUMPHREY,KIRZ,ROSENFELD,RHEE +  (LRL+SYRAC)

ANDERSON 62 CERN CONF 832        ANDERSON,CRAWFORD,GOLDEN,LLOYD +         (LRL)
AUBERT    62 NC     25  479      AUBERT,BRISSON,HENNESSY,SIX +      (PARIS-EP)
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 F 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,KIKUCHI +  (NW+BLGNA)
BROWN     63 PR    130  769      BROWN,KADYK,TRILLING,ROE +    (LRL+MICHIGAN)
CHRETIEN 63 PR     131  2208     CHRETIEN,CROUCH+  (BRAND+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+ (EP+CERN+UC LOND+RHEL+BERG)
HUBBARD   64 PR    135 B 183     HUBBARD,BERGE,KALBFLEISCH,SHAFER +       (LRL)
KERNAN    64 PR    133 B 1271    KERNAN,POWELL,SANDLER +  (LRL+UN-COLL-LOND)
KREISLER 64 PR 136 B 1074        M N KREISLER,O OVERSETH,J CRONIN   (PRINCE)
LIND      64 PR    135 B 1483    LIND,BINFORD,GOOD,STERN           (WISCONSIN)
RONNE     64 PL     11   357     RONNE+     (CERN+EP+UCOL-LONDON+UNIV.BERGEN)
SCHWARTZ 64 UCRL 11360 THESIS JOSEPH ADAM SCHWARTZ                        (LRL)

BAGLIN    65 NC 35 977           BAGLIN +     (EP,CERN,UC LONDON,RUTH,BERGEN)
BALTAY    65 PR 140 B 1027       BALTAY,SANDWEISS,CULWICK,KOPP +  (YALE+BNL)
BARLOW    65 PL    18   64       J BARLOW,BLAIR,CONFORTO+  (CERN+RUTH+PENNA)
CHARRIER 65 PL     15     66     CHARRIERE,GIBSON+         (EPUL+BRIST+CERN+MPI)
   ALSO       NC   46A  205      CHARRIERE,GIBSON +    (EPUL,BRIST,CERN, MPI)
CONFORTO 65 EC INT HERZEGNOVI G CONFORTO                                 (CERN)
ELY       65 PR 137 B1302        ELY,GIDAL,KALMUS,POWELL +    (LRL,UC LONDON)
HILL      65 PRL   15     85     D A HILL,K K LI,JENKINS              (BNL+MIT)
SCHMIDT   65 PR 140 B 1328       P SCHMIDT                          (COLUMBIA)

BERGE     66  BERKELEY 46        BERGE,CABIBBO                            (RVUE)
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+(HEIDBG+WEIZM)
LONDON    66 PR 143 1034         LONDON,RAU,GOLDBERG,LICHTMAN+ (BNL+SYRACUS)

AUERBACH 67 NC   47A  19         AUERBACH,BOWEN,DOBBS,LANDE,MANN+  (U OF PA)
BADIER    67 PL 25B 152          +BONNET,BRIANDET,SADOULET         (EP (PARIS))
MAYEUR    67 U.LIBR.BRUX.BUL32 C.MAYEUR,E.TOMPA,J.WICKENS (UL.BRUX+UC.LON)
CLELAND   67 PL 26B 45           CLELAND,BIENLEIN,CONFORTO+  (CERN,GVA,LUND)
OVERSETH 67 PRL   19  391        O E OVERSETH, R F ROTH (MICHIGAN+PRINCETON)

ANDERSSO 68 VIENNA ABS. 270      ANDERSSON,BIENLEIN,CLELAND +(CERN,GVA,LUND)
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)

BAGGETT   70 KIEV CONF           +BAGGETT,EISELE,FILTHUTH,FREHSE +      (HEID)
CHU       70 KIEV CONF           CHU+                (ARGONNE,CHIC,OHIO,WASH)
DAHL-JEN 70 NC (TO BE PUBL.)     DAHL-JENSEN+ (CERN+ANKARA+LAUSAN+MPIM+ROMA)
DEMIDOV   70 SJNP 10 681         +KIRILLOV-UGRYUMOV,PONOSOV,PROTASOV+ (ITEP)
OLSEN     70 PRL 24 843          +PONDROM,HANDLER,LIMON,SMITH +  (WISC,ANNA)

                                 PAPERS NOT REFERRED TO IN DATA CARDS

ARMENTER 62 CERN CONF 236        ARMENTEROS+(CERN+EP+LONDON+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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Σ^+

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                  19  SIGMA+   (1189,JP=1/2+)  I=1

                  19  SIGMA+ MASS (MEV)

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 1189.68     0.10               SCHMIDT   65 HBC  SEE NOTE N          6/68
M          1189.16     0.12               HYMAN     67 HEBC                     6/68
M          . . . . . . . . . .
M   AVG    1189.45     0.13    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)
M   FIT    1189.42     0.11   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.7)  2/71*
                       (SEE IDEOGRAM BELOW )
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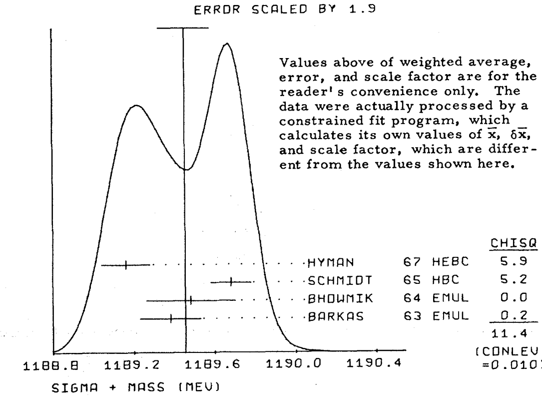
WEIGHTED AVERAGE = 1189.45 ± 0.13
ERROR SCALED BY 1.9



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.

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Note on $\Sigma^{\pm}$ Lifetime Errors

When combining lifetimes, we first convert mean lives τ to decay rates Γ, since for small numbers of events the distribution of the decay rates is more nearly Gaussian. However, in checking input data it is useful to bear in mind the theoretical minimum statistical error $\delta_{min}(\tau)$ in the mean life itself. This is

For notation, see illustrated key at beginning of data card listings.

$$\delta_{min} = \frac{\tau}{\sqrt{N_{eff}}} ,$$

$$N_{eff} = N\left[1 - x^2 \frac{e^x}{(e^x - 1)^2}\right] ,$$

where N = number of decays seen over the time interval Δt and $x = \Delta t/\tau$.

Thus we have checked the errors quoted in the various experiments for consistency with this minimum error. CHANG 66 turned out to have underestimated his errors in both the Σ^+ and the Σ^- lifetimes. We have therefore redone his χ^2 minimization, using his published data, and found the errors that we now quote.

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                   19  SIGMA+ LIFETIME (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  C         CHANG ERROR 0.018 RAISED BY US .SEE NOTE PRECEDING SIGMA+ LIST.   11/69
T   S        ERROR PURELY STATISTICAL
T            . . . . . . . . . .
T  AVG          0.7997   0.0059   0.0058 AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)

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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           . . . . . . . . . .
MM  AVG         2.59     0.46   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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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           . . . . . . . . . .
R1  AVG         0.4833   0.0084  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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

R3        SIGMA+ INTO (LAMBDA E+ NEU)/TOTAL (UNIT 10**-5) (P4)/TOTAL
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)

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)
                         (SEE IDEOGRAM BELOW )
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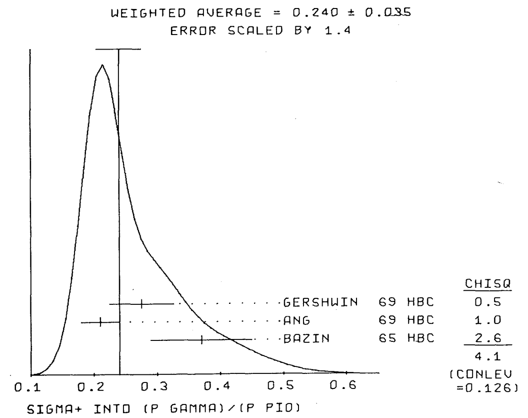


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R5      SIGMA+  INTO (N E+ NEU)/(N PI+)  (UNITS 10**-5)   (P7)/(P2)
R5 E      0     16220 EFFECTIVE DENOM.  COURANT    64 HBC     SEE NOTE E        11/67
R5 E      0      2720 EFFECTIVE DENOM.  MURPHY     64 HBC     SEE NOTE E        11/67
R5 E      1      9690 EFFECTIVE DENOM.  NAUENBERG 64 HBC      SEE NOTE E         6/68
R5 E                  EFFECTIVE DENOM.  TAKEN FROM EISELE 67                    11/67
R5        0   (32406)EFFECTIVE DENOM.   BIERMAN    68 HBC                         6/68
R5 UA     0   (80400)EFFECTIVE DENOM.   EISELE2    69 HBC   + STOP K-            6/68
R5 U      1     30000 EFFECTIVE DENOM.  NORTON     69 HBC                        11/69
R5 U      0    110200 EFFECTIVE DENOM.  EBENHOH    70 HBC     STOP K-          12/70*
R5 U                  EFFECTIVE DENOM. CALCULATED BY US
R5  A        EISELE2 69 REPLACED BY EBENHOH 70
R5           . . . . . . . . . .
R5      4.0     2.0  OR LESS C.L=.90    OUR AVERAGE USING ALL ABOVE            12/70*
R5       NUMBER OF EVENTS INCREASED TO 4.0 FOR 90PC CONFIDENCE LEVEL            2/71*

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 DENOM.  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           . . . . . . . . . .
R6      5.3     4.9  OR LESS  C.L=.90   OUR AVERAGE USING ALL ABOVE            11/69
R6       NUMBER OF EVENTS INCREASED TO 5.3 FOR 90PC CONFIDENCE LEVEL            2/71*
R6                  SEE NOTES ACCOMPANYING R5

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      6.7     0.035 OR LESS CL=.90    OUR AVERAGE  USING R5 AND R6            2/71*
R7       NUMBER OF EVENTS INCREASED TO 6.7 FOR 90PC CONFIDENCE LEVEL            2/71*

R8      SIGMA+ INTO (PROTON E+ E-)/  TOTAL (UNIT 10**-6) (P8)/TOTAL
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+ NU)/ SIGMA- INTO (N MU- NU)
R9        2  0.06       0.045    0.03   EISELE2    69 HBC  +-   STOP K-         10/69
R9           . . . . . . . . . .
R9      5.3     0.095 OR LESS CL=.90    OUR AVERAGE  USING R6                   2/71*
R9       NUMBER OF EVENTS INCREASED TO 5.3 FOR 90PC CONFIDENCE LEVEL            2/71*

R10     SIGMA+ INTO (N E+ NU)/ SIGMA- INTO (N E- NU)
R10 E     0    (0.03) OR LESS  CL=.90   EISELE2    69 HBC  +- STOP K-           10/69
R10       0     0.019 OR LESS  CL=.90   EBENHOH    70 HBC     STOP K-          12/70*
R10 E      EISELE2 REPLACED BY EBENHOH 70
R10          . . . . . . . . . .
R10     4.0     0.016 OR LESS CL=.90    OUR AVERAGE  USING R5                   2/71*
R10      NUMBER OF EVENTS INCREASED TO 4.0 FOR 90PC CONFIDENCE LEVEL            2/71*

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                   19 SIGMA+ DECAY PARAMETERS

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 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)

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 H  DECAY PROTONS SCATTERED OFF CARBON
AO           . . . . . . . . . .
AO  AVG        -0.991     0.019  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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 CON
F+           . . . . . . . . . .
F+  AVG        167.3      20.1     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)

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 H  DECAY PROTONS SCATTERED OFF CARBON

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Stable Particles

For notation, see illustrated key at beginning of data card listings.

REFERENCES
19 SIGMA + (1189,JP=1/2+) I=1


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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     (ROCHES)
CORK      60 PR 120 1000         CORK,KERTH,WENZEL,CRONIN,COOL (LRL+PRI+BNL)
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+HEIDLB+MD+NRL +BNL)
MURPHY    64 PR 134 B 188        C THORNTON MURPHY                 (WISCONSIN)
NAUENBER  64 PRL 12 679          NAUENBERG,MARATECK,BLUMENFELD+ (COL+RUT+PR)
WILLIS    64 PRL 13 291          WILLIS,COURANT,ENGELMAN+ (BNL+CERN+HEID+MD)

BALTAY    65 PR 140 B 1027       BALTAY,SANDWEISS,CULWICK,KOPP +  (YALE+BNL)
BAZIN     65 PRL 14 154          BAZIN,BLUMENFELD,NAUENBERG + (PRINCE+COLUM)
BAZIN2    65 PR 140  B1358         BAZIN,PLANO,SCHMIDT+ (PRINCE,RUTG,COLUM)
CARAYAN   65 PR 138 B 433        CARAYANNOPOULOS,TAUTFEST,WILLMANN  (PURDUE)
QUARENI   65 NC 40 A 928         QUARENI,CARTACCI +        (BOL+FIR+GEN+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+MASS+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+ (HEIDELB.)
HYMAN     67 PL 25 B 376         +LOKEN,PEWITT,MCKENZIE,KEYES+(ARG+CARN+NWU)
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-COLLAOR
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)                      (MD)
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 814 153          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)
  SEE 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,MASS,YALE)
EBENHOH   70 KIEV CONF           +EISELE,ENGELMANN,FILTHUTH,FOHLISCH+ (HEID)
    ALSO  70 ZPHY 228 151        ANG,EISELE,ENGELMANN,FILTHUTH +       (HEID)
EISELE    70 ZPHY 238 372        +FILTHUTH,HEPP,PRESSER,ZECH     (HEIDELBERG)
HARRIS    70 PRL 24 165          +OVERSETH,PONDROM,DETTMANN       (ANNA,WISC)

ALLEY     71 PR  D3  75          +BENBROOK,COOK,GLASS,GREEN,HAGUE +   (WASH)

                                 PAPERS NOT REFERRED TO IN DATA CARDS

GLASER    58 CERN CONF 270       GLASER,GOOD,MORRISON               (MICH+LRL)

          QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN THE DATA CARDS

TRIPP     62 PRL 8 175           R TRIPP,M WATSON,M FERRO-LUZZI         (LRL) P
ALFF      63 SIENA CONF 1 205    ALFF,NAUFNBERG,KIRSCH,BERLEY+(COLU+RUT+BNL)
    ALSO  65 PR 137 B 1105       ALFF,GELFAND,BRUGGER,BERLEY+(COLUM+RUT+BNL)
COURANT   63 SIENA CONF 1 73     COURANT,FILTHUTH,BURNSTEIN,DAY+ (CERN+MARY)
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20 SIGMA- (1198,JP=1/2+) I=1

20 SIGMA- MASS (MEV)

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M    N SEE NOTE PRECEDING LAMBDA MASS LISTINGS

M      3000 1197.47     0.11            SCHMIDT    65 HBC   SEE NOTE N          6/68
M               . . . . . . . . . . .
M    FIT      1197.375    0.072  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)  2/71*

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20 SIGMA- MASS DIFFER.(-)-(+)(MEV)

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D.       87      8.25       0.40            BARKAS     63 EMUL   -
D      2500      8.25       0.25            DOSCH      65 HBC
D               . . . . . . . . . . .
D    AVG         8.25       0.21    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D    FIT         7.95       0.12   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.4)  2/71*

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20 (SIGMA-) - (LAMBDA) MASS DIFFERENCE (MEV)

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DL   N    SEE NOTE PRECEDING LAMBDA MASS LISTINGS.

DL              81.70       0.19            BURNSTEIN 64 HBC                     9/66
DL         85   81.80       0.24            SCHMIDT    65 HBC   SEE NOTE N        6/68
DL       2279   81.64       0.09            HEPP       68 HBC                     8/68
DL              . . . . . . . . . . .
DL   AVG        81.666      0.077   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
DL   FIT        81.789      0.065  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)  2/71*

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20 SIGMA- LIFETIME (UNITS 10**-10)

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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  C        CHANG ERROR 0.026 RAISED BY US. SEE NOTE PRECEDING SIGMA+ LIST.  11/69
T   S       ERROR PURELY STATISTICAL
T           . . . . . . . . . .
T   AVG       1.489     0.022     0.022  AVERAGE (ERROR INCL. SCALE FACTOR OF 1.8)
                    (SEE IDEOGRAM BELOW )
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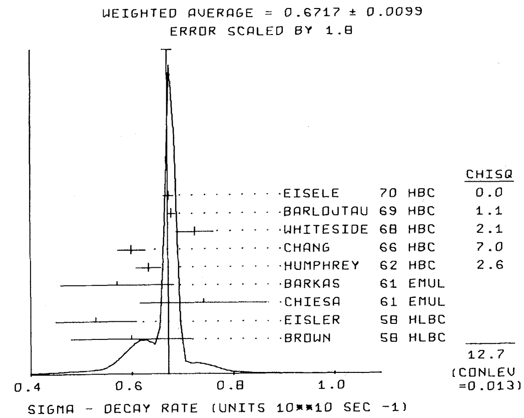


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20 SIGMA- PARTIAL DECAY MODES

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                                                           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

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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      0.13            NORTON     69 HBC     STOP. K-          10/69
R1            . . . . . . . . . .
R1   AVG      0.450     0.043   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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           (1.11)    (0.15)           SECHIZOR   68 HBC     PRELIMINARY       10/68
R2   A 331   (1.02)    (0.08)           ANG 1      69 HBC   - STOP K-           10/69
R2      58    0.97      0.13            NORTON     69 HBC                       10/69
R2     601    1.09      0.06            EBENHOH    70 HBC     STOP K-          12/70*
R2   A      ANG1 REPLACED BY EBENHOH 70                                        2/71*
R2            . . . . . . . . . .
R2   AVG      1.092     0.045   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3     SIGMA - INTO (LAMBDA E- NEU)/(N PI-) (UNITS 10**-4)(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)

R4     SIGMA - INTO (N PI- GAMMA)/(NPI-) (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     P(PI-) LT 110     10/69

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20 SIGMA- DECAY PARAMETERS

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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-    60000  -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)

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 CON
F-            . . . . . . . . . . .
F-   AVG      10.3      14.6    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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For notation, see illustrated key at beginning of data card listings.

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AV          GV/GA FOR SIGMA TO LAMBDA BETA DECAY (SEE TEXT FOR SIGN CONVENTION)
AV          PREDICTED TO BE ZERO BY CONSERVED VECTOR CURRENT THEORY
AV    B  45    0.31     0.30             BARASH    67 HBC                    11/67
AV    B                 BARASH 67 MEASURED ABSOLUTE VALUE
AV    S  81   +0.22     0.28             EISELE1   69 HBC                    10/68
AV    S  51    0.7      0.4              BALTAY    69 HBC     USING SIG+-     4/69
AV    S                 SIGN CHANGED TO AGREE WITH OUR CONVENTION
AV               . . . . . . . . . .
AV   AVG       0.35     0.18   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

AV1         GA/GV FOR SIGMA TO NEUTRON BETA DECAY (SEE TEXT FOR SIGN CONVENTIO)
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   C COLLERAINE AND EISELE MEASURE THE ABSOLUTE VALUE OF GA/GV              11/68
AV1         GERSHWIN 69 AND BOGERT 70 MEASURE THE SIGN , HOWEVER NEITHER HAS A
AV1         DEFINITE SIGN DETERMINATION AND THE TWO TOGETHER ARE CONSISTENT
AV1         WITH A ZERO VALUE OF GA/GV. SINCE THE SIGN IS UNDETERMINED THE
AV1         AVERAGE OF THE FOUR VALUES IS MEANINGLESS.
AV1              . . . . . . . . . .
AV1 AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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REFERENCES

20 SIGMA-(1198,JP=1/2+)I=1


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BROWN    58 CERN CONF 270      BROWN,GLASER,GRAVES,PERL,CRONIN +     (MICH)
EISLER   58 NC SER10 10 150    EISLER,BASSI,CONVERSI +  (COL+BNL+BOL+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  (MARY)
COURANT  64 PR 136 B 1791      COURANT,FILTHUTH+  (CERN+HEIDLB+MD+NRL+BNL)
MILLER   64 PL 11 262          MILLER,STANNARD,BEZAGUET+ (LOND+PARIS+BERG)
MURPHY   64 PR 134 B 188       C THORNTON MURPHY                (WISCONSIN)
NAUENBER 64 PRL 12 679         NAUENBERG,SCHMIDT,MARATECK+ (COL+RUT+PRINC)

BAZIN    65 PR 140 B 1358      BAZIN,PLANO,SCHMIDT +     (PRINC+RUTG+COLUM)
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,MASS,YALE)
BIERMAN  68 PRL 20 1459        BIERMAN,KOUNOSU,NAUENBERG +     (PRINCETON)
GERSHWIN 68 PRL 20 1270        GERSHWIN,ALSTON-GARNJOST,BANGERTER+   (LRL)
HEPP     68 ZEIT.PHYS. 214 71  V.HEPP,H. SCHLEICH              (HEIDELBERG)
SECHIZOR 68 TO BE PUBL.        DAY,GLASSER,KNOP+ VIENNA 375      (MARYLAND)
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)
NORTON   69 NEVIS 175 (THESIS) HERBERT NORTON                    (COLUMBIA)

BERLEY   70 PR D1 2015         +YAMIN,HERTZBACH,KOFLER +   (BNL,MASS,YALE)
BOGERT   70 PR D2 6            +LUCAS,TAFT,WILLIS,BERLEY + (BNL,MASS,YALE)
EBENHOH  70 KIEV CONF          +EISELE,ENGELMANN,FILTHUTH,FOHLISCH+ (HEID)
EISELE   70 ZPHY 238 372       +FILTHUTH,HEPP,PRESSER,ZECH     (HEIDELBERG)

                               PAPERS NOT REFERRED TO IN DATA CARDS

BROWN    57 PR 108 1036        J BROWN, D GLASER, M PERL  (MICHIGAN + BNL)
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21 SIGMA 0 (1193,JP=1/2+) I=1

21 (SIGMA-) - (SIGMA0) MASS DIFFERENCE (MEV)

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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    4.99     0.13             SCHMIDT   65 HBC   SEE NOTE N         6/68
D1             . . . . . . . . . .
D1   AVG       4.849    0.069   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D1   FIT       4.865    0.065  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)   2/71*

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21 (SIGMA 0) - (LAMBDA) MASS DIFFERENCE (MEV)

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DL   N   SEE NOTE PRECEDING LAMBDA MASS LISTINGS.

DL      208    76.63    0.28             SCHMIDT   65 HBC   SEE NOTE N         6/68
DL             . . . . . . . . . .
DL   FIT       76.924   0.089  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)   2/71*

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21 SIGMA0 LIFETIME (UNITS 10**-14)

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T           1.0 OR LESS                  DAVIS     62 EMUL

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21 SIGMA 0 PARTIAL DECAY MODES

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                                                        DECAY MASSES
P1        SIGMA 0 INTO LAMBDA GAMMA                     1115+   0
P2        SIGMA 0 INTO LAMBDA E+ E-                     1115+  .5+  .5

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21 SIGMA 0 BRANCHING RATIOS

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R1       SIGMA 0 INTO(LAMBDA E+ E-)/TOTAL                    (P2)/(P1+P2)
R1            (0.0054)   THEORET. CAL. FEINBERG  58          QUANTUM ELECT.    9/66

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REFERENCES

21 SIGMA 0(1193,JP=1/2+)I=1


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FEINBERG 58 PR 109 1019        G.FEINBERG                              (BNL)
DAVIS    62 PR 127 605         D DAVIS,R SETTI,M RAYMOND,G TOMASIN   (CHI)
BURNSTEI 64 PRL 13 66          BURNSTEIN,DAY,KEHOE,SECHI ZORN,SNOW  (MARY)
DOSCH    65 PL 14 239          DOSCH,ENGELMANN,FILTHUTH,HEPP,KLUGE+ (HEID)
SCHMIDT  65 PR 140 B 1328      P SCHMIDT                         (COLUMBIA)

                               PAPERS NOT REFERRED TO IN DATA CARDS.

COURANT  63 PRL 10 409         COURANT,FILTHUTH,FRANZINI+ (CERN+UMD+USNRL)

         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

22 XI- MASS (MEV)

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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         5 1320.69     0.93              CHIEN     66 HBC  +   6.9 PBAR P,ANTI  9/67
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 LAMDA MASS OF 1115.589-M(XI) IS 1322.18 IF M(LAMBDA) IS 1115.84
M             . . . . . . . . . .
M    AVG    1321.32     0.17    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M    FIT    1321.31     0.17   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)   2/71*

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22 XI+BAR MASS (MEV)

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M1        1(1322.0)    (1.3)              BROWN     62 HBC     ANTI-XI-          7/66
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   S   THE ERROR IS STATISTICAL ONLY

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22 MASS DIFFERENCE,(XI-)-(ANTI-XI-) IN 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   - K-P AT 1.8 GEV/C  2/71*

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22 XI- LIFETIME (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       2610    1.61     0.04           DAUBER    69 HBC                         6/68
T    S         (1.67)   (0.07)          BURGUN    68 HBC    K-P AT 1.3-1.8       2/71*
T    S   THE ERROR IS STATISTICAL ONLY
T             . . . . . . . . . .
T    AVG        1.660    0.037    0.035 AVERAGE (ERROR INCL. SCALE FACTOR OF 1.1)

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22 XI+BAR LIFETIME (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*

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22 XI- PARTIAL DECAY MODES

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                                                        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 SIGMA0 E- NEUTRINO                    1192+  .5+   0
P6       XI- INTO SIGMA0 MU- NEUTRINO                   1192+ 105+   0
P7       XI- INTO NEUTRON E- NEUTRINO                    939+  .5+   0

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22 XI- BRANCHING RATIOS

```
R1       XI- INTO (LAMBDA E- NEU)/(LAMBDA PI-) (UNITS 10**-3) (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         4    1.15     0.90     0.55   HUBBARD   68 RVUE
R1        HUBBARD 68 (RVUE) INCLUDES ALL ABOVE EVENTS                            6/68
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Stable Particles

For notation, see illustrated key at beginning of data card listings.

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R2        XI- INTO (NEUTRON PI-)/(LAMBDA PI-) (UNITS 10**-3) (P3)/(P1)
R2              (5.0)  OR LESS            FERRO-LUZ 63 HBC                        6/68
R2              (1.1)  OR LESS            DAUBER    69 HBC                        6/68

R3        XI- INTO (LAMBDA MU- NEUTRINO)/TOTAL (UNITS 10**-3) (P4)/TOTAL
R3             (12.0)  OR LESS            BERGE     66 HBC                        6/68
R3              (1.3)  OR LESS            DAUBER    69 HBC                        6/68

R4        XI- INTO (SIGMAO E- NEUTRINO)/TOTAL (UNITS 10**-3) (P5)/TOTAL
R4              (3.0)  OR LESS            BERGE     66 HBC                        6/68
R4              (0.5)  OR LESS            DAUBER    69 HBC                        6/68

R5          I  XI- INTO (SIGMAO MU- NEUTRINO)/TOTAL         (P6)/TOTAL
R5              (0.005)  OR LESS          BERGE     66 HBC                        7/66

R6            XI- INTO (N E- NEUTRINO) / (LAMBDA PI-)       (P7)/(P1)
R6              (0.01) OR LESS            BINGHAM   65 RVUE    CONF.LIMIT 0.9     9/66

R7        XI- INTO (SIGMAO E NEU + LAMBDA E NEU)/TOTAL (10**-3) (P2 +P5)/TOTAL
R7         14    0.62      0.20      0.30 DUCLOS    68 OSPK    PREL.SEE NOTE D  10/68
R7   D      THIS EXPERIMENT CANNOT DISTINGUISH SIGMAO FROM LAMBDA. THE CABIBBO
R7   D      THEORY EXPECT SIGMAO RATE ABOUT A FACTOR 6 SMALLER THAN THE LAMBDA
R7   D      TO GET A VALUE FOR THE TABLE R7 HAS BEEN AVERAGED WITH R1 -

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                        22  XI- DECAY PARAMETERS

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           BADIERI   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    A    USED ALPHALAMBDA = 0.647 PLUS OR MINUS 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        -0.402     0.031   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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    A    USED ALPHALAMBDA = 0.647 PLUS OR MINUS 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        -4.3       8.1     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)

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                                 REFERENCES

                        22  XI -  (1321,JP=1/2 )  I=1/2

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+        (PARIS+CERN+LOND+RUTH+BERGEN)
    ALSO  63 PL   5  261        JAUNEAU,MORELLET+ (EP,CERN,LON,RUTH,BERGEN)
SCHNEIDE  63 PL 4 360           H SCHNEIDER                          (CERN)

CARMONY   64 PRL  12 482        CARMONY,PJERROU,SCHLEIN,SLATER,STORK+(UCLA)
BADIERI   64 DUBNA CONF I 593   BADIER,DEMOULIN,BARLOUTAUD+ (PARIS+SAC+ZEE)
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                        (RVUE)
LONDON    66 PR 143 1034        LONDON,RAU,GOLDBERG,LICHTMAN+ (BNL+SYRACUS)
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)
DUCLOS    68 CERN W.I.69-7 163  DUCLOS,FREYTAG+ VIENNA 253(CERN,HEIDELBERG)
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)

          QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN THE DATA CARDS

CARMONY   64 PRL 12 482         CARMONY,PJERROU,SCHLEIN,SLATER,STORK+(UCLA) J

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                    23  XI 0  (1314,JP=1/2 ) I=1/2

                    23  XI 0  MASS (MEV)

M        1 1313.4     1.8              PALMER    68 HBC                         3/68
M            . . . . . . . . . .
M   FIT     1314.75    0.70   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)   2/71*

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                   23  XI       MASS DIFFERENCE (-)-(0)(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   FIT        6.57      0.68   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)   2/71*

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                    23  XI 0 LIFETIME (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            . . . . . . . . . .
T   AVG        3.03      0.18      0.16   AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)

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                    23  XI 0  PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      XI 0 INTO LAMBDA PIO                             1115+ 134
P2      XI 0 INTO PROTON PI-                              938+ 139
P3      XI 0 INTO PROTON E- NEU                           938+  .5+    0
P4      XI 0 INTO SIGMA+ E- NEU                          1189+  .5+    0
P5      XI 0 INTO SIGMA- E+ NEU                          1197+  .5+    0
P6      XI 0 INTO SIGMA+ MU- NEUTRINO                    1189+ 105+    0
P7      XI 0 INTO SIGMA- MU+ NEUTRINO                    1197+ 105+    0
P8      XI 0 INTO PROTON MU- NEUTRINO                     938+ 105+    0

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                    23  XI 0  BRANCHING RATIOS

R1      XIO INTO (PROTON PI-)/(LAMBDA PIO) (UNITS 10**-3) (P2)/(P1)
R1            (27.0)  OR LESS           TICHO     63 HBC                       6/68
R1             (5.0)  OR LESS           HUBBARD   66 HBC                       6/68
R1             (0.9)  OR LESS           DAUBER    69 HBC                       6/68

R2      XIO INTO (PROTON E- NEU)/(LAMBDA PIO) (UNITS 10**-3) (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

R3      XIO INTO (SIGMA+ E- NEU)/(LAMBDA PIO) (UNITS 10**-3) (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

R4      XIO INTO (SIGMA- E+ NEU)/(LAMBDA PIO) (UNITS 10**-3) (P5)/(P1)
R4             (6.0)  OR LESS           HUBBARD   66 HBC                       6/68
R4             (1.5)  OR LESS           DAUBER    69 HBC                       6/68

R5      XIO INTO (SIGMA+ MU- NEU)/TOTAL (UNITS 10**-3) (P6)/TOTAL
R5             (7.0)  OR LESS           HUBBARD   66 HBC                       6/68
R5             (1.5)  OR LESS           DAUBER    69 HBC                       6/68

R6      XIO INTO (SIGMA- MU+ NEU)/TOTAL (UNITS 10**-3) (P7)/TOTAL
R6             (6.0)  OR LESS           HUBBARD   66 HBC                       6/68
R6             (1.5)  OR LESS           DAUBER    69 HBC                       6/68

R7      XIO INTO (PROTON MU- NEU)/TOTAL  (UNITS 10**-3) (P8)/TOTAL
R7             (6.0)  OR LESS           HUBBARD   66 HBC                       6/68
R7             (1.3)  OR LESS           DAUBER    69 HBC                       6/68

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                    23  XI 0 DECAY PARAMETER

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   A    USED ALPHALAMBDA = 0.647 PLUS OR MINUS 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            . . . . . . . . . .
A    AVG       -0.351     0.077   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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   A    USED ALPHALAMBDA = 0.647 PLUS OR MINUS 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            . . . . . . . . . .
F    AVG        24.8      20.8     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
                         (SEE IDEOGRAM BELOW )
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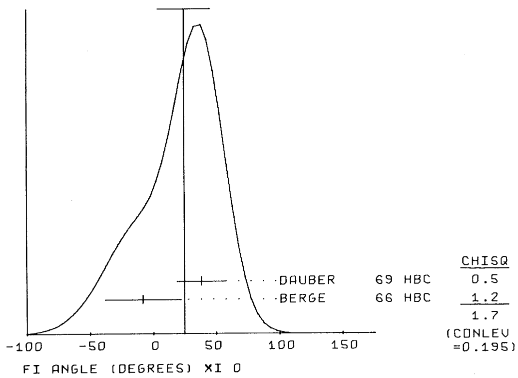
Stable Particles

For notation, see illustrated key at beginning of data card listings.

WEIGHTED AVERAGE = 24.8 ± 20.8
ERROR SCALED BY 1.3

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                              REFERENCES

                              23 XI 0(1314,JP=1/2)I=1/2

ALVAREZ  59 PRL 2 215         ALVAREZ,EBERHARD,GOOD,GRAZIANO,TICHO+ (LRL)
JAUNEAU  63 SIENA CONF 1 1    JAUNEAU+       (PARIS+CERN+LOND+RUTH+BERGEN)
   ALSO  63 PL 4 49           JAUNEAU+       (PARIS+CERN+LOND+RUTH+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+SYRACUS)
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,SYR)
DAUBER   69 PP  179 1262      +BERGE,HUBBARD,MERRILL,MILLER          (LRL)

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          24  OMEGA- (1675,JP=3/2+)    I=0

          QUANTUM NUMBERS ASSIGNED FROM SU3

       THERE ARE 28 REPORTED OMEGA- EVENTS
       SEE PREVIOUS EDITION (RMP 41 109) FOR MORE DETAILS

          24  OMEGA-  MASS (MEV)

M      1(1620.0)  (25.0)   (10.0) EISENBERG 54 EMUL
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      6 1671.9     1.2           SPETH     69 HBC    K-P 10. GEV/C    11/69
M         . . . . . . . . .
M   AVG   1672.49   0.52    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
                    (SEE IDEOGRAM BELOW )
```
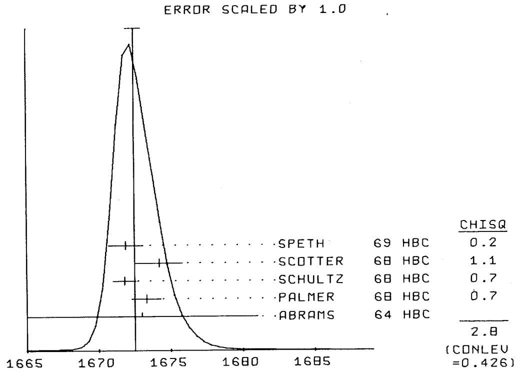

WEIGHTED AVERAGE = 1672.49 ± 0.52
ERROR SCALED BY 1.0

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            24  OMEGA- LIFETIME  (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       1 (2.3)                     SPETH     69 HBC            10/69
T       1 (0.31)                    SPETH     69 HBC            10/69

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            24 OMEGA- PARTIAL DECAY MODES

                                               DECAY MASSES
P1    OMEGA INTO LAMBDA K-                     1115+ 493
P2    OMEGA INTO XI 0 PI-                      1314+ 139
P3    OMEGA INTO XI- PI 0                      1321+ 134

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            24  OMEGA- BRANCHING RATIOS

   27 EXAMPLES OF OMEGA - DECAYS HAVE BEEN REPORTED.  16 HAVE
   DECAYED INTO LAMBDA K-, 9 INTO XIO PI-, 2 INTO XI- PIO, AND ONE IS
   AMBIGUOUS BETWEEN LAMBDA K- AND XIO PI-.
   1 BNL EVENT HAS NOT BEEN DESCRIBED.

R1        OMEGA- INTO LAMBDA K-                          P1
R1     2   EVENTS                PALMER    68 HBC                  11/69
R1     3   EVENTS                SCHULTZ   68 HBC                  11/69
R1     5   EVENTS  1 AMBIG. XIO PI- SCOTTER 68 HBC                 11/69
R1     6   EVENTS                SPETH     69 HBC                  11/69

R2        OMEGA- INTO XIO PI-                            P2
R2     1   EVENTS                ABRAMS    64 HBC                  11/69
R2     4   EVENTS                PALMER    68 HBC                  11/69
R2     3   EVENTS                SCOTTER   68 HBC                  11/69
R2     1   EVENT                 SPETH     69 HBC                  11/69

R3        OMEGA- INTO XI- PIO                            P3
R3     1   EVENT                 PALMER    68 HBC                  11/69
R3     1   EVENT                 SCOTTER   68 HBC                  11/69

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                           REFERENCES
                           24 OMEGA-(1675,JP=3/2+)  I=0

EISENBER 54 PR 96 541         Y EISENBERG                       (CORNELL)
ABRAMS   64 PRL 13 670        + BURNSTEIN,GLASSER +        (MARYLAND+USNRL)
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 +          (BIR+GLA+IC+MUN+OXF+RHFL)
RICHARDS 65 BAPS 10 115       RICHARDSON,BARNES,CRENNEL+    (BNL+SYRACUSE)
SAMIOS   65 ARGONNE CONF 189  N P SAMIOS                        ((RVUE) BNL)

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,SYR)
SCHULTZ  68 PR  168  1509     SCHULTZ+     (ILL,ARGONNE,NORTHWESTERN,WISC)
SCOTTER  68 PL 26B 474        SCOTTER+(BIRM,GLASGOW,IC LONDON,MUNICH,OXF)
SPETH    69 PL  29B 252       SPETH+    (AACHEN,BERLIN,CERN,LONDON,VIENNA)

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Mesons

For notation, see illustrated key at beginning of data card listings.

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CODE EVENTS QUANTITY  ERROR+  ERROR-  REFERENCE YR TECN SIGN COMMENTS  DATE
     ABOVE                                                          PUNCHED
    BACKGROUND

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$\boxed{\pi}$

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                 PI MESON (JPG=0--)  I=1
               SEE LISTING OF STABLE PARTICLES

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$\boxed{\sigma(410)}$

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               7  OLD SIGMA MESON (410, JPG=0++)  I = 0

               NO EVIDENCE FOR RESONANCE
               OMITTED FROM TABLE.
               SEE NOTE ON ETA 0+(700-1000)
               SEE REVIEW OF MORGAN AND PISUT 70.

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                           REFERENCES ON SIGMA

SAMIOS   62 PRL 9 139          +BACHMAN,LEA+                  (BNL+CCNY+CO+KY)

BLOKHINT 63 JETP 17 80         BLOKHINTSEVA,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,SOLOMON        (LRL)
CRAWFORD 64 PRL 13 421         +GROSSMAN,LLOYD,PRICE,FOWLER            (LRL)
DEL FABR 64 PRL 12 674         DEL FABRO,DE PRETIS,JONES+         (FRASCATI)
KALMUS   64 PRL 13  99         +KERNAN,PU,POWELL,DOWD       (LRL+WISCONSIN)

BIRGE    65 PR 139 B 1600      +ELY+GIDAL+KALMUS+CAMERINI+        (LRL+WISC)
BROWN    65 CORAL GABLES 219   BROWN+FAIER                    (NORTHWESTERN)

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+OTT+MCGILL+QMC)
CORBETT  67 PR 156 1451        +DAMERELL+MIDDLEMAS+NEWTON     (OXF+RUTHERF)
MALAMUD  67 PRL 19 1056        E.MALAMUD + P.E.SCHLEIN                (UCLA)
WALKER   67 PRL 18 630         +CARROLL,GARFINKEL,OH             (WISCONSIN)

BANDER   68 PR 168 1679        M. BANDER, G.L. SHAW, J.R. FULCO (UCI+UCSB)
BISWAS   68 PL 27 B 513        +CASON,JOHNSON,KENNEY,POIRIER+ (NOTRE DAME)
EISENHAN 68 PRL 20 758         EISENHANDLER,MISTRY,MOSTEK +        (CORNELL)
FOSTER   68 NP B 6 107         +GAVILLET+LABROSSE+MONTANET+    (CERN+PARIS)
JONES    68 PR 166 1405        +CALDWELL+ZACHAROV+HARTING+BLEULER+  (CERN)
MARATECK 68 PRL 21 1613        +HAGOPIAN,+  (PENN+LRL+COLO+PURD+TNTO+WISC)

DAVISON  69 PR 180 1333        +BACASTOW,BARKAS,+                (RIVS+BERK)
ELY      69 PR 180 1319        +GIDAL,HAGOPIAN,+            (BERK+LOUC+WISC)
GUTAY    69 NP B 12 31         +CARMONY,CSONKA,LOEFFLER,MEIERE     (PURDUE)
HALL     69 NP B 12 573        +MURRAY,RIDDIFORD                (BIRMINGHAM)
ROBERTS  69 PL 29 B 368        R.G. ROBERTS, F. WAGNER                (CERN)

BRODY    70 PRL 24 948         +GROVES,VANBERG,MAGLIC+(PENN+RUTG+UPNJ+ANL)
MAUNG    70 PL 33 B 521        +MASEK,MILLER,RUDERMAN,VERNON,+   (UCSD+LRL)
MORGAN   70 SPRINGER TRACTS MOD.PHYS.,VOL.55,P.1. MORGAN,PISUT(RHEL+CERN)

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$\boxed{\eta}$

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                 ETA    (549,   JPG=0-+)   I=0
               SEE LISTINGS OF STABLE PARTICLES
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$\boxed{\eta_{0+}(700\text{–}1000) \text{ or } \epsilon}$

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              14  ETA 0+(700-1000,JPG=0++) I=0
              ALSO CALLED EPSILON (720)
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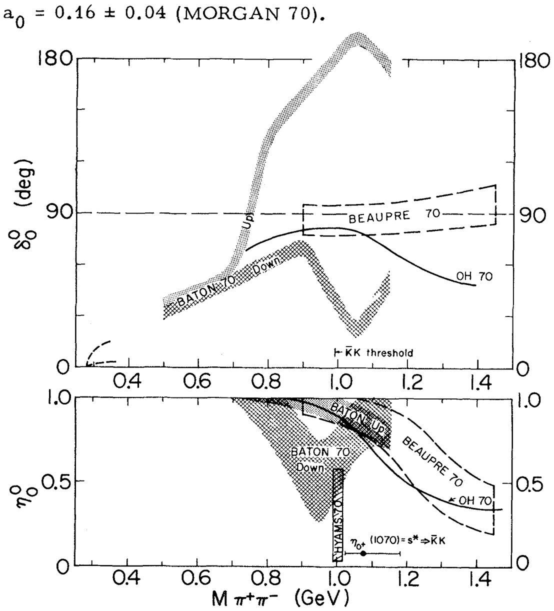
Information about the $\pi\pi$ system in the I = 0 S wave comes mainly from phase-shift analyses of the reaction $\pi^- p \to \pi^+\pi^- n$. Although no method used is free from serious objections, all analysts in the past (BATON 65, BATON 67, GUTAY 67, JOHNSON 67, WALKER 67, BISWAS 68, MARATECK 68, MALAMUD 69, SCHARENGUIVEL 69) have agreed that the S wave is near the unitarity limit in the region 650-900 MeV. However there was an ambiguity between two sets of phase shifts which crossed at about 700 MeV, leading to four possible tracks, called "down-up," "down-down," ... . The "down-up" solution, preferred by MARATECK 68 and SCHARENGUIVEL 69, leads to an "ϵ(720)" resonance, with Γ about 150 MeV. Experiments on the $\pi^0\pi^0$ system (BROWN 68, SMITH 69, DEINET 69, SONDEREGGER 69) have not yet removed this ambiguity. For a review, see MORGAN 70.

In the figure we have collected recent results on the S-wave phase δ_0^0 from analyses where the S_0 wave is permitted to be inelastic, as required by direct measurements of $\overline{K}K$ production (HYAMS 70). BATON 70 now rule out the low-energy "up" solution, and their "down-down" solution is mildly preferred because it has a rather big inelasticity compatible with that reported by HYAMS 70 at 1 GeV; moreover, above 1 GeV their "down-down" solution more-or-less agrees with that of OH 70 and BEAUPRE 70.

In the threshold region, MAUNG 70 have determined the scattering length to be $a_0 = 0.28 \pm 0.21$, in agreement with the previous most probable value, $a_0 = 0.16 \pm 0.04$ (MORGAN 70).



For notation, see illustrated key at beginning of data card listings.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                                 REFERENCES

BATON    65 NC 36 1149           J.P.BATON, J.REGNIER                    (SACLAY)
DURAND   65 PRL 14 329           L. DURAND AND Y.T. CHIU                   (YALE)
LOVELACE 66 PL  22  332          LOVELACE,HEINZ,DONNACHIE                  (CERN)

BATON    67 PL 25B 419           J.P. BATON, G. LAURENS, J. REGNIER (SACLAY)
BATON    67 NP B 3 349           J.P. BATON, G. LAURENS, J. REGNIER (SACLAY)
CLEGG    67 PR 163 1664          A.B.CLEGG                            (LANCASTER)
CORBETT  67 PR 156 1451          +DAMERELL+MIDDLEMAS+NEWTON     (OXF+RUTHERF)
GUTAY    67 PRL 18 142           +JOHNSON+LOEFFLER+MCILWAIN+    (PURDUE+UCRL)
JOHNSON  67 PR 163 1497          +GUTAY,EISNER,KLEIN,PETERS,SAHNI,YEN+(PURD)
WALKER   67 PRL 18 630           +CARROLL,GARFINKEL,OH                (WISCONSIN)
WALKER   67 RMP 39 695           W.D.WALKER                           (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       (HOBOKEN,NJ)
FOSTER   68 NP B 6 107           +GAVILLET+LABROSSE+MONTANET+    (CERN+PARIS)
JONES    68 PR 166 1405          +CALDWELL+ZACHAROV+HARTING+BLEULER+  (CERN)
JOHNSON  68 PR 176 1651          +POIRIER,BISWAS,GUTAY,DERADO+(NO+PURD+SLAC)
LOVELACE 68 PL 28 B 264          C.LOVELACE                                (CERN)
MARATECK 68 PRL 21 1613          +HAGOPIAN,+  (PENN+LRL+COLO+PURD+TNTO+WISC)

DEINET   69 PL 30 B 359          +MENZIONE,MULLER,STAUDENMAIER,+ (KARL+CERN)
FELDMAN  69 PRL 22 316           +FRATI,GLEESON,HALPERN,NUSSBAUM,+     (PENN)
GUTAY    69 NP B 12 31           +CARMONY,CSONKA,LOEFFLER,METERE     (PURDUE)
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               (MICH+LRL)
SONDEREG 69  SACLAY REPORT CONTR.TO LUND. P.SONDEREGGER,P.BONAMY (SACLAY)
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,MORRISON,+  (AACH+BERL+CERN)
BATON    70 PL 33 B 528          +LAURENS,REIGNIER                       (SACLAY)
BEAUPRE  70  CERN PHYS 70 42     +DEUTSCHMANN,GRAESSLER,+   (AACH+BERL+CERN)
DIAZ     70 NP B 16 239          +GAVILLET,LABROSSE,MONTANET+     (CERN+CDEF)
HYAMS    70 PHILAD. CONF.P.41 +KOCH,BEUSCH,JOHNSON(CERN+MUN+ETH+IC+HAWAI)
MAUNG    70 PL 33 B 521          +MASEK,MILLER,RUDERMAN,VERNON,+  (UCSD+LRL)
MORGAN   70 SPRINGER TRACTS MOD.PHYS.,VOL.55,P.1. MORGAN,PISUT(RHEL+CERN)
OH       70 PR D 1 2494          +GARFINKEL,MORSE,WALKER,PRENTICE(WISC+TNTO)
SHIBATA  70 PRL 25 1227          +FRISCH,WAHLIG                             (MIT)
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ρ(765)

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          9 RHO (765, JPG = 1-+)  I=1

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                   9 RHO  MASS (MEV)

 THERE ARE WIDE FLUCTUATIONS IN THE MEASURED VALUES FOR MASS AND WIDTH OF
 THE RHO DUE TO DIFFERENCES IN PRODUCTION MECHANISM, BACKGROUND, METHOD
 OF ANALYSIS AND PARAMETRIZATION.  UNCERTAINTIES IN THEORY GIVE RISE TO
 SYSTEMATIC ERRORS OF ABOUT 20 MEV IN MASS AND WIDTH.

 THE FOLLOWING ENTRIES ARE THE MOST SIGNIFICANT ONES. THEY ILLUSTRATE
 THE DISCREPANCIES, AND ARE ALSO REPEATED IN FOOTNOTE (C) OF THE MESON
 TABLE.

 ▷1 BATON 67,70    (RHO-0 FROM POLE EXTRAPOLATION)
 ▷2 HYAMS 68       (RHO 0 FROM PHYSICAL REGION FITS)
 ▷3 MARATECK 68    (RHO 0 FROM POLE EXTRAPOLATION)
 ▷4 PISUT 68       (RHO-0 FROM PHYSICAL REGION FITS)
 ▷5 AUGUSTIN2 69 (RHO 0 INTERFERING WITH OMEGA,FROM E+E- COLL.BEAMS)
 ▷6 AUSLENDER 69 (RHO 0 FROM E- E+ COLLIDING BEAMS)
 ▷7 MALAMUD 69     (RHO 0 FROM PHYSICAL REGION FITS)
 ▷8 ROOS 69        (COMPILATION OF RHO 0 FROM E+ E- COLLIDING BEAMS)
 ▷9 SCHARENGUIVEL 69 (RHO 0 FROM POLE EXTRAPOLATION)

M+  CHARGE PLUS ONLY
M+  R      (760.0)    (9.0)          CARMONY   64 HBC   +   3.5 PI+P,TCUT 4
M+          760.      10.            ARMENISE  65 HBC   +   2.8 PI+P
M+  R      (765.0)    (5.0)          ALFF-STEI 66 HBC   +   2-3 PI+ P        6/66
M+  R      (783.0)    (6.0)          JAMES     66 HBC   +   2.1 PI+ P        6/66
M+  R      (758.0)   (10.0)          JAMES     66 HBC   +   2.1 PI+,TCUT2.5  8/66
M+          777.0      7.0           ABC COLL. 68 HBC   +   8 PI+P TO P+3PI  5/68
M+          . . . . . . . . .
M+  AVERAGE MEANINGLESS (SCALE FACTOR = 1.4)

M+  CHARGE PLUS AND MINUS
M+  S      (750.0)    (3.0)          BALTAY    66 HBC   +-  0.0 PBAR P
M+          755.      10.            ALLES-BOR 67 HBC   +-  5.7 PBAR P      12/66
M+          730.      11.            BARLOW    67 HBC   +-  1.2 PBAR P      11/66
M+          782.       5.            FOSTER    68 HBC   +-  PBAR P AT REST   6/68
M+          . . . . . . . . .
M+  AVERAGE MEANINGLESS (SCALE FACTOR = 3.3)

M-  CHARGE MINUS ONLY
M-         (748.0)                   KENNEY    62 HBC   -   1.2 PI-P
M-    130 (775.0)                    GUIRAGOSS 63 HBC   -   3.3 PI-P
M-  R      (768.0)    (5.0)          BLIEDEN   65 MMSP  -   3-5 PI- P        6/66
M-          772.0     19.0           FIDECARO  66 OSPK  -   2.5 PI-,T CUT18 11/66
M-  R      (760.0)    (5.0)          HAGOPIAN1 66 HBC   -   3.0 PI- P        6/66
M-  R      (770.0)    (5.0)          HAGOPIAN2 66 HBC   -   2.14 PI-P        9/67
M-  R      (765.0)    (5.0)          HAGOPIAN2 66 HBC   -   2.14 PI-,TCUT12  9/67
M-  R 6014 (757.6)    (6.6)          JACOBS    66 HBC   -   2-3PI-           6/68
M-  R 2775 (753.5)   (10.5)          JACOBS    66 HBC   -   2-3PI-,T CUT 20  6/68
M-  R      (749.0)    (3.0)          WEST      66 HBC   -   2.1 PI- P       10/66
M-          752.0     14.0           BANNER    67 MMS   -   1.8 PI-P,  P+MM  9/67
M-  C 7666 (755.0)    (5.0)        ▷1 BATON    67 HBC   -   2.8 PI- P       10/67
M-          751.       5.            CLEAR     67 HBC   -   3 PI- P          7/67
M-          764.       4.            EISNER    67 HBC   -   4.2 PI-P         9/67
M-  R      (777.0)    (6.0)          MILLER    67 HBC   -   2.7 PI-,T CUT 5  9/66
M-  R      (775.0)    (5.0)          MILLER    67 HBC   -   2.7 PI-,T CUT10  9/66
M-  R      (768.0)    (5.0)          MILLER    67 HBC   -   2.7 PI-,T CUT20  9/66
M-  R      (773.0)    (2.0)          BATON     68 HBC   -   2.8 PI-,T CUT13  7/69
M-   12773  764.3      1.9      1.8 ▷4 PISUT   68 RVUE  -   1.7-3.2PI-,CT10  6/68
M-  A12773 (764.3)   (19.2)   (3.3)▷4 PISUT    68 RVUE  -   1.7-3.2PI-,CT10  6/68
M-  A   ERRORS ARE 2 STD AND INCLUDE SYSTEMATIC UNCERTAINTIES FROM THEORY
M-          776.0      4.0           REYNOLDS  69 HBC   -   2.26 PI- P       5/70
M-          . . . . . . . . .
M-  AVERAGE MEANINGLESS (SCALE FACTOR = 2.3)

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         (735.0)   (10.0)          ALYEA     65 DBC    0 2.2 K- P        6/66
MO         (750.0)                   CLARK     65 OSPK   0 1.5 PI-P
MO  S      (750.0)   (15.0)          GUTAY     65 HBC    0 2.0 PI- P       6/66
MO          768.0     14.0           ACCENSI   66 HBC    0 5.7 PBARP       6/66
MO  R      (750.0)    (5.0)          ALFF-STEI 66 HBC    0 2-3 PI+ P       5/66
MO  S      (751.)     (6.)           BALTAY    66 HBC    0 0.0 PBARP       6/66
MO  P      (728.0)    (8.0)          CAMBRIDGE 66 HBC    0 1.0-6.0 GAMMA P 10/66
MO  S      (773.0)   (12.0)          CASON     66 HBC    0 7.0 PI- P       9/66
MO  R      (775.0)    (5.0)          HAGOPIAN1 66 HBC    0 3.0 PI- P       6/66
MO  R      (770.0)    (5.0)          HAGOPIAN2 66 HBC    0 2.14 PI-P       9/67
MO  R      (770.)     (5.)           HAGOPIAN2 66 HBC    0 2.1 PI-,TCUT 12 2/67
MO  R 7760 (763.3)    (6.0)          JACOBS    66 HBC    0 2-3PI-          6/68
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          765.       5.            ASBURY 2  67 CNTR   0 GAMMA + PB      8/67
MO  R      (768.0)    (2.0)          BACON     67 HBC    0 1.7 PI-P      . 9/67
MO          745.       9.            BARLOW    67 HBC    0 1.2 PBAR P     11/66
MO    327   750.      10.            DANYSZ    67 HBC    0 3.0 PB P,6 PI   7/67
MO  O 240  (752.)    (10.)           DANYSZ    67 HBC    0 3.0 PB P,7 PI   6/68
MO  O       SELECTION ON OMEGA.
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         (777.0)    (5.0)          POIRIER   67 HBC    0 8.0 PI- P      11/67
MO          770.0      3.0           ABC COLL. 68 HBC    0 8 PI+P TO P+3PI. 5/68
MO  R      (775.0)    (2.0)          ARMENISE  68 DBC    0 5.1 PI+D        6/68
MO          763.      15.            BLECHSCHM 68 HBC    0 GAMMA P (BREMS) 6/68
MO          745.0      5.0           DONALD    68 HBC    0 1.2 PB P,4 PR.  9/68
MO          776.       5.            FOSTER    68 HBC    0 PBAR P AT REST  6/68
MO    2250  775.0      3.0         ▷2 HYAMS    68 OSPK   011.2 PI- P       9/68
MO  S      (765.0)    (6.0)          JONES     68 OSPK   0 12PI-, T LT 2.5. 5/68
MO  S      (745.0)   (13.0)          JONES     68 OSPK   0 18PI-, T LT 2.5 5/68
MO  S      (760.0)    (9.0)          JONES     68 OSPK   0 18PI-,T2.5 TO 5 5/68
MO  S      (749.0)    (5.0)          JONES     68 OSPK   0 12PI-,T 5 TO 10 5/68
MO  S      (761.0)    (6.0)          JONES     68 OSPK   0 18PI-,T 5 TO 10 5/68
MO  S      (750.0)    (8.0)          JONES     68 OSPK   0 12PI-,T10 TO 15 5/68
MO  S      (780.0)   (10.0)          JONES     68 OSPK   0 18PI-,T10 TO 15 5/68
MO  S      (760.0)    (5.0)          KEY       68 HBC    0 3.0 PI- P       5/68
MO          766.       4.            LAMSA     68 HBC    0 8.0 PI-P       11/67
MO  P      (740.0)   (10.0)          LANZEROTT 68 CNTR   0 GAMMA P(BREMS) 10/66
MO  F      (770.0)    (4.0)          AUGUSTI1  69 OSPK   0 E+E- COLL.BEAMS 4/69
MO          773.5      5.4         ▷5 AUGUSTI2 69 OSPK   0 E+E- COLL.BEAMS 8/69
MO          AUGUSTIN 2 TAKES ACCOUNT OF RHO-OMEGA INTERFERENCE, AND
MO          INCLUDES DATA OF AUGUSTIN 1.
MO  E      (754.0)    (9.0)        ▷6 AUSLENDER 69 OSPK  0 E+E- COLL.BEAMS 6/68
MO          SEE ALSO HAISSINSKI 69, WHO FITS AUSLENDER 69 DATA
MO  F      (768.)    (10.)           HAISSINSK 69 RVUE   0 E+E- COLL.BEAMS 9/69
MO          HAISSINSKI 69 IS FIT TO AUSLENDER 68 DATA
MO          768.4      2.4         ▷7 MALAMUD  69 RVUE   0 2-4 PI-P        5/70
MO  S      (755.0)   (15.0)          MOTT      69 HBC    0 4.1-5.5 K- P    7/69
MO          771.0      3.0           REYNOLDS  69 HBC    0 2.26 PI- P      5/70
MO          770.0      5.0         ▷8 ROOS     69 RVUE   0 E+E- COLL.BEAMS 9/69
MO  C      (759.0)    (7.0)        ▷9 SCHAREN  69 HBC    0 2-4 PI- P       5/70
MO          765.0     10.0           ALVENSLEB 70 CNTR   0 GAMMA A(BREMS)  5/70
MO  C12630 (760.0)                 ▷1 BATON    70 HBC    0 2.8 PI- P       1/71*
MO          765.0      3.0           BINGHAM   70 HBC    0 2.8 GAMMA P     5/70
MO          760.0      3.0           BINGHAM   70 HBC    0 4.7 GAMMA P     5/70
MO          767.7      1.9           BIGGS     70 CNTR   0PHOTOPRODUCTION  6/70
MO  S      (765.0)    (6.0)          GALLOWAY  70 HBC    0 5.97 PI- P      1/71*
MO          . . . . . . . . .
MO  AVERAGE MEANINGLESS (SCALE FACTOR = 1.8)

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           744.       9.            FRENCH    67 HBC  +-0 3-4 PBAR P      6/67
M           775.0      2.0           JOHNSON   68 HBC   -0 3.7-4.2 PI- P   7/69
M           . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

M        ----------NOTES----------

M   C    FROM POLE EXTRAPOLATION
M   E    INCLUDED IN ROOS 69 RVUE
M   P    PHOTOPRODUCTION,UNCORRECTED FOR PRODUCTION E-DEPENDENCE
                                           OR BACKGROUND INTERFERENCE
M   R    INCLUDED IN PISUT 68 RVUE
M   S    S-WAVE BREIT-WIGNER FIT, CANNOT BE COMBINED WITH OTHER VALUES

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              9  RHO(0) - 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+  CHARGE PLUS ONLY
W+          90.0      10.0           SACLAY    63 HBC   +   2.8 PI+P
W+  R      (77.0)    (20.0)          CARMONY   64 HBC   +   3.5 PI+P,TCUT 4
W+          160.      10.            ARMENISE  65 HBC   +   2.8 PI+P
W+  R     (100.0)                    ALFF-STEI 66 HBC   +   2-3 PI+ P        6/66
W+  R     (177.0)    (15.0)          JAMES     66 HBC   +   2.1 PI+ P        7/66
W+  R     (147.0)    (19.0)          JAMES     66 HBC   +   2.1 PI+,TCUT2.5  8/66
W+          149.0     22.0           ABC COLL. 68 HBC   +   8 PI+P TO P+3PI  5/68
W+          . . . . . . . . .
W+  AVERAGE MEANINGLESS (SCALE FACTOR = 3.6)

W+  CHARGE PLUS AND MINUS
W+  S     (150.0)    (30.0)          BALTAY    66 HBC   +-  0.0 PBARP        6/66
W+  S     (150.0)    (30.0)          BALTAY    66 HBC   +-  0.0 PBARP        6/66
W+          146.      31.            ALLES-BOR 67 HBC   +-  5.7 PBAR P      12/66
W+          130.      25.            BARLOW    67 HBC   +-  1.2 PBAR P      11/66
W+          145.      10.            FOSTER    68 HBC   +-  PBAR P AT REST   6/68
W+          . . . . . . . . .
W+  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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For notation, see illustrated key at beginning of data card listings.

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W-  CHARGE MINUS ONLY
W-      130 (125.0)                          GUIRAGOSS 63 HBC   -  3.3 PI-P
W-       98 (180.0)                          BONDAR    64 HBC   -  4.1 PI-P
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       (130.0)    (20.0)                HAGOPIAN2 66 HBC   -  2.14 PI-P          9/67
W-  R       (135.0)    (20.0)                HAGOPIAN2 66 HBC   -  2.14 PI-,TCUT12    9/67
W-  R 6014  (139.5)    (15.0)                JACOBS    66 HBC   -  2-3PI-             6/68
W-  R 2775  (137.1)    (20.0)                JACOBS    66 HBC   -  2-3PI-,T CUT 20    6/68
W-  R       (149.0)     (13.0)               WEST      66 HBC   -  2.1 PI- P         10/66
W-           100.0      30.0                 BANNER    67 MMS   -  1.8 PI-P,  P+MM    9/67
W-  C 7666  (110.0)     (9.0)              ▷1BATON     67 HBC   -  2.8 PI- P         10/67
W-           133.       11.                  EISNER    67 HBC   -  4.2 PI-P           9/67
W-  R       (137.0)    (17.0)                MILLER    67 HBC   -  2.7 PI-,T CUT 5    9/66
W-  R       (145.0)    (12.0)                MILLER    67 HBC   -  2.7 PI-,T CUT10    9/66
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-   12773   147.3       4.0           3.9 ▷4PISUT     68 RVUE  -  1.7-3.2PI-,CT10    6/68
W-           151.0      10.0                 REYNOLDS  69 HBC   -  2.26 PI- P         5/70
W-           . . . . . . . . .
W-  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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           110.0      20.0                 ALYEA     65 DBC   0 2.2 K- P            6/66
WO          (130.0)                          CLARK     65 OSPK  0 1.5 PI-P
WO  S        (80.0)    (15.0)                GUTAY     65 HBC   0 2.0 PI- P           6/66
WO            72.0      30.0                 ACCENSI   66 HBC   0 5.7 PBARP           6/66
WO  R       (100.0)                          ALFF-STEI 66 HBC   0 2-3 PI+ P           6/66
WO  S       (174.)     (31.)                 BALTAY    66 HBC   0 0.0 PBARP           6/66
WO  P       (175.0)                          CAMBRIDGE 66 HBC   0 5-6 GAM P           9/66
WO  S        (57.0)    (25.0)    (15.0)      CASON     66 HBC   0 7.0 PI- P           9/66
WO  R       (120.0)    (10.0)                HAGOPIAN1 66 HBC   0 3.0 PI- P           6/66
WO  R       (130.0)    (20.0)                HAGOPIAN2 66 HBC   0 2.14 PI-P           9/67
WO  R       (135.0)    (20.0)                HAGOPIAN2 66 HBC   0 2.14 PI-P,LOW T     9/67
WO  R 7760  (136.4)    (12.0)                JACOBS    66 HBC   0 2-3PI-              6/68
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           130.        5.                  ASBURY 2  67 CNTR  0 GAMMA + PB          8/67
WO  R       (148.0)     (8.0)                BACON     67 HBC   0 1.7 PI-P            9/67
WO            92.       42.                  BARLOW    67 HBC   0 1.2 PBAR P         11/66
WO      327  135.       25.                  DANYSZ    67 HBC   0 3.0 PB P,6 PI       7/67
WO  O   240  (80.)     (30.)                 DANYSZ    67 HBC   0 3.0 PB P,7 PI       6/68
WO  O           SELECTION ON OMEGA
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          (135.0)    (10.0)                POIRIER   67 HBC   0 8.0 PI- P          11/67
WO           165.0      10.0                 ABC COLL. 68 HBC   0 8 PI+P TO P+3PI     5/68
WO  R       (167.0)     (6.0)                ARMENISE  68 DBC   0 5.1 PI+D            6/68
WO           126.       20.                  BLECHSCHM 68 HBC   0 GAMMA P (BREMS)     6/68
WO           150.0      13.0                 DONALD    68 HBC   0 1.2 PB P,4 PR.      9/68
WO           132.       10.                  FOSTER    68 HBC   0 PBAR P AT REST      6/68
WO     2250  145.0       9.0               ▷2HYAMS     68 OSPK  011.2 PI- P           9/68
WO  S       (129.0)    (19.0)                JONES     68 OSPK  0 12PI-, T LT 2.5.    5/68
WO  S       (169.0)    (41.0)                JONES     68 OSPK  0 18PI-, T LT 2.5     5/68
WO  S       (175.0)    (30.0)                JONES     68 OSPK  0 18PI-,T2.5 TO 5     5/68
WO  S       (157.0)    (16.0)                JONES     68 OSPK  0 12PI-,T 5 TO 10     5/68
WO  S       (157.0)    (19.0)                JONES     68 OSPK  0 18PI-,T 5 TO 10     5/68
WO  S       (102.0)    (25.0)                JONES     68 OSPK  0 12PI-,T10 TO 15     5/68
WO  S       (157.0)    (31.0)                JONES     68 OSPK  0 18PI-,T10 TO 15     5/68
WO  S       (113.0)    (16.0)                KEY       68 HBC   0 3.0 PI- P           5/68
WO           111.        8.                  LAMSA     68 HBC   0 8.0 PI-P           11/67
WO  S       (160.0)    (10.0)                LANZEROTT 68 CNTR  0 GAMMA P             5/68
WO  C14890  (105.0)    (15.0)              ▷3MARATECK  68 HBC   0 1.9-3.0 PI- P       9/68
WO           122.0       7.0           6.0 ▷8ROOS      69 RVUE  0 E+E- COLL.BEAMS     9/69
WO  F       (111.0)     (6.0)                AUGUSTI1  69 OSPK  0 E+E- COLL.BEAMS     4/69
WO           110.7       5.3               ▷5AUGUSTI2  69 OSPK  0 E+E- COLL.BEAMS     8/69
WO          AUGUSTIN 2 TAKES ACCOUNT OF RHO-OMEGA INTERFERENCE, AND
WO          INCLUDES DATA OF AUGUSTIN 1.
WO  E       (105.0)    (20.0)              ▷6AUSLENDER 69 OSPK  0 E+E- COLL.BEAMS     6/68
WO          SEE ALSO HAISSINSKI 69, WHO FITS AUSLENDER 69 DATA
WO  F       (140.)     (14.)                 HAISSINSK 69 RVUE  0 E+E- COLL.BEAMS     9/69
WO  H       ABOVE VALUE FROM FIT TO AUSLENDER 68 DATA
WO           132.0      13.0               ▷7MALAMUD   69 RVUE  0 2-4 PI-P            5/70
WO  S       (130.0)    (40.0)                MOTT      69 HBC   0 4.1-5.5 K- P        7/69
WO           127.0       7.0                 REYNOLDS  69 HBC   0 2.26 PI- P          5/70
WO  C       (119.0)    (20.0)              ▷9SCHAREN   69 HBC   0 2-4 PI- P           5/70
WO           140.0       5.0                 ALVENSLEB 70 CNTR  0 GAMMA A(BREMS)      5/70
WO  C12630  (131.0)                        ▷1BATON     70 HBC   0 2.8 PI- P           1/71*
WO           132.0       6.0                 BINGHAM   70 HBC   0 2.8 GAMMA P         5/70
WO           141.0       5.0                 BINGHAM   70 HBC   0 4.7 GAMMA P         5/70
WO           146.1       2.9                 BIGGS     70 CNTR  0PHOTOPRODUCTION      6/70
WO  S       (120.0)     (7.0)                GALLOWAY  70 HBC   0 5.97 PI- P          1/71*
WO           . . . . . . . . . .
WO  AVERAGE MEANINGLESS (SCALE FACTOR = 2.1)

W   MIXED CHARGES
W       290 (110.0)                          CHADWICK  63 HBC  +-0 0.0 PBAR P
W             98.       30.                  FRENCH    67 HBC  +-0 3-4 PBAR P         6/67
W            154.0       6.0                 JOHNSON   68 HBC   -0 3.7-4.2 PI- P      7/69
W            . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

W       ----------NOTES----------

W   C   FROM POLE EXTRAPOLATION
W   F   INCLUDED IN ROOS 69 RVUE
W   R   INCLUDED IN PISUT 68 RVUE
W   P   PHOTOPRODUCTION, UNCORRECTED (SEE NOTE P UNDER RHO MASS)
W   S   S-WAVE BREIT-WIGNER FIT, CANNOT BE COMBINED WITH OTHER VALUES

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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

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                 9  RHO BRANCHING RATIOS

R1      RHO INTO 4PI/2PI

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      RHO 0 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,C.L.=0.9      HUSON      68 HLBC   0 16.0 PI- P         1/71*
R1            (0.0015) OR LESS,CL=0.90 GERMAN CO 69 HBC         0 2.5-5.8 GAMMA P  10/67

R2      RHO INTO PI GAMMA/2PI
R2  M         (0.02)OR LESS                LANZEROTT 65 CNTR      GAMMA P(BREMS)   11/66
R2            (0.005)OR LESS               FIDECARO  66 OSPK  -   0.97 CONF LEV    10/66
R2            (0.007)OR LESS               HUSON     66 HLBC  -   15 PI-PB          6/66
R2  M         (0.002)OR LESS,CL=0.90       GERMAN CO 69 HBC   -   3.5-5.5 GAMMA P   9/69
R2  M          ONE PION EXCHANGE MODEL USED IN THIS ESTIMATION

R3      RHO INTO(E+ E-)/(PI+PI-)      (UNITS 10**-4)
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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^0 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 we use at present, for the average, only the values from the $e^+e^- \to \pi^+\pi^-$ experiments.

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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   E       0.663     0.085             AUGUSTI1  69 OSPK    E+E- COLLID.BEAM  4/69
R3   E       ASSUMING RHO WIDTH 111MEV
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         . . . . . . . . .
R3  AVG      0.595     0.080   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)

R4        RHO INTO (PI ETA)/(2PI)
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-) (UN 10**-4)
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)

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REFERENCES FOR RHO


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ANDERSON 61 PRL 6 365          ANDERSON,BANG,BURKE,CARMONY,SCHMITZ   (LRL)
ERWIN    61 PR 6 628           A.R.,R.MARCH,W.D.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+CCNY+COLUM+KENT)
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+(SAC+ORSAY+BARI+BOLO)
CHADWICK 63 PRL 10 62          CHADWICK,DAVIES,DERRICK,CRESTI +   (OXF+PAD)
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+IMP-COL+MPI)
CARMONY  64 DUBNA CONF 1 486   CARMONY,HOA,LANDER,NG.H.XUONG,YAGER   (UCSD)
GOLDHABE 64 PRL 12 336         GOLDHABER,BROWN,KADYK,SHEN,TRILLING(LRL+UC)

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                (FLORIDA)
LANZEROT 65 PRL 15 210         LANZEROTTI,BLUMENTHAL,EHN,FAISSLER +(HARVD)
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+ (COL+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)
HAGOPIA1 66 PR 145 1128        HAGOPIAN,SELOVE,ALITTI,BATON+ (PENN+SACLAY)
HAGOPIA2 66 PR  152  1183      HAGOPIAN,PAN     (PENNSYLVANIA,LRL-BERKELEY)
HUSON    66 PL 20 91           HUSON,ALLARD,DRIJARD,HENNESSY +  (ORSAY+EP)
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)
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Mesons

For notation, see illustrated key at beginning of data card listings.


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ALLES-BO 67 NC 50 A 776        ALLES-BORELLI,FRENCH,FRISK,+      (CERN+BONN)
ASBURY 1 67 PRL 19 869         +BECKER+BERTRAM+JOOS+JORDAN+TING+(DESY+COL)
ASBURY 2 67 PRL 19 865         +BECKER+BERTRAM+JOOS+JORDAN+TING+(DESY+COL)
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+CDF+IR+LIVERPOOL)
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+WALKER+(TO+ANL+WIS)
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)
   (SEE ALSO ZDANIS 65)
HUWE     67 PL 24B 252         +MARQUIT+OPPENHEIMER+SCHULTZ+WILSON   (COL)
HYAMS    67 PL 24B 634         +KOCH+PELLETT+POTTER+VONLINDERN+ (CERN+MUN)
MILLER   67 PR 153 1423        MILLER,GUTAY,JOHNSON,LOEFFLER +     (PURDUE)
POIRIER  67 PR 163 1462        +BISWAS,CASON,DERADO,KENNEY+ (NOTRDAM+PENN)

ABC COLL 68 NP B4 501                 AACHEN+BERLIN+CERN COLLABORATION
ARMENISE 68 NC 54A 999         +GHIDINI,FORINO+ (BARI+BOLOGN+FIRENZ+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+MANCH)
  (SEE ALSO 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+PARIS)
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,DERADO+(ND+PURD+SLAC)
KEY      68 PR 166 1430        +PRENTICE+COOPER+MANNER+WALKER+(TO+ANL+WIS)
LAMSA    68 PR 166 1395        +CASON+BISWAS+DERADO+GROVES+    (NOTREDAME)
LANZEROT 68 PR 166 1365        LANZEROTTI,BLUMENTHAL,EHN,FAISSLER +(HARVD)
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,PANTUSOVA,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,+ (AMES+COLO)
MALAMUD  69 ARGONNE CONF.P.93 F.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+       (FLAS)
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)

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+  (DARE)
BINGHAM  70 PRL 24 955         +FRETTER,MOFFEIT,BALLAM+     (LRL+SLAC+TUFT)
GALLOWAY 70 PR D 1 3077        +MOTT,ALYA,LEE,MARTIN,PRICKETT          (IND)
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ω(784)

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        1  OMEGA (784,JPG=1--)  I=0

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                   1  OMEGA  MASS (MEV)

            HERE WE LIST ONLY EXPERIMENTS IN WHICH THE EFFECTS
            OF MASS RESOLUTION HAVE BEEN EVALUATED.

M    FROM K1-K1 MODE
M     64  779.4      1.4          ARMENTERO 62 HBC     0.0 PBAR P K1K1
M    155  779.5      1.5          BARASH    67 HBC     0.0 PBAR P K1K1 11/66
M         781.0      0.6          BIZZARR2  70 HBC     0.0 P PBAR K1K1  1/71*
M          . . . . . . . . .
M    AVG  780.60     0.52   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

M    FROM OTHER THAN K1-K1 MODE.
M    400  782.0      1.0          ALFF      62 HBC     2.3-2.9 PI+P
M     34  784.0      1.0          ARMENTERO 63 HBC     0.0 PBAR P
M    220  781.0      2.0          KRAEMER   64 DBC     1.2 PI+D
M         785.6      1.2          MILLER D  65 HBC     SEEN WITH K+K-
M    666  786.0      1.0          JAMES     66 HBC     2.1 PI+P          6/66
M   2199  783.4      0.7          BALTAY    67 HBC     0.0 PBAR P        9/66
M         784.8      1.1          KEY       68 HBC     3 PI-P           11/67
M   2400  782.4      0.5          BIZZARRI  69 HBC     0 PBAR P          9/69
M    250  784.       1.           DANBURG   69 DBC     1.2 PI+ D         9/69
M    500  786.       1.           DANBURG   69 DBC     1.4 PI+ D         9/69
M    600  784.       1.           DANBURG   69 DBC     1.7 PI+ D         9/69
M    500  786.       1.           DANBURG   69 DBC     1.9 PI+ D         9/69
M    400  785.       1.           DANBURG   69 DBC     2.1 PI+ D         9/69
M    200  785.       2.           DANBURG   69 DBC     2.3 PI+ D         9/69
M    750  784.1      1.2          ABRAMOVIC 70 HBC     3.9 PI- P         6/70
M         784.0      0.7          ATHERTON  70 HBC     3.6 PBAR P, 7 PI  5/70
M         783.2      1.6          BIGGS     70 CNTR    PHOTOPRODUCTION   6/70
M         783.4      1.0          BIZZARR2  70 HBC     0.0 P PBAR K+K-   1/71*
M    260  781.0      2.0          CASON     70 HBC     8.0 PI-P,4PI
M    369  784.0      1.4          MATTHEWS  71 DBC     6.95 PI+ D        2/71*
M          . . . . . . . . .
M    AVG  783.86     0.30   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
                            (SEE IDEOGRAM BELOW )

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                   1  OMEGA FULL WIDTH (MEV)

W     34    9.0      3.0          ARMENTERO 63 HBC     0.0 PBAR P
W          13.4      2.0          MILLER D  65 HBC     SEEN WITH K+ K-
W    666  (20.0)   OR LESS        JAMES     66 HBC     2.1 PI+P          6/66
W    155  (12.3)    (2.0)         BARASH    67 HBC     SEEN WITH K1 K1   6/66
W          16.2      3.2          AUGUSTI1  69 OSPK    E+ E- COLL.BEAMS. 4/69
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          10.3      1.4          BIZZARR2  70 HBC     0.0 P PBAR K1K1   1/71*
W          12.8      3.0          BIZZARR2  70 HBC     0.0 P PBAR K+K-   1/71*
W    369   14.0      5.1          MATTHEWS  71 DBC     6.95 PI+ D        2/71*
W          . . . . . . . . .
W    AVG   11.46     0.86   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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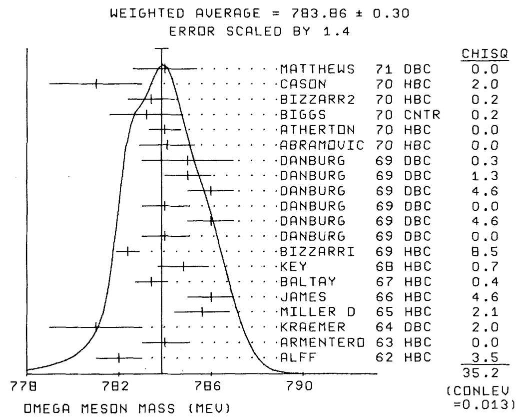


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                   1  OMEGA PARTIAL DECAY MODES

                                                              DECAY MASSES
P1     OMEGA INTO PI+ PI- PIO                                 139+ 139+ 134
P2     OMEGA INTO PI+ PI- (VIOLATES G)                        139+ 139
P3     OMEGA INTO PIO GAMMA (ONLY NEUTRAL INPUT TO FIT)       134+   0
P4     OMEGA 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    OMEGA INTO 3 GAMMA                                       0+   0+   0
P11    OMEGA INTO PIO MU+ MU-                                 134+ 105+ 105

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                   1  OMEGA  BRANCHING RATIOS
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Note on the branching fractions of ω(784)

Note that the errors of the decay branching fractions in the Meson Table are different from their values below (under "FROM FIT"), the table values being more conservative. The CONSTRAINED FIT only takes into account the decay modes $\pi^+\pi^-\pi^0$, $\pi^+\pi^-$, and neutrals, the latter defined as $\pi^0\gamma$. In the Meson Table we have also taken into account the upper limits, L_i (one-standard-deviation values), on the $\eta\gamma$, $\pi^+\pi^-\gamma$, and $\pi^0\pi^0\gamma$ decays by treating them as if they were measurement results of value $0 \pm L_i$.

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R1     OMEGA INTO NEUTRAL/(PI+ PI- PIO)
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          . . . . . . . . .
R1  AVG      0.1043    0.0091  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  FIT      0.1037    0.0070 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2     OMEGA INTO (PI+ PI-)/(PI+ PI- PIO).  SEE ALSO R15
R2 R         (0.011)OR MORE,C.L.=0.95 ABRAMOVIC 70 HBC     3.9 PI- P        6/70
R2 R         (0.035)OR LESS,C.L.=0.95 BIZZARRI  70 DBC    PBAR N AT REST    6/70
R2           (0.019)OR MORE,C.L.=0.95 CHAPMAN   70 HBC    1.6-2.2 P PBAR    6/70
R2  F        (.002)OR MORE,C.L.=0.9   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 1 70
R2           (0.0015)OR MORE,CL=.95   HAGOPIAN  71 HBC     2.3 PI- P        1/71*
R2          . . . . . . . . .
R2  FIT       0.0104    0.0028 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3     OMEGA INTO (PIO GAMMA) / (PI+ PI- PIO)
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          . . . . . . . . .
R3  FIT       0.1037    0.0070 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4     OMEGA INTO (PI+ PI- GAMMA)/(PI+ PI- PIO)
R4           (0.05)  OR LESS          FLATTE    66 HBC     1.8 K-P          9/66

R6     OMEGA INTO (MU+ MU-)/(PI+ PI- PIO)(UNITS 10**-3)
R6           (1.2)  OR LESS           GALTIERI  65 HBC     2.7 K-P
R6           (1.7)OR LESS             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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For notation, see illustrated key at beginning of data card listings.

```
R7      OMEGA INTO (2PIO GAMM)/(PIO GAMMA)
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

R8      OMEGA INTO(ETA PIO +ETA GAM)/(PI+PI-PIO)
R8            (0.017) OR LESS          FLATTE    66 HBC      1.8 K-P          9/66
R8            (0.045)OR LESS           JACQUET   69 HLBC    CL=0.95           4/70

R9      OMEGA INTO (NEUTRALS) / (CHARGED)
R9             0.124     0.021         FELDMAN   67 OSPK     1.2 PI- P        3/67
R9            . . . . . . . . .
R9  FIT        0.1027    0.0070 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R10     OMEGA INTO (2PIO GAMMA)/(PI+PI-PIO)
R10           (0.08) OR LESS           JACQUET   69 HLBC    CL=0.95           4/70

R11     OMEGA INTO (ETA GAMMA)/(PIO GAMMA)
R11           (0.58)    (0.30)         STRUGALSK 69 HLBC     2.34 PI+ N       8/69

R12     OMEGA INTO (PIO MU+ MU-) / TOTAL  (UNITS 10**-3)
R12           (2.)    OR LESS          WEHMANN   68 OSPK    12 PI- FE         6/68

R13     OMEGA INTO (E+ E-)/TOTAL    (UNITS 10**-4)
R13       3     2.        1.2          BINNIE    65 OSPK     PI-P NEAR THLD.  6/66
R13 B           MASS RESOLUTION 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  FROM 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         BOLLINI 1 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             0.76      0.14         AUGUSTI1  69 OSPK    SEE NOTE E        9/68
R13 E  FROM E+ E- COLLIDING BEAMS, ASSUMING OMEGA WIDTH 12.2+-1.3 MEV          4/69
R13           . . . . . . . . .
R13 AVG         0.66      0.17    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
                          (SEE IDEOGRAM BELOW )
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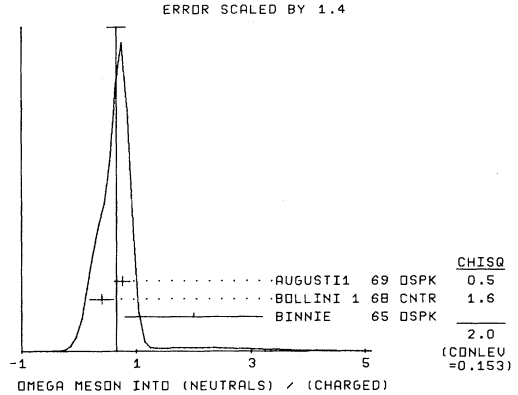
WEIGHTED AVERAGE = 0.66 ± 0.17
ERROR SCALED BY 1.4

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R14     OMEGA INTO NEUTRALS / TOTAL
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         BIZZARR2   70 HBC      0.0 P PBAR      1/71*
R14           . . . . . . . . .
R14 AVG        0.081     0.011    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R14 FIT        0.0931    0.0057 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R15     OMEGA INTO (PI PI)/(TOTAL). SEE ALSO R2
R15            0.032     0.028      0.019 AUGUSTI2  69 OSPK     E+E- COLL.BEAMS  8/69
R15           (0.003)OR MORE,C.L.=0.95 GOLDHABER 69 HBC       3.7-4.0 PI+P   11/69
R15           (0.014)OR MORE,C.L.=0.95 ALLISON   70 HBC     1.3-1.7 PBAR P  . 6/70
R15            0.0080    0.0028     0.0022BIGGS     70 CNTR   PHOTOPRODUCTION   6/70
R15           . . . . . . . . .
R15 AVG        0.0083    0.0025   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
              FOR COMPILATIONS, SEE GOLDHABER 70 AND ROOS 70
R15           (0.004)OR MORE,CL=.84     MOFFEIT   71 HBC      2.8,4.7 GAMMA P  2/71*
R15           . . . . . . . . .
R15 FIT        0.0093    0.0025 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R16     OMEGA INTO  (ETA GAMMA) / (ALL NEUTRALS)
R16           (0.24) OR LESS (CL=0.9)  DEINET     69 OSPK                     9/69

R17     OMEGA INTO  (2 PIO GAMMA) / (ALL NEUTRALS)
R17           (0.19) OR LESS (CL=0.9)  DEINET     69 OSPK                     9/69

R18     OMEGA INTO  (PIO GAMMA) / (ALL NEUTRALS)
R18           (0.81) OR GREATER(CL=0.9)DEINET     69 OSPK                     9/69
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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 1	.898+-.006		
P 2	-.382	.009+-.003	
P 3	-.914	-.024	.093+-.006

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REFERENCES FOR OMEGA

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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+NW)
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+COLL+FRANCE)
STEVENSO  62 PR 125 687           STEVENSON,ALVAREZ,MAGLIC,ROSENFELD    (LRL)

ARMENTER  63 SIENA CONF 1 296     ARMENTEROS,EDWARDS,JACOBSEN+    (CERN+PARIS)
BARMIN    63 SIENA CONF 1 207     BARMIN,DOLGOLENKO,KRESTNIKOV+          (ITEP)
BERTHELO  63 SIENA CONF 2 60      A BERTHELOT                      (CEN-SACLAY)
BUSCHBEC  63 SIENA CONF 1 166     BUSCHBECK,CZAPP+     (VIENNA+CERN+AMSTERDAM)
GELFAND   63 PRL 11 436           GELFAND,MILLER,NUSSBAUM,RATAU+ (COLUM+RUTG)
MURRAY    63 PL 7 358             MURRAY,FERROLUZZI,HUWE,SHAFER,SOLMITZ+(LRL)

BARMIN    64 JETP 18 1289         BARMIN,DOLGOLENKO,KRESTNIKOV +         (ITEP)
BEZAGUET  64 PL 12 70             BEZAGUET,NGUYEN KHAC,ROUSSET+ (PAR+BERG+LO)
KRAEMER   64 PR 136 B 496         KRAEMER,MADANSKY,MEER,FIELDS+ (JHU+NW+WOOD)

BINNIE    65 PL 18 348            BINNIE,DUANE,JANE,W JONES+ (IC-LOND+MANCHS)
GALTIERI  65 PRL 14 279           A BARBARO GALTIERI,R D TRIPP          (LRL)
MILLER D  65 CU-237(NEVIS 131)    DAVID C MILLER  (THESIS)         (COLUMBIA)
   MILLER 65 INCLUDES DATA OF     GELFAND 63 ABOVE
ZDANIS    65 PRL 14 721           ZDANIS,MADANSKY,KRAEMER,HERTZBACH+(JHU+BNL)

ALFF-STE  66 PR 145 1072          ALFF-STEINBERGER,BERLEY,BRUGGER+ (COL+RUTG)
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,ZANELLO  (COLUMBIA)
BARASH    67 PR  156  1399        BARASH,KIRSCH,MILLER,TAN         (COLUMBIA)
FELDMAN   67 PR 159 1219          +FRATI,GLEESON,HALPERN,NUSSBAUM+    (PENNA)
HERTZBAC  67 PR 155, 1461         HERTZBACH,KRAEMER,MADANSKI,ZDANIS+(JHU+BNL)
   (SEE ALSO ZDANIS 65)

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+WALKER+(TO+ANL+WIS)
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,BUON,GRACCO,HAISSINSKI,+  (ORSAY)
AUGUSTI2  69 LNC 2 214            +LEFRANCOIS,LEHMANN,MARIN,+         (ORSAY)
BIZZARRI  69 NP B 14 169          +FOSTER,GAVILLET,MONTANET,+      (CERN+CDF)
DANBURG   69  UCRL-19275          JEROME S. DANBURG, THESIS             (LRL)
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)
JUHALA    69 PR 184  1461         +LEACOCK,RHODE,KOPELMAN,LIBBY,+ (AMES+COLO)
MILLER    69 PR 178 2061          R.MILLER,LICHTMAN,WILLMANN          (PURDUE)
STRUGALS  69 PL 29 B 532          +CHUVILO,FENYVES,+          (WARS+JINR+BUDA)
WILSON    69 PRIVATE COMM.        RICHARD WILSON (SEE ALSO PR 178 2095)(HARV)

ABRAMOVI  70 NP B 20 209          ABRAMOVICH,BLUMENFELD,BRUYANT,+      (CERN)
ANGELOW   70 YAD.FIZ. 12 788      +GRAMENITSKY,KANASIRSKY,KERATSCHEW,+ (JINR)
ALLISON   70 PRL 24 618           +COOPER,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)
BIZZARR1  70 PRL 25 1385          +CIAPETTI,DORE,GASPERO,GUIDONI+  (ROMA+SYR)
BIZZARR2  70  CERN PHYS 70-35     +MONTANET,NILSSON,D-ANDLAU,+    (CERN+CDEF)
CASON     70 PR D 1 851           +ANDREWS,BISWAS,GROVES,HARRINGTON,+  (NDAM)
CHAPMAN   70 NP B 24 445          +DAVIDSON,GREEN,LYS,ROE,VANDER VELDE (MICH)
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       REVIEW TALK AT DARESBURY 70          (CERN)

HAGOPIAN  71 BAPS 16              S.HAGOPIAN                       (FSU+PENN)
MATTHEWS  71 PRL 26 400           +PRENTICE,YOON,CARROLL,WALKER,+ (TNTO+WISC)
MOFFEIT   71  UCRL-19753          +BINGHAM,FRETTER,BALLAM+(LRL+UCB+SLAC+TUFT)
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M(953)

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            59    M(953)   G=+1

                 WHILE MASS AND WIDTH ARE CONSISTENT WITH THOSE OF
                 THE ETA PRIME(958), THE (PI+ PI- GAMMA) DECAY DOES
  NOT SHOW A RHOO SIGNAL, UNLIKE THE ETA PRIME. THIS IS TAKEN AS EVIDENCE
  FOR A NEW PARTICLE. WHILE THIS DIFFERENCE IN DALITZ PLOT DISTRIBUTIONS
  APPEARS SIGNIFICANT, IT STILL NEEDS FURTHER CONFIRMATION TO BE REGARDED
  AS WELL ESTABLISHED.
                 OMITTED FROM 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*

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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*

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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                              765+    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)
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.)
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
R3       58    NOT OBSERVED         AGUILAR   70 HBC     3.9-4.6K-P,P K-M  1/71*

R4     M  INTO (PIO ETA NEUTR.)/TOTAL
R4       58    NOT OBSERVED         AGUILAR   70 HBC     3.9-4.6K-P,P K-M  1/71*
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For notation, see illustrated key at beginning of data card listings.

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                         REFERENCES FOR M

AGUILAR  70 PRL 25 1635       AGUILAR-BENITEZ,BASSANO,SAMIOS,BARNES+(BNL)

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η'(958)

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        2   ETA PRIME (958,JPG=0-+)  I=0

            KNOWN ALSO AS XO
            (JP = 2- NOT YET EXCLUDED.)
            (SEE NOTE ON QUANTUM NUMBERS AT END OF ETA
             PRIME LISTINGS)

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                  2   ETA PRIME MASS (MEV)

M       85 (957.0)                   DAUBER     64 HBC    1.95 K-P
M   K      (958.0)      (1.0)        KALBFLEIS  64 HBC    2.7 K-P          6/66
M   K        KALBFLEISCH 64 SUPERSEDED BY RITTENBERG 69
M           957.0       3.0          BADIER     65 HBC    3.0 K-P
M        8  960.0       2.0          TRILLING   65 HBC    3.65 PI+ P       9/66
M        7  955.0      10.0          COHN       66 DBC    3.3 PI+D         6/66
M           959.0       3.0          LONDON     66 HBC    2.2 K-P          6/66
M           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           956.0       2.0          AGUILAR    70 HBC    3.9-4.6K-P       1/71*
M           . . . . . . . . . .
M   AVG     957.46      0.75    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                  2   ETA PRIME WIDTH (MEV)

W       85   (4.0)OR LESS            DAUBER     64 HBC    1.95 K-P
W   K        (7.0)OR LESS            KALBFLEIS  64 HBC    2.7 K-P          6/66
W   K         KALBFLEISCH 64 SUPERSEDED BY RITTENBERG 69
W           (30.0)OR LESS            BADIER     65 HBC    3.0 K-P
W           (15.0)OR LESS            LONDON     66 HBC    2.2 K-P          6/66
W           (10.) OR LESS            RITTENBER  69 HBC    1.7-2.7 K- P     9/69
W           (20.0)  OR LESS          AGUILAR    70 HBC    3.9-4.6K-P       1/71*

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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+ 765
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                          139+ 139+ 139+ 139
P15        ETA PRIME INTO  PIO GAMMA GAMMA               134+   0+   0
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 0 (VIOLATES C)        134+ 765
P19        ETA PRIME INTO  PIO OMEGA (VIOLATES C)        134+ 783

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                  2   ETA PRIME BRANCHING RATIOS
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Note on η'(958) branching ratios

In our calculation of the constrained branching fractions of the $\eta'(958)$ we assume the following decay modes:

a) $\eta\pi\pi$ (including $\eta\pi^0\pi^0$, 72% of the η's have neutral decays),

b) $\rho^0\gamma$,

c) $\gamma\gamma$.

Note that the average of the directly observed $\gamma\gamma$ values $(9.9\,^{+4.4}_{-3.9})\%$ (BOLLINI 68, BENSINGER 70) is slightly different from the result of the overall fit, $(6.6 \pm 3.7)\%$, because of independent measurements of $(\eta' \to \text{all neutrals})/(\eta' \to \text{total})$. In the fit we do not use the constraint

$$R = \Gamma(\eta' \to \eta\pi^+\pi^-)/\Gamma(\eta' \to \eta\pi^0\pi^0) = 2$$

from I-spin conservation. The result of the fit is in agreement with it, $R = 2.2 \pm 0.5$.

```
R1           ETA PRIME INTO (PI+ PI- ETA (NEUTRAL DEC.))/TOTAL
R1  K    68   (0.36)   (0.05)        KALBFLEIS 64 HBC     2.7 K-P           10/66
R1  K          KALBFLEISCH 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        0.317    0.017  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

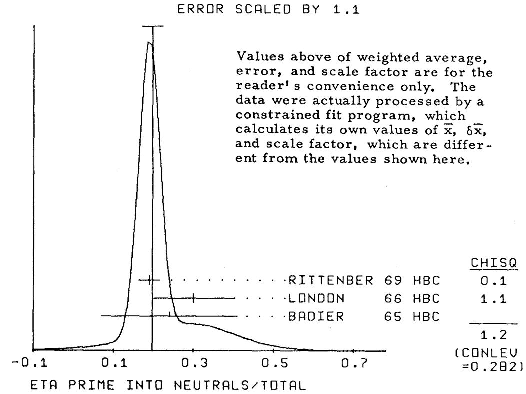
R2           ETA PRIME INTO (PI+ PI- NEUTRALS) / TOTAL
R2       33    0.35     0.06         BADIER    65 HBC     3.0 K-P           10/66
R2       39    0.4      0.1          LONDON    66 HBC     2.2 K-P           10/66
R2           . . . . . . . . . .
R2  AVG        0.363    0.051   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2  FIT        0.373    0.017  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R3           ETA PRIME INTO (PI+ PI- ETA (CHRGD.DECAY))/TOTAL
R3  K    44   (0.12)   (0.02)        KALBFLEIS 64 HBC     2.7 K-P           10/66
R3  K          KALBFLEISCH 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  FIT        0.1220   0.0066 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4           ETA PRIME INTO (PI+ PI- NEUTRALS (EXCLUDING
R4           PI+ PI- ETA (NEUTR.DEC.))) / TOTAL
R4  K    10   (0.05)   (0.04)        KALBFLEIS 64 HBC     2.7 K-P           10/66
R4  K          KALBFLEISCH 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        0.056    0.014  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R5           ETA PRIME INTO (NEUTRALS) / TOTAL
R5  K    54   (0.25)   (0.05)        KALBFLEIS 64 HBC     2.7 K-P           10/66
R5  K          KALBFLEISCH 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           . . . . . . . . . .
R5  AVG        0.197    0.027   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
R5  FIT        0.211    0.021  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
                        (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 0.197 ± 0.027
ERROR SCALED BY 1.1

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R6           ETA PRIME INTO (PI+ PI- GAMMA (INCLUDING RHO GAMMA))/TOTAL
R6  K    42   (0.22)   (0.04)        KALBFLEIS 64 HBC     2.7 K-P           10/66
R6  K          KALBFLEISCH 64 SUPERSEDED BY RITTENBERG 69
R6  B    35   (0.34)   (0.09)        BADIER    65 HBC     3.0 K-P           10/66
R6  B        CONTROVERSIAL BACKGROUND SUBTRACTION
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  FIT        0.294    0.027  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)
                        (SEE IDEOGRAM BELOW )
```
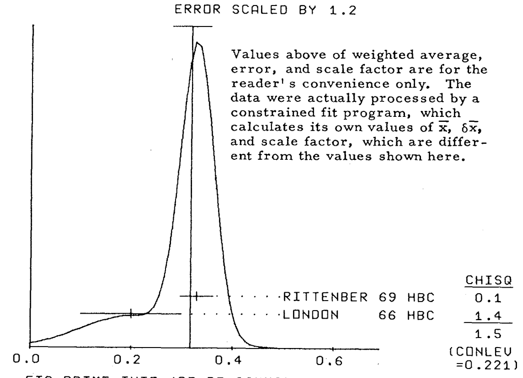

WEIGHTED AVERAGE = 0.316 ± 0.038
ERROR SCALED BY 1.2



Mesons

For notation, see illustrated key at beginning of data card listings.

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R7          ETA PRIME INTO (PI+ PI- GAMMA (INCLUDING RHO GAMMA))/(PI PI ETA)
R7             0.25      0.14               DAUBER    64 HBC       1.95 K-P            10/66
R7          . . . . . . . . . . 
R7  FIT        0.460     0.066  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R8          ETA PRIME INTO (PIO E+ E-)/TOTAL
R8            (0.013) OR LESS               RITTENBER 65 HBC                2.7 K-P    10/66

R9          ETA PRIME INTO (ETA E+ E-)/TOTAL
R9            (0.011) OR LESS               RITTENBER 65 HBC                2.7 K-P    10/66

R10         ETA PRIME INTO (PIO RHOO)/TOTAL
R10           (0.04)  OR LESS               RITTENBER 65 HBC                2.7 K-P    10/66

R11         ETA PRIME INTO (PIO OMEGA) /TOTAL
R11           (0.08)  OR LESS               RITTENBER 65 HBC                2.7 K-P    10/66

R12         ETA PRIME INTO (PI+ PI- E+ E-)/TOTAL
R12           (0.006) OR LESS               RITTENBER 65 HBC                2.7 K-P    10/66

R13         ETA PRIME INTO (2 PI)/TOTAL
R13           (0.07)  OR LESS  COMP.BY LONDON    66 HBC                                10/66

R14         ETA PRIME INTO (3 PI)/TOTAL
R14           (0.07)  OR LESS  COMP.BY LONDON    66 HBC                                10/66

R15         ETA PRIME INTO (4 PI)/TOTAL
R15           (0.01)  OR LESS  COMP.BY LONDON    66 HBC                                10/66

R16         ETA PRIME INTO (6 PI)/TOTAL
R16           (0.01)  OR LESS  COMP.BY LONDON    66 HBC                                10/66

R18         ETA PRIME INTO (RHOO GAMMA)/(PI PI ETA)
R18            0.31      0.15               DAVIS     68 HBC       5.5 K- P             9/68
R18         . . . . . . . . . . 
R18 FIT        0.460     0.066  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R19         ETA PRIME INTO (2 GAMMA)/TOTAL
R19 B    5    (0.055)   (0.036)  (0.030)BOLLINI    68 CNTR     1.9 PI- P            9/68
R19 B       CHANGED BY US BECAUSE OF NEW CROSS SECTION, BENSINGER 70
R19      5     0.085     0.055     0.045 BOLLINI    68 CNTR     1.9 PI- P            1/71*
R19      7     0.126     0.075           BENSINGER 70 DBC      2.2 PI+ D            1/71*
R19         . . . . . . . . . . 
R19 AVG        0.098     0.042   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R19 FIT        0.066     0.037  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R20         ETA PRIME INTO (PI+PI-)/TOTAL
R20           (0.02)  OR LESS               RITTENBER 69 HBC       1.7-2.7 K-P          9/69

R21         ETA PRIME INTO (PI+PI-PIO)/TOTAL
R21           (0.05)  OR LESS               RITTENBER 69 HBC       1.7-2.7 K-P          9/69

R22         ETA PRIME INTO (PI+PI+PI-PI-)/TOTAL
R22           (0.01)  OR LESS               RITTENBER 69 HBC       1.7-2.7 K-P          9/69

R23         ETA PRIME INTO (PI+PI+PI-PI-PIO)/TOTAL
R23           (0.01)  OR LESS               RITTENBER 69 HBC       1.7-2.7 K-P          9/69

R24         ETA PRIME INTO (PI+PI+PI-PI- NEUTRALS)/TOTAL
R24           (0.01)  OR LESS               RITTENBER 69 HBC       1.7-2.7 K-P          9/69

R25         ETA PRIME INTO (RHOO GAMMA)/(ALL PI+ PI- GAMMA)
R25            0.94      0.20               AGUILAR   70 HBC      3.9-4.6K-P           1/71*

R26         ETA PRIME INTO (PIO PIO ETA INTO 3 PIO)/TOTAL
R26      4     0.11      0.06               BENSINGER 70 DBC       2.2 PI+ D            1/71*
R26         . . . . . . . . . . 
R26 FIT        0.060     0.015  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
```

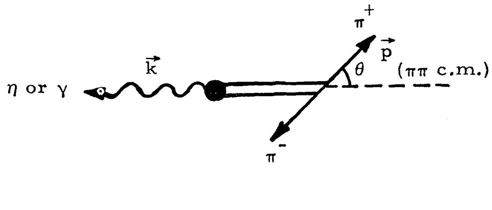
FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

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	.439+-.024			
P 2	-.428	.201+-.049		
P 3	-.408	-.302	.294+-.027	
P 4	.168	-.826	-.019	.066+-.035

UNCERTAINTY IN THE J^P ASSIGMENT OF $\eta'(958)$

For the dominant (64%) $\pi\pi\eta$ decay mode of the η', since the Dalitz plot population is rather flat (DAUBER 64, LONDON 66, RITTENBERG 69, DUFEY 69), and in particular does not vanish at the edges of the plot, the J^P = Normal series may be ruled out.



In the notation of the sketch, any Normal matrix element would have a factor $\sin\theta$ and would thus go to zero at the edge of the Dalitz plot [C. Zemach, Phys. Rev. 133, B1201 (1964)].

Since 1^+ is excluded by the observation of the $\gamma\gamma$ decay mode (BOLLINI 68, BENSINGER 70), this leaves us with 0^-, 2^-, $\cdots$ of the Abnormal series. Unfortunately, no information permits us at present to distinguish between 0^- and 2^- [A. Zaslavskij, V. Ogievetskij and W. Tybor, Soviet Journ. of Nucl. Phys. 9, 498 (1969)]:

The $\pi\pi\eta$ decay mode (RITTENBERG 69, LONDON 66, DUFEY 69) is fitted better with $J^P = 0^-$ than with $J^P = 2^-$, but the latter cannot be excluded, either when comparing the simplest matrix elements with the Dalitz plot density distribution or when judging from the θ-dependence or the η energy dependence of the squared element [Zaslavskij et al., op. cit., and S. Giler et al., Acta Phys. Polon. A 37, 475 (1970)].

Turning to the 29% mode $\eta' \rightarrow \pi^+\pi^-\gamma$, which RITTENBERG 69 has shown to be mainly $\rho^0\gamma$ decay, one gets a good fit with both $J^P = 0^-$ [$d\sigma/d(\cos\theta) \propto \sin^2\theta$] and $J^P = 2^-$ [$d\sigma/d(\cos\theta) \propto 6 + \sin^2\theta$ for the simplest possibility of pure M1 transition, or $d\sigma/d(\cos\theta) \propto 1.48 + \sin^2\theta$ from the vector dominance model (private communication from V. Ogievetskij)], so no distinction is possible here.

Moreover, the possible existence of a new resonance, M(953), which decays into $\pi\pi\gamma$ but not into $\rho^0\gamma$, makes a study of the $\pi\pi\gamma$ final state even more ambiguous.

A longer discussion appears in our 1970 editions.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                                  REFERENCES FOR ETA PRIME

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)
KALBFLEI 64 PRL 13 349          G.R.KALBFLEISCH,O.DAHL,A.RITTENBERG    (LRL)JP

BADIER   65 PL 17 337           BADIER,DEMOULIN,BARLOUTAUD +(PAR+SAC+ZEEMA)
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+UNCAR)
LONDON   66 PR 143 1034         LONDON,RAU,SAMIOS,GOLDBERG + (BNL+SYRACUSE)IJP

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)

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)

          QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN THE DATA CARDS

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+AMSTD+BOLOG+WEIZM+E.P.)I=0
DUFEY    69 PL 29 B 605         +GOBBI,POUCHON,CNOPS,+      (ETHZ+CERN+SACL)IJP

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For notation, see illustrated key at beginning of data card listings.

$\delta(962)$ AND $\pi_N(975)$

36 DELTA MESON (962,JPG=) I = 1
AND PI (975,JPG=N -) I = 1

The original, narrow $\delta^-(962)$ was seen with the CERN MMS (KIENZLE 65). Other missing-mass spectrometers (OOSTENS 66, BANNER-1 67, BANNER-2 67, ABOLINS 70) have added nothing conclusive to this evidence.

A claim for a $\delta^- \to \pi^-\pi^0$ decay at high $|t|$ in the reaction $\pi^-p \to \pi^-\pi^0p$ (ALLEN 66) can now be discounted by virtue of the results of a compilation (ROOS 70) of the same reaction; the compilation has 7 times larger statistics in the region 640-1000 MeV and $0.5 < |t| < 1.0\ (\mathrm{GeV}/c)^2$, and includes the data of ALLEN 66.

Claims for 3π decay (ALLISON 67, JUHALA 68) have also been contradicted (SAMIOS 68, KRUSE 69). For a review, see SAMIOS 68, MAGLIĆ 69.

Recent experiments have, however, shown evidence for a <u>broad</u> resonance, also called $\pi_N(975)$. These are BARNES 69 and AMMAR 70, who see a peak in the $\eta\pi$ system, and who claim that it cannot be explained by the kinematic effect discussed below under 2a; moreover, ABOLINS 70 see a peak of width 60 MeV in a missing mass spectrum.

The following references have possible relevance to the existence of the δ.

1) The $\pi_N(1016)$ may be interpreted as a virtual bound state in the $K\bar{K}$ channel. It would then correspond to a narrow resonance at about $975\ {}^{+15}_{-10}$ MeV (ASTIER 67) in open channels, e.g., $\eta\pi$ or 5π.

2) Further $\eta\pi$ enhancements have been reported at masses in the 960-980 MeV region. As evidences for a resonance they are however not yet convincing, because there are two kinematic effects that can produce $\eta\pi$ peaks in that mass region:

a) In the reactions $K^-n \to \Lambda\pi^-(MM)$ and $K^-p \to \Lambda\pi^+\pi^-(MM)$ (studied by CRENNELL 69, MILLER 69) with selection of the missing mass (MM) in the $\eta(549)$ region, a spurious δ peak can arise from contamination with $\Lambda\rho^-\pi^0$ final states. This has been pointed out by CRENNELL 69.

b) In final states containing many pions [e.g., $2\pi^+2\pi^-\pi^0$, $(3\pi)^\pm\pi^0$], and with the ω copiously produced, the constraint of at least one η combination in the $|\pi^\pm\pi^+\pi^-\pi^0|$ mass "fakes" a peak in the mass region around 960 MeV, due to reflections from the ω. This remark (by NELLEN 69) may apply to the observations of DEFOIX 68 and CAMPBELL 69. OTWINOWSKI 70 has shown, however, that the δ peak in OTWINOWSKI 69 cannot be explained this way.

If we accept $\delta \to \pi\eta$ by strong decay, then $I^G = 1^-$; nonobservation of 3π decay can be explained by choosing $J^P = 0^+$, or simply by saying that 3π background is too large to permit detection. These quantum numbers, $1^-(0^+)$, are then the same as those most likely for $\pi_N(1016)$, which could be just the $\bar{K}K$ decay mode of the δ.

An unattractive alternative is to believe that δ is really very narrow, and guess that its $\pi\eta$ decay is <u>G-violating</u> electromagnetic. (It is not clear whether there would be competition from $\pi\pi\eta$ decay, which is strong but has much smaller phase space.) However, in this electromagnetic (em) case, one would also expect slightly faster decay into $\pi\pi$, and we are not sure whether this mode should have been detected. To see why we expect $\pi\pi$ decay, note that these em decays into $\pi^-\pi^0$ or $\pi^-\eta$ involve emission and reabsorption of a photon, with rates proportional to e^4 (also $\pi\pi$ has slightly larger phase space than $\pi\eta$). <u>Neutral</u> em decays (as in the familiar $\eta^0 \to 3\pi$) have selection rules either

$$\Delta G = \text{Yes}, \qquad \Delta|I| = 1,$$

or

$$\Delta G = \text{No}, \qquad \Delta|I| = 2,$$

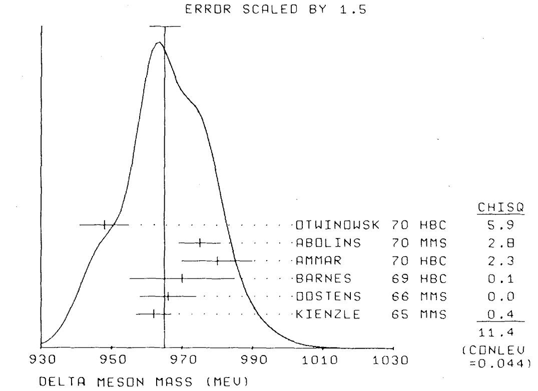
but <u>charged</u> decays ($\delta^- \to \pi^-\pi^0$ or $\pi^-\eta$) have no such rules (except $\Delta|I| \leq 2$).

---

35 DELTA MESON MASS (MEV)

M		262	962.0	5.0	KIENZLE	65 MMS	- 3-5 PI- P	9/66
M			966.0	8.0	OOSTENS	66 MMS	+ 3.8 PP TO D + MM.	9/66
M			(960.)	APPROX.	CHUNG S	68 HBC	- 3.2 PI-P .	5/70
M			(975.0)		DEFOIX	68 HBC	+- 1.2 PB P,ETA PI	3/69
M			970.0	15.0	BARNES	69 HBC	- 4-5 K-P,PI-ETA	9/69
M			(980.0)	(10.0)	MILLER	69 HBC	- 4.5 K-N,ETA PI	7/69
M	D	22	(948.0)	(6.0)	OTWINOWSK	69 HBC	+- 8 PI+P,P OO PI	11/69
M	D		OTWINOWSKI 69 SUPERSEDED BY OTWINOWSKI 70					
M			980.0	10.0	AMMAR	70 HBC	+- 4.1.5.5K-,ETA PI	5/70
M			975.0	6.0	ABOLINS	70 MMS	+ 3.8-5.3 PP--D+MM	1/71*
M		22	948.0	7.0	OTWINOWSK	70 HBC	+- 8 PI+P,P OO PI	11/69
M			. . . .					
M	AVG		965.0	4.4	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5) (SEE IDEOGRAM BELOW)			

WEIGHTED AVERAGE = 965.0 ± 4.4
ERROR SCALED BY 1.5



Mesons

For notation, see illustrated key at beginning of data card listings.

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                      36  DELTA MESON WIDTH (MEV)

W      262   (5.0)   OR LESS            KIENZLE   65 MMS   -   3-5 PI- P          9/66
W           (10.0)   OR LESS            OOSTENS   66 MMS   +  3.8 PP TO D + MM    9/66
W           (25.0)                      DEFOIX    68 HBC   +-  1.2 PB P,ETA PI    3/69
W           (50.0)   OR LESS            BARNES    69 HBC   -   4-5 K-P,PI-ETA     9/69
W           (60.0)    (30.0)            MILLER    69 HBC   -   4.5 K-N,ETA PI     7/69
W            80.0      30.0             AMMAR     70 HBC   +- 4.1,5.5K-,ETA PI    5/70
W            60.0      16.0     10.0    ABOLINS   70 MMS   +  3.8-6.3 PP--D+MM.   1/71*
W       22   31.0      28.0             OTWINOWSK 70 HBC   +- 8 PI+P,P DO PI     11/69
W            . . . . . . . . .
W   AVG      58.2      11.0     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                      36  DELTA MESON PARTIAL DECAY MODES

P2          DELTA MESON INTO 3 PI                          134+ 134+ 134
P3          DELTA MESON INTO 4 PI                          134+ 134+ 134+ 134
P5          DELTA MESON INTO ETA PI                        548+ 134

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                      36  DELTA MESON BRANCHING RATIOS

R1          CHARGED DELTA INTO (1 CHARGED) / (3 OR MORE CHARGED)
R1             1.3        0.9        0.7    KIENZLE   65 MMS   -   3-5 PI- P        9/66

R2          DELTA MESON INTO ETA PI
R2          SEEN                            BARNES    69 HBC   -   4-5 K-P,PI-ETA   9/69

R3          DELTA INTO (RHO PI)/(ETA PI)
R3            (0.25)OR LESS,C.L.=0.7        AMMAR     70 HBC   +- 4.1,5.5K-,ETA PI  5/70

R4          DELTA INTO (K KBAR)/(ETA PI)
R4            (0.2)OR LESS,C.L.=0.7         AMMAR     70 HBC   +- 4.1,5.5K-,ETA PI  5/70

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                           REFERENCES ON DELTA MESON
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TURKOT    63 SIENNA CONF 1 661 +COLLINS,FUJII,KEMP+         (BNL+PITTSBURGH)
KIENZLE   65 PL   19   438     + MAGLIC,LEVRAT,LEFEBVRES +            (CERN)
ALLEN D   66 PL  22   543      +GP FISHER,G GOODEN,L MARSHALL,SEARS (COLO)G=+
FOCACCI   66 PRL   17   890    + KIENZLE,LEVRAT,MAGLIC,MARTIN         (CERN)
OOSTENS   66 PL   22   708     +CHAVANON,CROZON,TOCQUEVILLE     (SACLAY,CF)I=1

ALLISON   67 PL 25B 619        +CRUZ+     (OXF+MU..+BIRM+RUTH+GLASG+LON(IC))
BANNER 1  67 PL   25 B  300    +FAYOUX,HAMEL,ZSEMBERY,CHEZE+ (SACLAY+CAEN)
BANNER 2  67 PL 25 B 569       +CHEZE,HAMEL,MAREL,TEIGER,CROZON+(CDF+SACL)

CHUNG S   68 PR 165 1491        +O.DAHL, J. KIRZ, D.H.MILLER           (LRL)
DEFOIX    68 PL 28 B 353       +RIVET,SIAUD,CONFORTO,SHIVELY(CDF+IPE+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+SYR)
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,+ (AMES+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,FLSNER,+         (PURDUE)
NELLEN    69  PRIVATE COMM.    B.NELLEN                          (BONN+CERN)
OTWINOWS  69 PL 29 B 529       S.OTWINOWSKI                         (WARSAW)

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)
OTWINOWS  70  1207/VI/PH       S.OTWINOWSKI                           (WARS)
ROOS      70  PRIV.COMM.       M.ROOS, L.D.JACOBS                (CERN+SACL)

ANDERSON  71 PRL 26 108        +DIXIT,+    (CHIC+ANL+CARL+LASL+OTTA+NAGOYA)
    SEE ONE-TENTH THE CROSS SECTION OF OOSTENS 66
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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 STATISTICALLY
SIGNIFICANT EVIDENCE FOR THE PRE-1968 H-ENHANCE-
MENT THEREFORE REMAINS (BARBARO-GALTIERI 69).
HOWEVER, GOLDHABER 69 REPORT A NEW (PI+PI-PIO)
ENHANCEMENT AT ABOUT THE SAME MASS, M=1000 MEV,
SEEN UNDER CONDITIONS DIFFERENT FROM THOSE OF THE
EARLIER OBSERVATIONS.  OMITTED FROM TABLE.

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                         REFERENCES ON  H MESON
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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   (OAK R.+UNIV.TENN)
ROSENFEL  67 RMP 39 1,APPENDIX  ROSENFELD,BARBARO-GALTIERI+(LRL+CERN+YALE)
ARMENISE  68 PL 26B 336        +GHIDINI,FORINO+ (BARI+BOLOGN+FIRENZ+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  PREPRINT         B.CHAUDHARY,E.MARQUIT              (MINNESOTA)
GORDON    70  COO 1195 179     THESIS,ILLINOIS                         (ILL)
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$\pi_N(1016) \to K\bar{K}$

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16 PI(1016,JPG=0+-) I=1

STILL NOT DECIDED WHETHER (K KBAR) RESONANCE, VIRTUAL
BOUND STATE OR ANTIBOUND STATE. MAY BE RELATED
TO THE DELTA (962)

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                    16 PI(1016) MASS  (MEV)

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

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                    16 PI(1016) WIDTH (MEV)

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

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                    16 PI(1016) PARTIAL DECAY MODES

                                                         DECAY MASSES
P1          PI(1016) INTO K KBAR                         493+ 497
P2          PI(1016) INTO ETA PI                         548+ 139

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                    16 PI(1016) BRANCHING RATIOS

R1          PI(1016) INTO (ETA PI) / (K KBAR)
R1             (5.0)  OR LESS           ASTIER    67 HBC      0. PBAR P          9/67

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                         REFERENCES FOR PI(1016)
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ARMENTER 65 PL 17 344          ARMENTEROS,EDWARDS,JACOBSEN +  (CERN+PARIS)
BARASH   65 PR  139 B  1659    +FRANZINI,KIRSCH,MILLER,STEINBERGER+(COLUM)
ROSENFEL 65 OXFORD CONF 58     A H ROSENFELD                    (LRL--RVUE)

BALTAY   66 PR  142 B  932     +LACH,SANDWEISS,TAFT,YEH,STONEHILL+  (YALE)

ASTIER   67 PL  25 B  294      +MONTANET,BAUBILLIER,DUBOC+  (CDF+CERN+IDR)
  ASTIER 67 INCLUDES DATA OF BARLOW 67,CONFORTO 67,ARMENTER)S 65.
BAILLON  67 NC 50A 393         +EDWARDS+D.ANDLAU+ASTIER+      (CERN+CDF +IR)
BARLOW   67 NC  50 A  701      +MONTANET,D-ANDLAU+(CERN+CDF+IDR+LIVERPOOL)
CONFORTO 67 NP B3 469          CONFORTO,MARECHAL,MONTANET+(CERN+PARIS+LIV)

SCHROEDE 69 PR 188  2081       SCHROEDER,KERNAN,FISHER,LIBBY,+ (AMES+COLO)

COOPER   70 NP B 23 605        +HANNER,MUSGRAVE,POLLARD,VOYVODIC      (ANL)
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$\phi(1019)$

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4  PHI (1019,JPG=1-- ) I=0

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                    4  PHI  MASS (MEV)

M         1017.0     2.0              ARMENTERO 63 HBC     0.0 PBAR P
M         1019.0     2.0              SCHLEIN   63 HBC   2.0 K- P
M         1018.6     0.5              MILLER D  65 HBC     0.0 PBAR P        8/66
M         1020.0     2.0              LONDON    66 HBC     2.2 K-P           6/66
M         1021.5     0.8              ABRAMS    67 HBC   4.2 K- P           11/67
M         1019.      3.               BARLOW    67 HBC     1.2 PBAR P       11/66
M         1021.0     4.0              DAHL      67 HBC     1-4 PI- P         9/66
M     165 1022.      1.5              MOSTEK    68 OSPK    1.8 GAMMA + C     6/68
M       (1018.)     (0.5)    (0.35)   HYAMS     70 OSPK    11. PI- P         6/70
M   C   (1020.)     (3.)              SABRE     70 DBC     3.0 K- N          1/71*
M   C    ERROR INCREASED FROM 1 TO 3 MEV SINCE PEAK HAS ONLY 40 EVENTS
M         . . . . . . . . .
M   AVG   1019.51    0.58     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
                   (SEE IDEOGRAM BELOW )
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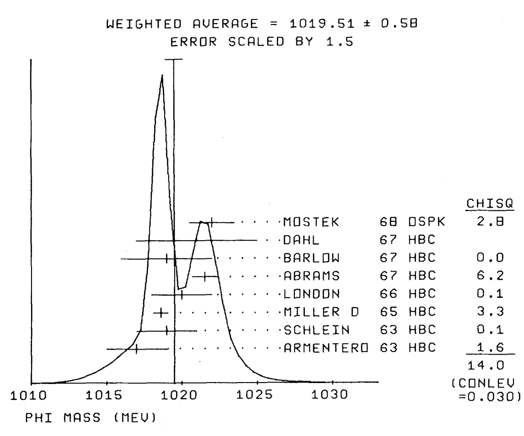


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                    4  PHI  WIDTH (MEV)

W          3.4       1.7              ARMENTERO 63 HBC     0.0 PBAR P
W     34  (5.0)  OR LESS              SCHLEIN   63 HBC     2.0 K-P
W          3.5       1.0              MILLER D  65 HBC     0.0 PBAR P        8/66
W          6.0       4.0              LONDON    66 HBC     2.2 K-P           6/66
W          1.8       3.0       1.5    ABRAMS    67 HBC   4.2 K- P           11/67
W        (10.)   OR LESS              BARLOW    67 HBC     1.2 PBAR P       11/66
W    165  (4.5)     (3.0)     (2.0)   MOSTEK    68 OSPK  1.8 GAMMA + C       6/68
W          4.09      0.29             BIZOT     70 OSPK  E+ E- COLL.BEAMS.   6/70
W   B     (4.1)     (0.5)             BALAKIN   69 OSPK  E+ E- COLL.BEAMS    9/69
W   B     BALAKIN 69 SUPERSEDED BY BALAKIN 70
W         (4.67)    (0.42)            BALAKIN   70 OSPK    E+ E- COLL.BEAM   1/71*
W         (3.3)     (1.5)     (0.9)   HYAMS     70 OSPK  11. PI- P           6/70
W         . . . . . . . . .
W   AVG    4.00      0.27     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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For notation, see illustrated key at beginning of data card listings.

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                    4  PHI PARTIAL DECAY MODES

                                                         DECAY MASSES
P1     PHI INTO K+ K-                                    493+ 493
P2     PHI INTO K01 K02                                  497+ 497
P3     PHI INTO PI+ PI- PI0 (INCLUDING RHO PI)           139+ 139+ 134
P4     PHI INTO PI+ PI- (VIOLATES G)                     139+ 139
P5     PHI INTO E+  E-                                    .5+  .5
P6     PHI INTO MU+ MU-                                  105+ 105
P7     PHI INTO PI0 GAMMA                                134+   0
P8     PHI INTO ETA GAMMA                                548+   0
P9     PHI INTO PI+PI-GAMMA                              139+ 139+   0
P10    PHI INTO OMEGA GAMMA (VIOLATES C)                 733+   0
P11    PHI INTO ETA PI0 (VIOLATES C)                     548+ 134
P12    PHI INTO RHO GAMMA (VIOLATES C)                   765+   0

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                    4  PHI  BRANCHING RATIOS

R1          PHI INTO (K+ K-)/TOTAL
R1  B   27   (0.26)   (0.06)        BADIER    65 HBC   (SEE NOTE B BELOW) 10/66
R1     252    0.48     0.04         LINDSEY   66 HBC      2.7 K-P         10/66
R1           (0.54)   (0.42)        BALAKIN   70 OSPK     E+ E- COLL.BEAM  1/71*
R1            0.493    0.044        BIZOT     70 OSPK    E+ E- COLL.BEAMS  6/70
R1          . . . . . . . . . .
R1  AVG       0.486    0.030   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  FIT       0.464    0.028  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R2          PHI INTO (K1 K2)/TOTAL
R2  B   25   (0.23)   (0.06)        BADIER    65 HBC   (SEE NOTE B BELOW) 10/66
R2     167    0.40     0.04         LINDSEY   66 HBC      2.7 K-P         10/66
R2          . . . . . . . . . .
R2  FIT       0.354    0.040  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.6)

R3          PHI INTO (PI+ PI- PI0 (INCL.RHO PI))/TOTAL
R3      30    0.12     0.08         LINDSEY   66 HBC      2.7 K-P        .10/66
R3           (0.203)  (0.042)       BALAKIN   70 OSPK     E+ E- COLL.BEAM  1/71*
R3          . . . . . . . . . .
R3  FIT       0.182    0.046  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.6)

R5          PHI INTO (K1 K2)/(K KBAR)
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         LONDON    66 HBC      2.2 K-P        .10/66
R5          . . . . . . . . . .
R5  AVG       0.448    0.044   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R5  FIT       0.433    0.034  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.4)

R6          PHI INTO (PI+ PI- PI0 (INCL.RHO PI))/(K KBAR)
R6            0.30     0.15         LONDON    66 HBC      2.2 K-P         10/66
R6          . . . . . . . . . .
R6  FIT       0.222    0.068  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.6)

R7          PHI INTO (PI+ PI- PI0 (INCL.RHO PI))/(K1 K2)
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          . . . . . . . . . .
R7  FIT       0.51     0.18   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.7)

R8          PHI INTO (PI+ PI-)/(K KBAR)    (SEE ALSO R18)
R8           (0.2)   OR LESS        LONDON    66 HBC      2.2 K-P         10/66

R9          PHI INTO (E+ E-)/(K+ K-)    (UNITS 10**-4) (SEE ALSO R16)
R9      40    6.1      1.7          BECKER    68 CNTR         GAMMA C      9/68

R10         PHI INTO (MU+ MU-)/TOTAL (UNITS 10**-4)
R10          (53.)   OR LESS        GALTIERI  65 HBC    2.7 K- P          10/66
R10          (7.4)   OR LESS        CHASE     67 CNTR     PHOTOPROD.       6/68
R10           3.5      3.5     1.8  WEHMANN   68 OSPK   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         . . . . . . . . . .
R10 AVG       2.26     0.51    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R11         PHI INTO (ETA GAMMA)/TOTAL
R11          (0.2)   OR LESS        BADIER    65 HBC      3.0 K-P         10/66
R11          (0.08)  OR LESS        LINDSEY   66 HBC      2.7 K-P         10/66
R11          (0.020)  (0.0075)      BENAKSAS  70 OSPK        E+ E-         1/71*

R12          (0.05)  OR LESS        LINDSEY   65 HBC      2.7 K-P         10/66
R12         PHI INTO (PI+ PI- GAMMA)/(K KBAR)

R13         PHI INTO (ETA NEUTRALS)/(K KBAR)
R13          (0.15)  OR LESS        LINDSEY   66 HBC      2.7 K-P         10/66

R14         PHI INTO (OMEGA GAMMA) / TOTAL
R14          (0.05)  OR LESS        LINDSEY   66 HBC      2.7 K-P         10/66

R15         PHI INTO (RHO GAMMA) / TOTAL
R15          (0.02)  OR LESS        LINDSEY   66 HBC      2.7 K-P         10/66

R16         PHI INTO (E+ E-)/TOTAL      (UNITS 10**-4) (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 B        (3.4)    (0.4)         BALAKIN   69 OSPK   E+ E- COLL.BEAMS   9/69
R16 B         BALAKIN 69 SUPERSEDED BY BALAKIN 70
R16          (2.81)   (0.25)        BALAKIN   70 OSPK    E+ E- COLL.BEAM   1/71*
R16           3.45     0.27         BIZOT     70 OSPK   E+ E- COLL.BEAMS   6/70
R16         . . . . . . . . . .
R16 AVG       3.50     0.27    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R17         PHI INTO (PI0 GAMMA)/(TOTAL)
R17          (.0035)OR LESS         BEMPORAD  69 CNTR      5.5 GAMMA N     7/69
R17          (0.0024)OR LESS,CL=.95 BENAKSAS  70 OSPK        E+ E-         1/71*

R18         PHI INTO (PI+ PI-)/(TOTAL)    (SEE ALSO R8)
R18          (0.05) OR LESS         LINDSEY2  65 HBC    1.7-2.7 K-P
R19          (0.006)OR LESS,C.L.=0.95 BALAKIN 70 OSPK    E+ E- COLL. 5  .
```

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 1 .464+-.028
 P 2   -.154    .354+-.040
 P 3   -.565      -.729    .182+-.054
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                               REFERENCES FOR PHI
BERTANZA 62 PRL 9 180         BERTANZA,BRISSON,CONNOLLY,HART +   (BNL+SYR)
ARMENTER 63 SIENA CONF 2 70   ARMENTEROS,EDWARDS,ASTIER+ (CERN+CDF-PARIS)
GELFAND  63 PRL 11 438        GELFAND,MILLER,NUSSBAUM,KIRSCH+ (COLU+RUTG)
   GELFAND 63 DATA INCLUDED IN MILLER 65 BELOW
SCHLEIN  63 PRL 10 368        SCHLEIN,SLATER,SMITH,STORK,TICHO      (UCLA)

BADIER   65 PL 17 337         BADIER,DEMOULIN,BARLOUTAUD+ (PAR+LPCHE+ZEE)
BERLEY   65 PR 139 B 1097     D BERLEY,N GELFAND            (BNL+COLUMB+A)
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 DATA INCLUDED IN LINDSEY 66 BELOW
LINDSEY2 65 UCRL 16526        JAMES S. LINDSEY (THESIS)              (LRL)   0
MILLER D 65 CU-237(NEVIS 131) DAVID C MILLER  (THESIS)          (COLUMBIA)

GRAY, L  66 PRL  17  501      +HAGERTY,BIZZARRI,CIAPETTI +     (SYR+ROME)JPG
LINDSEY  66 PR  147  913      JAMES S LINDSEY, GERALD A SMITH        (LRL)
LINDSEY1 66 PL 20 93          J.S.LINDSEY, G.A.SMITH                 (LRL)
   LINDSEY 1 66 DATA INCLUDED  IN LINDSEY 66 ABOVE
LONDON   66 PR 143 1034       LONDON,RAU,SAMIOS,GOLDBERG + (BNL+SYRACUSE)

ABRAMS   67 MD TECH REP 720   GERALD ABRAMS , THESIS            (MARYLAND)
BARLOW   67 NC 50A 701        +LILLESTOL+MONTANET+(CERN+CDF+IR+LIVERPOOL)
CHASE    67 PRL 18 710        R.C.CHASE,P.ROTHWELL,R.WEINSTEIN(CEA+NEAST)
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)
    ALSO 67 PRL 19 869        ASBURY,BECKER,BERTRAM,TING+ (DESY+COLUMBIA)
BECKER   68 PRL 21 1504       +BERTRAM,BINKLEY,JORDAN,KNASEL+   (DESY+MIT)
BINNIE   68 PL 27B 106        +DUANE+FARUQI+HORSEY+      (I.C.LON+RUTHERF)
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)

BALAKIN  69  IYAF 327 TRANS   +BUDKER,KORSHUNOV,MISHNEV,SIDOROV+    (NOVO)
   SEE ALSO SIDOROV 69
BEMPORAD 69 PL 29 B 383       +BRACCINI,CASTALDI,LUBELSMEYER,+(PISA+BONN)
MOY      69  THESIS           KEN MIN MOY      (NORTH-EASTERN UNIVERSITY)
SCOTTER  69 NC 62 A 1057      +ERSKINE,PALER,+  (BIRM+GLAS+LOIC+MPIM+OXF)
SIDOROV  69 LIVERPOOL SYMP.ON ELECTRONS+PHOTONS,P.227, SIDOROV      (NOVO)

BALAKIN  70  PREPRINT         +BUTLER,PAKHTUSOVA,SIDOROV,SKRINSKY,+(NOVO)
BENAKSAS 70  LAL 1240         +COSME,JEAN-MARIE,JULLIAN,LAPLANCHE+ (ORSA)   0
BIZOT    70 PL 32 416         +BUON,CHATELUS,JEANJEAN,LALANNE,+     (ORSA)
   SEE ALSO PEREZ-Y-JORBA, LIVERPOOL SYMP.69
BIZOT1   70  PRIV.COMM.       PEREZ-Y-JORBA                         (ORSA)
EARLES   70 PRL 25 1312       +FAISSLER,GETTNER,LUTZ,MOY,TANG,+     (NEAS)
HYAMS    70  PRIV.COMM.       +KOCH,POTTER,V.LINDERN,LORENZ,LUTJENS(CERN)
SABRE    70  PREPRINT         SABRE COLLABOR.  (SACL+AMST+BGNA+REHO+EPOL)

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NOTE ON $I^G = 0^+$ PEAKS WITH M = 1000 – 1120 MeV [$S^* \to K\bar{K}$, $\eta_N(1080) \to \pi\pi$].

Evidence for $I^G = 0^+$ peaks in this region comes from two distinct final states: $K\bar{K}$ and $\pi^+\pi^-$. As the $K\bar{K}$ peaks undoubtedly have $J^P = 0^+$, whereas the $\pi^+\pi^-$ peaks in some cases favor $J^P = 2^+$, it is not clear whether there are one or more objects in this region. For the time being we continue to treat the $K\bar{K}$ and $\pi\pi$ peaks as two distinct objects, named $\eta_{0^+}(1070)$ or S^*, and $\eta_N(1080)$, respectively.

Final understanding of these resonances, which can decay into both $K\bar{K}$ and $\pi\pi$, requires coupled-channel analyses. For a summary of the S-wave $\pi\pi$ partial wave amplitude in this region, see the earlier mini-review on the $\eta_{0^+}(700\text{-}1000)$ or ϵ, meson.

The disagreement between some of the observed widths of the $K\bar{K}$ peaks is related to an ambiguity in interpretation either as a resonance (above threshold) or as a scattering length effect in the $K\bar{K}$ channel. Computation of the average values of mass and width of the S^* would be useless because of the large discrepancies. In the meson table we give the values estimated in the review of BEUSCH 70.

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".

For notation, see illustrated key at beginning of data card listings.

Note that the selection made in some HBC experiments to reduce the background under the $\eta_N(1080)$ in the reaction $\pi^- p \rightarrow \pi^+\pi^- n$ may lead to a sample of events ambiguous with $\pi^- p \rightarrow p\pi^-\pi^0\pi^0$. This is because selecting on small momentum transfer to the $\pi^+\pi^-$-system, together with large $\pi^-_{in}\pi^-_{out}$ scattering angle, leads to rather high lab momenta of the π^+, so that ionization cannot be used to discriminate between the two hypotheses (BATON 70, footnote p. 525, and private communications from G. Laurens).

$\eta_{0+}(1070)$ or S^*

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3 ETA (1070,JPG=0++)I=0
NAMED S* BY CRENNELL 66. SEE NOTE ABOVE.
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                      3 ETA (1070) MASS (MEV)

M          (1000.0)   APPROX              BINGHAM   62 HLBC      6-18 PI-N
M          (1000.0)   APPROX              BIGI      62 HBC       10.0 PI-P
M          (1000.0)                       ERWIN     62 HBC       2.10 PI-P       10/66
M        30(1030.0)   APPROX.             BALTAY    64 HBC       3.7 PBAR P
M          (1025.0)   APPROX.             BARMIN    64 HLBC      2.8 PI-P         6/66
M        20 1068.0      10.0              CRENNELL  66 HBC            6.0 PI- P   6/66
M       120  SCATT.LENGTH FITS BETTER.    HESS      66 HBC       1.6-4.2 PI- P   10/66
M       730 1079.0       6.0       5.0    BEUSCH    67 OSPK    5,7,12 PI-P        9/67
M        54 1030.       10.               ALITTI    68 HBC,DBC  3.6-5.0 K- N      7/69
M           1046.0       7.0              AGUILAR-  69 HBC       0.7,1.2 PBAR P   7/69
M           AGUILAR 69 SEES INDICATION OF D-WAVE IN ETA(1060) REGION.
M    H     (1070.)   (SEE NOTE (1))     HOANG     69 OSPK 4 PI-P,KS KS N        5/70
M    H     (1040.)   (SEE NOTE (2))     HOANG     69 OSPK 4 PI-P,KS KS N        5/70
M    H     (1030.)   (SEE NOTE (3))     HOANG     69 OSPK 4 PI-P,KS KS N        5/70
M    H      SCATTERING LENGTH FITS EQUALLY WELL. VALUES ARE (IN F)               5/70
M    H      +-(1.2  +0.3/-0.4),NO SIGNIFICANT IM PART  (FOR 4 GEV/C DATA)        5/70
M    H      +-(1.0  +-0.3     ),NO SIGNIFICANT IM PART  (FOR 5 GEV/C DATA)       5/70
M    B     (1112.)   (SEE NOTE (1))     BEUSCH    70 OSPK 4,6 PI-P              5/70
M    B     (1053.)   (SEE NOTE (2))     BEUSCH    70 OSPK 4,6 PI-P              5/70
M    B      SCATTERING LENGTH FITS ONLY WITH EFFECTIVE RANGE. VALUE (F) IS       5/70
M    B      +-(1.3 + 0.35 *I), WITH EFF.RANGE = 1.4 F.(NOTE THAT SCATT.          5/70
M           LENGTH PLUS EFFECTIVE RANGE TERM ALWAYS SIMULATE RESONANCE IF
M           RELATIVE SIGN CHOSEN NEGATIVE.)
M
M   (1)     FIT ASSUMING BRANCHING RATIO (2 PI)/(K KBAR) OF  0.                  5/70
M   (2)     FIT ASSUMING BRANCHING RATIO (2 PI)/(K KBAR) OF  1.                  5/70
M   (3)     FIT ASSUMING BRANCHING RATIO (2 PI)/(K KBAR) OF  2.                  5/70
M           . . . . . . . . .
M   AVG     1061.7     10.7     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.9)

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                      3 ETA (1070) WIDTH (MEV)

W        20   80.0      15.0              CRENNELL  66 HBC       6.0 PI-P         6/66
W            168.0      21.0      19.0    BEUSCH    67 OSPK    5,7,12 PI-P        9/67
W       BEUSCH 67 ASSUME NO S WAVE SCATTERING LENGTH. WITH S WAVE THE WIDTH
W       BECOMES NARROWER THAN QUOTED ABOVE.
W        54   45.0      35.0      15.0    ALITTI    68 HBC,DBC  3.6-5.0 K- N      7/69
W             40.0      20.0              AGUILAR-  69 HBC       0.7,1.2 PBAR P   7/69
W    H      (200.)   (SEE NOTE (1))     HOANG     69 OSPK 4 PI-P,KS KS N        5/70
W    H      (160.)   (SEE NOTE (2))     HOANG     69 OSPK 4 PI-P,KS KS N        5/70
W    H      (150.)   (SEE NOTE (3))     HOANG     69 OSPK 4 PI-P,KS KS N        5/70
W    H       SCATTERING LENGTH FITS EQUALLY WELL. SEE UNDER MASS ABOVE.          5/70
W    B      (361.)   (SEE NOTE (1))     BEUSCH    70 OSPK 4,6 PI-P              5/70
W    B      (208.)   (SEE NOTE (2))     BEUSCH    70 OSPK 4,6 PI-P              5/70
W    B       SCATT. LENGTH WITH EFFECTIVE RANGE ALSO FITS. SEE UNDER MASS.       5/70
W
W   (1)     FIT ASSUMING BRANCHING RATIO (2 PI)/(K KBAR) OF  0.                  5/70
W   (2)     FIT ASSUMING BRANCHING RATIO (2 PI)/(K KBAR) OF  1.                  5/70
W   (3)     FIT ASSUMING BRANCHING RATIO (2 PI)/(K KBAR) OF  2.                  5/70
W           . . . . . . . . .
W   AVG      85.8      27.4     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.9)

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                      3 ETA (1070) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1          ETA (1070) INTO KKBAR                          493+ 497
P2          ETA (1070) INTO PIPI                           139+ 134

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                      3 ETA (1070) BRANCHING RATIOS

R1          ETA (1070) INTO (PI PI)/(K KBAR)
R1            (2.5)  OR LESS              CRENNELL  66 HBC       90 PCT CONF LEV   7/66
R1             1.0       0.6       0.3    LAI       68 HBC       6 PI- P          11/68

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                         REFERENCES FOR ETA(1070)

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 +  (PARIS+EC POLY+CERN)
ERWIN     62 PRL 9 34             ERWIN,HOYER,MARCH,WALKER,WANGLER    (WIS+BNL)

BALTAY    64 DUBNA CONF 1 409     BALTAY,LACH,CRENNELL,OREN,STUMP +(YALE+BNL)
BARMIN    64 DUBNA CONF 1 433     BARMIN,DOLGOLENKO,YEROFEEV,KRESTNI+  (ITEP)

CRENNELL  66 PRL 16 1025          CRENNELL,KALBFLEISCH,LAI,SCARR,SCHU+  (BNL)
HESS      66 PRL 17 1109          +DAHL+HARDY+KIRZ+MILLER               (LRL)

BARLOW    67 NC 50A 701           +LILLESTOL+MONTANET+(CERN+COF+IR+LIVERPOOL)
BEUSCH    67 PL 25 B 357          +FISCHER,GOBBI,ASTBURY,MICHELINI+(ETH+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+CDF)
    ALSO  BARLOW 67
    ALSO  69 NP B 14 195          M.AGUILAR-BENITEZ,J.BARLOW,+     (CERN+CDF)
HOANG     69 NC 61 A 325          T.F.HOANG                             (ANL)
HOANG     69 PR 184  1363         +EARTLY,PHELAN,ROBERTS,+  (ANL+ILL(CH)+NDAM)

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                         (ETH+CERN)
HYAMS     70 PHILA.CONF.P.41      +KOCH,BEUSCH,+    (CERN+MUNI+ETH+LOIC+HAWA)
OH        70 PR D 1 2494          +GARFINKEL,MORSE,WALKER,PRENTICE(WISC+TNTO)
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A1(1070)

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10  A1 MESON (1070, JPG=1+-)  I=1
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The Threshold Enhancements A1, A3, Q, and L

We present here first some general remarks about these four related peaks; second, some remarks specifically about A1.

The four peaks under study generally arise from a reaction of the form

$$M + T \rightarrow M^* + \pi + T \qquad (1)$$
$$\quad\;\; \lfloor\!\rightarrow M + \pi,$$

where T is the target (proton or deuteron), M the beam particle, and M^* a resonance in the $M\pi$ system. The relevant quantities for each of the enhancements are given below:

M	$M^*(J^P)$	$M^*\pi$ enhancements mass in (MeV)	Mass threshold M^* and π (MeV)
π	$\rho(1^-)$	A1(~ 1070)	920
π	$f^0(2^+)$	π_A(~ 1640) or A3	1400
K	$K^*_{890}(1^-)$	K_A(~ 1300) or Q	1030
K	$K^*_{1420}(2^+)$	K_A(~ 1770) or L	1560

These enhancements share the following features:

1) Large widths (150 to 400 MeV), with little structure except for compilations discussed in the note on the Q peak.

2) Mass about 200 MeV above $M^*\pi$ threshold.

3) They are produced strongly only in diffractive processes [reaction(1)]; exceptions are discussed in point 7 below.

4) Each enhancement has one predominant decay mode, described in reaction (1), although the Q, which is just above $K\rho$ threshold, can hardly avoid showing some $K\rho$ signal.

5) As would be required of a resonance, the enhancement seems to appear in a single partial wave. In fact for all four peaks, preliminary analyses favor a relative s-wave for the $M^*\pi$ system.

6) Some of these enhancements [reaction(1)] have

been "reasonably" well described by the Reggeized Deck model, which does not invoke resonance production in the $M^*\pi$ system. However, the duality hypothesis makes the meaning of these fits unclear.

7) There have been some reports of these enhancements produced in "nondiffractive" processes [i. e., other than reaction (1)] (e. g., Q in $\pi p \to \Lambda K^* \pi$, A1 in $Kp \to Kp\rho\pi$, etc.) Sometimes this is taken as evidence supporting the resonance interpretation, since the production mechanisms are different. However, there are multi-Regge models that can produce low-mass enhancements just as the double-Regge models do. Hence the warnings of (6) apply. This warning was voiced by BERLINGHIERI 69 (footnote 5) as a warning against their own A1 peak produced "nondiffractively" by K^+ mesons. See also discussion of CASO 70 below.

8) There has been a considerable amount of confusion related to these enhancements. Usually the mass distributions from different experiments are quite similar except that the mass distribution from one experiment may be a smooth broad peak, while others may have one or more peak(s) on top of it. In the former case it is natural to attribute the whole enhancement to one effect, resulting in broad width and mainly one decay mode. In the latter case one tends to perform a background subtraction and various cuts to remove the broad enhancement, leaving narrow resonances with several decay modes. The width, cross section, and branching ratio are therefore very sensitive to the assumed background since it is high and rapidly varying. This probably explains why two groups sometimes state very different conclusions while their data are actually very similar.

***

We have already mentioned in the text (Sec. III) and under point 6 above that for these four peaks it is not yet possible to distinguish between two different interpretations (threshold enhancement vs resonance) which are linked by the notion of duality. Our procedure is to enter all four on the Meson Table, with a warning about the interpretation.

Note on Nondiffractive A1 Production

Very many authors have shown that A1 production according to reaction (1) above ($\pi p \to p$ A1) can be described by a Reggeized Deck model. (Two recent papers are BRANDENBURG 70 and CHIEN-1 70.) Hence it is particularly interesting to see if A1 is also produced in other reactions that are free from this complication.

• ANDERSON 69 reported A1 production in $\pi^- p \to p\,A1^-$ in the backward direction. The A1 so produced has much steeper u dependence than exhibited by the other well-known resonances also produced in the same experiment, and this steep $d\sigma/du$ has no simple theoretical explanation. Hence we still accept this result with some reservation.

• DANYSZ 67 and FRIDMAN 68 reported A1 in $\bar{p}p \to 3\pi^+ 3\pi^- \pi^0$. However, the evidence is not overwhelming because of low statistics and high background. The further facts that A1 is neither observed in simpler final states (e. g., $\bar{p}p \to 2\pi^+ 2\pi^- \pi^0$) in the same experiments, nor observed in other $\bar{p}p$ experiments, make the case for A1 production in $\bar{p}p$ reactions quite dubious.

• ALLABY 69 measured the deuteron momentum spectra from the reaction $pp \to d + MM$ at 21.1 GeV/c. Broad peaks were observed with MM at 1100 and 1300 MeV. However, in these measurements the MM system was not observed, hence it is not clear if these peaks were indeed produced in a $\rho\pi$ system. Also SHIH 70 has shown that a double-Regge-pole model produces a broad A1-like enhancement in reactions in which baryon exchange dominates and a $\rho\pi$ system exists in the final state.

• CASO 70 study the following final states in $\pi^- p$ reactions at 11.2 GeV/c:

(1)	$\pi^- p \to p\pi^-(k\pi^0)$,	$k \geqslant 2$,
(2)	$p\pi^+\pi^-\pi^-$,	
(3)	$p\pi^+\pi^-\pi^-\pi^0$,	
(4)	$p\pi^+\pi^-\pi^-(k\pi^0)$,	$k \geqslant 2$,
(5)	$n\pi^+\pi^+\pi^-\pi^-$,	
(6)	$p\pi^+\pi^+\pi^-\pi^-\pi^-$	
(7)	$n\pi^+\pi^+\pi^-\pi^-(k\pi^0)$.	$k \geqslant 1$.

Reactions (2) and much of (1) are of course the classical Deck examples which we are trying to avoid in this note. But the remaining reactions each do show an A1 peak, and when they are all added, the peak shows up quite well. However, we must restate here more precisely our reservation given in point 7 above. Figure 1(a) shows a double-Regge-pole diagram that contributes to reaction 2. The matrix element is called M_2, and we know that it more-or-less explains the A1 peak. Figure 1(b) shows how the DRP diagram must be modified to explain reaction (6) which involves two more pions. One can simply add one more link to the chain, and put a ρ at the new vertex. The triple-Regge-pole matrix element M_3 can then be written $M_3 = M_2\, M_1$, where M_2 already contains the A1 peak, and M_1 just involves another propagator. We do not see why the extra factor M_1 should destroy

Mesons

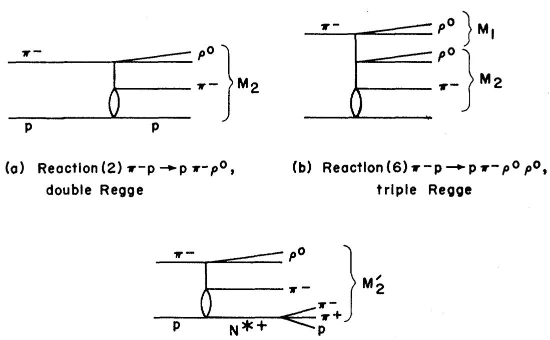
For notation, see illustrated key at beginning of data card listings.

the A1 peak. Then how can we say that reaction 6 is new evidence for a resonant interpretation of the A1 peak?

Another way to draw this reaction 6 is sketched in Fig. 1(c). M_2' might have much the same shape as M_2.

One can look for new evidence where there is charge-exchange at the lower vertex, so that Pomeron exchange is forbidden. $M_2(n)$ should then simulate the A1 peak less well than $M_2(p)$. Unfortunately their charge-exchange reaction (7) does not show a very good A1 signal. We conclude that it is hard to find an independent "nondiffractive" example of A1 production.

In summary, reports on A1 production in "nondiffractive" reactions (i.e., other than $\pi^{\pm}p \to \rho^0\pi^{\pm}p$) become increasingly abundant. (For details, see GARELICK 70.) But the most striking example is still that of ANDERSON 69, and even here we have stated some reservations. CASO 70 also looks quite convincing. In general, contrary to the overwhelming evidence of A1 production in $\pi^{\pm}p \to \rho^0\pi^{\pm}p$ reactions reported in every $\pi^{\pm}$ experiment, A1 production in "nondiffractive" reactions has been reported in very few experiments with much lower statistics. More experiments and re-examination of the "nonreporting" experiments are needed; e.g., it is important to examine other high-energy πp experiments for reactions 1 to 7 to compare with CASO 70.



(a) Reaction (2) $\pi^-p \to p\pi^-\rho^0$, double Regge

(b) Reaction (6) $\pi^-p \to p\pi^-\rho^0\rho^0$, triple Regge

(c) N* interpretation of reaction (6)

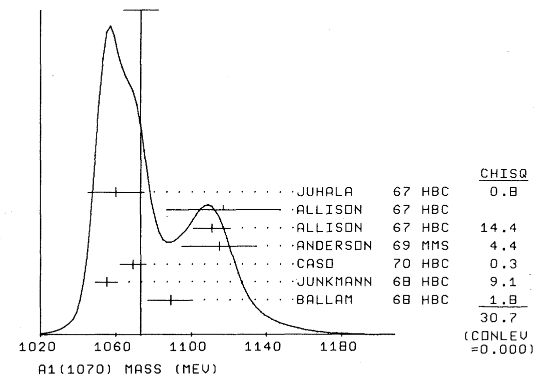
Fig. 1. Regge pole diagrams for A1 production.

```
                    10  A1 MESON  MASS (MEV)

M       MASS AND WIDTH MIGHT HAVE LARGE SYSTEMATIC
M       ERRORS DUE TO COMPLICATED BEHAVIOR OF BACKGROUND.

M    PRODUCED BY PIONS, RESONANCE INTERP. CONFUSED BY DECK EFFECT
M
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
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
M    PRODUCED BY PIONS,BACKWARDS SCATT. NO DECK EFFECT.
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
M    PRODUCED BY K-, SEE TYPED NOTE.
M          1111.       10.              ALLISON   67 HBC  +   6 K-P,LAM +5 PI     1/68
M          1117.       30.              ALLISON   67 HBC  +   6 K-P,LAM +4 PI     1/68
M          1060.       15.              JUHALA    67 HBC    0 4.6-5 K-P,5BODY     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 AND TYPED NOTE.
M
M          . . . . . . . . .
M    AVG   1073.1       9.2    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.5)
                      (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 1073.1 ± 9.2
ERROR SCALED BY 2.5

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                    10  A1 MESON  WIDTH (MEV)

W       SEE NOTE UNDER A1 MESON MASS.

W    PRODUCED BY PIONS, RESONANCE INTERP. CONFUSED BY DECK EFFECT
W
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
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
W    PRODUCED BY PIONS,BACKWARDS SCATT. NO DECK EFFECT.
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
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,5BODY     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 AND TYPED NOTE.
W         (130.0)    (20.0)             BERLINGHI 69 HBC  + 0 12.7 K+ P           9/69
W
W          . . . . . . . . .
W    AVG    96.6       10.1    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
                      (SEE IDEOGRAM BELOW )
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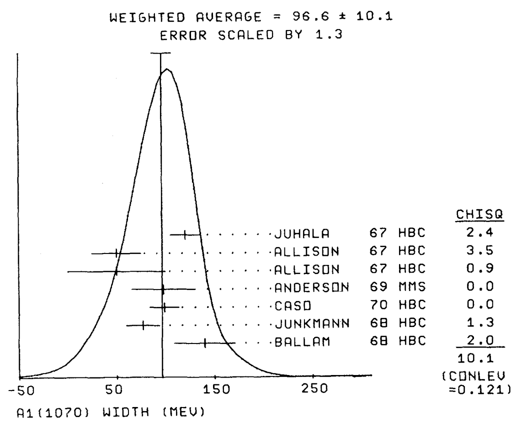
For notation, see illustrated key at beginning of data card listings.



10 A1 PARTIAL DECAY MODES

		DECAY MASSES
P1	A1 INTO RHO PI	765+ 139
P2	A1 INTO KBAR K	493+ 497
P3	A1 INTO ETA PI	548+ 139
P4	A1 INTO ETA PRIME PI	957+ 139
P5	A1 INTO 3 PI	139+ 139+ 139

10 A1 BRANCHING RATIOS

R1	A1 INTO (KBAR K)/(RHO PI)					
R1	(0.0025)OR LESS	DAHL	67 HBC	-	4.0 PI- P	.10/66
R1	A1 INTO (KBAR K)/(RHO PI)					

REFERENCES FOR A1

ADERHOLZ 64 PL 10 226 AACH+BERL+BIRM+BONN+DESY+HAMB+IMP.COL+ MPI
DEUTSCHM 66 PL 20 82 DEUTSCHMANN,STEINBERG + (AACH+BERLIN+CERN)

ALLISON 67 PL 25B 619 +CRUZ+ (OXF+MUN+BIRM+RUTH+GLASG+LON(IC))
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)

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+MIL+SACL)
CHUNG 68 PR 165 1491 S.U.CHUNG,O.DAHL,J.KIRZ,D.H.MILLER (LRL)
FRIDMAN 68 PR 167 1268 +MAURER,MICHALON,OUDET+(HEIDELB+STRASBOURG)
JUNKMANN 68 NP B8 471 +COCCONI+ (AACH+BERL+BONN+CERN+WARS)
KEY 68 PR 166 1430 +PRENTICE+COOPER+MANNER+WALKER+(TO+ANL+WIS)

ALEXANDE 69 PR 183 1168 G.ALEXANDER,A.FIRESTONE,G.GOLDHABER (LRL)
ALLABY 69 PL 29B 198 +BINON+DIDDENS+DUTEIL+KLOVNING+... (CERN)
ANDERSON 69 PRL 22 1390 +COLLINS,+ (BNL+CARN)
BERLINGH 69 PRL 23 42 BERLINGHIERI,FARBER,+ (ROCH)
JUHALA 69 PR 184 1461 +LEACOCK,RHODE,KOPELMAN,LIBBY,+ (AMES+COLO)

ARMENISE 70 LNC 4 199 +GHIDINI,FORING,CARTACCI,+ (BARI+BGNA+FIRZ)
CASO 70 LNC 3 707 +CORDS,COSTA,DARO+(GENO+DESY+HAM+MILA+SACL)
ALSO CASO 68
CRENNELL 70 PRL 24 781 +KARSHON,LAI,SCARR,SIMS (BNL)
RABIN 70 PRL 24 925 +GALTIERI,DFRENZO,FLATTE,FRIEDMAN+ (LRL)
SHIH 70 BNL 14059-REV +YOUNG (BNL)

PAPERS NOT REFERRED TO IN DATA CARDS

BELLINI 63 NC 29 896 BELLINI,FIORINI,HERZ,NEGRI,RATTI (MILAN)
GOLDHABE 64 PRL 12 336 GOLDHABER,BROWN,KADYK,SHEN,TRILLING(LRL+UC)
LANDER 64 PRL 13 346 A LANDER,ABOLINS,CARMONY,HENDRICKS + (UCSD) JP
ABOLINS 65 ATHENS(OHIO)CONF. +CARMONY,LANDER,XUONG,YAGER (LA JOLLA)I=1
ALITTI 65 PL 15 69 ALITTI,BATON,DELER,CRUSSARD+ (SAC+BOL)
ALLARD 66 NC 46A 737 +DRIJARD+HENNESSY+ (ORSAY+MILAN+SAC+BERK)
HESS 66 UCRL-16832 R I HESS (THESIS, BERKELEY) (LRL)
SLATTERY 67 NC 50A 377 +KRAYBILL+FORMAN+FERBEL (YALE+ROCH) JP
ARMENISE 68 PL 26 B 336 +FORINO+CARTACCI+ (BARI+BOL+FIR+ORSAY)
CNOPS 68 PRL 21 1609 +HOUGH,COHN,BUGG+ (BNL+ORNL+ORUC+TENN+PENN)
DONALD 69 NP B 11 551 +EDWARDS,BURAN,BETTINI,+ (LIVP+OSLO+PADO)
FAYOLLE 69 NP B 13 40 +DE MONTAIGNAC,MORAND,STRACHMAN+ (PARIS)
KENYON 69 PRL 23 146 +KINSON,SCARR,+ (BNL+ORUC+ORNL)
CHIEN2 70 JHU 7011 C.Y.CHIEN (JOHNS HOPKINS)
CHIEN1 70 TORONTO PREPRINT +CHAO,JOHNSTON,PRENTICE,WALKER (TOR+WISC)
BRANDENB 70 NP B16 369 +BRENNER,IOFFREDO,JOHNSON,KIM+ (HARVARD)
GARELICK 70 PHILAD.CONF.P.205 D.A.GARELICK,REVIEW (NORTHEASTERN)

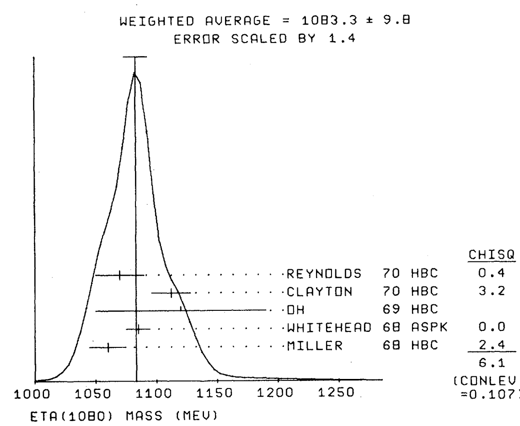
$\eta_N(1080)$ $\to\pi\pi$

30 ETA N (1080, JPG=N +) I=0 J GREATER THAN 1
SOME EXPERIMENTS SUGGEST J=2.
SEE NOTE ABOVE ETA(1070,0+)

OMITTED FROM TABLE

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) (SEE IDEOGRAM BELOW)				



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+ 0	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 OF 1.0)				

REFERENCES FOR ETA N

MILLER 68 PRL 21 1489 +GUTAY,JOHNSON,KENNEY+ (PURDUE+NDAME+SLAC)
WHITEHEA 68 NC 53 A 817 C.WHITEHEAD + (HARWELL+STHAMPT+U.C.LON)

OH 69 PRL 23 331 +WALKER,CARROLL,FIREBAUGH,+ (WISC+TNTO)

BATON 70 PL 33 B 528 +LAURENS,REIGNIER (SACLAY)
DIAZ 70 NP B 16 239 +GAVILLET,LABROSSE,MONTANET+ (CERN+CDEF)
CLAYTON 70 NP B 22 85 +MASON,MUIRHEAD,RIGOPOULOS,+ (LIVP+ATEN)
OH 70 PR D 1 2494 +GARFINKEL,MORSE,WALKER,PRENTICE(WISC+TNTO)
REYNOLDS 70 NP B 21 77 +ALBRIGHT,BRADLEY,+ (ATHO+FLAS+MINN+COLO)

$A_{1.5}(1170)$

44 A 1.5 (1170, JPG= -) I=1

THIS ENTRY LISTS REFERENCES TO PEAKS OF LOW STATISTICAL SIGNIFICANCE IN THE 3 PI SYSTEM BETWEEN THE A1 AND THE A2. OMITTED FROM TABLE.

REFERENCES ON A 1.5 (1170)

BUTTERWO 67 HEIDELB.CONF.P.28 REVIEW TALK ON MESONS 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)
VON 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)

For notation, see illustrated key at beginning of data card listings.

B(1235)

```
                  11   B MESON (1235,JPG=1++)  I=1

                  ASCOLI 68 FIND JP EITHER =1+, OR = 2+,3-,...
                  BIZZARRI 69 GET GOOD FIT ONLY FOR JP=1+ OR 1-.
                  THE SERIES JP=3-,5-,...SEEMS UNLIKELY BECAUSE 2PI AND
                  K KBAR  DECAYS ARE NOT OBSERVED.

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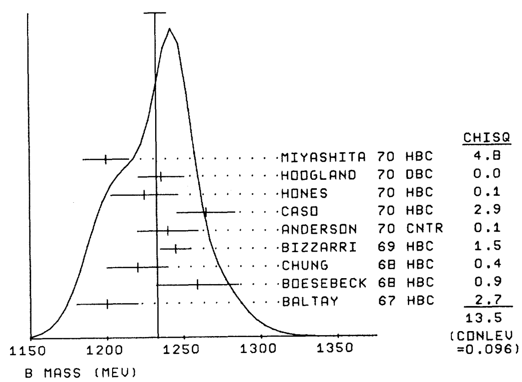
                  11   B MESON  MASS (MEV)

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       25(1250.)  ESTIMATED        LEE       67 HBC  -   3.6 PI- P       1/68
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      IN THE 3-4 PI-P DATA,THE B ENHANCEMENT MAY BE DECK EFFECT (CHUNG 68)
M      300 1245.     10.            BIZZARRI  69 HBC  +-  0 PBAR P      . 9/69
M    B        OVERLAPPING B-MESON BANDS TAKEN INTO ACCOUNT BY BIZZARRI
M          1240.0    20.0           ANDERSON  70 CNTR   0 5-18 GAMMA P  11/70*
M          1265.0    19.0           CASO      70 HBC  - 11.2PI-P          5/70
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 DBC  -   3.0 K- D        2/71*
M          1200.0    15.0           MIYASHITA 70 HBC  -   6.7 PI-P,4PI
M          . . . . . . . . .
M    AVG   1232.9     7.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
                       (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 1232.9 ± 7.2
ERROR SCALED BY 1.3

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                  11   B MESON  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      300   83.      12.                 BIZZARRI  69 HBC  +-  0 PBAR P       9/69
W    B        OVERLAPPING B-MESON BANDS TAKEN INTO ACCOUNT BY BIZZARRI
W          (100.0)  APPROX.               ANDERSON  70 CNTR   0 5-18+GAMMA P  11/70*
W          (150.0)                        CASO      70 HBC  - 11.2PI-P         5/70
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           . . . . . . . . .
W    AVG    104.4      9.0     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
                        (SEE IDEOGRAM BELOW )
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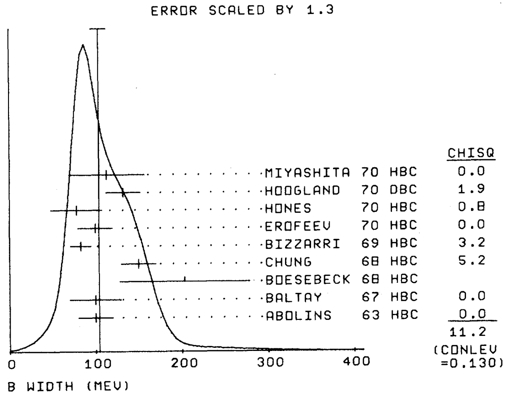
WEIGHTED AVERAGE = 104.4 ± 9.0
ERROR SCALED BY 1.3

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                  11   B MESON PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      B MESON INTO OMEGA+PI                                783+ 139
P2      B MESON INTO 2PI+ 2PI-                               139+ 139+ 139+ 139
P3      B MESON INTO K KBAR                                  493+ 493
P4      B MESON INTO PI PI                                   139+ 139
P5      B MESON INTO PI PHI                                  134+1018
P6      B MESON INTO ETA PI (FORBIDDEN BY G)                 548+ 139
P7      B MESON INTO K KBAR PI                               493+ 493+ 139

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                  11   B MESON  BRANCHING RATIOS

R1      B INTO  4PI/(OMEGA PI)
R1            (0.5)  OR LESS            ABOLINS   63 HBC  +   3.5 PI+P

R2      B MESON INTO (K KBAR)/(OMEGA PI)
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 MESON INTO (PI PI)/(PI OMEGA)
R3            (0.3)  OR LESS            ADERHOLZ  64 HBC     4.0 PI+P        7/66

R4      B MESON INTO (PI PHI) / (PI OMEGA)
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 MESON INTO (ETA PI) / (PI OMEGA)
R5            (0.25) OR LESS (CL 90)    BALTAY    67 HBC  +- 0.0 PBAR P      2/67

R6      B+- INTO ((K KBAR)+- PIO) / (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 PBAR 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 MESON

ABOLINS   63 PRL 11 381          ABOLINS,LANDER,MEHLHOP,XUONG,YAGER    (UCSD)
ADERHOLZ  64 PL 10 240           AACHEN+BERLIN+BIRM+BONN+HAMBUR+IC-LOND+MPI
GOLDHABE  65 PRL 15 118          G GOLDHABER,S GOLDHABER,KADYK,SHEN     (LRL)

BALTAY    67 PRL 18 93           +SEVERIENS+YEH+ZANELLO             (COL+BNL)
DAHL      67 PR 163 1377         +HARDY+HESS+KIRZ+MILLER                (LRL)
LEE       67 PR 159 1156         +MOEBS,ROE,SINCLAIR,VANDERVELDE  (MICHIGAN)

BOESEBEC  68 NP B 4 501          BOESEBECK,DEUTSCHMANN,+(AACHEN+BERLIN+CERN)
CASO      68 NC 54 A 983         +CONTE+CORDS+DIAZ+    (GENOVA+HAMB+MIL+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,MONTANET,+       (CERN+CDF)

ANDERSON  70 PR D 1 27           +GUSTAVSON,JOHNSON,+  (SLAC+CALT+UCSB+NEAS)
CASO      70 LNC 3 707           +CONTE,TOMASINI,CORDS+(GENO+HAMB+MILA+SACL)
CASON     70 PR D 1 851          +ANDREWS,BISWAS,GROVES,HARRINGTON,+  (NDAM)
EROFEEV   70 YAD.FIZ. 11 805     +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)

                   PAPERS NOT REFERRED TO IN DATA CARDS

BONDAR    63 PL 5 209            BONDAR,DODD+ (AACHEN+BIRM+HAMB+IC-LOND+MPI)
CARMONY   64 PRL 12 254          CARMONY,LANDER,RINDFLEISCH,XUONG,YAGER (UC) JP
BALLAM    67 HEIDBG CONF P.33    +BRODY,CHADWICK,FRIES,GUIRAGOSSIAN+   (SLAC)
SLATTERY  67 NC 50A 377          +KRAYBILL+FORMAN+FERBEL          (YALE+ROCH)
ASCOLI    68 PRL 20 1411         +CRAWLEY,MORTARA,SHAPIRO            (URBANA) JP
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f(1260)

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                  5   F   (1260,JPG=2++)  I=0

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                  5   F    MASS (MEV)

M             1250.0     25.0          SELOVE     62 HBC     3.0 PI-P
M             1260.0     35.0          VEILLET    63 FBC     6.1 PI-P
M            5(1250.0)                 GUIRAGOSS  63 HBC     3.3 PI-P
M             1240.0     20.0          ACCENSI    66 HBC     5.7 PBAR P        6/66
M        1416 1267.0     10.0          JACOBS     66 HBC    2-3 PI-P,T CUT20  10/67
M             1275.0     25.0          WAHLIG     66 OSPK    10.0 PI-P         6/66
M            (1255.)    (13.)          BARLOW     67 HBC    (K01 K01 MODE)    11/66
M    S       (1276.)    (11.)          RABIN      67 HBC     8.5 PI+ P       . 9/67
M             1261.       4.           ARMENISE   68 DBC     5.1 PI+N,P PI+ -  6/68
M             1270.       5.           ARMENISE   68 DBC     5.1 PI+N,P PIO 0  6/68
M             1265.       8.           BOESEBECK  68 HBC     8 PI+ P           6/68
M             1241.      38.           FOSTER     68 HBC     PBAR P AT REST    6/68
M             1267.      15.           LAMSA      68 HBC     9 PI-P           10/67
M    J        1268.0      6.0          JOHNSON    68 HBC     3.7-4.2 PI- P     7/69
M    J        JOHNSON 68 INCLUDES BONDAR 63, LEE 64, DERADO 65, EISNER 67.
M    S       (1270.0)   (15.0)         WHITEHEAD  68 ASPK    3.2 PI-P,PI+PI-N  6/68
M         161 1269.0     21.0          ARMENISE   69 DBC     5.1 PI+D,3PI++-   5/70
M             1255.0     10.0          DONALD     69 HBC     1.2 PB P,2PI      8/69
M            (1270.0)                  CASO       69 HBC     11. PI- P,N2PI    8/69
M             1265.      16.           AGUILAR    70 HBC     3.9-4.6 K- P      1/71*
M             1275.0     13.0          ARMENISE   70 HBC   0 9 PI+ N -- F P    1/71*
M             1273.0      7.0          ARMENISE   70 HBC   0 9 PI+ N -- MM P   1/71*
M    C        1277.      16.           EISENSTE   70 DBC     4.2 PI+ N         1/71*
M    C        INCLUDES 14 MEV SYSTEMATIC ERROR ESTIMATED FROM RHO MASS SHIFT
M         600 1275.0     10.0          OH         70 HBC     1.26 PI- P,P F    1/71*
M    A        1273.0      6.0          STUNTEBEC  70 HBC     8. PI- P          1/71*
M    S   5300 1277.0      4.0          FLATTE     71 HBC     7.PI+P,DELTA++F   1/71*
M    A        SOME EVIDENCE FOR ASYMMETRIC SPLITTING.
M    S         S-WAVE BREIT-WIGNER FIT
M             . . . . . . . . .
M    AVG      1268.9      1.8      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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For notation, see illustrated key at beginning of data card listings.

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                    5  F   WIDTH (MEV)

W              100.0     25.0            SELOVE     62 HBC      3.0 PI-P
W             (200.0)  OR LESS           VEILLET    63 FBC      6.1 PI-P
W              102.0     46.0            ACCENSI    66 HBC      5.7 PBAR P         6/66
W        1416   99.0     10.0            JACOBS     66 HBC    2-3 PI-P,T CUT20    10/67
W             (100.)                     WAHLIG     66 OSPK    10.0 PI-P          11/66
W              (82.)    (34.)            BARLOW     67 HBC    (K01 K01 MODE)      11/66
W   S         (155.)    (17.)            RABIN      67 HBC     8.5 PI+ P         . 9/67
W              216.      13.             ARMENISE   68 DBC     5.1 PI+N,P PI+ -    6/68
W              188.      15.             ARMENISE   68 DBC     5.1 PI+N,P PI0 0    6/68
W              128.      23.             BOESEBECK  68 HBC     8 PI+ P             6/68
W              172.      49.             FOSTER     68 HBC     PBAR P AT REST      6/68
W              113.      30.             LAMSA      68 HBC     8 PI-P             10/67
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   S         (160.0)   (20.0)           WHITEHEAD  68 ASPK    3.2 PI-P,PI+PI-N    6/68
W         161  216.0     60.0            ARMENISE   69 DBC     5.1 PI+D,3PI++-     5/70
W             (150.0)                    CASO       69 HBC     11. PI- P,N2PI      8/69
W              150.0     30.0            DONALD     69 HBC     1.2 PB P,2PI        8/69
W              141.      35.             AGUILAR    70 HBC     3.9-4.6 K- P        1/71*
W              131.0     25.0            ARMENISE   70 HBC    0 9 PI+ N -- MM P    1/71*
W              173.0     11.0            ARMENISE   70 HBC    0 9 PI+ N -- F P     1/71*
W         600  120.0     15.0            OH         70 HBC    1.26 PI- P,P F       1/71*
W    A         196.0     18.0            STUNTEBEC  70 HBC     8. PI- P            1/71*
W    A    SOME EVIDENCE FOR ASYMMETRIC SPLITTING.
W   S 5300 (183.0)      (15.0)           FLATTE     71 HBC    7.PI+P,DELTA++F      1/71*
W   S      S-WAVE BREIT-WIGNER FIT, NO EVIDENCE FOR SPLITTING
W
W              . . . . . . . . . .
W  AVG         154.0     10.9      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.5)
                              (SEE IDEOGRAM BELOW )
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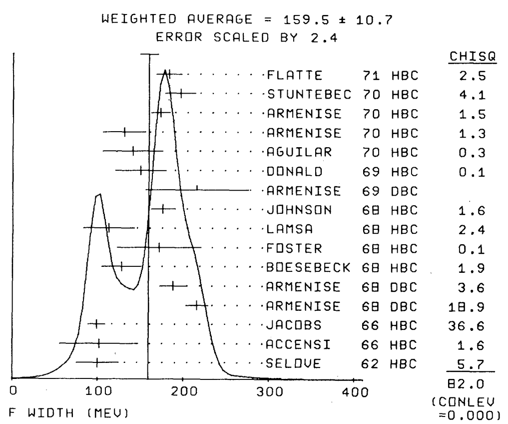


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                    5  F   PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      F   INTO PI+ PI-                                  139+ 139
P2      F   INTO 2PI+ 2PI-                                139+ 139+ 139+ 139
P3      F   INTO K KBAR                                   497+ 497

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                    5  F   BRANCHING RATIOS

R10     F PARTIAL WAVE  (I.E. I=1,  JP=2+) AMPLITUDE AT F RESONANCE
R10          WE TABULATE X = 1/2 (1 + ETA).  THIS SHOULD BE PI PI FRACTION
R10          FOR PURE BW WITH NO BACKGROUND.
R10     250    0.85     0.05           BEAUPRE   70 HBC    08 PI+ P,DELTA++F  1/71*
R10     600    0.8      0.04           OH        70 HBC    01.26 PI- P,P F    1/71*
R10          . . . . . . . . . .
R10 AVG        0.820    0.031   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R1      F INTO (2PI+ 2PI-) / (PI PI)
R1    ASCOLI 68 SUGGEST DECAY IS MAINLY RHO-RHO, 1/3 OF WHICH YIELD 2PI+ 2PI-
R1      SOME UPPER LIMITS (X OR LESS) HAVE BEEN PUNCHED AS (0 +-X)
R1           SO THEY CAN BE PROCESSED BY OUR AVERAGING ROUTINES
R1             0.08     0.06           BONDAR    63 HBC      4.0 PI-P
R1             0.04     0.05           CHUNG     65 HBC      3.2 PI-P
R1       50    0.07     0.04           ASCOLI    68 HBC     5 PI- P             6/68
P1           (0.048)OR LESS            BARDADIN  70 HBC      8 PI+ P            1/71*
R1      600    0.07     0.02           OH        70 HBC     1.26 PI- P,P F      1/71*
R1           . . . . . . . . . .
R1   AVG       0.068    0.016   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2      F INTO (K KBAR)/(PI PI)
R2           DETERMINATION DIFFICULT BECAUSE PROXIMITY OF A2 WHICH HAS SAME
R2           NEUTRAL (K KBAR) MODES. SINCE INTERFERENCE MAY BE CONSTRUCTIVE
R2           OR DESTRUCTIVE, EVEN UPPER LIMITS ARE DUBIOUS.
R2      SOME UPPER LIMITS (X OR LESS) HAVE BEEN PUNCHED AS (0 +-X)
R2             0.00     0.09           BARMIN    65 HLBC     2.8 PI-           10/66
R2             0.00     0.16           WANGLER   65 HBC      3.0 PI-P
R2             PROBABLY SEEN           BARLOW    67 HBC     1.2 PBAR P--K1K1   11/66
R2           (0.047)  (0.012)+ SYST.   BEUSCH    67 OSPK    5,7,12 PI-P       . 9/67
R2             0.000     0.025         DAHL      67 HBC      1.6-4.2 PI- P     10/66
P2   A       (0.031)  (0.012)          ADERHOLZ  69 HBC      8 PI+ P,K+K-PI-   8/69
R2   A         K+K- PEAK IS AT ABOUT 1260 MEV WHILE (KKBAR)+ PEAKS AT 1320.
R2   A         ALSO (CROSSSECTION*BRANCHING RATIO) FOR A2 IS SMALL.
R2      600    0.06     0.02           OH        70 HBC     1.26 PI- P,P F      1/71*
R2           . . . . . . . . . .
R2   AVG       0.035    0.021   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)

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                           REFERENCES FOR F

SELOVE   62 PRL 9 272          SELOVE,HAGOPIAN,BRODY,BAKER,LEBOY    (PENNA)
BONDAR   63 PL 5 153           BONDAR+ (AACHEN+BIRM+BONN+DESY+IC-LOND+MPI)
GUIRAGOS 63 PRL 11 85          Z.G.T. GUIRAGOSSIAN                    (LRL)
HAGOPIAN 63 PRL 10 533         V HAGOPIAN,W SELOVE                  (PENNA)
VEILLET  63 PRL 10 29          VEILLET,HENNESSY,BINGHAM,BLOCH+ (PAR+MILAN)

ADERHOLZ 64 PL 10 240          AACHEN+BERLIN+BIRM+BONN+HAMBUR+IC-LOND+MPI  IJ
BRUYANT  64 PL 10 232          BRUYANT,GOLDBERG,HOLDER,FLEURY,HUC(CERN+PA) I
LEE      64 PRL 12 342         LEE,ROE,SINCLAIR,VANDERVELDE      (MICHIGAN)
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+CDF+IR+LIVERPOOL)
BEUSCH   67 PL 25 B 357        +FISCHER,GOBBI,ASTBURY,MICHELINI+(ETH+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+ (NOTRDAM+PENN)
RABIN    67 THESIS             M. RABIN                           (RUTGERS)

ARMENISE 68 NC 54 A 999        +FORINO+CARTACCI+(BARI+BOLOG+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+PARIS)
JOHNSON  68 PR 176 1651        +POIRIER,BISWAS,GUTAY,DERADO+(ND+PURD+SLAC)
    ALSO BONDAR 63, LEE 64, DERADO 65, EISNER 67
LAMSA    68 PR 166 1395        +CASON+BISWAS+DERADO+GROVES+    (NOTREDAME)
    ALSO POIRIER 67
WHITEHEA 68 NC 53A 817         +MCEWEN,OTT,AITKEN+   (AERE+SHAMPT+UC.LOND)

ADERHOLZ 69 NP B 11 259        +BARTSCH,+        (AACH+BERL+CERN+KRAK+WARS)
AGUILAR- 69 PL 29 B  241       M.AGUILAR-BENITEZ,J.BARLOW,+      (CERN+CDF)
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+SYR)
ARMENISE 70 LNC 4  199         +GHIDINI,FORING,CARTACCI,+ (BARI+BGNA+FIRZ)
BADIER   70 NP B 22 512        +BONNET,DREVILLON,BAURILLIER,+  (EPOL+IPNP)
BARDADIN 70  PREPRINT          BARDANIN-OTWINOWSKA,HOFMOKL,+         (WARS)
BEAUPRE  70  CERN PHYS 70 42   +DEUTSCHMANN,GRAESSLER,+    (AACH+BERL+CERNJ)
EISENSTE 70  COO 1195 194      EISENSTEIN,GORDON                      (ILL)
OH       70 PR D 1 2494        +GARFINKEL,MORSE,WALKER,PRENTICE(WISC+TNTOJ)
STUNTEBE 70 PL 32 B 391        STUNTEBECK,KENNEY,DEERY,BISWAS,CASON+(NDAM)

FLATTE   71  UCRL  20273       ALSTON-G,BARBARO-G,DERENZO,FRIEDMAN,+ (LRL)
             SUBM. PHYS.LET.B 5300 F EVENTS SHOW NO SPLITTING         UNSPLIT
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D(1285)

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           8  D MESON (1285,JPG=  +) I=0

           (JP=0-,1+,2- WITH 1+ FAVORED.)

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                    8  D MESON  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    D    (1329.0)  (10.0)         OTWINOWSK 69 HBC      8 PI+ P, P+6PI    9/69
M    D     SUPERSEDED BY OTWINOWSKI 70
M          1303.0     8.0          OTWINOWSK 70 HBC      8 PI+ P, P+6PI    9/69
M
M          . . . . . . . . . .
M   AVG    1286.4     4.3     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
                         (SEE IDEOGRAM BELOW )
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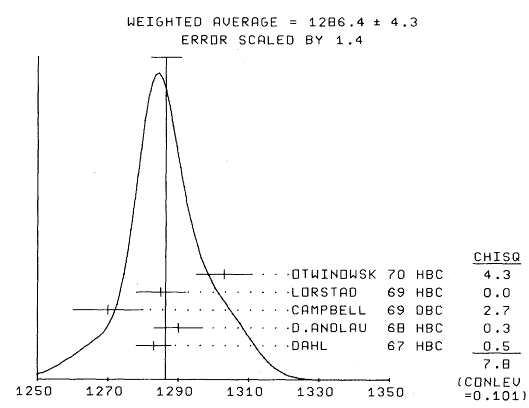

For notation, see illustrated key at beginning of data card listings.

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                    8  D MESON WIDTH (MEV)

W           35.0      10.0           DAHL      67 HBC      1.6-4.2 PI- P   10/66
W           30.        5.            D.ANDLAU  68 HBC  1.2 PBAR P, 5-6 PFS  6/68
W          (40.0)                    DEFOIX    68 HBC      1.2 PB P,7 PI     3/69
W           30.0      15.0           CAMPBELL  69 DBC      2.7 PI+ D         8/69
W           60.       15.            LORSTAD   69 HBC  0.7 PB P, 4,5-BODY    9/69
W    D     (52.0)    (29.0)          DTWINOWSK 69 HBC       8 PI+ P, P+6PI   9/69
W    D    SUPERSEDED BY OTWINOWSKI 70
W           44.0      24.0           OTWINOWSK 70 HBC       8 PI+ P, P+6PI   9/69
W         . . . . . . . . .
W    AVG    33.4       4.1      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                    8   D MESON PARTIAL DECAY MODES

                                                          DECAY MASSES
P1          D MESON INTO K KBAR PI                       497+ 497+ 134
P2          D MESON INTO PI PI RHO                       134+ 134+ 765
P3          D MESON INTO ETA PI PI                       548+ 134+ 134
P4          D MESON INTO DELTA(962) PI                   956+ 134

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                    8  D MESON BRANCHING RATIOS

R1          D MESON INTO (PI PI RHO) / (K KBAR PI)
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,5PI . 8/69
R1   D          THIS IS FOR (RHOO PI+ PI-)/(K KBAR PIO)

R2          D MESON INTO (K KBAR PI)/(ETA PI PI)
R2            (0.124)  (0.035)         DEFOIX    68 HBC      1.2 PB P,7 PI     3/69

R3          D MESON INTO (DELTA PI)/(ETA PI PI)
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

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                               REFERENCES FOR D MESON

BARLOW   67 NC  50 A  701      +MONTANET,D-ANDLAU+(CERN+CDF+IOR+LIVERPOOL)
DAHL     67 PR 163 1377        +HARDY+HESS+KIRZ+MILLER                (LRL)I JP
   SEE ALSO 65 PRL 14 1074     MILLER,CHUNG,DAHL,HESS,HARDY,KIRZ+ (LRL+UC)
D.ANDLAU 68 NP   B 5  693      +ASTIER,BARLOW,MONTANET+ (CDF+CERN+RAD+LIV)I JP
DEFOIX   68 PL  28 B 353       +RIVET,SIAUD,CONFORTO,SHIVELY(CDF+IPE+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,+       (CDF+CERN)  JP
OTWINOWS 69 PL  29 B 529       S.OTWINOWSKI                         (WARSAW)

AMMAR    70 PR                 +KROPAC,DAVIS,DERRICK+ (KANS+NWES+ANL+WISC)
OTWINOWS 70  1207/VI/PH        S.OTWINOWSKI                           (WARS)

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A2(1300) `12  A2 MESON (1300,JPG=2+-)  I=1`

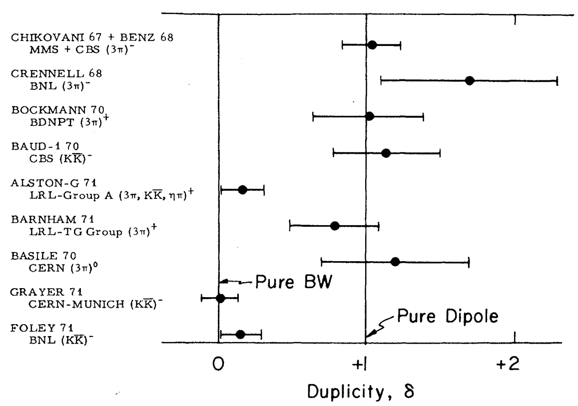
There are now several important experiments which disagree on the issue of whether the A2 is split or not. As can be seen from the summary table, the division between splitting and not-splitting experiments is not simply correlated to any physical property such as A2 charge, momentum transfer, beam energy, decay mode, etc. If indeed all experiments are correct (and we have no reason to suspect the contrary) then a symmetric dipole is excluded. It seems possible, by invoking two interfering resonances, to fit the line shape of all the observed A2 peaks. But then the mechanism responsible for the necessary energy-dependence and charge-dependence of the interference phase and/or the degree of coherence remains an unsolved problem.

The experimental evidence for and against splitting is shown in the figure, taken from G. R. Lynch, UCRL 20622. Each mass spectrum is fitted to an unphysical mixture of the form

$$dn/dm = \delta\,(\text{Dipole}) + (1 - \delta)\,(\text{BW}) + \text{Background}$$

where (Dipole) and (BW) are best fits to each hypothesis separately.

The "Duplicity" parameter δ is easily visualized and plotted because it spans the conflicting hypotheses. We repeat that it makes no physical sense to mix hypotheses.



SUMMARY OF EXPERIMENTS THAT INVESTIGATED A2 SPLITTING

Reaction	Momentum (GeV/c)	Reference	Method	$\Gamma_r/2$ (MeV)	t range $(GeV/c)^2$	Events in peak	Probability of fit[a] BW	Dipole	2 coh. BW	2 incoh. BW
$\pi^-p \to X^-p$	6, 7	CHICOVANI 67	Jac. peak	8.3	0.20-0.29	1400	<<0.1%	≥40%	≥40%	<0.2%
$\to X^-p$	2.65	BENZ 68	0°	5.2	----	1100				
$\to K^-K_Sp$	7	BAUD-1 70	Jac. peak	<10	0.20-0.29	145	1%	>60%		
$\to \eta\pi^-p$	11	BAUD-2 70	Jac. peak	20	0.20-0.30	~90				
$\to \pi^-X^0p$	6	CRENNELL 68	HBC	10	0.22-0.39	100				
$\to X^0n$	3.2	BASILE 70	CNTR	7.5	0.35-0.65	2600	1%	65%		25%
$\pi^+p \to \pi^+\pi^-\pi^+p$	7	ALSTON-G 71	HBC	6.7	> 0.2	941	42%	9%		
$\to \eta\pi^+p$	7	ALSTON-G 71	HBC	9.2	all	189	33% (combined: 16%)	21% (combined: 0.2%)		
$\to K^+K_Sp$	7	ALSTON-G 71	HBC	3.8	all	132	4%	0.6%		
$\to \rho^0\pi^+p$	5	BOCKMANN 70	HBC	5	t' > 0.1	108	20%	63%		70%
$\bar{p}p \to K^\pm K_1\pi^\mp$	0, 0.7, 1.2	AGUILAR-1 69	HBC	5	----	270	4%	65%		28%
$\to 2\pi^+2\pi^-$	1.2	DONALD 69	HBC	12	----	~100	2%			40%
$\pi^-p \to K^-K_Sp$	17.2	GRAYER 71	ASPK	6.7	<0.7	~950	32%	"Not a dipole"		

a. These confidence levels permit only qualitative comparisons, since they depend on the size and number of bins used and the treatment of the number of adjustable parameters; these choices differ from group to group.

Mesons

For notation, see illustrated key at beginning of data card listings.

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                    THE MASS AND WIDTH DATA ARE SEPARATED INTO 4 GROUPS
                    A2L CONTAINS INFORMATION ON THE LOWER PEAK(3PI,K KBAR)
                    A2H CONTAINS INFORMATION ON THE HIGHER PEAK(3PI,KBARK)
                    A2K CONTAINS INFORMATION ON K KBAR(UNSPLIT,UNRESOLVED)
                    A2 CONTAINS THE REMAINING INFORMATION (NO SEPARATION)

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                    12  A2L MESON MASS (MEV)

ML  A     (1274.)     (16.)               CHIKOVANI 67 MMS   -  6,7 PI- P          6/68
ML  A   INCLUDED IN BENZ 68 FIT OF 2 COHERENT SYMMETRIC POLES.
ML         1289.       5.                 BENZ      68 MMS   -  2.65 PI- P        12/68
ML         1269.0      5.0                CRENNELL  68 HBC   -  6.0 PI-P,X-        6/68
ML  BZ    (1281.0)    (3.0)               AGUILAR 1 69 HBC  +- 0-1.2 PB P,K1K+-    5/69
ML   Z     AGUILAR 1 69 INCLUDES BARLOW 67, CONFORTO 67.
ML  C     (1289.0)    (10.0)              CRENNELL  69 DBC   -  3.9 K- N,PI-RHO    8/69
ML  C  MAY BE DIFFERENT OBJECT. JP=1- FAVORED OVER 2+,2-,1+.
ML  C  NOTE THAT IGJP=1-1- IS EXOTIC IN THE QUARK MODEL.
ML         1268.0     12.0                DONALD    69 HBC  +-  1.2 PB P(4 PI)     9/69
ML  B     (1276.)     (6.)                BAUD1     70 MMS   - 7. PI-P, P KKBAR  11/69
ML      35 1265.0      6.0                BAUD2     70 CBS   - 11.PI-P,P ETA PI    5/70
ML  B     (1275.0)    (6.0)               BOCKMANN  70 HBC   +  5. PI+P,INCOHER.   5/70
ML  B     (1287.0)    (2.2)               BASILE    70 CNTR   0 3.16 PI- P         1/71*
ML      60 1286.       5.0                NEF       70 MMS   - 7. PI-P, P KKBAR  11/69
ML  B      FIT TO TWO INCOHERENT BREIT WIGNERS
ML         . . . . . . . . . .
ML         AVG BELOW IS BASED ONLY ON VALUES FROM COHERENT FITS.
ML         . . . . . . . . . .
ML  AVG    1277.8      5.1      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.0)
                           (SEE IDEOGRAM BELOW )------------------------------->

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                    12  A2H MESON MASS (MEV)

MH  A     (1320.)     (16.)               CHIKOVANI 67 MMS   -  6,7 PI- P          6/68
MH  A   INCLUDED IN BENZ 68 FIT OF 2 COHERENT SYMMETRIC POLES.
MH         1309.       5.                 BENZ      68 MMS   -  2.65 PI- P        12/68
MH         1315.0      5.0                CRENNELL  68 HBC   -  6.0 PI-P,X-        6/68
MH  BZ    (1325.0)    (3.0)               AGUILAR 1 69 HBC  +- 0-1.2 PB P,K1K+-    5/69
MH   Z     AGUILAR 1 69 INCLUDES BARLOW 67, CONFORTO 67.
MH         1324.0     25.0                DONALD    69 HBC  +-  1.2 PB P(4 PI)     9/69
MH  B     (1323.)     (6.)                BAUD1     70 MMS   - 7. PI-P, P KKBAR  11/69
MH      35 1331.0      9.0                BAUD2     70 CBS   - 11.PI-P,P ETA PI    5/70
MH  B     (1338.0)    (4.0)               BOCKMANN  70 HBC   +  5. PI+P,INCOHER.   5/70
MH  B     (1329.0)    (1.9)               BASILE    70 CNTR   0 3.16 PI- P         1/71*
MH      60 1314.       5.0                NEF       70 MMS   - 7. PI-P, P KKBAR  11/69
MH  B      FIT TO TWO INCOHERENT BREIT WIGNERS
MH         . . . . . . . . . .
MH         AVG BELOW IS BASED ONLY ON VALUES FROM COHERENT FITS.
MH         . . . . . . . . . .
MH  AVG    1314.5      3.4      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
                           (SEE IDEOGRAM BELOW )------------------------------->

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                    12  A2  MESON MASS (MEV), K KBAR, UNSPLIT, UNRESOLVED

MK    NOTE THAT NEUTRAL MODE CAN INTERFERE WITH F.
MK      80 1317.0      3.0                BARLOW    67 HBC  +-  1.2 PBAR P, KK     9/67
MK      60 1333.0     13.0                BARLOW    67 HBC  +-  1.2 PBAR P, KK     9/67
MK        (1344.0)    (7.)      (6.)      BEUSCH    67 OSPK   0 5-12 PI-P,K1K1     7/67
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         1315.7     10.9                DAHL      67 HBC    0 2.7-4.5 PI- P      8/67
MK         1311.0      5.0                CRENNELL  68 HBC    0 6.0 PI-P,K1K1      6/68
MK      12(1315.0)                        ADERHOLZ  69 HBC   +   8 PI+ P,K+K0      8/69
MK     132 1301.0      7.0                ALSTON-GA 70 HBC   +  7.0 PI+P,K+KS P    1/71*
MK     730 1313.0      4.0                FOLEY     71 CNTR  - 20.3 PI- P,K- KS    2/71*
MK     950(1321.0)    (3.0)               GRAYER    71 ASPK  - 17.2 PI-P,K-KS P    1/71*
MK         . . . . . . . . . .
MK  AVG    1313.9      2.7      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
                           (SEE IDEOGRAM BELOW )------------------------------->

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               12  A2 MESON MASS  (MEV),3PI,ETA PI MODES,SPLITTING UNRESOLVED

M         (1320.0)                        ADERHOLZ  64 HBC      4.0 PI+P
M          1335.0     10.0                GOLDHABER 64 HBC  +-  3.7 PI+- P
M      130(1310.0)                        FORINO    65 DBC  + 0 4.5 PI+ D         10/66
M     1425 1290.0      5.0                LEFEBVRES 65 MMSP  -  5.6,6.0 PI-P       6/66
M         (1300.0)                        SEIDLITZ  65 DBC   -  3.2 PI-D           6/66
M          1290.0     10.0                BARNES    66 HBC   -  6.0 PI-P           6/66
M          1310.0     10.0                BENSON    66 DBC    0 3.65 PI+D          6/66
M     1800(1310.0)    (10.0)    COMP.BY   FERBEL    66 RVUE +-  PI+- P            10/66
M     1060 1286.       8.                 LEVRAT    66 MMS   -   6-7 PI- P         2/67
M      137 1285.      20.                 BALTAY    67 HBC    0 8.5 PI+ P          7/67
M     4000 1307.      16.                 CHIKOVANI 67 MMS   -  7 PI- P            8/67
M          1269.       9.                 DANYSZ    67 HBC  +-  3,3.6 PBAR P       7/67
M          1311.0      6.0                ARMENISE  68 DBC    0 5.1 PI+D           9/67
M          1282.0     15.0                BALLAM    68 HBC   - 16.0 PI- P          9/68
M          1320.      10.                 BOESEBECK 68 HBC    0 8 PI+ P            6/68
M   B     (1280.)     (10.)               BOESEBECK 68 HBC   +  8 PI+ P            6/68
M   B      ASSUMING A1 AND A1.5 MESONS OF FIXED MASS AND WIDTH
M          1310.      20.                 CHUNG     68 HBC   -  2.7-4.5 PI- P      5/68
M          1287.0     10.0                CRENNELL  68 HBC   -  6.0 PI-P,X-        6/68
M          1275.      17.                 FRIDMAN   68 HBC  +-  5.7 PBAR P         6/68
M          1280.      12.                 KEY       68 HBC   -  3 PI-P            11/67
M         (1301.0)    (8.0)               VON KROGH 68 HBC   -  6.7 PI- P          9/68
M          1300.0      4.0                JUNKMANN  68 HBC   -  16. PI- P, 5PI     9/69
M   A     (1299.)     (14.)               LAMSA     68 HBC   -  8 PI- P            1/71*
M          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      189 1312.0      7.0                ALSTON-GA 70 HBC   + 7.0 PI+P,PI ETA     1/71*
M          1313.0      7.0                BOCKMANN  70 HBC    05. PI+P             5/70
M         (1290.0)                        CAROLL    70 HBC   -  7 PI- P            1/71*
M         (1310.0)                        CAROLL    70 DBC    0 7 PI+ D            1/71*
M         (1305.0)                        CAROLL    70 HBC    0 25 PI- P           1/71*
M          1288.0     10.0                CASO      70 HBC   - 11.2PI-P,PI RHO     5/70
M          1300.0     20.0                CASO      70 HBC   - 11.2PI-P,PI ETA     5/70
M         (1300.0)    (20.0)    (14.0)    DZIERBA   70 HBC   -  8. PI- P,PI ETA 11/70*
M          1335.0     15.0                DIAZ      70 HBC  +- 0. PBAR P, 4 PI     5/70
M   D     (1330.0)    (15.0)              GARFINKEL 70 DBC   -  4.5 K-D,LAMBDA     1/71*
M   D   MAY BE DIFFERENT OBJECT,JPC=2++. COMPARE CRENNELL 69.
M         (1274.0)    (22.0)              GORDON    70 DBC    0 4.2 PI+ D          1/71*
M          1288.0      7.0                JOHNSTON  70 HBC   -  7.PI-P,PI-ETA P.   1/71*
M   A      ANALYSIS COMPLICATED BY NEARBY PEAK (A1.5)
M          . . . . . . . . . .
M   AVG    1300.4      2.7      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)
                           (SEE IDEOGRAM BELOW )------------------------------->

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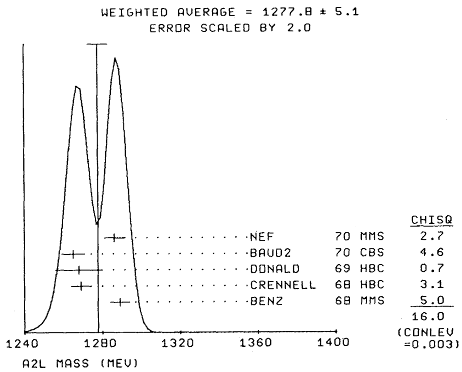

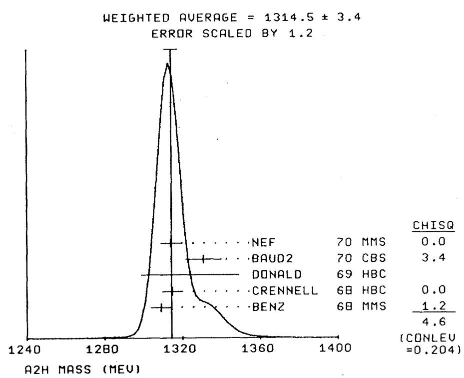

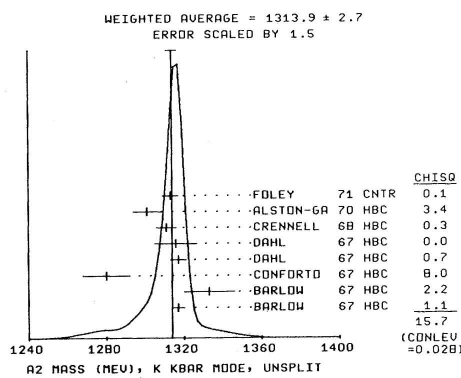

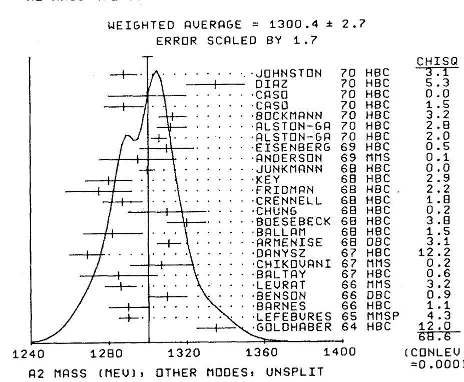

Mesons

For notation, see illustrated key at beginning of data card listings.

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                         12  A2L MESON WIDTH (MEV)

WL  A      (29.)    (10.)               CHIKOVANI 67 MMS   -  6,7 PI- P        6/68
WL  A    INCLUDED IN BENZ 68 FIT OF 2 COHERENT SYMMETRIC POLES.
WL          22.       5.                BENZ      68 MMS   -  2.65 PI- P      12/68
WL          24.0     10.0               CRENNELL  68 HBC   -  6.0 PI-P,X-      6/68
WL  BZ     (22.0)   (10.0)    (7.0)     AGUILAR 1 69 HBC  +- 0-1.2 PB P,K1K+-  5/69
WL   Z     AGUILAR 1 69 INCLUDES BARLOW 67, CONFORTO 67.
WL  C      (40.0) OR LESS               CRENNELL  69 DBC   -  3.9 K- N,PI-RHO  8/69
WL  C  MAY BE DIFFERENT OBJECT. JP=1- FAVORED OVER 2+,2-,1+.
WL  C  NOTE THAT IGJP=1-1- IS EXOTIC IN THE QUARK MODEL.
WL          5.0      12.0       5.0     DONALD    69 HBC  +-  1.2 PB P(4 PI)   9/69
WL  B      (27.0)   (13.0)              BOCKMANN  70 HBC   + 5. PI+P,INCOH5R=  5/70
WL  B      (23.0)    (8.8)              BASILE    70 CNTR  0 3.16 PI- P        1/71*
WL          20.      10.0               NEF       70 MMS   - 7. PI-P, P KKBAR 11/69
WL  B      FIT TO TWO INCOHERENT BREIT WIGNERS
WL         . . . . . . . . . .
WL         AVG BELOW IS BASED ONLY ON VALUES FROM COHERENT FITS.
WL         . . . . . . . . . .
WL  AVG     18.8      3.9      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)

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                         12  A2H MESON WIDTH (MEV)

WH  A      (35.)    (10.)               CHIKOVANI 67 MMS   -  6,7 PI- P        6/68
WH  A    INCLUDED IN BENZ 68 FIT OF 2 COHERENT SYMMETRIC POLES.
WH          22.       5.                BENZ      68 MMS   -  2.65 PI- P      12/68
WH          12.0     10.0               CRENNELL  68 HBC   -  6.0 PI-P,X-      6/68
WH  BZ     (22.0)   (10.0)    (7.0)     AGUILAR 1 69 HBC  +- 0-1.2 PB P,K1K+-  5/69
WH   Z     AGUILAR 1 69 INCLUDES BARLOW 67, CONFORTO 67.
WH          21.0     10.0               DONALD    69 HBC  +-  1.2 PB P(4 PI)   9/69
WH  B      (17.0)    (5.0)              BOCKMANN  70 HBC   + 5. PI+P,INCOHER.  5/70
WH  B      (10.2)   (14.8)   (10.2)     BASILE    70 CNTR  0 3.16 PI- P        1/71*
WH          30.      10.0               NEF       70 MMS   - 7. PI-P, P KKBAR 11/69
WH  B      FIT TO TWO INCOHERENT BREIT WIGNERS
WH         . . . . . . . . . .
WH         AVG BELOW IS BASED ONLY ON VALUES FROM COHERENT FITS.
WH         . . . . . . . . . .
WH  AVG     21.6      3.8      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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              12  A2  MESON WIDTH(MEV), K KBAR, UNSPLIT, UNRESOLVED

WK     NOTE THAT NEUTRAL MODE CAN INTERFERE WITH F.
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           88.      23.      22.      BEUSCH    67 OSPK  0 5-12 PI-P,K1K1    7/67
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           80.5     36.5              DAHL      67 HBC   0 2.7-4.5 PI- P     8/67
WK           21.0     10.0      6.0     CRENNELL  68 HBC   -  6.0 PI-P,K1K1    6/68
WK      12  (34.0)                      ADERHOLZ  69 HBC   +  8 PI+ P,K+K0     8/69
WK     132   90.0     24.0              ALSTON-GA 70 HBC   + 7.0 PI+P,K+KS P   1/71*
WK     730  114.0     10.0              FOLEY     71 CNTR  - 20.3 PI- P,K- KS  2/71*
WK     950 (123.0)    (7.0)             GRAYER    71 ASPK  - 17.2 PI-P,K-KS P  1/71*
WK          . . . . . . . . . .
WK  AVG      59.8     14.5      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.9)
                          (SEE IDEOGRAM BELOW )

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        12  A2 MESON WIDTH (MEV),3PI,ETA PI MODES,SPLITTING UNRESOLVED

W          (100.0)                      ADERHOLZ  64 HBC      4.0 PI+P
W            90.0     10.0              GOLDHABER 64 HBC  +-  3.7 PI+- P
W     1425   99.0     15.0              LEFEBVRES 65 MMSP  -  6.0 PI-P         6/66
W          (140.0)                      SEIDLITZ  65 DBC   -  3.2 PI-D         6/66
W            70.0     10.0              BARNES    66 HBC   -  6.0 PI-P         6/66
W           100.      15.               BENSON    66 DBC   0 3.65 PI+D         1/67
W     1800  (80.0)   (10.0)   COMP.BY FERBEL      66 RVUE +-  PI+- P          10/66
W     1060   98.       5.               LEVRAT    66 MMS   -  6,7 PI- P        2/67
W      137  100.      25.               BALTAY    67 HBC   0 8.5 PI+ P         7/67
W   A       (84.)    (30.)    (20.)     CASON     67 HBC   -  8 PI- P          5/67
W   A       ANALYSIS COMPLICATED BY NEARBY PEAK (A1.5) AT 1190 MEV
W     4000   90.      15.               CHIKOVANI 67 MMS   -  7 PI- P          8/67
W            45.      22.               DANYSZ    67 HBC  +-  3,3.6 PBAR P     7/67
W            96.0     16.0              ARMENISE  68 DBC   0 5.1 PI+D          9/67
W           125.0     40.0              BALLAM    68 HBC   - 16.0 PI- P        9/68
W           (90.)   APPROX.             BOESEBECK 68 HBC   +  8 PI+ P          6/68
W            56.      21.               BOESEBECK 68 HBC   0 8 PI+ P           6/68
W            80.      20.               CHUNG     68 HBC   -  2.7-4.5 PI- P    5/68
W            94.0     30.0     20.0     CRENNELL  68 HBC   -  6.0 PI-P,X-      6/68
W           (80.)   APPROX.             FRIDMAN   68 HBC  +-  5.7 PBAR P       6/68
W            91.      18.               KEY       68 HBC   -  3 PI-P          11/67
W           (40.0)   (25.0)             VON KROGH 68 HBC   -  6.7 PI- P        9/68
W            52.0     16.0              JUNKMANN  68 HBC   -  16. PI- P, 5PI   9/69
W            90.0     10.0     50.0     ANDERSON  69 MMS   -  16 PI- P,BACKW9  8/69
W   AF 241 (164.0)   (20.0)             ARMENISE  69 DBC   +  5.1 PI+D,3PI++-  5/70
W   F    BACKGROUND SUBTRACTION MODEL-DEPENDENT.                               5/70
W            80.0     30.0              EISENBERG 69 HBC   + 4.3,5.3 GAMMA P  12/69
W      941   79.0     12.0              ALSTON-GA 70 HBC   + 7.0 PI+P,3PI P    1/71*
W      189  103.0     20.0              ALSTON-GA 70 HBC   + 7.0 PI+P,PI ETA   1/71*
W            70.0     29.0              BOCKMANN  70 HBC    05. PI+P           5/70
W          (102.0)                      CAROLL    70 HBC   -  7 PI- P          1/71*
W          (122.0)                      CAROLL    70 DBC   0 7 PI+ D           1/71*
W           (85.0)                      CAROLL    70 HBC   0 25 PI- P          1/71*
W           135.0     26.0              CASO      70 HBC   - 11.2PI-P,PI RHO   5/70
W          (120.0)                      CASO      70 HBC   - 11.2PI-P,PI ETA   5/70
W   D       (41.0)   (20.0)   (16.0)    DZIERBA   70 HBC   -  8. PI- P,PI ETA 11/70*
W            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   D    MAY BE DIFFERENT OBJECT,JPC=2++. COMPARE CRENNELL 69.
W          (215.0)   (22.0)             GORDON    70 DBC   0 4.2 PI+ D         1/71*
W   A       ANALYSIS COMPLICATED BY NEARBY PEAK (A1.5)
W            38.0     15.0              JOHNSTON  70 HBC   -  7.PI-P,PI-ETA P  1/71*
W   D       STRONGLY DEPENDENT ON BACKGROUND SUBTRACTION
W           . . . . . . . . . .
W   AVG      87.3      3.8      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
                          (SEE IDEOGRAM BELOW )

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                     12  A2 MESON PARTIAL DECAY MODES

                                                             DECAY MASSES
P1       A2 MESON INTO RHO PI                                765+ 139
P2       A2 MESON INTO KBAR K                                493+ 497
P3       A2 MESON INTO ETA PI                                548+ 139
P4       A2 MESON INTO ETA PRIME PI                          957+ 139
P5       A2 MESON INTO PI+ PI- PIO EXCL.RHO PI. (SMALL,      139+ 139+ 134
                       NOT USED IN FIT)
P6       A2 MESON INTO PI+ PI- PI- EXCL.RHO PI. (SMALL,      139+ 139+ 139
                       NOT USED IN FIT)

------ --------- --------- --------- --------- --------- --------- --------
```
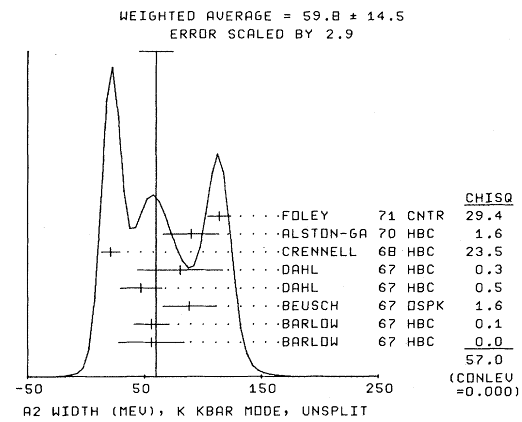
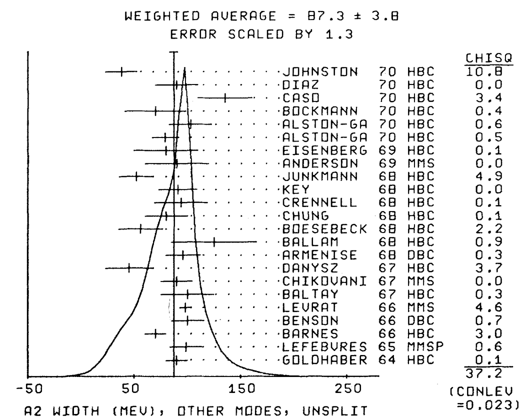
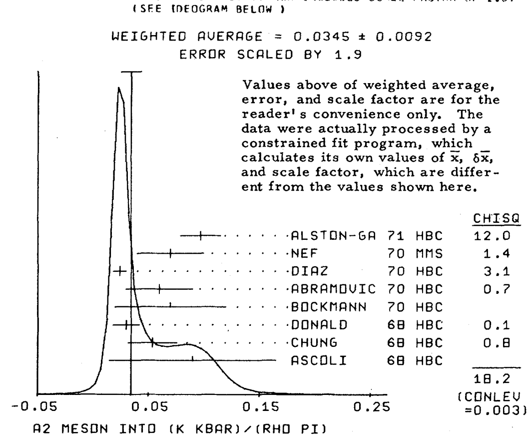






```
                     12  A2 MESON  BRANCHING RATIOS

R1       A2 MESON  INTO (K KBAR) / (RHO PI)
R1           (0.08) OR LESS               LANDER    64 HBC  +   3.5 PI+P        10/66
R1  N        (0.13)    (0.03)             BEUSCH    67 OSPK  0 5,7,12 PI-+       9/67
R1      11    0.09      0.06      0.09    ASCOLI    68 HBC  -   5 PI-P           6/68
R1  B        (0.022)   (0.008)            BOESEBECK 68 HBC  +   8 PI+ P          6/68
R1  B    SUPERSEDED BY MORRISON 71, SEE R8.
R1            0.054     0.022             CHUNG     68 HBC  -   3.2 PI-P         1/67
R1            0.03      0.012             DONALD    68 HBC  +-  1.2 PBAR P       6/68
R1  N        (0.14)    (0.05)             BOCKMANN  70 HBC   0 5.0 PI+P          9/69
R1            0.07      0.05              BOCKMANN  70 HBC  +   5.0 PI+P         9/69
R1  N  THE NEUTRAL MODE CAN INTERFERE WITH F.
R1            0.06      0.03              ABRAMOVIC 70 HBC  -   3.93 PI- P       1/71*
R1            0.024     0.006             DIAZ      70 HBC  +- 0. PBAR P, 4 PI   5/70
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          . . . . . . . . . .
R1  AVG       0.0345    0.0092  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)
R1  FIT       0.0351    0.0086 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.8)
                        (SEE IDEOGRAM BELOW )
```



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.

For notation, see illustrated key at beginning of data card listings.

```
R2        A2 MESON INTO (ETA PI)/TOTAL
R2   B         (0.084)  (0.023)          BOESEBECK 68 HBC  +   8 PI+ P           6/68
R2   B  NO LONGER VALID SINCE R1 VALUE HAS CHANGED (MORRISON 71).
R2             . . . . . . . . . .
R2   FIT        0.179    0.018   FROM FIT

R3        A2 MESON INTO (ETA PI) / (RHO PI)
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     0.08             CHUNG     68 HBC  -   3.2 PI-P          12/66
R3            (0.072)OR LESS              DONALD    68 HBC  +-  1.2 PBAR P         6/68
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             ABRAMOVIC 70 HBC  -   3.93 PI- P       . 1/71*
R3      167     0.246    0.042            ALSTON-GA 71 HBC  +   7.0 PI+ P          2/71*
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         (0.18)   (0.07)            DZIERBA   70 HBC  -   8. PI- P          11/70*
R3   D       STRONGLY DEPENDENT ON BACKGROUND SUBTRACTION
R3             . . . . . . . . . .
R3   AVG        0.225    0.027   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3   FIT        0.229    0.028  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4        A2 MESON INTO (ETA PRIME PI) / TOTAL
R4            (0.1)  OR LESS              CHUNG     65 HBC  -   3.2 PI-P
R4   B        (0.004)  (0.004)            BOESEBECK 68 HBC  +   8 PI+ P            6/68
R4   B  NO LONGER VALID SINCE R1 VALUE HAS CHANGED (MORRISON 71).
R4             . . . . . . . . . .
R4   FIT        0.0122   0.0071 FROM FIT

R5        A2 MESON INTO (ETA PRIME PI)/(RHO PI)
R5            (0.04) OR LESS              ALSTON-GA 71 HBC  +   7.0 PI+ P          2/71*
R5        14    0.07     0.03             ASCOLI    68 HBC  -   5.0 PI-P           6/68
R5              0.04     0.03      0.04   BOCKMANN  70 HBC    0 5.0 PI+ P          9/69
R5            (0.15)   (0.09)             DZIERBA   70 HBC  -   8. PI- P          11/70*
R5             . . . . . . . . . .
R5   AVG        0.057    0.023   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R5   FIT        0.0156   0.0093 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R6        A2 MESON INTO (PI+ PI- PI0) / (RHO PI)
R6            (0.17) OR LESS              BENSON    66 DBC    0 3.7 PI+D

R7        A2 MESON INTO (ETA PI)/(K KBAR)
R7            (3.0)  OR LESS              FOSTER    68 HBC  -   PBAR P,PBA REST  9/69
R7             . . . . . . . . . .
R7   FIT        6.5      1.8     FROM FIT

R8        A2 MESON INTO (K KBAR)/ TOTAL
R8              0.04     0.02             BUTLER    70 HBC  +   3.56-3.82 PI+ P  1/71*
R8            (0.04)   (0.02)             MORRISON  71 HBC  +   8 PI+ P          1/71*
R8             . . . . . . . . . .
R8   FIT        0.0274   0.0065 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.8)

R9        A2 MESON INTO (PI+ PI- PI-)/(3 PI)
R9            (0.23) OR LESS, C.L.=0.9 ABRAMOVIC 70 HBC  -   3.93 PI- P         1/71*

R10       A2 MESON INTO (ETA PRIME PI) / (ETA PI)
R10             0.04     0.04             ABRAMS    70 HBC  +   3.7 PI+ P          1/71*
R10            . . . . . . . . . .
R10 FIT         0.068    0.040   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
```

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 .782+-.020
 P 2   -.188     .027+-.007
 P 3   -.990       -.114     .179+-.018
 P 4   -.407       -.048        .079    .012+-.008
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REFERENCES FOR A2


```
ADERHOLZ 64 PL 10 248            AACHEN+BERLIN+BIRM+BONN+HAMB+IC-LONDON+MPI
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
CHUNG    65 PRL  15  325         +DAHL,HARDY,HESS,JACOBS,KIRZ,MILLER   (LRL)
FORINO   65 PL 19 68             +GESSAROLI+LENDINARA+(BOL+BARI+FIR+ORS+SAC)
LEFEBVRE 65 PL 19 434            CERN MISSING MASS SPECTROMETER GROUP (CERN)
SEIDLITZ 65 PRL 15 217           L SEIDLITZ,O I DAHL,D H MILLER         (LRL)

BARNES   66 PRL 16 41            BARNES,FOWLER,LAI,ORENSTEIN +     (BNL+CCNY)
BENSON   66 MICH COO-1112-4      G.C.BENSON, THESIS                (MICHIGAN)
    ALSO 66 PRL 16 1177          G BENSON,LOVELL,MARQUIT,ROE  +    (MICHIGAN)
EHRLICH  66 PR 152 1194          R. EHRLICH,W.SELOVE,H.YUTA    (PENNSYLVANIA)
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+BOL+FIR+ORSAY)
BALTAY   67 PL 25B 160           +KIRSCH+KUNG+YEH+RABIN  (COLUM+BNL+RUTGERS)
BARLOW   67 NC 50A 701           +LILLESTOL+MONTANET+(CERN+CDF+IR+LIVERPOOL)
BARTSCH  67 PL 25B 48            +DEUTSCHMANN+GROTE+COCCONI+(AACH+BERL+CERN)
BEUSCH   67 PL 25 B 357          +FISCHER,GOBBI,ASTBURY,MICHELINI+(ETH+CERN)
CASON    67 PRL 18 880           +LAMSA,BISWAS,DERADO,GROVES,+    (NOTREDAME)
  ALSO LAMSA 68
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,MONTANET+ (CERN+CF+IPN+LIVERPOOL)
CONTE    67 NC   51 A  175       +TOMASINI,COROS+ (GENOVA+HAM+MILANO+SACLAY)
DAHL     67 PR 163 1377          +HARDY+HESS+KIRZ+MILLER                (LRL)
DANYSZ   67 NC 51 A 801          DANYSZ+FRENCH+SIMAK                   (CERN)

ARMENISE 68 PL 26B 336           ARMENISE,FORINO,+          (BARI+BOL+FIR+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+MIL+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,MONTANET,+    (CERN+CDEF)
FRIDMAN  68 PR 167 1268          +MAURER,MICHALON,OUDET+(HEIDELB+STRASBOURG)
JUNKMANN 68 NP B8 471           +COCCONI,+           (AACH+BERL+BONN+CERN+WARS)
KEY      68 PR 166 1430          +PRENTICE+COOPER+MANNER+WALKER+(TO+ANL+WIS)
LAMSA    68 PR 166 1395          +CASON+BISWAS+DERADO+GROVES+     (NOTREDAME)
VON KROG 68 PL 27 B 253          +MIYASHITA,KOPELMAN,MARSHALL LIBBY    (COLO)

ADERHOLZ 69 NP B 11 259          +BARTSCH,+           (AACH+BERL+CERN+KRAK+WARS)
AGUILAR 169 PL 29 B  62          +BARLOW,JACOBS,DELLA NEGRA+(CERN+CDF +LIVP)
    ALSO BARLOW 67,CONFORTO 67
AGUILAR 269 PL 29 B  241         M.AGUILAR-BENITEZ,J.BARLOW,+     (CERN+CDF)
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 YAD.FIZ. 9 596       VETLITSKY,GRIGOREYEV,GRISHIN,GUZHAVIN+(ITEP)

ABRAMOVI 70 NP B 29 466          ABRAMOVICH,BLUMENFELD,BRUYANT,+      (CERN)  JP
ABRAMS   70  UCRL 20067          +BARNHAM,BUTLER,COYNE,GOLDHABER,HALL,+(LRL)
ALSTON-GA70 PL 33 B 607          +BARBARO,BUHL,DERENZO,EPPERSON,FLATTE+(LRL)
ASCOLI   70  COO 1195 193        +BROCKWAY,CRAWLEY,EISENSTEIN,HANFT,+  (ILL)  JP
BASILE   70 LNC 4 838            +DALPIAZ,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)
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,MONTANET+     (CERN+CDEF)JP
DZIERBA  70  PREPRINT            +SHEPHARD,BISWAS,CASON,JOHNSON,KENNEY(NDAM)
   ALSO  68 LAMSA
GARFINKE 70 PL 33 B 536          GARFINKEL,AMMANN,CARMONY,YEN       (PURDUEJ)C
GORDON   70  COO 1195 179        THESIS,ILLINOIS                         (ILL)
JOHNSTON 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.CONF.P.369 G.SUTHERLAND,INTERFERING RESONANCE(GLASGOW)

ALSTON-GA71 PL 34 B 156          +BARBARO,BUHL,DERENZO,EPPERSON,FLATTE+(LRL)
BARNHAM  71  UCRL 20293          K.W.J.BARNHAM AND G. GOLDHABER
FOLEY    71 PRL 26 413           +LOVE,OZAKI,PLATNER,LINDENBAUM,+ (BNL+CUNY)
GRAYER   71 PL 34 B 333          +HYAMS,JONES,SCHLEIN,BLUM,DIETL+(CERN+MPIM)
MORRISON 71  PRIV.COMM.          D.MORRISON                   (AACH+BERL+CERN)

                                 PAPERS NOT REFERRED TO IN DATA CARDS

CHUNG    64 PRL 12 621           +DAHL,HARDY,HESS,KALBFLEISCH,KIRZ,+    (LRL)
LANDER   64 PRL 13 346 A         LANDER,ABOLINS,CARMONY,HENDRICKS +    (UCSD)  JP
ADERHOLZ 65 PR 138 B 897         AACHEN+BERLIN+BIRM+BONN+HAMB+LOND+MUENCHEN
ALITTI   65 PL 15 69             ALITTI,BATON,DELER,CRUSSARD+ (SACLAY+BOLOG)  JP
SLATTERY 67 NC 50A 377           +KRAYBILL+FORMAN+FERBEL           (YALE+ROCH)  JP
BAUD3    70 PL 31 B 401          CERN BOSON SPECTROMETER GROUP          (CERN)
BEKETOV  70  MOSCOW 70 816       +SOMBKOWSKY,KONOWALOV,KRUTSCHININ,+   (ITEP)  JP
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$A2_{I=2}(1320)$

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37  A2,2 (1320) I=2 OR GREATER

SEEN AS A BUMP IN RHO- PI- SPECTRUM.
EVIDENCE NOT COMPELLING. DROPPED.
SEE JAN. 67 EDITION.
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E(1422)

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6  E MESON  (1422,JPG=A +)  I=0

BAILLON 67 FAVOR JP=0-. DAHL 67 FAVOR 1+ BUT DO NOT
EXCLUDE 2-, 0-. LORSTAD 69 FIND 0- OR 1+.

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                  6 E MESON MASS (MEV)

M          1425.       7.              BAILLON   67 HBC      0. PBAR P        11/66
M          1420.0     20.0             DAHL      67 HBC       1.6-4.2 PI- P   10/66
M          1423.      10.              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           . . . . . . . . . .
M   AVG    1422.5      4.3     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                  6 E MESON 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           . . . . . . . . . .
W   AVG      69.3      7.6     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                  6 E MESON PARTIAL DECAY MODES

                                                             DECAY MASSES
P1          E INTO K K*(890)                               493+ 892
P2          E INTO K KBAR PI                               497+ 497+ 139
P3          E MESON INTO PI PI RHO                         134+ 134+ 765
P4          E INTO PI(1016) PI                            1016+ 139
P5          E INTO ETA PI PI                               548+ 139+ 139

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                  6  E MESON BRANCHING RATIOS

R1          E INTO K K*(890)/((K K*)+(PI(1016) PI))
R1              .50      .10           BAILLON   67 HBC      0.0 PBAR P       11/66

R2          E MESON INTO (PI PI RHO) / (K KBAR PI)
R2            (2.0)  OR LESS           DAHL      67 HBC    0 CHARGED PI ONLY 10/66

R3       E MESON INTO (ETA 2 PI)/(K KBAR PI)
R3             (1.5)OR LESS (CL=0.95)  FOSTER    68 HBC  -   PBAR P,PBA REST  9/69
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For notation, see illustrated key at beginning of data card listings.


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                                      REFERENCES FOR E MESON

BAILLON   67 NC 50A   393          +EDWARDS+D.ANDLAU+ASTIER+      (CERN+CDF+IR)
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+UC)
FRENCH    67 NC 52A 438            +KINSON+MCDONALD+RIDDIFORD+       (CERN+BIRM)
FOSTER    68 NP B 8 174            +GAVILLET,LABROSSE,MONTANET,+     (CERN+CDEF)
BETTINI   69 NC 62 A 1038          +CRESTI,LIMENTANI,BERTAUZA,BIGI+(PADO+PISA)IC
LORSTAD   69 NP B 14 63            B.LORSTAD,D.ANDLAU,ASTIER,+        (CDF+CERN)  JP
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$K_S K_S(1440)$ $\rho\rho(1410)$

```
29 KSKS(1440) AND RHORHO(1410) (JPG=V +) I GTE 0

EVIDENCE NOT YET COMPELLING. OMITTED FROM TABLE.
IF RHOO RHOO AND KS KS ARE MODES OF THE SAME
RESONANCE, THEN I=0.
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                   29  KSKS AND RHORHO MASS  (MEV)

M    -------RHOO RHOO MODE-------
M         (1410.0)                    BETTINI    66 DBC    0  0. PBARP TO 5PR  9/66

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         (1425.0)                    FOLEY      71 CNTR  - 20.3 PI- P,K- KS   2/71*
M          . . . . . . . . .
M    AVG   1437.5      5.3      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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                   29  KSKS AND RHORHO WIDTH (MEV)

W    -------RHOO RHOO MODE-------
W          (90.0)                     BETTINI    66 DBC    0 0. PBAR P TO 5PR  9/66

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          (20.0)  OR LESS            FOLEY      71 CNTR  - 20.3 PI- P,K- KS   2/71*
W          . . . . . . . . .
W    AVG    46.4      17.0      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                         REFERENCES FOR KSKS(1440) AND RHO RHO(1410)

BETTINI  66 NC 42A 695           +CRESTI,LIMENTANI,LORIA,PERUZZO+ (PAD+PISA)
ABRAMS   67 PRL 18 620           +KEHOE,GLASSER,SECHI-ZORN,WOLSKY (MARYLAND)
BARLOW   67 NC  50 A  701        +MONTANET,D-ANDLAU+(CERN+CDF+IDR+LIVERPOOL)
BEUSCH   67 PL 25 B 357          +FISCHER,GOBBI,ASTBURY,MICHELINI+(ETH+CERN)
DONALD   69 NP B 11 551          +EDWARDS,BURAN,BETTINI,+    (LIVP+OSLO+PADO)
FOLEY    71 PRL 26 413           +LOVE,OZAKI,PLATNER,LINDENBAUM,+ (BNL+CUNY)
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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(1514) 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       70 1513.0      7.0            BARNES    67 HBC      4.6, 5. K- P      10/67
M          . . . . . . . . .
M    AVG   1514.0      4.9      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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                   13  F PRIME(1514) WIDTH (MEV)

W    B    5  (53.)    (18.)           ABRAMS    67 HBC     4.25 K- P           5/67
W    B   BACKGROUND ESTIMATION DIFFICULT.                                      5/67
W            35.0     25.0            AMMAR     67 HBC      5.5 K-P            9/67
W       70   87.0     15.0            BARNES    67 HBC      4.6, 5. K- P      10/67
W          . . . . . . . . .
W    AVG     73.2     22.9      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.8)
                            (SEE IDEOGRAM BELOW )
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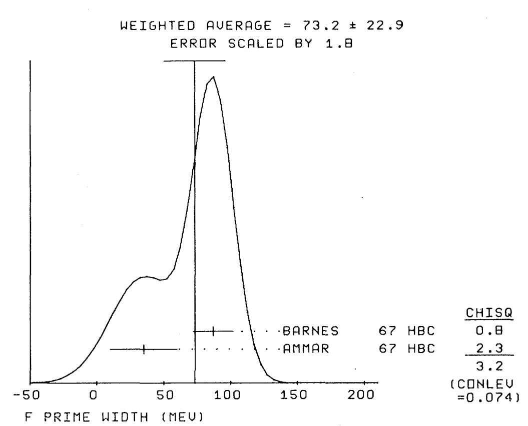


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                   13  F PRIME PARTIAL DECAY MODES

                                                              DECAY MASSES
P1          F PRIME INTO PI+ PI-                              139+ 139
P2          F PRIME INTO K KBAR                               497+ 497
P3          F PRIME INTO K K*(890)                            493+ 892
P4          F PRIME INTO ETA ETA                              548+ 548
P5          F PRIME INTO PI PI ETA                            139+ 139+ 548
P6          F PRIME INTO PI K KBAR                            139+ 497+ 497
------ --------- --------- --------- --------- --------- --------- --------

                   13  F PRIME BRANCHING RATIOS

R1          F PRIME INTO (PI+ PI-)/(K KBAR)
R1            (0.2)  OR LESS          AMMAR      67 HBC      5.5 K-P ,CL=.67  9/67
R1            (0.18) OR LESS          BARNES     67 HBC      4.6, 5.0 K- P   10/67

R3          F PRIME INTO (ETA ETA)/(K KBAR)
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)
R4            (0.3)  OR LESS          AMMAR      67 HBC      CL=0.67         10/67
R4             0.25     0.13          BARNES     67 HBC      4.6, 5.0 K- P   10/67

R5          F PRIME INTO (PI K KBAR + K K*(890))/(K KBAR)
R5            (0.4)  OR LESS          AMMAR      67 HBC      CL=0.67         10/67
R5            (0.14) OR LESS          BARNES     67 HBC      4.6, 5.0 K- P   10/67

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                              REFERENCES FOR F PRIME

CRENNELL 66 PRL  16  1025        + KALBFLEISCH,LAI,SCARR,SCHUMANN +     (BNL)I
ABRAMS   67 PRL 18 620           +KEHOF,GLASSER,SECHI-ZORN,WOLSKY (MARYLAND)
AMMAR    67 PRL  19  1071        +DAVIS,HWANG,DAGAN,DERRICK +     (NWU+ANL)  JP
BARNES   67 PRL  19  964         +DORNAN,GOLDBERG,LEITNER +   (BNL+SYRACUSE)ICJP
ALITTI   68 PRL 21 1705          +BARNES,CRENNELL,FLAMINIO,GOLDBERG,+  (BNL)
LORSTAD  69 NP B 14 63           B.LORSTAD,D.ANDLAU,ASTIER,+       (CDF+CERN)  JP
SCOTTER  69 NC 62 A 1057         +ERSKINE,PALER,+  (BIRM+GLAS+LOIC+MPIM+OXF)
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$\pi/\rho(1540)$ or F_1

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47  PI/RHO (1540,JPG=   ) I=1

NAMED F1 BY AGUILAR 69
JP=2-,1+ FAVORED, 0- LESS PROBABLE.
ALSO CONTAINS PHOTOPRODUCED BUMP AT 1550 MEV,I UNKNOWN
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                   47  PI/RHO (1540)   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    D    (1550.0)   (40.0)           DAVIER    69 STRC   04.5-18 BREMS,4PI 11/69
M    D     WITH STATISTICS INCREASED FOURFOLD (MAY 70), DAVIER ET AL STILL
M    D     FIND A BROAD  FOUR PION ENHANCEMENT, BUT LITTLE EVIDENCE FOR A1+
M    D     STRUCTURE. NO INFORMATION ON ISOSPIN.
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                   47  PI/RHO (1540)  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    D     (260.0)  (110.0)           DAVIER    69 STRC   04.5-18 BREMS,4PI 11/69
M    D      SEE NOTE UNDER MASS ABOVE.
------ --------- --------- --------- --------- --------- --------- --------

                   47  PI/RHO (1540)  PARTIAL DECAY MODES

                                                              DECAY MASSES
P1          PI/RHO (1540) INTO K KBAR PI                      134+ 497+ 497
P2          PI/RHO (1540) INTO K*(890) KBAR                   892+ 497

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                           REFERENCES FOR PI/RHO (1540)

ADERHOLZ 69 NP B 11 259          +BARTSCH,+        (AACH+BERL+CERN+KRAK+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)
DAVIER   69  SLAC-PUB-666        +DERADO,FRIES,LIU,MOZLEY,ODIAN,PARK+ (SLAC)
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$\pi_A(1640)$ or A3

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34  PI (1640, JPG=A -)  I = 1
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This peak is seen in the $f\pi$ spectrum in $\pi^{\pm}p \rightarrow \pi^{\pm}\pi^{+}\pi^{-}p$ reactions. It is only 230 MeV above $f\pi$ threshold, and its interpretation is ambiguous. See note on A1, Q, A3, and L in these listings, just before the A1.

Recently CRENNELL 70 clearly demonstrated that A3 is an s-wave $f\pi$ enhancement. A recent compilation on high-energy $\pi^{\pm}p$ data (CHIEN-2 70) also shows that $f\pi$ is the only dominant mode. BRANDENBURG 70 and CHIEN-1 70 both showed that A3 production in $\pi^{-}p$ at 7, 13, and 20 GeV/c can be described by a Reggeized Deck model.

For notation, see illustrated key at beginning of data card listings.

A3 production is also reported in $\bar{p}p$ and other reactions, but the statistics are relatively poor and results inconclusive.

```
                  THIS ENTRY CONTAINS G=-1 PEAKS AND THE R2 PEAK.
                  BARTSCH 68 FIND BEST FIT WITH JP=2-.NEXT BEST 1+,0-,3+
                  NOTE THAT (OMEGA PI PI) PEAKS HAVE DIFFERENT MASS,WIDTH

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                  34  PI (1640) 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
M           1630.      10.          BALTAY    68 HBC  +  7, 8.5 PI+ P     6/68
M           1660.0     16.0         BARTSCH   68 HBC  +  8. PI+ P,3PI P   8/69
M          (1650.0)                 IOFFREDO  68 HBC  - 13-20 PI-P,PI-F   9/68
M           1610.      19.          LAMSA     68 HBC  -  8.0 PI-P, PI-F  11/67
M       297 1673.0     40.0         ARMENISE  69 DBC  +  5.1 PI+D,3PI++-  5/70
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    5/70
M           1645.0     10.0         CRENNELL  70 HBC  -  6. PI- P,F PI    5/70
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   70 HBC  -  4.45 PI- P       1/71*
M           . . . . . . . . .
M    AVG    1640.1      6.2      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
                             (SEE IDEOGRAM BELOW )
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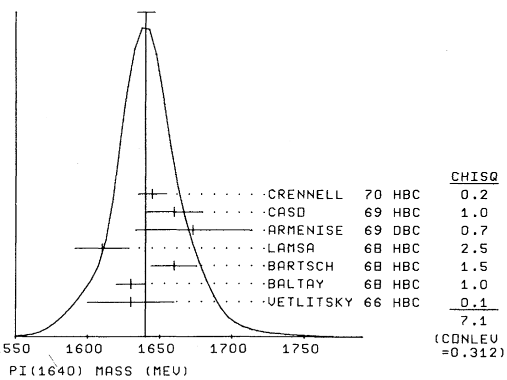
WEIGHTED AVERAGE = 1640.1 ± 6.2
ERROR SCALED BY 1.1

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M        OMEGA PI PI PEAKS AND THE R2
M           1689.      10.          DANYSZ    67 HBC     0 3,3.6 PBAR P   7/67
M    M      1700.      15.          DUBAL     67 MMS  -  7,11.5,12PI- P   7/67
M    M   R2 PEAK FROM CERN MMS EXPT. DECAY MODES AND G PARITY UNKNOWN.
M           1670.0     18.0         YOST      68 HBC     04.3 K-P,LMBD.5PI 9/68
M           1695.0     20.0         BARNES    69 HBC     0 4.6 K-P,OMEG2PI 8/69
M           . . . . . . . . .
M    AVG    1689.3      7.1      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                  34  PI (1640) WIDTH  (MEV)

W        20 (100.)                  VETLITSKY 66 HBC  -  4.7 PI-P          6/66
W           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    8/69
W           100.       50.     30.  LAMSA     68 HBC  -  8.0 PI-P  PI-F   11/67
W    P   OBSERVED IN (OMEGA PI+PI-) AND (OMEGA RHO0) MODES IN RATIO 2/1
W    A  297 (240.0)   (50.0)        ARMENISE  69 DBC  +  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 SUBTRACTION DIFFICULT.
W          (128.0)                  BEKETOV   70 HBC  -  4.45 PI- P        1/71
W           . . . . . . . . .
W    AVG    107.7      18.7      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W        OMEGA PI PI PEAKS AND THE R2
W    R      (21.)    OR LESS        LEVRAT    66 MMS  -  7,12 PI- P        7/67
W    R   R2 PEAK FROM CERN MMS EXPT. DECAY MODES AND G PARITY UNKNOWN.
W           38.        18.          DANYSZ    67 HBC     0 3,3.6 PBAR P    7/67
W           50.0       15.0         YOST      68 HBC     04.3 K-P,LMBD.5PI 9/68
W          (80.0)                   BARNES    69 HBC     0 4.6 K-P,OMEG2PI 8/69
W           . . . . . . . . .
W    AVG    45.1       11.5      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                  34  PI (1640) PARTIAL DECAY MODES

                                                        DECAY MASSES
P1          PI(1640) INTO 3 PI                          134+ 134+ 134
P2          PI(1640) INTO RHO PI                        134+ 765
P3          PI(1640) INTO ETA PI                        134+ 548
P4          PI(1640) INTO 5 PI
P5          PI(1640) INTO K K*(890)                     497+ 892
P6          PI(1640) INTO K KBAR PI                     497+ 497+ 134
P7          PI(1640) INTO K KBAR                        497+ 497
P8          PI(1640) INTO F PI                         1264+ 134
P9          PI(1640) INTO OMEGA PI PI                   783+ 134+ 134

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                  34  PI (1640)  BRANCHING RATIOS

R2          PI(1640)+- INTO (PI+- RHO0)/(ALL PI+- PI+ PI-)
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             CONSISTENT WITH 0.0   IOFFREDO  68 HBC   - 13-20 PI-P        9/68

R3          PI(1640)+- INTO (PI+- F)/(ALL PI+- PI+ PI-)
R3                      (WITH F INTO PI+ PI-)
R3             INDICATION 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  +   9. 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             SEEN                  IOFFREDO  68 HBC  -  13-20 PI-P,PI-F   9/68
R3            (0.76)    (0.24)   (0.34) ARMENISE 69 DBC + 5.1 PI+D,3PI++-   5/70
R3             CONSISTENT WITH 1.0   CRENNELL  70 HBC  -   6. PI- P,F PI    5/70

R4          R1 MESON FRACTION INTO ONE / THREE / FIVE OR MORE CHARGED TRACKS
R4            (0.37)/   0.59 /   0.04  FOCACCI 66 MMS  -  3-12 PI-P        10/66

R5          PI(1640) +- INTO (PI+- ETA)/(ALL PI+- PI+ PI-)
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          PI(1640)+- INTO (PI+- 2PI+ 2PI-)/(ALL PI+- PI+ PI-)
R6            (0.1) OR LESS          BALTAY    68 HBC  +  7,8.5 PI+ P       6/68
R6            (0.10)OR LESS          CRENNELL  70 HBC  -   6. PI- P,F PI    5/70

R7          PI(1640) INTO (OMEGA PI PI)/(F PI)
R7   P        (4.)  OR GREATER       BARNES    69 HBC     0 4.6 K-P,OMEG2PI 8/69
R7   P         NOT CLEAR IF (OMEGA PI+PI-) PEAK IS DECAY MODE OF PI(1640)

R8          PI(1640)+- INTO (RHO PI)/(F PI)
R8             0.03      0.37      0.03  CASO      69 HBC  -  11 PI- P      5/70

R9          PI(1640)+- INTO (PI+- PI+ PI-)/(F PI)
R9             0.06      0.47      0.06  CASO      69 HBC  -  11 PI- P      5/70

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REFERENCES FOR PI(1640)


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FORINO   65 PL 19 68             +GESSAROLI+LENDINARA+(BOL+BARI+FIR+ORS+SAC)
FOCACCI  66 PRL  17  890         CERN MISSING MASS SPECTROMETER GROUP (CERN)
LEVRAT   66 PL   22  714         CERN MISSING MASS SPECTROMETER 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)
  ALSO   68 THESIS 1456          L.DUBAL                            (GENEVE)

BALTAY   68 PRL 20 887           +KUNG+YEH+FERBEL+     (COLMB+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+MIL+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)
YOST     68  UMD  T.REPORT849    +YODH,FINSCHLAG,DAY,GLASSER           (UMD)

ARMENISE 69 LNC 2 501            +GHIDINI,FORINO,CARTACCI+  (BARI+BGNA+FIRZ)
BARNES   69 PRL 23 142           +CHUNG,EISNER,FLAMINIO,+              (BNL)
CASO     69 LNC 2 437            +CONTE,TOMASINI,CANTORE+   (GENO+MILA+SACL)
  ALSO CASO 68.

BEKETOV  70  MOSCOW 70 816       +SOMBKOWSKY,KONOWALOV,KRUTSCHININ,+  (ITEP)
BRANDENB 70 NP B16 369           +BRENNER,IOFFREDO,JOHNSON,KIM+    (HARVARD)
CRENNELL 70 PRL 24 781           +KARSHON,LAI,SCARR,SIMS               (BNL)
CHIEN1   70  TORONTO PREPRINT    +CHAO,JOHNSTON,PRENTICE,WALKER  (TOR+WISC)
CHIEN2   70 PHILAD.CONF.P.275    C.Y.CHIEN, REVIEW           (JOHNS HOPKINS)
MIYASHIT 70 PR D 1 771           MIYASHITA,VON KROGH,KOPELMAN,LIBBY   (COLO)
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$\phi_N(1650)$
$\to\rho^0\pi^0$

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                  45  PHI (1650,JPG=  -) I=0

                  THIS 3 PI BUMP OVERLAPS IN MASS THE PI(1640) F PI BUMP
                  CALLED THE A3, BUT IN SOME EXPTS. ONE CAN ESTABLISH THA
                  THE ENHANCEMENT IS RHO 0 PI INSTEAD OF F PI, SO THE
                  PHI(1650) AND THE PI(1640) HAVE DIFFERENT ISPIN.
                  MATTHEWS 71 SUGGEST JP = NORMAL, A POSSIBLE RECURRENCE
                  OF THE OMEGA MESON.

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                  45  PHI (1650)   MASS (MEV)

M           1636.0     20.0         ARMENISE  68 DBC     0 5.1 PI+D       9/68
M           1670.0     20.0         KENYON    69 DBC      8 PI+ D,3PI 2P  8/69
M          (1640.00)                ARMENISE  70 DBC      9. PI+ D        1/71*
M    G     (1616.0)   (30.0)        GORDON    70 DBC     0 4.2 PI+ D      1/71*
M       100 1679.0     17.0         MATTHEWS  71 HBC     06.95 PI D,2P 3PI 1/71*
M    G      NOT CERTAIN IF PHI(1650) IS OBSERVED IN THIS EXPERIMENT
M           . . . . . . . . .
M    AVG    1663.6     12.9      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
                             (SEE IDEOGRAM BELOW )

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                  45  PHI (1650)  WIDTH (MEV)

W           112.0      60.0         ARMENISE  68 DBC     0 5.1 PI+D       9/68
W           100.0      40.0         KENYON    69 DBC      8 PI+ D,3PI 2P  8/69
W    G     (188.0)    (47.0)        GORDON    70 DBC     0 4.2 PI+ D      1/71*
W       100 155.0      20.0         MATTHEWS  71 HBC     06.95 PI D,2P 3PI 1/71*
W    G      NOT CERTAIN IF PHI(1650) IS OBSERVED IN THIS EXPERIMENT
W           . . . . . . . . .
W    AVG    141.4      17.1      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                  45  PHI (1650)  PARTIAL DECAY MODES

                                                        DECAY MASSES
P1          PHI (1650) INTO 3 PI                        134+ 134+ 134
P2          PHI (1650) INTO 5 PI                        134+ 134+ 134+ 134
P3          PHI (1650) INTO RHO PI                      765+ 134

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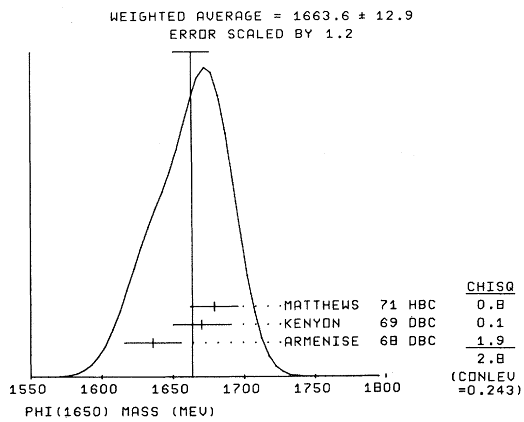
Mesons

For notation, see illustrated key at beginning of data card listings.




```
                  45  PHI (1650)  BRANCHING RATIOS

R1         PHI (1650) INTO (5 PI)/(3 PI)
R1            0.10      0.10           KENYON    69 DBC     0 8. PI + D          8/69

R2         PHI (1650) INTO (RHO PI) / (3 PI)
R2  G        (0.75)    (0.11)          GORDON    70 DBC     0 4.2 PI+ D          1/71*
R2     100   (0.75) OR GREATER         MATTHEWS  71 HBC     06.95 PI D,2P 3PI    1/71*
R2  G      NOT CERTAIN IF PHI(1650) IS OBSERVED IN THIS EXPERIMENT

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                  45  PHI (1650)  CROSS SECTIONS

CS               FOR A COMPILATION SEE MATTHEWS 71 HBC      06.95 PI D,2P 3PI   1/71*

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                        REFERENCES FOR PHI (1650)

ARMENISE 68 PL 26B 336         +GHIDINI,FORINO+  (BARI+BOLOGN+FIRENZ+ORSAY)
KENYON   69 PRL 23 146         +KINSON,SCARR,+                (BNL+ORUC+ORNL)

ARMENISE 70 LNC 4 199          +GHIDINI,FORINO,CARTACCI,+  (BARI+BGNA+FIRZ)
GORDON   70  COO 1195 179      THESIS,ILLINOIS                         (ILL)
MATTHEWS 71  SUBM. TO PR       +PRENTICE,YOON,CARROLL,FIRFBAUG (TNTO+WISC)

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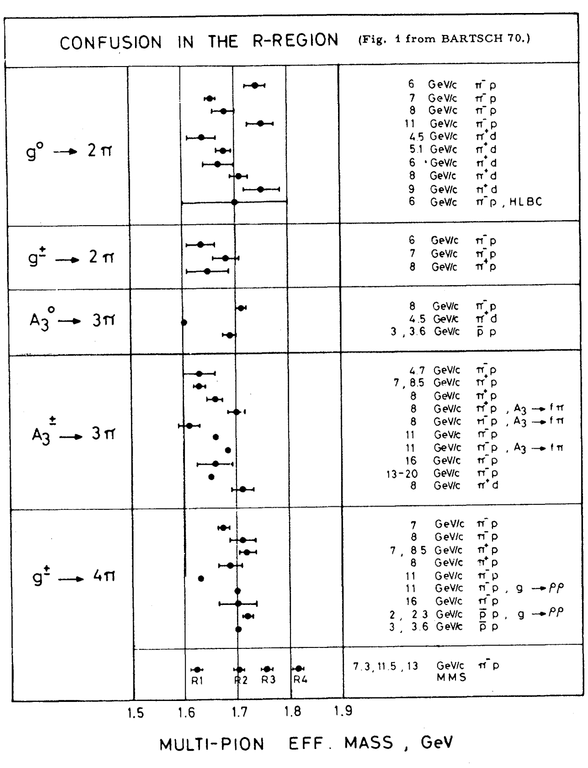

$\rho_N(1660)$ or g

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15  RHO (1660, JPG= N+) I=1

THIS ENTRY CONTAINS THE R1, G(2 PI) AND K KBAR PEAKS.
FOR POSSIBLE 4 PI MODES SEE RHO(1710)

      CRENNELL 68 SUGGEST JP=3- FROM THE PI PI SCATTERING ANGLE DISTR.
      BARTSCH 70 USES OPE MODEL,SUGGESTS ELASTICITY LESS THAN 1

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                  15  RHO (1660)  MASS (MEV)

M          1700.0    100.0              BELLINI   65 HLBC   0 6.1 PI-P           6/66
M         (1640.0)                      FORINO    65 DBC    0 4.5 PI+D           6/66
M          1670.0     30.0              GOLDBERG  65 HBC    0 6 PI+D, 8 PI-P
M    R    (1630.)    (15.)              DUBAL     67 MMS    -  7,11.5,12PI- P    7/67
M    R     R1 PEAK FROM CERN MMS EXPT. DECAY MODES AND G PARITY UNKNOWN.
M    R     NOTE THAT THE R1 HAS MUCH SMALLER WIDTH THAN THE OTHER ENTRIES.
M         (1683.)    (13.)              ARMENISE  68 DBC    0 5.1 PI+ D          6/68
M    B    (1620.)    (20.)              BOESEBECK 68 HBC    +   8 PI+ P        . 6/68
M    B     BOESEBECK 68 SUPERSEDED BY BARTSCH 70
M          1720.0     20.0              CRENNELL  68 HBC    0 6.0 PI- P         12/68
M          1640.0     25.0              CRENNELL  68 HBC    -  6.0 PI- P        12/68
M          1640.0     20.0     25.0     CRENNELL  68 HBC   +-  6.0 PI-P,KBAR K  12/68
M         (1655.0)   (10.0)             JOHNSTON  68 HBC    0 7.0 PI- P          6/68
M       13(1650.0)                      ADERHOLZ  69 HBC    +   8 PI+ P,K+KO   . 8/69
M         (1600.)                       BARISH    69 HBC    -  8 PI- P           5/70
M         (1750.0)                      CASO      69 HBC    0 11. PI- P,N2PI     8/69
M          1650.0     35.0              BARTSCH   70 HBC    + 8 PI+ P,2 PI       5/70
M          1652.0     15.0              KRAMER    70 HBC    + 13.1 PI+ P,2PI    11/70*
M          1737.0     23.0              ARMENISE  70 HBC    0 9 PI+ N -- GO P   1/71*
M          1655.0      4.0              STUNTEBEC 70 HBC    0 8. PI-P,PI+PI-    1/71*
M          . . . . . . . . .
M    AVG   1658.5      7.1      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.0)
                             (SEE IDEOGRAM BELOW )
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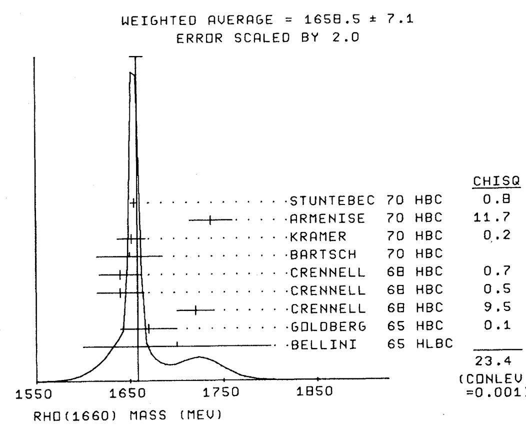


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                  15  RHO (1660)  WIDTH (MEV)

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    R    (21.)    OR LESS              LEVRAT    66 MMS    -  7,12 PI- P        7/67
W    R     R1 PEAK FROM CERN MMS EXPT. DECAY MODES AND G PARITY UNKNOWN.
W          188.       49.               ARMENISE  68 DBC    0 5.1 PI+ D          6/68
W    B    (108.)     (40.)              BOESEBECK 68 HBC    +   8 PI+ P          6/68
W    B     BOESEBECK 68 SUPERSEDED BY BARTSCH 70
W          200.0    100.0               CRENNELL  68 HBC    -  6.0 PI- P        12/68
W          200.0    100.0               CRENNELL  68 HBC    0 6.0 PI- P         12/68
W           79.0     70.0     25.0      CRENNELL  68 HBC   +-  6.0 PI-P,KBAR K  12/68
W         (80.0)    (20.0)              JOHNSTON  68 HBC    0 7.0 PI- P          6/68
W       13 (100.0)                      ADERHOLZ  69 HBC    +   8 PI+ P,K+KO   . 8/69
W         (200.)                        BARISH    69 HBC    -  8 PI- P           5/70
W         (200.0)                       CASO      69 HBC    0 11. PI- P,N2PI     8/69
W          171.0     65.0               ARMENISE  70 HBC    0 9 PI+ N -- GO P   1/71*
W          180.0     30.0               BARTSCH   70 HBC    + 8 PI+ P,2 PI       5/70
W           40.0     32.0               KRAMER    70 HBC    + 13.1 PI+ P,2PI    11/70*
W           20.0     (8.0)              STUNTEBEC 70 HBC    0 8. PI-P,PI+PI-    1/71*
W          . . . . . . . . .
W    AVG   136.0     23.9      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
                            (SEE IDEOGRAM BELOW )

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                  15  RHO (1660)     PARTIAL DECAY MODES

                                                      DECAY MASSES
P1        RHO (1660) INTO PI PI                       139+ 139
P2        RHO (1660) INTO  4PI                        139+ 139+ 139+ 139
P5        RHO (1660) INTO K KBAR                      497+ 497

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                  15  RHO (1660)  BRANCHING RATIOS
        (FOR OTHER POSSIBLE MODES SEE RHO(1715) BELOW)

R1        R1 MESON FRACTION INTO ONE / THREE / FIVE OR MORE CHARGED TRACKS
R1          (0.37)/   0.59 /   0.04  FOCACCI   66 MMS    -                  10/66

R3        RHO(1660) INTO (K KBAR) / (2 PI)
R3           INDICATION SEEN             EHRLICH   66 HBC  +-0 7.9 PI- P          3/67
R3           PROBABLY SEEN               ABRAMS    67 HBC    0 4.25 K- P          6/67
R3           0.08      0.08     0.03     CRENNELL  68 HBC      6.0 PI- P         12/68
R3           0.08      0.03              BARTSCH   70 HBC  +   8. PI+ P           1/71*
R3         . . . . . . . . .
R3   AVG     0.080     0.026   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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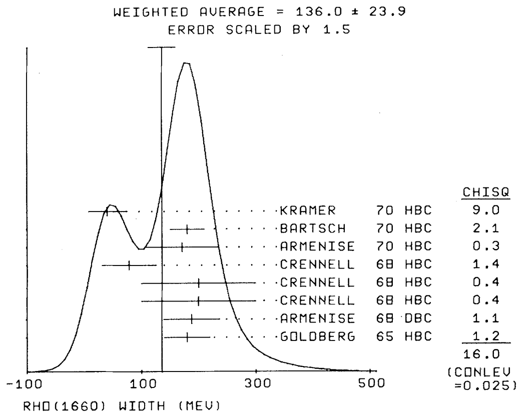
For notation, see illustrated key at beginning of data card listings.

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                         REFERENCES FOR RHO(1660)

BELLINI  65 NC 40 A 948          BELLINI,DI CORATO,DUIMINO,FIORINI  (MILANO)
FORINO   65 PL 19 65             FORINO,GESSAROLI +   (BOLOGNA+ORSAY+SACLAY)
GOLDBERG 65 PL 17 354            GOLDBERG+(CERN+PARIS+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)

ABRAMS   67 PRL 18 620           +KEHOE+GLASSER+SECHI-ZORN+WOLSKY (MARYLAND)
DUBAL    67 NP B3 435            CERN MISSING MASS SPECTROMETER GROUP (CERN)
   ALSO  68 THESIS 1456          L.DUBAL                            (GENEVE)

ARMENISE 68 NC 54 A 999          +FORINO+CARTACCI+(BARI+BOLOG+FIRENZE+ORSAY)I
BOESEBEC 68 NP B 4 501           BOESEBECK,DEUTSCHMANN,+(AACHEN+BERLIN+CERN)
CRENNELL 68 PL 28 B 136          +KARSHON,LAI,SCARR,SKILLICORN         (BNL)
JOHNSTON 68 PRL 20 1414          +PRENTICE,STEENBERG,YOON     (TORONTO+WISC)

ADERHOLZ 69 NP B 11 259          +BARTSCH,+         (AACH+BERL+CERN+KRAK+WARS)
BARISH   69 PR 184  1375         +SELOVE,BISWAS,CASON,+       (PENN+NDAM+ROCH)
CASO     69 NC 62 A 755          +CONTE,BENZ,+      (GENO+DESY+HAMB+MILA+SACL)

ARMENISE 70 LNC 4  199           +GHIDINI,FORING,CARTACCI,+ (BARI+BGNA+FIRZ)
BARTSCH  70  CERN/D./PHYS70-4 +KRAUS,TSANOS,GROTE,KOTZAN+(AACH+BERL+CERN)
KRAMER   70 PRL 25 396           +BARTON,GUTAY,LICHTMAN,MILLER,+    (PURDUE)
STUNTEBE 70 PL 32 B 391          STUNTEBECK,KENNEY,DEERY,BISWAS,CASON+(NDAM)

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ρ(1710) →4π

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              38  RHO(1710,JPG=  +) I = 1 OR 2

              THIS ENTRY CONTAINS 4PI, RHO 2PI, 2RHO, OMEGA PI, AND K*KBAR
              ENHANCEMENTS, AND THE R1 AND THE R2.
              NOTE THAT THE (OMEGA PI) PEAKS HAVE DIFFERENT MASS.
              DECAY RHO(1710) INTO 4PI MAY BE INEL.DECAYS OF G-MESON ABOVE.
              SEE BARTSCH 70.
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              38  MASS (MEV)

M   R    80 1717.      7.                DANYSZ    67 HBC    0SEE NOTE R BELOW  5/67
M   R    SEEN IN 2.5-3 PBAR P. 2PI+2PI-,WITH 0,1,2 PI+PI- PAIRS IN RHOO BAND
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           1720.      15.               BALTAY    68 HBC  +  7, 8.5 PI+ P   . 6/68
M   J      (1675.0)   (10.0)             JOHNSTON  68 HBC  -  7.0 PI- P        6/68
M   J       NOT SEPARATED FROM 2 PI DECAY
M           1690.0     16.0              ADERHOLZ  69 HBC  +  8 PI+ P,KKBARPI  8/69
M           1700.0     47.0              ANDERSON  69 MMS  -  16 PI- P,BACKW   8/69
M          (1627.)    (12.)    (17.)     BARNHAM   70 HBC  + 10 K+ P,RHO PIPI  6/70
M           1670.0     30.0              BARTSCH   70 HBC  + 8 PI+ P,4 PI      5/70
M           1705.0     21.0              CASO      70 HBC  - 11.2PI-P,RHO 2PI  5/70
M    M     (1700.0)                      MAURER    70 HBC   05.7 PBAR P,7 PI   2/71*
M    M   SEEN IN 2 RHOO, NOT IN 4 PI OUTSIDE RHO BANDS.
M           . . . . . . . . . . .
M   AVG     1711.5      6.0     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
                      (SEE IDEOGRAM BELOW )

M          OMEGA PI DECAYS AND THE R1.
M    R      1630.      15.               DUBAL     67 MMS  -  7,11.5,12PI- P   7/67
M    R   R1 PEAK FROM CERN MMS EXPT. DECAY MODES AND G PARITY UNKNOWN.
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           . . . . . . . . . . .
M   AVG     1632.9      8.3     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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              38  WIDTH (MEV)

W   M       (30.)    OR LESS             LEVRAT    66 MMS  -  7-12 PI- P       7/67
W   M    R2 PEAK FROM CERN MMS EXPT. DECAY MODES AND G PARITY UNKNOWN.
W   R  80   (40.)    (12.)               DANYSZ    67 HBC    0SEE NOTE R BELOW  5/67
W   R    SEEN IN 2.5-3 PBAR P. 2PI+2PI-,WITH 0,1,2 PI+PI- PAIRS IN RHOO BAND
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           112.0     60.0               ADERHOLZ  69 HBC  +  8 PI+ P,KKBARPI  8/69
W          (195.0)                       ANDERSON  69 MMS  -  16 PI- P,BACKW   8/69
W           (72.)    (29.)    (20.)      BARNHAM   70 HBC  + 10 K+ P,RHO PIPI  6/70
W           160.0     40.0               BARTSCH   70 HBC  + 8 PI+ P,4 PI      5/70
W          (160.0)                       CASO      70 HBC  - 11.2PI-P,RHO 2PI  5/70
W           . . . . . . . . . . .
W   AVG     123.8     24.1      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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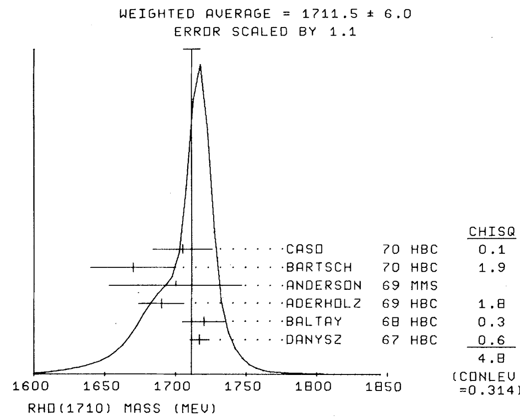


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W        OMEGA PI DECAYS AND THE R1.
W   M       (30.)    OR LESS             LEVRAT    66 MMS  -  7-12 PI- P       7/67
W   M    R1 PEAK FROM CERN MMS EXPT. DECAY MODES AND G PARITY UNKNOWN.
W           130.      73.       43.      BARNHAM   70 HBC  + 10 K+ P,OMEGA PI  6/70
W          (60.0)                        CASO      70 HBC  - 11.2PI-P,PI OMEG  5/70

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              38  RHO (1710) PARTIAL DECAY MODES

                                                         DECAY MASSES
P1          RHO(1710) INTO 4 PI                       139+ 139+ 139+ 139
P2          RHO(1710) INTO A2 PI                      139+1300
P3          RHO(1710) INTO OMEGA PI                   139+ 783
P4          RHO(1710) INTO PHI PI                    1018+ 139
P5          RHO(1710) INTO 2 RHO                      765+ 765
P6          RHO(1710) INTO PI PI RHO                  765+ 139+ 139

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              38  RHO(1710) BRANCHING RATIOS

R1          R2 MESON FRACTION INTO ONE / THREE / FIVE OR MORE CHARGED TRACKS
R1            (0.42)/   0.56 /   0.01  FOCACCI   66 MMS  -                    10/66

R2          RHO(1710)+- INTO (PI+- A20)/(ALL PI+- PI+ PI- PIO)
R2                           (WITH A20 INTO (PI+ PI- PIO))
R2             0.40      0.20          BALTAY    68 HBC  +  7,8.5 PI+P      . 6/68
R2             NOT SEEN                JOHNSTON  68 HBC  -  7 PI- P           6/68

R3          RHO(1710)+- INTO (PI OMEGA)/(ALL PI+- PI+ PI- PIO)
R3                           (WITH OMEGA INTO(PI+ PI- PIO))
R3             0.25      0.10          BALTAY    68 HBC  +  7-8.5 PI+P      . 5/68
R3              .25      0.10          JOHNSTON  68 HBC  -  7.0 PI- P         6/68
R3             . . . . . . . . . .
R3   AVG       0.250     0.071   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4          RHO(1710)+- INTO (PI PHI)/(ALL PI+- PI+ PI- PIO)
R4            (0.11) OR LESS           BALTAY    68 HBC  +  7,8.5 PI+P        6/68

R5          RHO(1710)+- INTO (RHO 2PI)/(ALL 4PI)
R5             CONSISTENT WITH 1.      CASO      68 HBC  -  11 PI- P          6/68
R5             SEEN                    VETLITSKY 69 HBC    04.7-5.7 PI- P   . 6/70

R6          RHO(1710)+- INTO (RHO+- RHOO)/(ALL RHO 2PI)
R6             0.48      0.16          CASO      68 HBC  -  11 PI- P          6/68

R7          RHO(1710)   INTO (2 RHO) / (ALL 4PI)
R7             SEEN                    DANYSZ    67 HBC    0 3-4 PBAR P       5/68
R7             SEEN                    BALTAY    68 HBC  +  7,8.5 PI+ P     . 6/68
R7             SEEN                    JOHNSTON  68 HBC  -  7 PI-P            6/68

R8          RHO(1710)+- INTO (PI+- 2PI+ 2PI- PIO)/(ALL PI+- PI+ PI- PIO)
R8            (0.15) OR LESS           BALTAY    68 HBC  +  7,8.5 PI+ P       6/68

R9          RHO(1710)+- INTO (PI+- PIO) / (ALL PI+- PI+ PI- PIO)
R9   D        (0.08) OR LESS           BALTAY    68 HBC  +  7-8.5 PI+ P       6/68
R9   D         USING DATA OF DEUTSCHMANN 65 ON PI+P TO PI+ PIO P              6/68

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                         REFERENCES FOR RHO(1710)

DEUTSCHM 65 PL 18 351            M.DEUTSCHMANN ET AL    (AACHEN+BERLIN+CERN)
FOCACCI  66 PRL  17  890         CERN MISSING MASS SPECTROMETER GROUP (CERN)
LEVRAT   66 PL   22  714         CERN MISSING MASS SPECTROMETER GROUP (CERN)

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)

BALTAY   68 PRL 20 887           +KUNG+YEH+FERBEL+    (COLMB+ROCH+RUTG+YALE)I=1 .
CASO     68 NC 54 A 983          +CONTE+CORDS+DIAZ+   (GENOVA+HAMB+MIL+SACL)
JOHNSTON 68 PRL 20 1414          +PRENTICE,STEENBERG,YOON     (TORONTO+WISC)IJP

ADERHOLZ 69 NP B 11 259          +BARTSCH,+         (AACH+BERL+CERN+KRAK+WARS)
ANDERSON 69 PRL 22 1390          +COLLINS,BLIEDEN+                  (BNL+CARN)
VETLITSK 69 SJNP 9 461           +GUZHAVIN,KLIGER,KOLGANOV,LEBEDEV+   (ITEP)

BARNHAM  70 PRL 24 1083          +COLLEY,JOBES,KENYON,PATHAK,RIDDIFORD(BIRM)
BARTSCH  70  CERN/D./PHYS70-4 +KRAUS,TSANOS,GROTE,KOTZAN+(AACH+BERL+CERN)
CASO     70 LNC 3 707            +CONTE,TOMASINI,CORDS+(GENO+HAMB+MILA+SACL)
MAURER   70  THESIS NO.588       G.MAURER                       (STRASBOURG)

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For notation, see illustrated key at beginning of data card listings.

R(1750)

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39   R(1750) I=1

THIS ENTRY CONTAINS I=1 PEAKS AND THE R3 PEAK
NOT A FIRMLY ESTABLISHED RESONANCE - OMITTED FROM TABLE
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                    39   R(1750) MASS(MEV)

M          1748.      16.            DUBAL      67 MMS    -  7,11.5,12 PI- P  7/67
M    F    (1740.)                    FRENCH     67 HBC  (KO K+-) 3-4 PBAR P   7/67
M    F     SEE FIG. 9 OF FRENCH 67
M          1764.0     15.0           STUNTEBEC 70 HBC     0 8. PI-P,PI+PI-   1/71*
M          . . . . . . . . . .
M    AVG   1756.5     10.9     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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                    39   R(1750) WIDTH (MEV)

W         (38.)    OR LESS           LEVRAT     66 MMS    -  7,12 PI- P      7/67
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          87.0       14.0     20.0  STUNTEBEC 70 HBC     0 8. PI-P,PI+PI-   1/71*
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                    39   R(1750) BRANCHING RATIOS

R3         R3 MESON FRACTION INTO ONE / THREE / FIVE OR MORE CHARGED TRACKS
R3   C       (0.14)/    0.80 /    0.05  FOCACCI    66 MMS    -                 10/66
R3   C        FRACTION INTO ONE CHARGED  PROB. LARGER THAN GIVEN ABOVE.
R3   C                                                CF. DUBAL 67
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REFERENCES FOR R (1750)


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FOCACCI   66 PRL  17  890        CERN MISSING MASS SPECTROMETER GROUP (CERN)
LEVRAT    66 PL   22  714        CERN MISSING MASS SPECTROMETER GROUP (CERN)
DUBAL     67 NP B3 435           CERN MISSING MASS SPECTROMETER GROUP (CERN)
FRENCH    67 NC 52A 442          +KINSON+MCDONALD+RIDDIFORD+       (CERN+BIRM)

STUNTEBE  70 PL 32 B 391         STUNTEBECK,KENNEY,DEERY,BISWAS,CASON+(NDAM)
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$\eta_{A,I\geq 0}(1830) \rightarrow 4\pi, K^*\bar{K}$

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42  ETA OR RHO (1830) G=+1 (JPG=  +) I GTE 0

THIS ENTRY CONTAINS 4 PI AND K PI KBAR AND THE
R4 MMS PEAK. R4 IS ONLY A 3 STANDARD DEVIATION
EFFECT. OMITTED FROM TABLE.
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                    42 MASS (MEV)

M      110 1832.       6.            DANYSZ     67 HBC    OSEE NOTE R BELOW  5/67
M    R      SEEN IN 2.5-3. PBAR P. 2PI+2PI-, WITH 0,1,2 PI+PI- PAIRS
M    R                                                IN RHOO BAND
M    M     (1830.)    (15.)          DUBAL      67 MMS    -  7,11.5,12.PI- P 6/68
M    M      MISSING MASS R4 PEAK,FINAL STATE UNKNOWN
M           1820.      12.           FRENCH     67 HBC    OSEE NOTE K BELOW  7/67
M    K      SEEN IN 3.-3.6 PBAR P TO (KS KO PIO...). G PARITY UNKNOWN
M           . . . . . . . . . .
M    AVG    1829.6     5.4       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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                    42 WIDTH (MEV)

W      110   42.       11.           DANYSZ     67 HBC    OSEE NOTE R BELOW  5/67
W    R       SEEN IN 2.5-3. PBAR P. 2PI+2PI-, WITH 0,1,2 PI+PI- PAIRS
W    R                                                IN RHOO BAND
W    M     (30.0) OR LESS            DUBAL      67 MMS    - 7,11.5,12 PI-P   6/68
W    M       MISSING MASS R4 PEAK,FINAL STATE UNKNOWN
W            50.       23.           FRENCH     67 HBC    OSEE NOTE K BELOW  7/67
W    K       SEEN IN 3.-3.6 PBAR P TO (KS KO PIO...). G PARITY UNKNOWN
W            . . . . . . . . . .
W    AVG     43.5      9.9       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
------ --------- --------- --------- --------- --------- --------- --------

                    42 PARTIAL DECAY MODES

                                                      DECAY MASSES
P1        ETA OR RHO (1830) INTO 4 PI                 139+ 139+ 139+ 139
P2        ETA OR RHO (1830) INTO RHO PI PI            139+ 139+ 765
P3        ETA OR RHO (1830) INTO RHO RHO              765+ 765
P4        ETA OR RHO (1830) INTO K KBAR PI            134+ 497+ 497
****** ********* ********* ********* ********* ********* ********* ********
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REFERENCES


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DANYSZ    67 PL 24B 309          +FRENCH+KINSON+SIMAK+       (CERN+LIVERPOOL)
DUBAL     67 NP B3 435           CERN MISSING MASS SPECTROMETER GROUP (CERN)
   ALSO   68 THESIS 1456         L.DUBAL                            (GENEVE)
FRENCH    67 NC 52A 442          +KINSON+MCDONALD+RIDDIFORD+      (CERN+BIRM)
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$\phi_{A,I\geq 0}(1830) \rightarrow 5\pi, K^*\bar{K}$

```
43  PHI OR PI (1830) G=-1 (JPG=  -) I GTE 0

THIS ENTRY CONTAINS OMEGA PI PI AND K PI KBAR
AND THE R4 MMS PEAK. R4 IS ONLY A 3 STANDARD
DEVIATION EFFECT. I=1 IF (OMEGA RHO) MODE
EXISTS. OMITTED FROM TABLE.
------ --------- --------- --------- --------- --------- --------- --------

                    43  MASS (MEV)

M    O    (1849.)    (11.)           DANYSZ     67 HBC     O 3,3.6 PBAR P     7/67
M    O     OBSERVED IN (OMEGA PI+ PI-) (AND POSSIBLY (OMEGA RHO(0))) MODE
M    K    (1820.)    (12.)           FRENCH     67 HBC     O 3,3.6 PBAR P     7/67
M    K     OBSERVED IN (KS KO PIO...) MODE  (G-PARITY UNKNOWN)
M    M    (1830.)    (15.)           DUBAL      67 MMS    -  7,11.5,12.PI- P  6/68
M    M     MISSING MASS R4 PEAK,FINAL STATE UNKNOWN
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                    43  WIDTH (MEV)

W    O    (67.)    (27.)             DANYSZ     67 HBC     O 3,3.6 PBAR P     7/67
W    O     OBSERVED IN (OMEGA PI+ PI-) (AND POSSIBLY (OMEGA RHO(0))) MODE
W    K    (50.)    (20.)             FRENCH     67 HBC     O 3-4 PBAR P       7/67
W    K     OBSERVED IN (KS KO PIO...) MODE  (G-PARITY UNKNOWN)
W    M    (30.0) OR LESS             DUBAL      67 MMS    - 7,11.5,12 PI-P    6/68
W    M     MISSING MASS R4 PEAK,FINAL STATE UNKNOWN
------ --------- --------- --------- --------- --------- --------- --------

                    43 PARTIAL DECAY MODES

                                                      DECAY MASSES
P1        PHI (1830) INTO 5 PI                        139+ 139+ 139+ 139
P2        PHI (1830) INTO OMEGA PI PI                 139+ 139+ 783
P3        PHI (1830) INTO OMEGA RHO                   783+ 765
P4        PHI (1830) INTO K KBAR PI                   134+ 497+ 497
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REFERENCES


```
DANYSZ    67 NC 51A 801          DANYSZ+FRENCH+SIMAK                   (CERN)
DUBAL     67 NP B3 435           CERN MISSING MASS SPECTROMETER GROUP (CERN)
   ALSO   68 THESIS 1456         L.DUBAL                            (GENEVE)
FRENCH    67 NC 52A 442          +KINSON+MCDONALD+RIDDIFORD+      (CERN+BIRM)
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S(1930) REGION

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31 S(1930,JPG=    ) I=1 OR 2

THIS ENTRY CONTAINS, BESIDES THE S(1930) SEEN BY
CHIKOVANI 66 WITH A MMS, AND CONFIRMED BY CLINE 70 IN
PBAR P BACKWARD ELASTIC SCATTERING, VARIOUS OTHER
PEAKS NEARBY.  FOR REVIEWS, SEE ASTIER 70,MONTANET 69.
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                    31   S (1930)   MASS (MEV)

M          1929.0     14.0       CHIKOVANI 66 MMSP   -   12.0 PI-P          8/66
M          1900.      40.        BOESEBECK 68 HBC   +    8 PI+ P,PI+ PIO   6/68
M    X    (1945.0)               CLINE      68 HBC      .3-.7 PB P ELAST   9/68
M    X    (1925.0)               CLINE      68 HBC      .3-.7 PB P ELAST   9/68
M    X     CLINE 68 SUPERSEDED BY CLINE 70 BELOW
M     C    1973.0     15.0       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     K    1975.0     12.0       KRAMER     70 HBC   +  13.1 PI+ P,2PI    11/70*
M     K    HAS IG=1+ FROM ABSENCE OF PI+PI+ PEAK. THUS JP=(ODD)-.         11/70*
M     E   (1926.0)               CLINE      70 HBC     0 .25-.74 PB P EL   1/71*
M     E          FROM FIT TO EXTRAPOLATED 180-DEG.DIFF. CROSS SECTION      1/71*
M    C    (1925.0)    (2.3)      CLINE      70 HBC     0 .25-.74 PB P EL   1/71*
M    C    (1947.0)   (16.0)      CLINE      70 HBC     0 .25-.74 PB P EL   1/71*
M    C           FROM FIT WITH 2 BREIT-WIGNER CURVES                       1/71*
M          . . . . . . . . . .
M    AVG   1958.0     13.5      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.8)
                          (SEE IDEOGRAM BELOW )
```

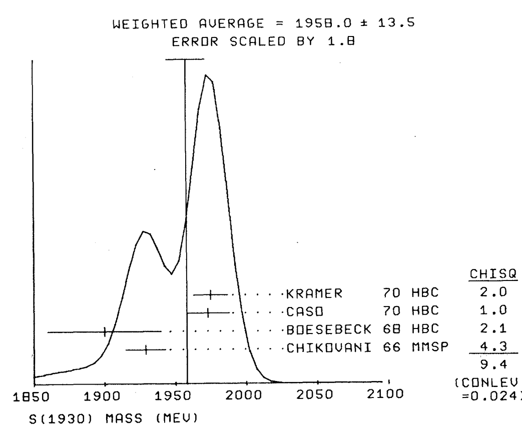


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                    31   S (1930) WIDTH (MEV)

W         (35.0)  OR LESS        CHIKOVANI 66 MMSP   -   12.0 PI-P          8/66
W          216.     105.         BOESEBECK 68 HBC   +    8 PI+ P,PI+ PIO   6/68
W    X    (22.0)                 CLINE      68 HBC      .3-.7 PB P ELAST   9/68
W    X    (10.0)                 CLINE      68 HBC      .3-.7 PB P ELAST   9/68
W    X     CLINE 68 SUPERSEDED BY CLINE 70 BELOW
W     C   (80.0)                 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     K   (52.0)  OR LESS  CL=0.90  KRAMER  70 HBC   +  13.1 PI+ P,2PI    11/70*
W     K    HAS IG=1+ FROM ABSENCE OF PI+PI+ PEAK. THUS JP=(ODD)-.         11/70*
W     E   (18.0)                 CLINE      70 HBC     0 .25-.74 PB P EL   1/71*
W     E          FROM FIT TO EXTRAPOLATED 180-DEG.DIFF. CROSS SECTION      1/71*
W    C     (7.6)     (3.5)       CLINE      70 HBC     0 .25-.74 PB P EL   1/71*
W    C    (52.0)    (10.0)       CLINE      70 HBC     0 .25-.74 PB P EL   1/71*
W    C           FROM FIT WITH 2 BREIT-WIGNER CURVES                       1/71*
------ --------- --------- --------- --------- --------- --------- --------

                    31   S MESON PARTIAL DECAY MODES

                                                      DECAY MASSES
P1        S  INTO PI+ PI-                             139+ 139
P2        S  INTO PBAR P                              938+ 938
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Mesons

For notation, see illustrated key at beginning of data card listings.

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               31 D(SIGMA)/D(T)  ( MICROBARNS/(GEV/C)**2 )

CS          35.0     12.0          FOCACCI   66 MMS  .22 LTE T LTE .36    9/66

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                          REFERENCES FOR S(1930)

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,THITTY  (WISCONSIN)

MONTANET 69 LUND CONF.P.189     L.MONTANET, RAPPORTEUR              (CERN)

ASTIER   70 KIEV CONF.          RAPP.TALK ON BOSON RESONANCES       (CDF)
CASO     70 LNC 3  707          +CORDS,COSTA,DARO+(GENO,DESY,HAM,MILA,SACL)
CLINE    70 PREPRINT, DEC 70    D.CLINE,J.ENGLISH,D.D.REEDER       (WISC)J
            PRIV.COMM. FEB 71   SUPERSEDES DEC 70 PREPRINT
KRAMER   70 PRL 25 396          +BARTON,GUTAY,LICHTMAN,MILLER,+   (PURDUE)

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ρ(~2100) REGION

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          51 RHO (2100, JPG=  +) I=1

          NICHOLSON 69 SUGGEST IG=1+,JP=3- FROM  ANALYSIS OF
          DIFFERENTIAL CROSS-SECTIONS FOR PBAR PI -- 2PI.
          OMITTED FROM TABLE.
------ --------- --------- --------- --------- --------- --------- --------

               51 RHO (2100)  MASS (MEV)

M         2096.0     38.0          ANDERSON  69 MMS   - 16 PI- P,BACKW   8/69
M         (2120.)                  NICHOLSON 69 CNTR   0 .7-2.4 PB P,2PI  9/69
------ --------- --------- --------- --------- --------- --------- --------

               51 RHO (2100)  WIDTH (MEV)

W         (150.0)                  ANDERSON  69 MMS   - 16 PI- P,BACKW   8/69
W    N    (249.)                   NICHOLSON 69 CNTR   0 .7-2.4 PB P,2PI  9/69
W    N     THE WIDTH INCLUDES RESOLUTION.

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                          REFERENCES FOR RHO(2100)

ANDERSON 69 PRL 22 1390         +COLLINS,BLIEDEN+               (BNL+CARN)
NICHOLSO 69 PRL 23 603          NICHOLSON,BARISH,DELORME,+  (CALT+ROCH+BNL)

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T(2200) REGION

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          32 T(2200,JPG=   ) I=1 OR 2

          THIS ENTRY CONTAINS, BESIDES THE T(2200) SEEN BY
          CHIKOVANI 66 WITH A MMS, VARIOUS OTHER PEAKS NEARBY.
          FOR REVIEWS,SEE MONTANET 69, KALBFLEISCH 70
          OMITTED FROM TABLE.
------ --------- --------- --------- --------- --------- --------- --------

               32 T(2200)  MASS (MEV)

M         2195.0     15.0          CHIKOVANI 66 MMSP  -  12.0 PI-P        8/66
M    B    (2190.)    (10.)         ABRAMS     70 CNTR    S CHANNEL NBAR N  1/71*
M    B     SEEN AS BUMP IN I=1 STATE. WIDTH MUCH LARGER THAN IN
M    B     THE MMSP EXPT.  SEE ALSO COOPER 68
M    B     BRICMAN (69) SEES NO BUMP, SPIN LESS THAN 5 IS SO EXCLUDED
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    K    (2190.0)                 KALBFLEIS 69 HBC    0 S-CHANNEL PBARP  7/69
M    K     SEEN IN PBAR P TO RHOO RHOO PIO. IG=1-.
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    D    2157.0     10.0          KRAMER     70 HBC  +  13.1 PI+ P,2PI  11/70*
M    D     HAS IG=1+ FROM ABSENCE OF PI+PI+ PEAK. THUS JP=(OOD)-.          11/70*
M          . . . . . . . . .
M    AVG  2184.7      9.8      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.8)
                            (SEE IDEOGRAM BELOW )
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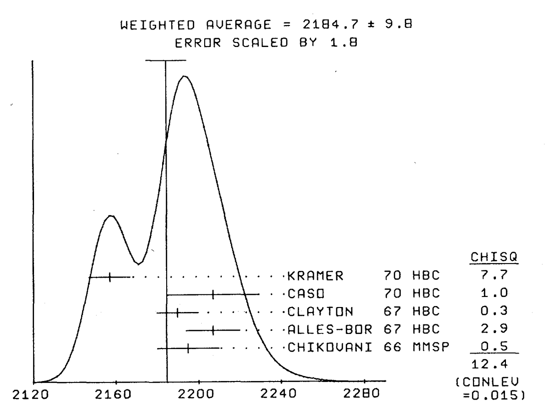


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               32 T(2200) WIDTH (MEV)

W         (13.0) OR LESS           CHIKOVANI 66 MMSP  -  12.0 PI-P        8/66
W    B    (85.)                    ABRAMS     67 CNTR    S CHANNEL NBAR N  7/67
W    B     SEE NOTE B UNDER T(2200) MASS ABOVE.
W         62.      52.             ALLES-BOR 67 HBC    0 5.7 PBAR P     12/66
W    K     BETWEEN 20 AND 80 MEV   KALBFLEIS 69 HBC    0 S-CHANNEL PBARP  7/69
W    K     SEEN IN PBAR P TO RHOO RHOO PIO. IG=1-.
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    D    68.0      22.0           KRAMER     70 HBC  +  13.1 PI+ P,2PI  11/70*
W    D     HAS IG=1+ FROM ABSENCE OF PI+PI+ PEAK. THUS JP=(OOD)-.          11/70*
W          . . . . . . . . .
W    AVG  67.1      20.3      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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               32 D(SIGMA)/D(T)  ( MICROBARNS/(GEV/C)**2 )

CS          29.0     10.0          FOCACCI   66 MMS  .22 LTE T LTE .36    9/66
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               32 SIGMA (MB) FOR FORMATION BY NUCLEON ANTINUCLEON

CS        (5.5)                    ABRAMS     70 CNTR    S CHANNEL NBAR N  1/71*
CS   K    (0.5)     (0.1)          KALBFLEIS 69 HBC    OS CHANNEL NBAR N  7/69
CS         SEEN IN PBAR P TO RHOO RHOO PIO.IG=1-.

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                          REFERENCES FOR T(2200)

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)
  ALSO ABRAMS 70
ALLES-BO 67 NC 50 A 776         ALLES-BORELLI,FRENCH,FRISK,+    (CERN+BONN)G=-
CLAYTON  67 HEIDBG.CONF.P.57    +MASON,MUIRHEAD,FILIPPAS+  (LIVPOOL+ATHENS)
COOPER   68 PRL 20 1059         +HYMAN,MANNER,MUSGRAVE,VOYVODIC        (ANL)

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)
  ALSO CASO 69
KALBFLEI 70 PHILAD.CONF.P.409 G.KALBFLEISCH AND D.MILLER REVUES        (BNL)
KRAMER   70 PRL 25 396          +BARTON,GUTAY,LICHTMAN,MILLER,+     (PURDUE)

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ρ(~2275) REGION

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          52 RHO (2275, JPG=  +) I=1

          NICHOLSON 69 SUGGEST IG=1+,JP=5- FROM  ANALYSIS OF
          DIFFERENTIAL CROSS-SECTIONS FOR PBAR PI -- 2PI.
          OMITTED FROM TABLE.
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               52 RHO (2275)  MASS (MEV)

M         2260.0     18.0          ANDERSON  69 MMS   - 16 PI- P,BACKW   8/69
M         (2290.)                  NICHOLSON 69 CNTR   0 .7-2.4 PB P,2PI  9/69
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               52 RHO (2275)  WIDTH (MEV)

W         (25.0) OR LESS           ANDERSON  69 MMS   - 16 PI- P,BACKW   8/69
W    N    (165.)                   NICHOLSON 69 CNTR   0 .7-2.4 PB P,2PI  9/69
W    N     THE WIDTH INCLUDES RESOLUTION.

****** ********* ********* ********* ********* ********* ********* ********

                          REFERENCES FOR RHO(2275)

ANDERSON 69 PRL 22 1390         +COLLINS,BLIEDEN+               (BNL+CARN)
NICHOLSO 69 PRL 23 603          NICHOLSON,BARISH,DELORME,+  (CALT+ROCH+BNL)

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$N\bar{N}_{I=1}$(2350)

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          58 N NBAR (2350) I=1

          OMITTED FROM TABLE
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               58 MASS

M    B    (2350.)    (10.)         ABRAMS     70 CNTR    S CHANNEL NBAR N  1/71*
M    B     SEEN AS BUMP IN I=1 STATE. WIDTH MUCH LARGER THAN IN MMS EXPT.
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               58 WIDTH

W    B    (140.)                   ABRAMS     67 CNTR    S CHANNEL PBAR N  7/67
W    B     SEEN AS BUMP IN I=1 STATE. WIDTH MUCH LARGER THAN IN MMS EXPT.
------ --------- --------- --------- --------- --------- --------- --------

               58 SIGMA (MB) FOR FORMATION BY NUCLEON ANTINUCLEON

CS        (3.2)                    ABRAMS     70 CNTR    S CHANNEL NBAR N  1/71*

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                          REFERENCES FOR N NBAR (2350)

ABRAMS   67 PRL 18 1209         +COOL,GIACOMELLI,KYCIA,LEONTIC,LI,+   (BNL)
ABRAMS   70 PR D 1 1917         +COOL,GIACOMELLI,KYCIA,LEONTIC,LI,+   (BNL)

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For notation, see illustrated key at beginning of data card listings.

U(2375) REGION

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33 U(2375)      I=1
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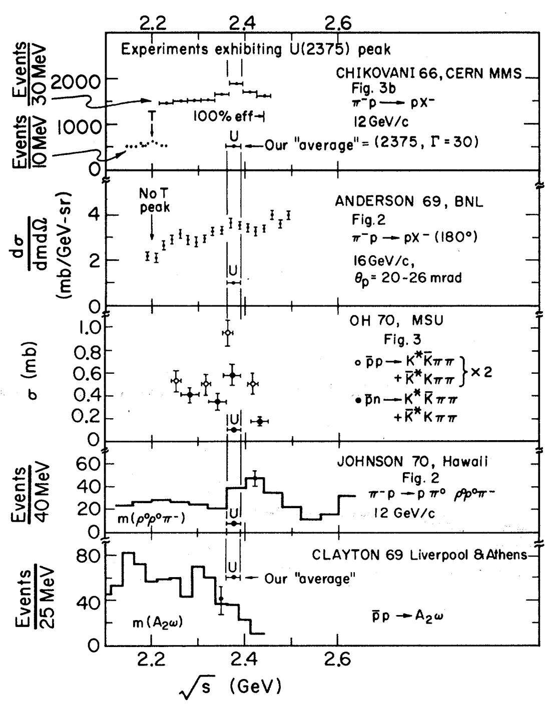
Evidence for the existence of a non-strange, I=1 meson in the 2375-MeV region, having $\Gamma \lesssim 30$ MeV, originally came from the CERN Missing-Mass Spectrometer group (CHIKOVANI 66). Others have since found indications of a peak in the neighborhood; the figure shows the current situation.

Removed from our figure and data cards since the last edition is some previously reported evidence for the U in the reactions $\bar{p}p \to K\bar{K}\omega$ and $\bar{p}p \to K_S K_L +$ neutrals (RING-1 69 and RING-2 69). The groups involved now have added more data and do not see any significant peak in the U region (OH 70 and private communication).

We show the CLAYTON 69 and JOHNSON 70 mass distributions, although the peaks in these experiments do not appear to line up with those of the other experiments. There is also a peak in the I=1 $\bar{p}p$ total cross section reported by ABRAMS 67, but it is 140 MeV wide and is not shown.

Although the net evidence for the U is not very strong, we continue to include it in our Meson Table because of the concurrence of several experiments on its mass and width.

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                    33 U(2375)  MASS (MEV)

M          2382.0     24.0           CHIKOVANI 66 MMSP  -  12.0 PI-P        8/66
M    C    (2324.0)   (20.0)          CLAYTON   67 HBC  +- 2.5PBAR,A2+OMEGA 11/69
M    C     MAY BE DIFFERENT OBJECT. VALUE QUOTED IN HEIDELBERG PROC. OF
M    C     2380 +- 10 IS MISTAKE... PRIV. COMM. FROM MUIRHEAD.
M          2370.      17.            ANDERSON  69 ASPK  - 16 PI- BKSCAT    11/69
M         (2420.0)   (25.0)          JOHNSON   70 HBC   -  12.0 PI- P       1/71*
M          2360.0     25.0           OH        70 HDBC  -OPBAR(P,N),K*K2PI  5/70
M          . . . . . . . . . .
M    AVG   2370.7     12.1      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                    33 U(2375) WIDTH (MEV)

W           (30.0)  OR LESS          CHIKOVANI 66 MMSP  -  12.0 PI-P        8/66
W           (57.)                    ANDERSON  69 ASPK  - 16 PI- BKSCAT    11/69
W           (80.0) OR LESS           JOHNSON   70 HBC   -  12.0 PI- P       1/71*
W           (60.0)OR LESS            OH        70 HDBC  -OPBAR(P,N),K*K2PI  5/70

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                    33 D(SIGMA)/D(T) ( MICROBARNS/(GEV/C)**2 )

CS            42.0     14.0          FOCACCI   66 MMS  .28 LTE T LTE .36    9/66

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                    33  U MESON BRANCHING RATIOS

R1         U- MESON FRACTION INTO ONE / THREE / FIVE OR MORE CHARGED TRACKS
R1            (0.30)/   0.45 /    0.25  FOCACCI   66 MMS   -                10/66

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                              REFERENCES FOR U(2375)

CHIKOVAN 66 PL   22  233          CERN MISSING MASS SPECTROMETER GROUP (CERN)
FOCACCI  66 PRL  17  890          CERN MISSING MASS SPECTROMETER GROUP (CERN)

CLAYTON  67 HEIDBG.CONF.P.57   +MASON,MUIRHEAD,FILIPPAS+  (LIVPOOL+ATHENS)
    ALSO 71 PRIV.COMM.         W.MUIRHEAD                           (LIVP)

ANDERSON 69 PRL 22 1390        +BLESER,BIRNBAUM,EDELSTEIN,+     (BNL+CARN)

JOHNSON  70  UH 511 77 70      +PETERS,STENGER,YEE                   (HAWA)
OH       70 PRL 24 1257        +PARKER,EASTMAN,SMITH,SPRAFKA,MA (MICHIGAN)

                               PAPERS NOT REFERRED TO IN DATA CARDS

ABRAMS   67 PRL 18 1209        +COOL,GIACOMELLI,KYCIA,LEONTIC,LI,+   (BNL)

BRICMAN  69 PL 29 B 451        +FERRO-LUZZI,BIZARD,+       (CERN+CAEN+SACL)
CASO     69 LNC 3 707          +CONTE,BENZ,+     (GENO+DESY+HAMB+MILA+SACL)
RING1    69  MICH PREPRINT     +CHAPMAN,CHURCH,LYS,MURPHY,VANDERVELD(MICH)
RING2    69                    JOINT PREPRINT COMBINES RING1 AND OH 70

LYS      70  MICH PREPRINT     J.LYS                                (MICH)
SMITH    70  PHILA.CONF.       G.A.SMITH                             (MSU)

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$N\bar{N}_{I=0}(2375)$

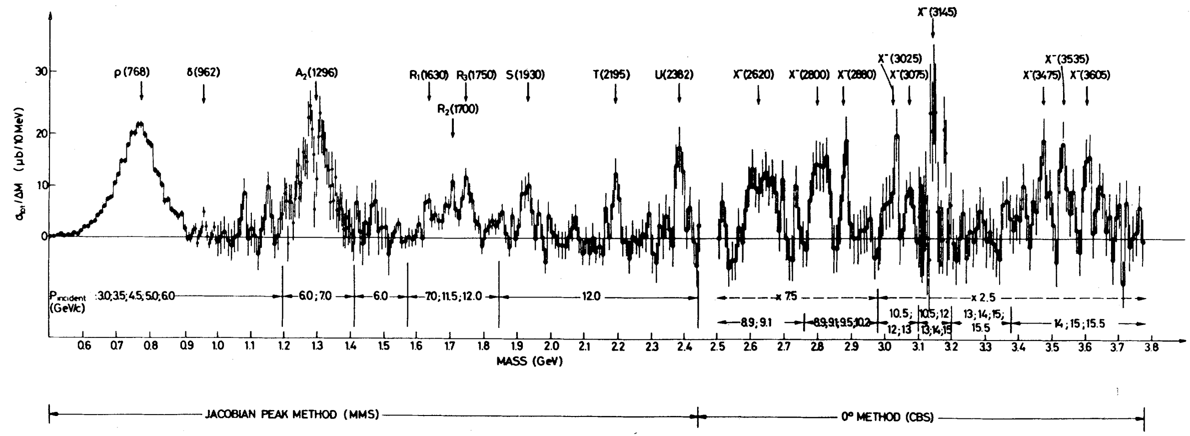
```
41  N NBAR (2375) I=0

EVIDENCE FOR RESONANCE PRELIMINARY.
OMITTED FROM TABLE.

------ --------- --------- --------- --------- --------- --------- --------

                    41 MASS

M          2375.      10.            ABRAMS     70 CNTR    S CHANNEL NBAR N  1/71*

------ --------- --------- --------- --------- --------- --------- --------

                    41 WIDTH

W          (190.)                    ABRAMS     70 CNTR    S CHANNEL NBAR N  1/71*

------ --------- --------- --------- --------- --------- --------- --------

                    41 SIGMA (MB) FOR FORMATION BY NUCLEON ANTINUCLEON

CS           (2.5)                   ABRAMS     70 CNTR                      1/71*

****** ********* ********* ********* ********* ********* ********* ********

                              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)

****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
```

$X^-(2500)$

```
46   X- (2500, JPG=   ) I=1 OR 2

          OMITTED FROM TABLE

------ --------- --------- --------- --------- --------- --------- --------

                    46  X- (2500)  MASS (MEV)

M          2500.0     32.0           ANDERSON  69 MMS   -  16 PI- P,BACKW9  8/69

------ --------- --------- --------- --------- --------- --------- --------

                    46  X- (2500)  WIDTH (MEV)

W          (87.0)                    ANDERSON  69 MMS   -  16 PI- P,BACKW9  8/69

****** ********* ********* ********* ********* ********* ********* ********

                              REFERENCES FOR X-(2500)

ANDERSON 69 PRL  22 1390       +COLLINS,+                       (BNL+CARN)

******* ********* ********* ********* ********* ********* ********* *******
******* ********* ********* ********* ********* ********* ********* *******
```

For notation, see illustrated key at beginning of data card listings.

BOSON MASS-SPECTRUM IN $\pi^- + p \rightarrow p + (BOSON)^-$, CERN 1965-70



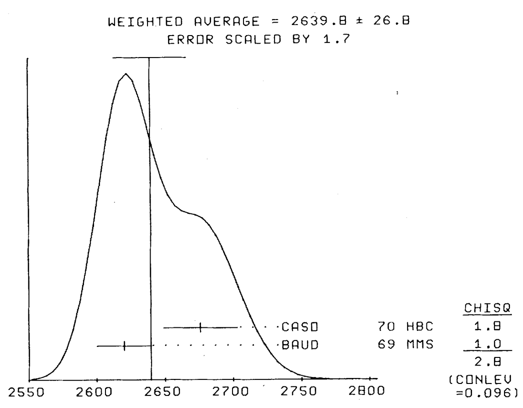
From Baud et al. paper, presented by G. Damgaard, Proceedings 1970 Philadelphia Conference.

$X^-(2620)$ through $X^-(3535)$

The figure on this page shows the X^- spectrum, as studied with the CERN Boson Spectrometer. The background is not shown but is about ten times as large as the signal. Uncertainties in where to draw this background make it extremely difficult to measure the width of these peaks, or to judge their statistical significance.

$X^-(2620)$

```
48   X- (2620, JPG=    ) I=1 OR 2
          OMITTED FROM TABLE
------ --------- --------- --------- --------- --------- --------- --------

          48  X- (2620)  MASS (MEV)

M       550 2620.      20.               BAUD       69 MMS   -  8.-10. PI- P     9/69
M           2676.0     27.0              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           . . . . . . . . .
M    AVG    2639.8     26.8      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)
                      (SEE IDEOGRAM BELOW )
```




```
          48  X- (2620)  WIDTH (MEV)

W       550   85.       30.              BAUD       69 MMS   -  8.-10. PI- P     9/69
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

****** ********* ********* ********* ********* ********* ********* ********

                    REFERENCES FOR X-(2620)

BAUD     69 PL  30B 129        CERN BOSON SPECTROMETER GROUP          (CERN)
CASO     70 LNC 3 707          +CONTE,TOMASINI,CORDS+(GENO+HAMB+MILA+SACL)

******* ********* ********* ********* ********* ********* ********* *******
******* ********* ********* ********* ********* ********* ********* *******
```

$X^-(2800)$

```
49   X- (2800, JPG=    ) I=1 OR 2
          OMITTED FROM TABLE
------ --------- --------- --------- --------- --------- --------- --------

          49  X- (2800)  MASS (MEV)

M       640 2800.      20.               BAUD       69 MMS   -  8.-10. PI- P     9/69
------ --------- --------- --------- --------- --------- --------- --------

          49  X- (2800)  WIDTH (MEV)

W       640   46.      10.               BAUD       69 MMS   -  8.-10. PI- P     9/69

****** ********* ********* ********* ********* ********* ********* ********

                    REFERENCES FOR X-(2800)

BAUD     69 PL  30B 129        CERN BOSON SPECTROMETER GROUP          (CERN)

******* ********* ********* ********* ********* ********* ********* *******
******* ********* ********* ********* ********* ********* ********* *******
```

$X^-(2880)$

```
50   X- (2880, JPG=    ) I=1 OR 2
          OMITTED FROM TABLE
------ --------- --------- --------- --------- --------- --------- --------

          50  X- (2880)  MASS (MEV)

M       230 2880.      20.               BAUD       69 MMS   -  8.-10. PI- P     9/69
------ --------- --------- --------- --------- --------- --------- --------

          50  X- (2880)  WIDTH (MEV)

W       230           15.  OR LESS       BAUD       69 MMS   -  8.-10. PI- P     9/69

****** ********* ********* ********* ********* ********* ********* ********

                    REFERENCES FOR X-(2880)

BAUD     69 PL  30B 129        CERN BOSON SPECTROMETER GROUP          (CERN)

******* ********* ********* ********* ********* ********* ********* *******
******* ********* ********* ********* ********* ********* ********* *******
```

Mesons

For notation, see illustrated key at beginning of data card listings.

X⁻(3030)

```
53  X- (3030, JPG=   ) I=1 OR 2
      OMITTED FROM TABLE
------ --------- --------- --------- --------- --------- --------- --------

                53  X- (3030)  MASS (MEV)

M        3035.0      25.0              ALEXANDER 70 HBC      7. PBAR P,7 PI    5/70
M        3025.0      20.0              BAUD        70 MMS   - 10.5-13 PI- P    5/70
M       . . . . . . . . . .
M   AVG  3028.9      15.6     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
------ --------- --------- --------- --------- --------- --------- --------

                53  X- (3030)  WIDTH (MEV)

W         200.0      60.0              ALEXANDER 70 HBC      7. PBAR P,7 PI    5/70
W        (25.0)  APPROX.               BAUD        70 MMS   - 10.5-13 PI- P    5/70
****** ********* ********* ********* ********* ********* ********* ********

                REFERENCES FOR X-(3030)

ALEXANDE 70 PRL 25 63        +BAR-NIR,DAGAN,GIDAL,GRUNHAUS+    (TEL-AVIV)
BAUD       70 PL 31 B 549     CERN BOSON SPECTROMETER GROUP          (CERN)
****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
```

X⁻(3075)

```
54  X- (3075, JPG=   ) I=1 OR 2
      OMITTED FROM TABLE
------ --------- --------- --------- --------- --------- --------- --------

                54  X- (3075)  MASS (MEV)

M        3075.0      20.0              BAUD        70 MMS   - 10.5-13 PI- P    5/70
------ --------- --------- --------- --------- --------- --------- --------

                54  X- (3075)  WIDTH (MEV)

W        (25.0)  APPROX.               BAUD        70 MMS   - 10.5-13 PI- P    5/70
****** ********* ********* ********* ********* ********* ********* ********

                REFERENCES FOR X-(3075)

BAUD       70 PL 31 B 549     CERN BOSON SPECTROMETER GROUP          (CERN)
****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
```

X⁻(3145)

```
55  X- (3145, JPG=   ) I=1 OR 2
      OMITTED FROM TABLE
------ --------- --------- --------- --------- --------- --------- --------

                55  X- (3145)  MASS (MEV)

M        3145.0      20.0              BAUD        70 MMS   - 10.5-15 PI- P    5/70
------ --------- --------- --------- --------- --------- --------- --------

                55  X- (3145)  WIDTH (MEV)

W        (10.0)  OR LESS               BAUD        70 MMS   - 10.5-15 PI- P    5/70
****** ********* ********* ********* ********* ********* ********* ********

                REFERENCES FOR X-(3145)

BAUD       70 PL 31 B 549     CERN BOSON SPECTROMETER GROUP          (CERN)
****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
```

X⁻(3475)

```
56  X- (3475, JPG=   ) I=1 OR 2
      OMITTED FROM TABLE
------ --------- --------- --------- --------- --------- --------- --------

                56  X- (3475)  MASS (MEV)

M        3475.0      20.0              BAUD        70 MMS   - 14-15.5 PI- P    5/70
------ --------- --------- --------- --------- --------- --------- --------

                56  X- (3475)  WIDTH (MEV)

W        (30.0)  APPROX.               BAUD        70 MMS   - 14-15.5 PI- P    5/70
****** ********* ********* ********* ********* ********* ********* ********

                REFERENCES FOR X-(3475)

BAUD       70 PL 31 B 549     CERN BOSON SPECTROMETER GROUP          (CERN)
****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
```

X⁻(3535)

```
57  X- (3535, JPG=   ) I=1 OR 2
      OMITTED FROM TABLE
------ --------- --------- --------- --------- --------- --------- --------

                57  X- (3535)  MASS (MEV)

M        3535.0      20.0              BAUD        70 MMS   - 14-15.5 PI- P    5/70
------ --------- --------- --------- --------- --------- --------- --------

                57  X- (3535)  WIDTH (MEV)

W        (30.0)  APPROX.               BAUD        70 MMS   - 14-15.5 PI- P    5/70
****** ********* ********* ********* ********* ********* ********* ********

                REFERENCES FOR X-(3535)

BAUD       70 PL 31 B 549     CERN BOSON SPECTROMETER GROUP          (CERN)
****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
```

K

```
            K MESON          ( JP=0- )    I=1/2
         SEE LISTINGS OF STABLE PARTICLES
****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
```

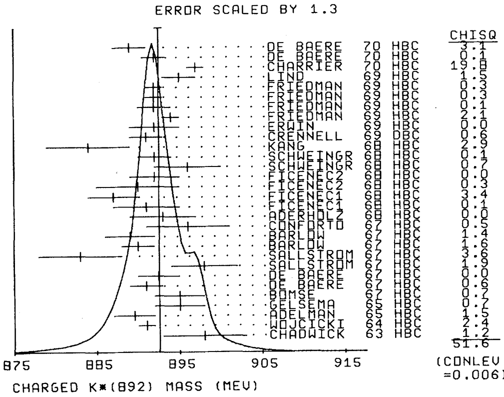
κ(725)

```
17  KAPPA (725,JP=   )  I=1/2
EVIDENCE NOT COMPELLING. OMITTED FROM TABLE.
FOR A COMPILATION, SEE APPENDIX A OF JAN 67 EDITION
(RMP 39, 1) OF THIS DATA SUMMARY.
   SEE ALSO ROSENFELD, PROC.1968 UNIV.OF PENN.CONF.ON MESON SPECTROSCOPY
****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
```

K*(892)

```
18  K*  (892,JP =1- )  I=1/2
------ --------- --------- --------- --------- --------- --------- --------

                18  K* (892) MASS (MEV)

M  CHARGED ONLY. THIS IS WHAT APPEARS ON MESON TABLE
M            898.0      5.0          CHADWICK  63 HBC  +   1.5 K+P
M     3870   891.0      1.0          WOJCICKI  64 HBC  -   1.7 K-P
M            889.5      2.5          ADELMAN   65 HBC  -   1.5 K-P              6/66
M   D       (891.0)    (3.0)         FERRO-LUZ 65 HBC  +   3.0 K+P
M   D VALUE ABOVE SUPERSEDED BY DE BAERE 70 BELOW                              1/71*
M            895.0      3.0          GELSEMA   65 HBC  -   1.5 K-P
M            895.       3.           BOMSE     67 HBC  +  2.3 K+P               7/67
M            891.       2.           DE BAERE  67 HBC  +  3.5 K+P (K0 PI+)      7/67
M            892.5      2.5          DE BAERE  67 HBC  +  3.5 K+P (K+ PI0)      7/67
M            898.       4.           SALLSTROM 67 HBC  +  3. K+ P (K0 PI+)      7/67
M            883.       5.           SALLSTROM 67 HBC  +  3. K+ P (K+ PI0)      7/67
M            890.       2.           BARLOW    67 HBC  +-  1.2 PBAR P          11/66
M            889.       3.           BARLOW    67 HBC  +-  1.2 PBAR P          11/66
M            896.0      5.0          CONFORTO  67 HBC  +-  0. PBAR P            9/67
M            893.       4.           ADERHOLZ  68 HBC  -   10 K- P              6/68
M            891.       4.           FICENEC1  68 HBC  -   1.3 K-P (K-PI0)      9/67
M            887.       3.           FICENEC1  68 HBC  -   1.3 K-P (K0PI-)      9/67
M            890.0      5.0          FICENEC2  68 HBC  -   2.7 K- P(K-PI0)      2/69
M            892.0      3.0          FICENEC2  68 HBC  -   2.7 K- P(K0PI-)      2/69
M            896.0      4.0          SCHWEINGR 68 HBC  -   4.1 K-P              9/67
M            892.0      2.0          SCHWEINGR 68 HBC  -   5.5 K-P              9/67
M            884.0      5.0          KANG      68 HBC  -   4.6 K- P             7/69
M            891.0      2.0          CRENNELL  69 DBC  -   3.9 K-N (K0PI-)      7/69
M            892.0      3.0          ERWIN     69 HBC  +   3.5 K+ P             9/69
M     2886   894.       1.           FRIEDMAN  69 HBC  -   2.1  K-P (3BDY)      9/69
M      728   892.       2.           FRIEDMAN  69 HBC  -   2.45 K-P (3BDY)      9/69
M     3229   892.       1.           FRIEDMAN  69 HBC  -   2.6  K-P (3BDY)      9/69
M     1027   892.       1.           FRIEDMAN  69 HBC  -   2.7  K-P (3BDY)      9/69
M            895.       2.           LIND      69 HBC  +   9. K+ P              9/69
M            897.0      1.0          CHARRIER  70 HBC  +   8.25 K+ P           1/71*
M            892.0      1.5          DE BAERE  70 HBC  +   3.5 K+ P            1/71*
M            889.0      2.0          DE BAERE  70 HBC  +   5.0 K+ P            1/71*
M           . . . . . . . . . .
M   AVG      892.55     0.45    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
                       (SEE IDEOGRAM BELOW )
```

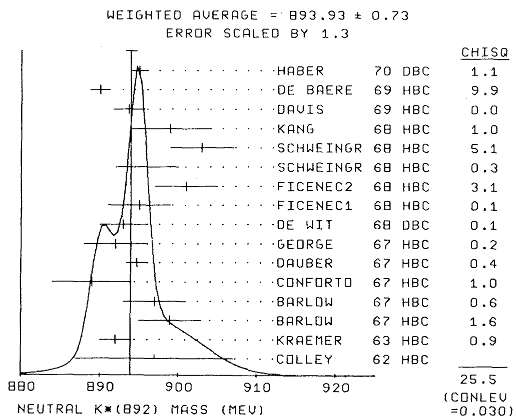
WEIGHTED AVERAGE = 892.55 ± 0.45
ERROR SCALED BY 1.3




```
M  MIXED-- CHARGED AND NEUTRAL. NOT TABULATED
M      200 (880.0)                   ALEXANDER 62 HBC  + 0 2.2 PI-P
M            895.0      2.0          FERRO-LUZ 65 HBC  + 0 3.0 K+P             6/66
M           (895.0)                  WANGLER   65 HBC  + 0 3.0 PI- P           6/66
M            894.       5.           FRENCH    67 HBC  +-0 3-4 PBAR P          6/67
M           . . . . . . . . . .
M   AVG      894.9      1.9     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

M  NEUTRAL ONLY. BUT WE DONT USE THIS FOR MASS DIFF. - SEE TYPED NOTE
M       70   897.0     10.0          COLLEY    62 HBC    0 2.0 PI-P
M      200   892.0      2.0          KRAEMER   63 HBC    0 2.3 K+P
M      150  (885.0)                  SMITH     63 HBC    0 2.3 PI-P
M            899.       4.           BARLOW    67 HBC    0 1.2 PBAR P         11/66
M            897.       4.           BARLOW    67 HBC    0 1.2 PBAR P         11/66
M            889.0      5.0          CONFORTO  67 HBC    0 0. PBAR P           9/67
M            894.7      1.3          DAUBER    67 HBC    0  2.0 K- P          12/66
M            892.0      4.0          GEORGE    67 HBC    0 5.0 K+ P           11/67
M            893.       3.           DE WIT    68 DBC    0 3. K- D             9/69
M  F         895.       4.           FICENEC1  68 HBC    0 1.3 K-P (K-PI+)    11/69
M  F         901.       4.           FICENEC2  68 HBC    0 2.7 K- P(K-PI+)    11/69
M  F FICENEC ERROR RAISED       SEE TYPED NOTE
M            896.0      4.0          SCHWEINGR 68 HBC    0 4.1 K-P             9/67
M            903.0      4.0          SCHWEINGR 68 HBC    0 5.5 K-P             9/67
M            899.0      5.0          KANG      68 HBC    0 4.6 K- P            7/69
M    10700   893.7      2.0          DAVIS     69 HBC    0 12. K+ P            9/69
M  D  2000   890.0      1.25         DE BAERE  69 HBC    0 5.0 K+ P            9/69
M  D DE BAERE ERRORS ENLARGED BY US TO   GAMMA/SQRT(N). SEE TYPED NOTE.       11/69
M     4000   895.0      1.0          HABER     70 DBC    0 3. K-N              5/70
M           . . . . . . . . . .
M   AVG      893.93     0.73    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
                       (SEE IDEOGRAM BELOW )
```

Mesons

For notation, see illustrated key at beginning of data card listings.

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------ --------- --------- --------- --------- --------- --------- --------

                 13  K*(0) - K*(+-) MASS DIFF. (MEV)

D   ALL ERRORS ENLARGED BY US, SEE TYPED NOTE
D     330     6.3      6.0             BARASH     67 HBC     0 PBAR P        8/67
D    1400     6.5      5.0             FICENEC1   68 HBC     1.3 K- P        2/69
D    1600     9.5      5.0             FICENEC2   68 HBC     2.7 K- P        2/69
D          . . . . . . . . .
D   AVG       7.6      3.0        AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
```

Note on K^* Masses and Mass Differences

This note is divided into two discussions:

I. Basic difficulties in determining the mass difference because of interferences and biases.

II. Impossibly small errors reported by some experiments. We have increased some errors that violate the laws of statistics, and scaled up some errors that are inconsistent; but we warn that most of the errors in our data cards are inconsistent. One cannot then obtain a K^* mass difference by calculating an average mass for K^{*0} and for $K^{*\pm}$ and just subtracting the two.

I. BASIC DIFFICULTIES

There are two difficulties in measuring a mass difference $m(K^{*0}) - m(K^{*\pm})$ of ~7 MeV when the half-width $\Gamma/2$ of the K^* is 25 MeV:

1) Interference between the resonant amplitude and background can in general shift the peak in the mass spectrum by some fraction of $\Gamma/2$.

2) The two charges of K^* have different topologies; this introduces differences in the measuring and fitting of the events, which can also produce mass shifts.

Some reactions (symmetric under reflection of I_z) are immune to the first difficulty. Thus compare the mass of K^{*0} produced in

$$\pi^- p \to \Lambda \pi^- K^+$$

with the mass of K^{*+} in the I_z-reflected reaction

$$\pi^+ n \to \Lambda \pi^+ K^0 .$$

The final-state amplitudes of each will contain not only the $|K^*\rangle$ with Ispin 1/2, but also an interfering I = 3/2 P-wave, which we can call $|K^*_{3/2}\rangle$. But I_z symmetry forces $\langle \pi^- p|\Lambda K^{*0}\rangle$ to equal $\langle \pi^+ n|\Lambda K^{*+}\rangle$; and similarly for the two $K^*_{3/2}$ amplitudes, so that the shifting of the K^* peak is the same in both reactions. Nobody has published a mass difference exploiting this fact.

II. IMPOSSIBLY SMALL ERRORS

Consider a sample of N events, with their invariant masses m distributed as an S-wave Breit-Wigner resonance:

$$\text{i.e.,} \quad P(\epsilon - \epsilon_R) = \frac{1/\pi}{(\epsilon-\epsilon_R)^2 + 1}, \tag{1}$$

where $\epsilon = \frac{m}{\Gamma/2}$, $\epsilon_R = \frac{m_R}{\Gamma/2}$. One can then show that the minimum possible error on the determination of the central value ϵ_R is

$$\delta_{min}(\epsilon_R) = \pm\sqrt{\frac{2}{N}}, \text{ i.e.,} \quad \delta_{min}(m_R) = \pm\sqrt{\frac{2}{N}}\frac{\Gamma}{2}. \tag{2}$$

This lower limit assumes no background events. In practice, with background, the error will be larger, by another factor $\alpha \approx \sqrt{2}$.

We illustrate errors with small and large backgrounds with a table summarizing the recent experiment ("Unsplit K^*'s") by DAVIS 69.

Mass Errors δm of DAVIS 69

• Sample with 5% background/signal at peak

Events: $K^*(892)$, 10 700 events in resonance, $\frac{\Gamma}{2} \approx 25$ MeV.

Lower limit from Eq. (2), $\delta_{min}(m) = \sqrt{\frac{2}{N}}\frac{\Gamma}{2} = \pm 0.35$ MeV.

Their likelihood fit yields two sorts of errors:

$\underline{\delta_1(m)}$. Ignore correlations, i.e., keep all parameters (background, width, etc.) fixed, vary m only:

$$\delta_1(m) = \pm 0.41, \quad \delta_1(m)/\delta_{min}(m) = 1.16.$$

$\underline{\delta_2(m)}$. As m is varied, reoptimize other parameters.

$$\delta_2(m) = \pm 0.53, \quad \delta_2(m)/\delta_{min}(m) = 1.5.$$

DAVIS 69 mention $\delta_2 = 0.53$, but to hedge against systematic effects, they quote $\underline{\delta_3}$=2 MeV. We punch 2 MeV.

• Sample with 50% background/signal at peak.

Events: $K^*(1420)$, 2200 events in resonance, $\frac{\Gamma}{2} = 50$ MeV.

$$\delta_{min}(m) = 1.6 \text{ MeV},$$

$\underline{\delta_1(m)} = \pm 2.2$ MeV, $\delta_1(m)/\delta_{min}(m) = 1.4,$

$\underline{\delta_2(m)} = \pm 2.6$ MeV, $\delta_2(m)/\delta_{min}(m) = 1.6.$

Width Errors $\delta\Gamma$ of DAVIS 69

For width, the equivalent of Eq. (2) is $\delta_{min}(\Gamma) = \pm\sqrt{\frac{8/3}{N}}\frac{\Gamma}{2} = 1.15\ \delta_{min}(m)$. For convenience we neglect the factor 1.15 and use $\delta_{min}(\Gamma) \approx \delta_{min}(m)$.

• 5% background, $K^*(892)$:

$$\delta_2(\Gamma) = \pm 1.6 \text{ MeV}, \quad \delta_2(\Gamma)/\delta_{min}(m) = \frac{1.6}{0.35} = 4.6.$$

• 50% background, $K^*(1420)$:

$$\delta_2(\Gamma) = \pm 10 \text{ MeV}, \quad \delta_2(\Gamma)/\delta_{min}(m) = \frac{10}{1.6} = 6.25.$$

For notation, see illustrated key at beginning of data card listings.

We note that $\delta_2(m)/\delta_{min}(m)$ does not change rapidly with background (1.5 at 5%, 1.6 at 50%) and hence conclude that it is hard to believe an error with $\delta_2/\delta_{min} < 1.4 = \sqrt{2}$. We chose $\sqrt{2}$ because together with Eq. (2) it leads to the simple "realistic" result

$$\delta(m) > \sqrt{2}\sqrt{\frac{2}{N}}\frac{\Gamma}{2} = \frac{\Gamma}{\sqrt{N}} . \qquad (3)$$

We conclude that for a sensitive subtraction like $m(K^{*0}) - m(K^{*\pm})$, the experiments as listed are useless, and we must either re-evaluate them all or concentrate on those two experiments that explicitly quote a mass difference. For a detailed discussion of how we have actually treated those experiments, we refer to the January 1970 edition of this note.

The table above also allows us to concoct a criterion for "realistic" errors in width $\delta(\Gamma)$. We average the 5% and 50% background results [to give $\delta(\Gamma)/\delta_{min}(m) \approx 5$ to 6] and express the result in terms of Γ, in the style of Eq. (3). We then get the "realistic" test for widths:

$$\delta\Gamma > 4\frac{\Gamma}{\sqrt{N}} . \qquad (4)$$

```
------ --------- --------- --------- --------- --------- --------- --------

                 18  K* (892) WIDTH (MEV)

W  CHARGED ONLY. THIS IS WHAT APPEARS ON MESON TABLE
W           46.0      8.0               CHADWICK  63 HBC  +  1.5 K+P
W    3870   46.0      3.0               WOJCICKI  64 HBC  -  1.7 K-P
W           51.0      3.0               ADELMAN   65 HBC  -  1.5 K-P          6/66
W           47.0      4.0               FERRO-LUZ 65 HBC  +  3.0 K+P
W           50.0     15.0               GELSEMA   65 HBC  -  1.5 K-P
W           50.       5.                BOMSE     67 HBC  + 2.3 K+P           7/67
W   D      (56.)     (4.5)              DE BAERE  67 HBC  + 3.5 K+P (K0 PI+)  7/67
W   D VALUE ABOVE SUPERSEDED BY DE BAERE 70 BELOW                             1/71*
W           53.       8.                DE BAERE  67 HBC  + 3.5 K+P (K+ PI0)  7/67
W           68.      10.                SALLSTROM 67 HBC  + 3. K+ P (K0 PI+)  7/67
W           47.      10.                SALLSTROM 67 HBC  + 3. K+ P (K+ PI0)  7/67
W           44.       7.                BARLOW    67 HBC +-  1.2 PBAR P      11/66
W           43.       9.                BARLOW    67 HBC +- 1.2 PBAR P       11/66
W           53.       7.                BARLOW    67 HBC +-  1.2 PBAR P      11/66
W          (43.)                        CONFORTO  67 HBC +-  0. PBAR P        9/67
W           58.       7.                ADERHOLZ  68 HBC  -  10 K- P          6/68
W           58.      16.                FICENEC1  68 HBC  -  1.3 K-P (K-PI0)  9/67
W           44.      13.                FICENEC1  68 HBC  -  1.3 K-P (K0PI-)  9/67
W           41.0      8.0               SCHWEINGR 68 HBC  -  4.1 K-P          9/67
W           47.0      4.0               SCHWEINGR 68 HBC  -  5.5 K-P          9/67
W           57.0     13.0               FICENEC2  68 HBC  -  2.7 K- P(K-PI0)  2/69
W           48.0      9.0               FICENEC2  68 HBC  -  2.7 K- P(K0PI-)  2/69
W           52.0      8.0               KANG      68 HBC  -  4.6 K- P         7/69
W          (27.0)    (8.0)     (6.0)    ERWIN     69 HBC  +  3.5 K+ P         9/69
W           53.       3.                FRIEDMAN  69 HBC  -  2.1  K-P (3BDY). 9/69
W           49.       4.                FRIEDMAN  69 HBC  -  2.45 K-P (3BDY)  9/69
W           46.       2.                FRIEDMAN  69 HBC  -  2.6  K-P (3BDY)  9/69
W           49.       3.                FRIEDMAN  69 HBC  -  2.7  K-P (3BDY)  9/69
W           50.       7.                LIND      69 HBC  +  9. K+ P          5/70
W           57.0      3.0               CHARRIER  70 HBC  +  8.25 K+ P        1/71*
W           56.0      4.0               DE BAERE  70 HBC  +  3.5 K+ P         1/71*
W           70.0      5.0               DE BAERE  70 HBC  +  5.0 K+ P         1/71*
W          . . . . . . . . .
W   AVG     50.3      1.1      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
                     (SEE IDEOGRAM BELOW )

W  MIXED-- CHARGED AND NEUTRAL. NOT TABULATED
W     200   60.0      5.0               ALEXANDER 62 HBC  + 0 2.2 PI-P
W           51.8      3.5               FERRO-LUZ 65 HBC  + 0 3.0 K+P         6/66
W          (40.0)                       WANGLER   65 HBC  + 0 3.0 PI- P       6/66
W           60.      10.                FRENCH    67 HBC +-0 3-4 PBAR P       6/67
W          . . . . . . . . .
W   AVG     54.9      2.8      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W  NEUTRAL ONLY.
W      70   60.0     10.0               COLLEY    62 HBC    0 2.0 PI-P
W     200   50.0      5.0               KRAEMER   63 HBC    0 2.3 K+P
W     150  (50.0)                       SMITH     63 HBC    0 2.3 PI-P
W           53.      13.                BARLOW    67 HBC    0 1.2 PBAR P     11/66
W           34.       8.                BARLOW    67 HBC    0 1.2 PBAR P     11/66
W          (43.)                        CONFORTO  67 HBC    0 0. PBAR P       9/67
W           44.       4.                DAUBER    67 HBC    0  2.0 K- P      12/66
W           58.       8.                DE WIT    68 DBC    0 3. K- D         9/69
W           52.      12.                FICENEC1  68 HBC    0 1.3 K-P (K-PI+) 9/67
W           50.0      8.0               FICENEC2  68 HBC    0 2.7 K- P(K-PI+) 2/69
W           48.0      8.0               KANG      68 HBC    0 4.6 K- P        7/69
W           51.0     11.0               SCHWEINGR 68 HBC    0 5.5 K-P         9/67
W           53.0     11.0               SCHWEINGR 68 HBC    0 4.1 K-P         9/67
W   10700   53.2      1.6               DAVIS     69 HBC    0 12. K+ P        9/69
W  D 2000   58.0      5.0               DE BAERE  69 HBC    0 5.0 K+ P        9/69
W  D DE BAERE ERRORS ENLARGED BY US TO 4*GAMMA/SQRT(N). SEE TYPED NOTE.      11/69
W    4000   54.0      3.0               HABER     70 DBC    0 3. K-N          5/70
W          . . . . . . . . .
W   AVG     52.2      1.2      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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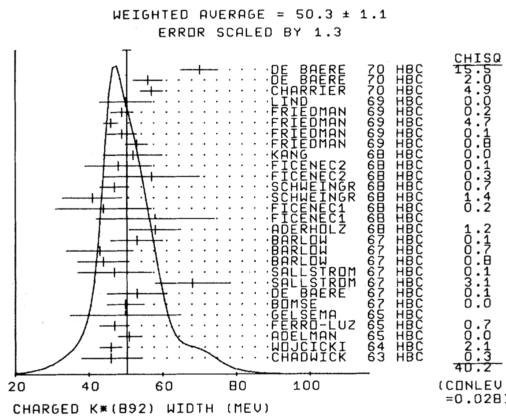


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                 18  K* (892) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      K*(892) INTO K PI                                    493+ 139
P2      K*(892) INTO (K PI PI)                               493+ 139+ 139

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                 18  K* (892) BRANCHING RATIOS

R1      K*(892) INTO (K PI PI)/(K PI)
R1         0   (0.002)OR LESS          WOJCICKI2 64 HBC   -  1.7 K-P

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REFERENCES FOR K*(892)

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ALSTON    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,DAVIES,BETTINI+(OXF+PADU)
GOLDHABE  63 ATHENS CONF 92       SULAMITH GOLDHABER                     (LRL)
KRAEMER   63 ATHENS CONF 130      R KRAEMER L MADANSKY +     (JOHNS HOPKINS)
SMITH     63 PRL 10 138           SMITH,SCHWARTZ,MILLER,KALBFLEISCH,HUF+(LRL)

WOJCICKI  64 PR 135 B 484         STANLEY G WOJCICKI                     (LRL)

ADELMAN   65 ATHENS 527           STUART LEE ADELMAN               (CAVENDISH)
FERRO-LJ  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)  (AMSTERD)
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+CDF+IOR+LIVERPOOL)
BOMSE     67 PR 158 1298          +BORENSTEIN+COLE+GILLESPIE+  (JOHN HOPKINS)
CONFORTO  67 NP B3 469            +MARECHAL,MONTANET+ (CERN+CF+IPN+LIVERPOOL)
DAUBER    67 PR 153 1403          +SCHLEIN,SLATER,TICHO                 (UCLA)
DE BAERE  67 NC 51 A 401          +GOLDSCHMIDT-CLERMONT,HENRI+     (BRUX+CERN)
FRENCH    67 NC 42A 442           +KINSON+MCDONALD+RIDDIFORD+      (CERN+BIRM)
GEORGE    67 NC 49A 9             +GOLDSCHMIDT-CLERMONT+HENRI+     (CERN+BRUX)
SALLSTRO  67 NC 49A 348           SALLSTROM+OTTER+EKSPONG          (STOCKHOLM)

ADERHOLZ  68 NP B 5  567          +DEUTSCHMANN+  (AACH+BERL+CERN+I.C.+VIENNA)
DE WIT    68  THESIS              S. DE WIT                        (AMSTERDAM)
FICENEC1  68 PR 169 1034          +HULSIZER+SWANSON+TROWER            (URBANA)
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,AMMAR+(ANL+NW)

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-CLERMONT,HENRI,+   (BELG+CERN)
ERWIN     69 NP B 9 364           +WALKER,GOSHAW,WEINBERG    (WISC+PRIN+VAND)
FRIEDMAN  69  UCRL-18860          J.FRIEDMAN,PH.D. THESIS                (LRL)
LIND      69 NP B 14 1            +ALEXANDER,FIRESTONE,FU,GOLDHABER  (LRL) JP
JUHALA    69 PR 184  1461         +LEACOCK,RHODE,KOPELMAN,LIBBY,+ (AMES+COLO)

ATHERTON  70 NP B 16 416          +FRANEK,FRENCH,FRISK,BEDNAR+     (CERN+PRAG)
CHARRIER  70  CERN PHYS 70-50     CHARRIERE,DRIJARD,DUNWOODIE,+    (LHEB+CERN)
DE BAERE  70  CERN PHYS 70 41     +DEBAISIEUX,DE WOLF,DUFOUR,+     (LHEB+CERN)
HABER     70 NP B 17 289          +SHAPIRA,ALEXANDER+    (REHO+SACL+BGNA+EPOL)
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$K_N(1080-1260) \rightarrow K\pi$

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19  KN(1080-1260)

OMITTED FROM TABLE.
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For a recent review of <u>$K\pi$ phase shifts</u>, see ASTIER 70. However, there may be more structure than reported at Kiev, but the final results (superseding TRIPPE 68, SCHLEIN 69) are not yet public, so we refrain from further comments here on phase shift analyses.

For notation, see illustrated key at beginning of data card listings.

As to the existence of peaks in the $K\pi$ mass distribution in this region, the situation is as follows (for histograms see our August 1970 edition in Phys. Letters 33B, 1):

• DODD 69, compiling ~7600 $K^+p \to K_S\pi^+p$ events produced at 3-3.5 GeV/c, see an excess of events at M = 1080 MeV and a small peak at M = 1260 MeV, $\Gamma \approx 70$ MeV. Antiselecting for Δ_{33}^{++}, the peak is enhanced to 4.6 σ.

• CRENNELL 69 have 3044 $K^-n \to K_S\pi^-n$ events produced at 3.9 GeV/c, and see a 5σ peak at M = 1160 MeV, Γ = 90 MeV, without Δ_{33} antiselection. The effects of DODD 69 and CRENNELL 69 tend to cancel, if added.

• FIRESTONE 70 see a spike at M = 1247 ± 5 MeV, $\Gamma = 20^{+9}_{-6}$ MeV in the reaction $K^+n \to K^+\pi^-p$ at 12 GeV/c.

• The international K^+ compilation (private communication, V. Henri, CERN) has 77,220 $K^+p \to K^+\pi^-p\pi^+$ events produced at 2.5-12.7 GeV/c, and see no structure in the $K^+\pi^-$ mass distribution.

Thus the combined information on narrow peaks is contradictory or cancelling, to the extent that no safe conclusions can be drawn about the existence of resonances.

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                                REFERENCES FOR KN(1080-1260)

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 70  UCRL-20091         A.FIRESTONE,G.GOLDHABER,D.LISSAUER    (LRL)
ASTIER    70 KIEV CONF.          RAPP.TALK ON BOSON RESONANCES           (CDF)

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$K_{A,I=3/2}(1175)$

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24  KA 3/2 (1175,JP=  ) I = 3/2

EVIDENCE NOT COMPELLING. OMITTED FROM TABLE.
FOR A DISCUSSION SEE ROSENFELD 68 AND
GIACOMELLI 70 WHO CONCLUDES THAT IF THIS
STATE HAS WIDTH NOT LARGER THAN 100 MEV,
THEN ITS PRODUCTION CROSS SECTION IS 1 OR 2
ORDERS OF MAGNITUDE SMALLER THAN THAT OF
NON-EXOTIC K*S.

REFERENCES ON KA3/2(1175)

WANGLER   64 PL 9 71             T P WANGLER,A R ERWIN,W D WALKER  (WISCONS)
MILLER    65 PL 15 74            MILLER,KOVACS,MCILWAIN,PALFREY +   (PURDUE)
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)

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$K_{A,I=3/2}(1265)$

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25  KA 3/2 (1265,JP=  ) I = 3/2

EVIDENCE NOT COMPELLING. OMITTED FROM TABLE.
FOR A DISCUSSION SEE ROSENFELD 68.

REFERENCES ON K*3/2 (1265)

FRENCH    67 NC 52A 442          +KINSON+MCDONALD+RIDDIFORD+      (CERN+BIRM)
ROSENFEL 68 PHILA.CONF.P.455   A.H.ROSENFELD                          (LRL)
CHO       70 PL 32 B 409         +DERRICK,JOHNSON,MUSGRAVE,+ (ANL+NWES+KANS)

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Q REGION, $K\pi\pi(1240-1400)$

There is a peak in the $K^*\pi$ spectrum centered at about 1300 MeV, or just about 270 MeV above $K^*\pi$ threshold. The Q($\to K^*\pi$) is then the hypercharge = 1 analog of the A1($\to \rho\pi$), and its interpretation as resonance vs. threshold enhancement is ambiguous. (For more discussion see text Sect. III and the note on "A1, A3, Q, L", just before the A1 in these listings.)

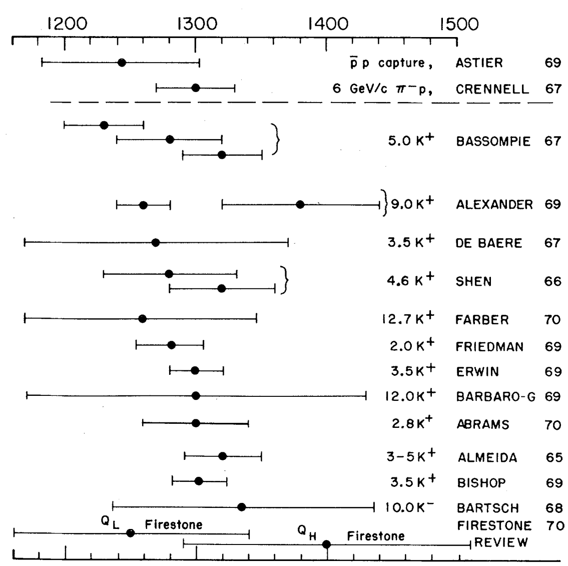
However, in the case of the Q region, there are two additional complications:

1) The $K_A^*(1240)$ or "C" meson, with width only 120 MeV, seems to be produced nondiffractively in $\bar{p}p$ capture at rest, and in the reaction $\pi^-p \to \Lambda K\pi\pi$.

2) The Q peak in the $K\pi\pi$ mass distribution does not have a simple Breit-Wigner shape (FIRESTONE 70 and private communication from V. Henri, CERN). It can be fitted by two Breit-Wigner shapes (5-parameter fit) at all energies with reasonable χ^2 (FIRESTONE 70).

The figure shows M and Γ for all peaks reported in this region. We list first the results of the $\bar{p}p$ production of the "C", and the $\pi^-p \to \Lambda Q^0$ experiment, so as to separate them from the conventional diffractive experiments $K^{\pm}p \to Q^{\pm}p$. The remaining Q reports are ordered by increasing mass.

The dominant J^P assignment throughout the Q region is 1^+. $K^*\pi$ is the dominant decay mode. While there is $K\rho$ and interference between $K^*\pi$ and $K\rho$, there is no evidence for other decay modes. From the coherent production of Q in K^-d experiments, I = 1/2 is confirmed.



Mass and widths of peaks reported in Q region

$\Gamma/2$ $\Gamma/2$ M

For notation, see illustrated key at beginning of data card listings.

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                   28   Q REGION   I=1/2

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                   28   Q REGION MASSES (MEV)

M   PRODUCED BY BEAMS OTHER THAN K MESONS
M        1242.0      9.0      10.0    ASTIER     69 HBC     0 PBAR P           9/69
M   A  THIS IS THE C MESON.
M   A     ERRORS OF ASTIER 69 ARE STATISTICAL. TRUE UNCERTAINTY IS LARGER
M      45(1300.)                      CRENNELL   67 HBC     0 6 PI- P,LK2PI     7/67
M
M   PRODUCED BY K BEAMS
M   C     (1230.0)   (15.0)           BASSOMPIE 67 HBC  +    5. K+ P           11/67
M   C     (1260.0)   (10.0)           ALEXANDER 69 HBC       9.0 K+ P           5/70
M         1260.      20.              FARBER    70 HBC  +   12.7 K+ P           6/70
M         (1270.)    APPROX.          DE BAERE  67 HBC  +    3.5 K+ P           7/67
M   C     (1280.)                     SHEN      66 HBC  + 0 4.6 K+P,5 BODY    11/67
M   C   35(1280.0)   (10.0)           BASSOMPIE 67 HBC  +    5. K+ P           11/67
M         1281.       7.              FRIEDMAN  69 HBC  --   2.6,2.7 K- P     . 9/69
M       21 1300.0    10.0             ERWIN     69 HBC    0 3.5 K+P(K* PI)     9/69
M          1300.0    10.0             ABRAMS    70 HBC  +   2.5-3.2 K+ P      11/70*
M       45 1301.0    10.0             BISHOP    69 HBC  +   3.5 K+P(K* PI)     9/69
M         (1300.)    APPROX.          BARBARO   69 HBC  +   12.K+ P (K 2PI)    9/69
M       12 1320.0    25.0             ALMEIDA   65 HBC  +   3-5 K+  P          8/66
M   C   70(1320.0)   (10.0)           SHEN      66 HBC  +   4.6 K+  P          8/66
M   C     (1320.0)   (15.0)           BASSOMPIE 67 HBC  +   5. K+ P           11/67
M          1335.0     6.0             BARTSCH   68 HBC      10. K-P,K NPI    . 9/69
M   C     (1380.0)   (20.0)           ALEXANDER 69 HBC      9.0 K+ P           5/70
M   C      SPLIT THE Q REGION INTO SEVERAL PEAKS. NOT AVERAGED.
M          . . . . . . . . . .
M   AVG    1298.8     11.3     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 3.4)
                            (SEE IDEOGRAM BELOW )
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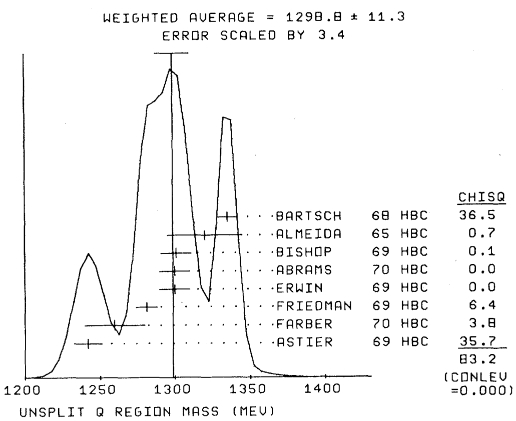


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                   28   Q REGION WIDTHS (MEV)

W   PRODUCED BY BEAMS OTHER THAN K MESONS
W          127.0      7.0      25.0   ASTIER     69 HBC     0 PBAR P           9/69
W   A      ERRORS OF ASTIER 69 ARE STATISTICAL. TRUE UNCERTAINTY IS LARGER
W       45  (60.)                     CRENNELL   67 HBC     0 6 PI- P           7/67
W
W   PRODUCED BY K BEAMS
W   M=1230                            BASSOMPIE 67
W   C       (60.0)    (20.0)          BASSOMPIE 67 HBC  +    5. K+ P           11/67
W   M=1260                            ALEXANDER 69
W   C       (40.0)    (10.0)          ALEXANDER 69 HBC       9.0 K+ P           5/70
W   M=1260                            FARBER    70
W           180.       28.            FARBER    70 HBC  +   12.7 K+ P           6/70
W   M=1270 APPROX.                    DE BAERE  67
W          (200.)    APPROX.          DE BAERE  67 HBC  +  3.5 K+ P             7/67
W   M=1280                            SHEN      66
W   C      (100.0)    (20.0)          SHEN      66 HBC  + 0 4.6 K+P,5 BODY    11/67
W   M=1280                            BASSOMPIE 67
W   C    35  (80.0)   (20.0)          BASSOMPIE 67 HBC  +    5. K+ P           11/67
W   M=1281                            FRIEDMAN  69                           .
W            51.       22.            FRIEDMAN  69 HBC   -   2.6,2.7 K- P       9/69
W   M=1300                            ERWIN     69
W        21   40.0     15.0           ERWIN     69 HBC     0 3.5 K+P(K* PI)     9/69
W   M=1300                            ABRAMS    70
W             80.0     20.0           ABRAMS    70 HBC  +   2.5-3.2 K+ P      11/70*
W   M=1301                            BISHOP    69
W        45   40.0     10.0           BISHOP    69 HBC  +   3.5 K+P(K* PI)      9/69
W   M=1300 APPROX.                    BARBARO   69
W   B        250. APPROX.             BARBARO   69 HBC  +   12.K+ P (K 2PI)    9/69
W   B      NO BACKGROUND SUBTRACTION.
W   M=1320                            ALMEIDA   65
W        12   60.0     20.0           ALMEIDA   65 HBC  +   3-5 K+P             8/66
W   M=1320                            SHEN      66
W   C    70  (80.0)   (20.0)          SHEN      66 HBC  +   4.6 K+P             8/66
W   M=1320                            BASSOMPIE 67
W   C        (60.0)   (20.0)          BASSOMPIE 67 HBC  +   5. K+ P            11/67
W   M=1325                            BARTSCH   68 .
W            196.0     16.0           BARTSCH   68 HBC     10. K- P,K NPI    . 9/69
W   M=1380                            ALEXANDER 69
W   C       (120.0)   (20.0)          ALEXANDER 69 HBC      9.0 K+ P            5/70
W   C      SPLIT THE Q REGION INTO SEVERAL PEAKS. NOT AVERAGED.
W          . . . . . . . . . .
W   AVG      82.5      21.6     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 3.8)
                            (SEE IDEOGRAM BELOW )
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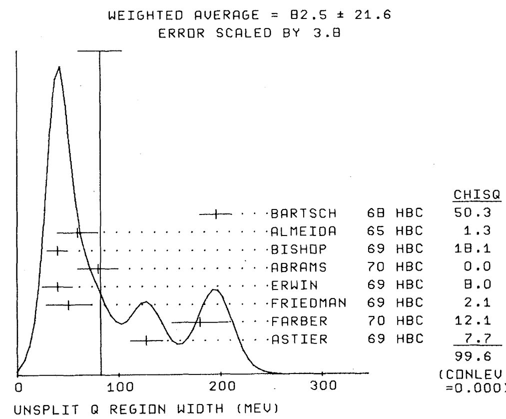


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                   28   Q REGION PARTIAL DECAY MODES

                                                            DECAY MASSES
P1          Q REGION INTO K*(890) PI                      493+ 139+ 139
P2          Q REGION INTO K RHO                           493+ 139+ 139
P3          Q REGION INTO K PI                            493+ 139+ 139
P4          Q REGION INTO K ETA                           493+ 139+ 139
P5          Q REGION INTO K OMEGA                         493+ 139+ 139
P6          Q REGION INTO K PI PI                         493+ 139+ 139

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                   28   Q REGION BRANCHING RATIOS

    PRODUCED BY BEAMS OTHER THAN K MESONS
R1       Q REGION INTO (K RHO)/TOTAL   (UNITS OF 10**-2)
R1          75.0      10.0           ARMENTERO 64 HBC       0.0 PBAR P          6/66
R2       Q REGION INTO (K* PI)/TOTAL   (UNITS OF 10**-2)
R2          25.0      10.0           ARMENTERO 64 HBC       0.0 PBAR P          6/66
R9          Q REGION INTO (K+ PI-) / (K+0 PI0+ PI-)
R9            (0.2)  OR LESS (CL=.90)  CRENNELL   67 HBC    0 6.0 PI-P          7/67
R10         Q REGION INTO (K0 PI+ PI- PI0) / (K+0 PI0+ PI-)
R10           (0.1)  OR LESS (CL=.90)  CRENNELL   67 HBC    0 6.0 PI-P          7/67

    PRODUCED BY K BEAMS
R1          Q REGION PEAK INTO (K PI) / (K*(890) PI)
R1            (0.8)  OR LESS           SHEN       66 HBC     4.6 K+P, 5 BODY  11/67
R1          Q REGION PEAK INTO K*(890) PI AND K RHO (OVERLAPPING BANDS)
R1       70   (1.0)                    SHEN       66 HBC  +  4.6 K+P            8/66
R2          Q REGION PEAK INTO (K OMEGA)/(K*(890) PI)
R2            (0.1)  OR LESS           SHEN       66 HBC  +  4.6 K+P           10/66
R8          Q REGION PEAK INTO (K PI) / (K*(890) PI)
R8            (0.30) OR LESS           SHEN       66 HBC  +  4.6 K+P           10/66
R1   A      Q REGION INTO K*(890) PI AND K RHO (OVERLAPPING BANDS)
R1      200   (1.0)                    BERLINGHI 67 HBC  +   12.7 K+ P          7/67
R2   A      Q REGION INTO (K PI) / TOTAL
R2            (0.02) OR LESS           BERLINGHI 67 HBC  +   12.7 K+ P         11/67
R2            (0.02) OR LESS, C.L.=.95 BARTSCH   68 HBC  - 10.0 K- P           9/68
R3          Q REGION INTO (K ETA) / TOTAL
R3            (0.02) OR LESS           BERLINGHI 67 HBC  +   12.7 K+ P         11/67
R4          Q REGION INTO (K OMEGA) / TOTAL
R4            (0.02) OR LESS           BERLINGHI 67 HBC  +   12.7 K+ P         11/67
R4       12     0.01     0.005         BARTSCH   68 HBC  -   10.0 K- P          9/68
R5          Q REGION INTO (K RHO) / (K*(890) PI)
R5              0.91     0.25          BERLINGHI 67 HBC  +   12.7 K+ P         11/67
R5      701     0.4      0.1           BARTSCH   68 HBC  - 10.0 K- P            9/68
R5            . . . . . . . . . .
R5   AVG        0.47     0.18    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)
R6          Q REGION INTO (K PI) / (K*(890) PI)
R6            (0.21) OR LESS           DE BAERE  67 HBC  +   3.5 K+ P          11/66
R7          Q REGION INTO (K PI PI) / TOTAL
R7      201     0.22     0.08          BARTSCH   68 HBC  - 10.0 K- P            9/68

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REFERENCES FOR Q REGION


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      PRODUCED BY BEAMS OTHER THAN K MESONS

ARMENTER 64 DUBNA CONF 1 577  ARMENTEROS,EDWARDS,D-ANDLAU +    (CERN+CDF)
                         SEE ALSO PL 9, 207
    ALSO     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

      PRODUCED BY K BEAMS

ALMEIDA  65 PL 16 184          ALMEIDA,ATHERTON,BYER,DORNAN,FORSON+(CAMBR)

SHEN     66 PRL  17  726       +BUTTERWORTH,FU,GOLDHABERS,TRILLING   (LRL)
    ALSO 66  (PRIVATE COMMUN)GERSON 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)
   AND PRIVATE COMMUNICATION BY B. JONGEJANS

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+   (JOHNHOPK)  1+
    ALSO 70 ANTICH
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For notation, see illustrated key at beginning of data card listings.


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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,+        (LRL)
COLLEY   69 NC A 59 519        +EASTWOOD,+  (BIRM+GLAS+LOIC+MPIM+OXF+RHEL)
WERNER   69 PR 188 2023        +AMMAR,DAVIS,KROPAC,YARGER,CHO,+ (NWES+ANL) 1+
BISHOP   69 NP B 9 403         +GOSHAW,ERWIN,WALKER                  (WISC)
ERWIN    69 NP B 9 364         +WALKER,GOSHAW,WEINBERG    (WISC+PRIN+VAND)
FRIEDMAN 69  UCRL-18860        J.FRIEDMAN,PH.D. THESIS                (LRL)
CHIEN    69 PL 29B 433         +MALAMUD,MELLEMA,RUDNICK,SCHLEIN+     (UCLA)
CHUNG    69 PR 182 1443        +EISNER+BALI+LUERS                     (BNL)
WERNER   69 PR 188 2023        +AMMAR,DAVIS,KROPAC,YARGER,CHO+   NWES+ANL

ABRAMS   70 PR D 1 2433        +EISENSTEIN,KIM,MARSHALL,O-HALLORAN,+ (ILL)
ANTICH   70 NP B 20 201        +CARSON,CHIEN,COX,DENEGRI,ETTLINGER,+ (JHU)  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)
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$K_N(1420)$ or K^{**}

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22  KN (1420,JP=2+) I=1/2

JP = 3- IS UNLIKELY BUT NOT YET COMPLETELY RULED OUT.
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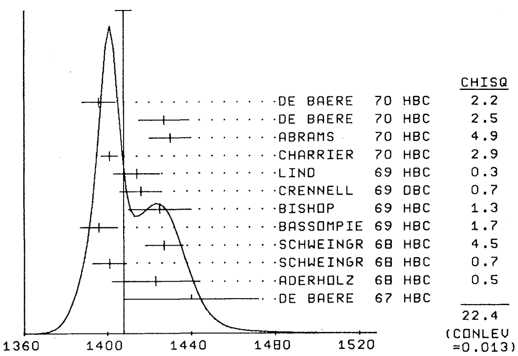
                 22  KN(1420) MASS (MEV)

M   FOR DIFFICULTIES IN MEASURING MASS DIFFERENCE, SEE TYPED NOTE UNDER K*

M   CHARGED ONLY, WITH FINAL STATE K PI
M   D      (1427.)     (15.0)          DE BAERE   67 HBC   +  3.5 K+P (K0 PI+) 10/66
M   D VALUE ABOVE SUPERSEDED BY DE BAERE 70 BELOW                               1/71*
M           1440.      24.0     40.    DE BAERE   67 HBC   +  3.5 K+P (K+ PI0) 10/66
M           1423.      21.             ADERHOLZ   68 HBC   -   10 K- P (K PI)   6/68
M           1401.0      8.0            SCHWEINGR  68 HBC   -   4.1 K- P (K PI)  9/67
M           1427.0      9.0            SCHWEINGR  68 HBC   -   5.5 K- P (K PI)  9/67
M   B   125 1396.       9.             BASSOMPIE  69 HBC   +   5 K+P (K PI)    11/69
M           1425.0     15.0            BISHOP     69 HBC   +   3.5 K+ P         9/69
M           1416.0     10.0            CRENNELL   69 DBC   -   3.9 K-N (K0PI-)  7/69
M           1414.      11.             LIND       69 HBC   +   9. K+ P(K0 PI+)  9/69
M           1401.0      4.0            CHARRIER   70 HBC   +   8.25 K+ P        1/71*
M           1430.      10.             ABRAMS     70 HBC   +  2.5-3.2 K+P,K2PI 11/70*
M           1427.0     12.0            DE BAERE   70 HBC   +   3.5 K+ P         1/71*
M           1396.0      8.0            DE BAERE   70 HBC   +   5.0 K+ P         1/71*
M           . . . . . . . . .
M   AVG     1407.8      3.7      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
                       (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 1407.8 ± 3.7
ERROR SCALED BY 1.5



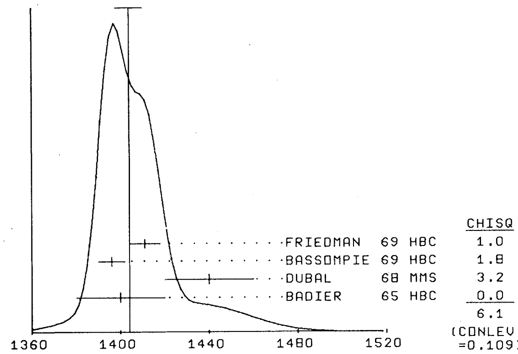
CHARGED KN(1420) MASS (MEV) (K PI MODE)

```
M   CHARGED ONLY, WITH OTHER FINAL STATES
M           1400.0     20.0            BADIER     65 HBC   -  3.  K- P (K*PI) 10/66
M        20 1440.0     20.0            DUBAL      68 MMS   -  11.5 K- P         6/68
M   B   240 1396.       6.             BASSOMPIE  69 HBC   +  5 K+P (K 2PI)   11/69
M           1411.       7.             FRIEDMAN   69 HBC   -  2.7 K-P (K 2PI)   9/69
M           . . . . . . . . .
M   AVG     1404.0      6.2      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
                       (SEE IDEOGRAM BELOW )

M   CHARGED AND NEUTRAL
M           1404.0     15.0            FOCARDI    65 HBC   -0 3.  K- P (K PI) 10/66
M           1390.0     30.0            SHEN       66 HBC   + 0 4.6 K+ P (K PI) 10/66
M           1430.0     10.0            SHEN       66 HBC   + 0 4.6 K+ P (K*PI) 10/66
M           1423.0      7.0            BASSANO    67 HBC   -0 4.6, 5.0 K- P   10/67
M           1420.0     10.0            GOLDHABER  67 HBC      9.0 K+ P(K 2PI) 10/67
M           . . . . . . . . .
M   AVG     1421.2      4.7      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

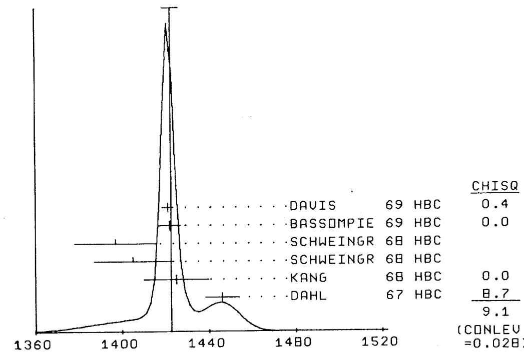
M   NEUTRAL ONLY
M          (1440.)                     CRENNELL   67 HBC    0 6 PI- P (K 2PI)   7/67
M           1446.0      7.9            DAHL       67 HBC    0 4.PI- P (KPI)    10/66
M           1425.0     15.0            KANG       68 HBC    0 4.6 K- P          7/69
M           1405.0     18.0            SCHWEINGR  68 HBC    0 4.1 K- P (K PI)   9/67
M           1397.0     19.0            SCHWEINGR  68 HBC    0 5.5 K- P (K PI)   9/67
M   B   420 1422.       5.             BASSOMPIE  69 HBC    0 5 K+P (K PI)     11/69
M   B BASSOMP. ERRORS ENLARGED BY US TO  GAMMA/SQRT(N). SEE K* TYPED NOTE.    11/69
M      2200 1421.1      2.6            DAVIS      69 HBC    0 12. K+ P(K+PI-)   9/69
M           . . . . . . . . .
M   AVG     1422.7      3.8      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)
                       (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 1404.0 ± 6.2
ERROR SCALED BY 1.4



CHARGED KN(1420) MASS (MEV) (K 2PI MODE)

WEIGHTED AVERAGE = 1422.7 ± 3.8
ERROR SCALED BY 1.7



NEUTRAL KN(1420) MASS (MEV)

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                 22  KN(1420) WIDTH (MEV)

W   CHARGED ONLY, WITH FINAL STATE K PI
W   D       (90.0)    (28.0)           DE BAERE   67 HBC   +   3.5 K+ P          10/66
W   D VALUE ABOVE SUPERSEDED BY DE BAERE 70 BELOW                                1/71*
W           175.       57.             ADERHOLZ   68 HBC   -   10 K- P (K PI)     6/68
W   B   125 123.       35.             BASSOMPIE  69 HBC   +   5 K+P (K PI)      11/69
W           110.0      25.0            BISHOP     69 HBC   +   3.5 K+ P           9/69
W            43.       13.             FRIEDMAN   69 HBC   -   2.7 K-P (K 2PI)    9/69
W            96.       18.             LIND       69 HBC   +   9. K+ P            5/70
W           150.0      10.0            CHARRIER   70 HBC   +   8.25 K+ P          1/71*
W            80.0      20.0            ABRAMS     70 HBC   +  2.5-3.2 K+P,K2PI  11/70*
W           100.0      25.0            DE BAERE   70 HBC   +   3.5 K+ P           1/71*
W           123.0      25.0            DE BAERE   70 HBC   +   5.0 K+ P           1/71*
W           . . . . . . . . .
W   AVG     107.1      15.4      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.6)
                       (SEE IDEOGRAM BELOW )
```
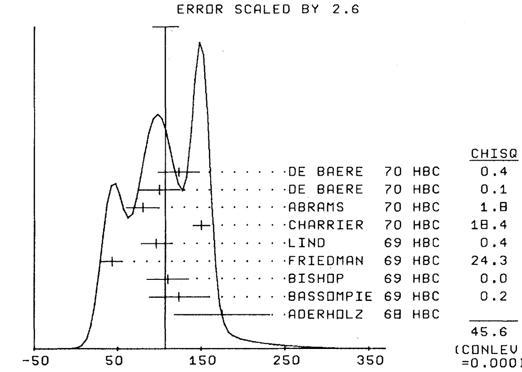
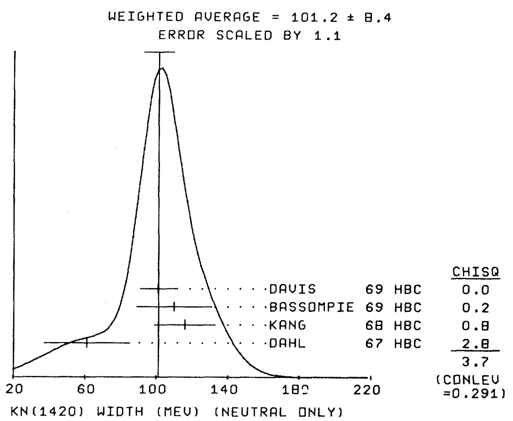

WEIGHTED AVERAGE = 107.1 ± 15.4
ERROR SCALED BY 2.6



CHARGED KN(1420) WIDTH (MEV)

For notation, see illustrated key at beginning of data card listings.

```
W    CHARGED ONLY, WITH OTHER FINAL STATES
W              105.0      30.0               BADIER     65 HBC   -  3.0 K-P            6/66
W  B   240     110.       25.                BASSOMPIE 69 HBC   +   5 K+P (K 2PI)    11/69
W              . . . . . . . . .
W    AVG       108.0      19.2      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W    CHARGED AND NEUTRAL
W               92.0      14.0               FOCARDI    65 HBC   -0 3.0 K- P (K PI)
W               75.0      25.0               SHEN       66 HBC  + 04.6 K+ P            8/66
W               65.0      20.0               BASSANO    67 HBC   -0 4.6, 5.0 K- P    10/67
W               80.0      20.0               GOLDHABER 67 HBC      9.0 K+ P(K 2PI)  10/67
W              107.0      20.0               SCHWFINGR 68 HBC   -0 4.1+5.5 K-P        9/67
W              . . . . . . . . .
W    AVG        85.9       8.4      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W    NEUTRAL ONLY
W               61.0      24.0               DAHL       67 HBC    0 3.8-4.2 PI- P      9/66
W              116.0      17.0               KANG       68 HBC    0 4.6 K- P           7/69
W  B   420     110.       21.                BASSOMPIE 69 HBC    0 5 K+P (K PI)     11/69
W  B BASSOMP. ERRORS ENLARGED BY US TO 4*GAMMA/SQRT(N). SEE K* TYPED NOTE.  11/69
W     2200     101.       10.                DAVIS      69 HBC    0 12. K+ P (K PI)   9/69
W              . . . . . . . . .
W    AVG       101.2       8.4      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
                          (SEE IDEOGRAM BELOW )
```

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                 22  KN (1420) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1         KN(1420) INTO K PI                             493+ 139
P2         KN(1420) INTO K*(890) PI                       892+ 139
P3         KN(1420) INTO K RHO                            493+ 765
P4         KN(1420) INTO K OMEGA                          493+ 783
P5         KN(1420) INTO K ETA                            493+ 548

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                 22  KN(1420) BRANCHING RATIOS

R1         KN(1420) INTO (K PI)/TOTAL
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 OF OTHER RATIOS.
R1             . . . . . . . . .
R1  FIT         0.569     0.040  FROM FIT

R2         KN(1420) INTO (K*(890) PI) / TOTAL
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         0.274     0.032  FROM FIT

R3         KN(1420) INTO (K RHO)/TOTAL
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         0.092     0.035  FROM FIT

R4         KN(1420) INTO (K OMEGA)/TOTAL
R4              0.07      0.04          BADIER     65 HBC       3.0 K-P            6/66
R4             . . . . . . . . .
R4  FIT         0.045     0.019  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R5         KN(1420) INTO (K ETA)/TOTAL
R5              0.02      0.02          BADIER     65 HBC       3.0 K-P            6/66
R5             . . . . . . . . .
R5  FIT         0.020     0.014  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R6         KN(1420) INTO (K*(890) PI) / (K PI)
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          (0.9)     (0.2)          BASSOMPIE 69 HBC  + 0 5 K+P              9/69
R6  Q     84   (0.93)    (0.11)         BISHOP     69 HBC      3.5 K+ P           9/69
R6              0.44      0.09          AGUILAR    70 HBC      3.9-4.6 K- P      1/71*
R6             . . . . . . . . .
R6  AVG         0.483     0.066   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R6  FIT         0.481     0.078  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)
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R7         KN(1420) INTO (K OMEGA) / K PI
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           BASSOMPIE 69 HBC     0 5 K+ P              9/69
R7              0.05     0.04           AGUILAR    70 HBC       3.9-4.6 K- P       1/71*
R7             . . . . . . . . .
R7  AVG         0.070    0.035    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R7  FIT         0.080    0.033   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R8         KN(1420) INTO (K RHO) / (K PI)
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           BASSOMPIE 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              0.15     0.06           AGUILAR    70 HBC       3.9-4.6 K- P       1/71*
R8             . . . . . . . . .
R8  AVG         0.164    0.056    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R8  FIT         0.162    0.068   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R9         KN(1420) INTO (K RHO) / (K*(890) PI)
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             . . . . . . . . .
R9  FIT         0.34     0.15    FROM FIT

R10        KN(1420) INTO (K OMEGA) / (K*(890) PI)
R10 Q          (0.10)   (0.04)          FIELD      67 HBC   - 3.8 K- P             6/67
R10            . . . . . . . . .
R10 FIT         0.166    0.072   FROM FIT

R11        KN(1420) INTO (K ETA) / (K*(890) PI)
R11 Q          (0.07)   (0.04)          FIELD      67 HBC   - 3.8 K- P             6/67
R11            . . . . . . . . .
R11 FIT         0.072    0.050   FROM FIT

R12        KN(1420) INTO (K ETA) / (K PI)
R12            (0.025)OR LESS           BASSOMPIE 69 HBC       5.0 K+ P            9/68
R12            (0.02) OR LESS           BISHOP     69 HBC       3.5 K+ P            9/69
R12            (0.04) OR LESS,C.L.=0.95 AGUILAR    70 HBC       3.9-4.6 K- P       1/71*
R12            . . . . . . . . .
R12 FIT         0.035    0.026   FROM FIT

R13        KN(1420) INTO (K PI PI) / (K PI)
R13            (0.5)  OR LESS           BIRMINGHA 70 HBC   +   10 K+ P             1/71*
R13            . . . . . . . . .
R13 FIT         0.64     0.11    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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<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 1	.569+-.040				
P 2	-.477	.274+-.032			
P 3	-.433	-.355	.092+-.035		
P 4	-.234	-.242	-.104	.045+-.018	
P 5	-.155	-.117	-.044	-.034	.020+-.018

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                         REFERENCES FOR KN(1420)
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BADIER    65 PL 19 612             BADIER,DEMOULIN,GOLDBERG+ (EP+SACLY+ZEEMAN)
CHUNG     65 PRL  15  325          +DAHL,HARDY,HESS,JACOBS,KIRZ,MILLER     (LRL)
FOCARDI   65 PL 16 351             FOCARDI,MINGUZZI RANZI,SERRA+ (BOLOGNA+CEN)

SHEN      66 PRL  17  726          +BUTTERWORTH,FU,GOLDHABERS,TRILLING     (LRL)
    ALSO 66  (PRIVATE COMMUN)GERSON GOLDHABER                              (LRL)

BASSANO   67 PRL  19  968          +GOLDBERG,GOZ,BARNES,LFITNER+(BNL+SYRACUSE)
BASSOMPI 67 PL 26B 30              BASSOMPIERRE,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-CLERMONT,HENRI+     (BRUX+CERN)
FIELD     67 PL 24B 638            +HENDRICKS+PICCIONI+YAGER          (LAJOLLA)
GOLDHABE 67 PRL 19  972            G.GOLDHABER,FIRESTONE,SHEN              (LRL)

ADERHOLZ 68 NP B 5  567            +DEUTSCHMANN+  (AACH+BERL+CERN+I.C.+VIENNA)
    ALSO 66 PL 22 357              BARTSCH,DEUTSCHMANN,MORRISON+    (ABCL(IC)V)
ANTICH    68 PRL 21 1842          +CALLAHAN,CARSON,COX,DENEGRI,+          (JHOP)
DUBAL     68 THESIS    1456        L.DUBAL                              (GENEVE)
KANG      68 PR 176 1587           Y.W.KANG                               (IOWA)
SCHWEING 68 PR 166 1317            SCHWEINGRUBER,DERRICK,FIELDS,AMMAR+(ANL+NW)
   ALSO  67  THESIS                F.L.SCHWEINGRUBER   (NORTHWESTERN,EVANSTON)

BASSOMPI 69 NP  B13 189            BASSOMPIERE,GOLDSCHMIDT-CLERM.+ (CERN+BRUX) JP
    ALSO 69 DE BAERE
    ALSO 70 DE BAERE
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,ALSTON,LYNCH,SOLMITZ   (LRL)
DE BAERE 69 NC 61 A 397            +GOLDSCHMIDT-CLERMONT,HENRI,+    (BELG+CERN)
    ALSO 70 DE BAERE
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,O-HALLORAN,+ (I66)
AGUILAR   70 PRL 25 1362           AGUILAR-BENITEZ,BASSANO,EISNER,+ (BNL+PURD)
BIRMINGH 70  KIEV CONF.            ASTIER RAPPORTEURS TALK     (BIRM+GLAS+OXF)
CHARRIER 70  CERN PHYS 70-50       CHARRIERE,DRIJARD,DUNWOODIE,+    (LHEB+CERN)
DE BAERE 70  CERN PHYS 70 41       +DEBAISIEUX,DE WOLF,DUFOUR,+     (LHEB+CERN)
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For notation, see illustrated key at beginning of data card listings.

$K_N(1660)$

```
                    27  KN (1660, JP=  )  I = 1/2
              EVIDENCE NOT COMPELLING, OMITTED FROM TABLE
------ --------- --------- --------- --------- --------- --------- --------

                    27  KN (1660) MASS  (MEV)

M        (1660.0)                    CARMONY   67 HBC  -  3.8 K-P,OMEGA K 11/67
M         1660.0    10.0             JOBES     67 HBC  +  5. K+ P         11/67
M    J    CLAIMED BY  JOBES IN (K PI), (K*(890) PI), AND (K*(1420) PI)
M    J    MODES. K PI BUMP INTERFERES MOSTLY WITH DELTA(1236).
------ --------- --------- --------- --------- --------- --------- --------

                    27  KN (1660) WIDTH (MEV)

W          60.0     20.0             JOBES     67 HBC  +  5. K+ P         11/67
------ --------- --------- --------- --------- --------- --------- --------

                    27  KN (1660) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      KN*(1660) INTO K PI                             493+ 139
P2      KN*(1660) INTO K PI PI                          493+ 139+ 139
P3      KN*(1660) INTO K*(890) PI                       892+ 139
P4      KN*(1660) INTO KN*(1430) PI                    1409+ 139

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                          REFERENCES FOR KN(1660)

CARMONY  67 PRL  18  615      D.CARMONY,T.HENDRICKS,L.LANDER   (LA JOLLA)
JOBES    67 PL 26B 49         +BASSOMPIERRE,DE BAERE +    (BIRM+CERN+BRUX)

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L(1770)

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                    23  L (1770, JP=  )  I = 1/2
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For a review of the L-meson data up to May 1970, see CHIEN 70.

This peak is seen in most $K^{\pm}p$ and $K^{-}d$ experiments, with a large decay mode into $K_N(1420)\pi$, only ~200 MeV above that threshold. There is at present no agreement among experimenters about whether to interpret this peak as a resonance, with decay into several open channels, or as a pure $K_N(1420)\pi$ threshold enhancement of possibly "kinematic" origin. We list only one branching ratio

$$\frac{L \to K_N(1420)\pi}{L \to K\pi\pi},$$

which has bearing on this contradiction.

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------ --------- --------- --------- --------- --------- --------- --------

                    23  L (1770) 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          11/67
M   B     1785.0    12.0             BARTSCH   68 HBC     10.0 K- P         9/69
M   B     INCLUDED IN BARTSCH 70                                              1
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        (1753.0)  (10.0)            BIRMINGH. 70 HBC  +  10.K+P,K(1420)PI 11/70*
M        (1773.0)  (20.0)            BIRMINGH. 70 HBC  +  10.K+P,K* 2PI    11/70*
M         1760.0    15.0             LUDLAM    70 HBC  -  12.6 K- P         1/71*
M         . . . . . . . . .
M   AVG   1769.9     7.0     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
------ --------- --------- --------- --------- --------- --------- --------

                    23  L (1770) 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          11/67
W   B     127.0     43.0             BARTSCH   68 HBC     10.0 K- P         9/69
W   B     INCLUDED IN BARTSCH 70                                            1/71*
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        (174.0)   (23.0)   (18.0)   BIRMINGH. 70 HBC  +  10.K+P,K(1420)PI 11/70*
W        (155.0)   (22.0)            BIRMINGH. 70 HBC  +  10.K+P,K* 2PI    11/70*
W          50.0     40.0     20.0    LUDLAM    70 HBC  -  12.6 K- P         1/71*
W         . . . . . . . . .
W   AVG    77.4     16.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
                   (SEE IDEOGRAM BELOW )
```

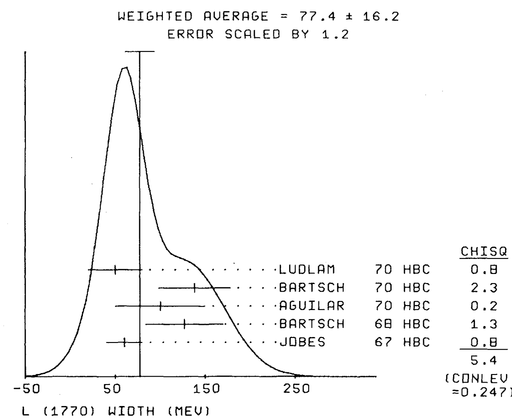


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                    23  L (1770) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      L INTO K PI PI                                  497+ 134+ 134
P2      L INTO K*(1420) PI                              134+1409
------ --------- --------- --------- --------- --------- --------- --------

                    23  L (1770) BRANCHING RATIOS

R1      L INTO (K*(1420) PI) / (K PI PI )
R1        LARGE                      DENEGRI   68 DBC  -  12.6 K- D         1/71*
R1          (1.0)                    BARBARO   69 HBC  +  12.0 K+ P         1/71*
R1          (0.60) OR LESS CL=0.95   AGUILAR   70 HBC  -  0.6 K- P          1/71*
R1        LESS THAN 1.0              BARTSCH   70 HBC  -  10.1 K- P         1/71*
R1        LARGE                      BIRMINGH. 70 HBC  +  10.K+P,4-6 BODY  11/70*
R1        DOMINANT                   LUDLAM    70 HBC  -  12.6 K- P         1/71*

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                          REFERENCES FOR L (1770)

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+     (JOHNSHOP)
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)
BIRMINGH 70  PREPRINT         BIRMINGHAM GLASGOW COLL.         (BIRM+GLAS)
CHARRIER 70  CERN PHYS 70-50  CHARRIERE,GOLDSCHMIDT-C,DEBAERE+(CERN+BRUX)
CHIEN    70  PHILA.CONF.P.275 C.Y.CHIEN                   (JOHNS HOPKINS)
LUDLAM   70 PR D 2 1234       +SANDWEISS,SLAUGHTER                  (YALE)
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$K^*(2240)$

```
                    40   K* (2240, JP=  )  I=1/2
              ENHANCEMENT SEEN IN (ANTIHYPERON+NUCLEON) MASS.
              EVIDENCE NOT COMPELLING, OMITTED FROM TABLE.
------ --------- --------- --------- --------- --------- --------- --------

                    40   K* (2240)  MASS (MEV)

M       15 2240.      20.            ALEXANDER 68 HBC  + 0 9 K+P,YBAR+N+..  6/68
------ --------- --------- --------- --------- --------- --------- --------

                    40   K* (2240)  WIDTH (MEV)

W       15   70.      20.            ALEXANDER 68 HBC  + 0 9 K+P,YBAR+N+..  6/68

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```
                          REFERENCES FOR K*(2240)

ALEXANDE 68 PRL 20 755        ALEXANDER,FIRESTONE,GOLDHABER,SHEN    (LRL)
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Baryons

Note on Resonance Parameters from Partial-Wave Analyses

I. Speed Plots

In the discussion which follows, we use the term "speed plot" to indicate a plot showing the variation with C. M. energy m of the derivative $|dT/dm|$ of a partial-wave amplitude T. (See section IV. C of the main text.) In principle such plots are a very sensitive and useful means of searching for a resonance. A rapid increase in speed followed by a rapid decrease is certainly a good indication of the presence of a resonance. In practice these plots must be judiciously used because:

1) The values of dT/dm are sensitive to variations in T. It is difficult enough to determine T(m); finding its derivative is necessarily more difficult.

2) Once the speed plot tells us that a resonance is present, the determination of precise parameters from such a plot requires additional considerations:

a) the maximum of the speed is not necessarily at the resonance mass,

b) the width cannot simply be obtained by the relation $|dT/dm|_{m=M} = 2x/\Gamma$.

Consider for example the P_{33} partial-wave amplitude in π-N scattering. Since its elasticity (x) is one, we have

$$T(m) = \frac{\Gamma(m)/2}{M-m-i\Gamma(m)/2} . \qquad (1)$$

If we let $\Gamma'(m) = d\Gamma/dm$, then we find that

$$\text{"Speed"} = \left|\frac{dT}{dm}\right| = \frac{2}{\Gamma}\,\frac{1+(M-m)\Gamma'/\Gamma}{1+4(M-m)^2/\Gamma^2} . \qquad (2)$$

To estimate where Eq. (2) is maximum, we let $\delta = M-m$ ($|\delta| < \Gamma/2$) and keep only linear terms in δ. Thus

$$\left|\frac{dT}{dm}\right| \approx \frac{2}{\Gamma}\left(1+\delta\frac{\Gamma'}{\Gamma}\right). \qquad (3)$$

Since all reasonable parametrizations of $\Gamma(m)$ agree that $\Gamma' \geq 0$, we may conclude that to first order the "speed" will have its maximum value at an energy less than the resonant value, m=M.

This effect is illustrated in Fig. 1, which is taken from UCRL-20030 πN.[1] For the P_{33} partial wave, the CERN experimental and CERN Kirsopp solutions indicate the instability of $|dT/dm|$ in the region of a resonance (the other solutions are "smooth" by the nature of the analysis). In addition, each of the plots, quite consistently, gives $2/\Gamma \approx 16$ GeV^{-1} at a resonant mass of ~1236 MeV. This corresponds to a width at resonance of ~125 MeV. The speed, however, peaks some 10 to 15 MeV lower in mass and at a value of ~18.5 GeV^{-1}. Hence, were we to estimate the mass and width of the 33-resonance from the maximum speed, we would get M ≈ 1220 MeV and Γ = 108 MeV. For additional discussion on the mass and width of this resonance, see the mini-review at the beginning of the Δ(1236) listings.

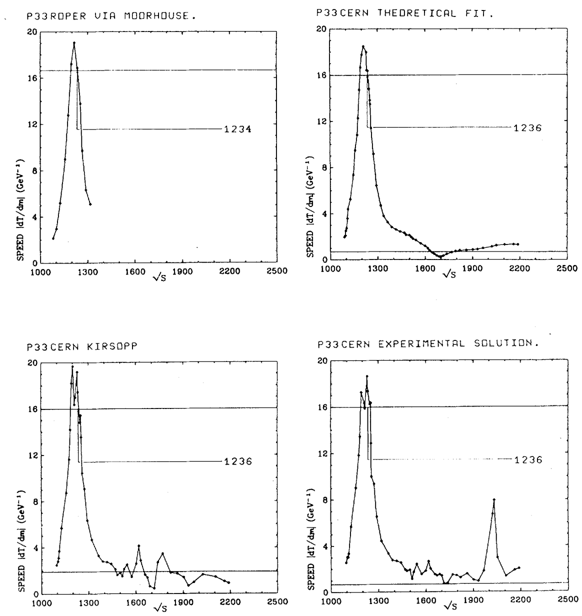

Fig. 1. Speed plots as computed from four solutions compiled in Ref. 1. ($\sqrt{s}$ = m = C. M. energy in MeV)

II. Effect of Partial-Wave Parametrization

To appreciate the systematic differences that arise in extracting resonance parameters from the data, we have compared several recent analyses in Table I. The notation is standard: T is the scattering amplitude, S = 1 + 2 i T, and f is the spin non-flip amplitude. The subscripts B and R refer to background and resonant contributions, respectively. The first part of the table refers to analyses of the πN system, the second part to the $\bar{K}$N.

Table I. Representative examples of energy-dependent parametrizations used to determine resonance parameters.

	Authors	E_{CM} Range (MeV)	Data	Model	Background
πN	AYED 70	1320-2480	$\pi^{\pm}p, \uparrow$, CEX, $\uparrow$	$\begin{cases} 1.\ T=T_B+T_R e^{i\phi_R} \\ 2.\ S=S_B \cdot S_R \end{cases}$	$\delta_B=\Sigma a_n q^n$ $\eta_B=1/[1+(\Sigma b_m q^m)^2]$ a_n, b_m, ϕ_R free
	DAVIES 70	1320-1960	$\pi^{\pm}p, \uparrow$, CEX, $\uparrow$	$S=e^{2i\phi} \cdot [B+ie^{i\alpha} \frac{\Gamma_{e\ell}}{M-E-i\Gamma/2}]$	$\phi=a+bx+cx^2$ $B=1/(1+\lvert dx+ex^2 \rvert)$ $x=k^2-(460 MeV/c)^2$ α, a-e free
	HULL 70	2030-2560	$\pi^- p, \uparrow$ $\lvert t \rvert \leq .6 (GeV/c)^2$	$f=f_B+f_R$	$f_B=(\alpha+i)\frac{k\sigma}{4\pi}e^{bt/2}$ α, σ, b free
$\overline{K}N$	BRICMAN-1 70	1780-1950	$K^- p, \uparrow$, CEX	$T=T_B+T_R\, e^{i\phi_R}$	$T_B=a+b(p-p_0)$ a, b free, complex ϕ_R free, real
	GALTIERI 70	1610-2170	$\Delta\pi$, $\Sigma\pi$	$T=T_B+T_R\, e^{i\phi_R}$	$T_B=(a+bk)\exp[i(c+dk)]$ a, b, c, d, ϕ_R free, real
	KIM 71	1430-1880	$\overline{K}N, \Lambda\pi, \Sigma\pi$	K matrix, multichannel	Expand K matrix in successive intervals
	LITCHFIELD 70	1800-2170	$\Lambda\pi$	$T=T_B+(T_R)$	$T_B=\sum_{n=0}^{N} a_n P_n(x)$ P_n are Legendre polyns. x is linear in momentum such that $x=\pm 1$ at p_{max}, p_{min}. a_n complex, free

The problem of adding background to a resonant amplitude has been extensively discussed in the literature.[2] It is not very clear what is meant by background. After it has been parametrized as an expansion in the incident momentum (or other similar parametrizations as shown in Table I), it may turn out to move fast enough across the Argand plot to represent a resonance. In this case the parameters obtained for the T_R part of the amplitude are very much dependent upon the parametrization of T_B, and one might have to reparametrize the amplitude with an additional resonance. This is an extreme situation, but in general any nonconstant background is very critical to the determination of resonance parameters.

We now discuss the models displayed in Table I.

A. πN System. There have been several determinations made of the parameters for nucleon resonances. We have tabulated all these parameters in Table II of the following "Note on N's and Δ's." It is useful for extending the comparison here, which we restrict to the analyses mentioned in Table I of the present note.

1. AYED 70 have done an energy-independent phase-shift analysis and then fit their experimental Argand plots (reported in Fig. 3 of Note on N's and Δ's) in order to obtain resonance parameters. They use the two methods shown in Table I for combining background and resonances. Both essentially can be written as

$$T = T_B + \gamma T_R \quad \text{with} \quad T_B = \frac{S_B - 1}{2i} = \frac{\eta_B e^{2i\delta_B} - 1}{2i}$$

and

Model 1: $\gamma_1 = e^{i\phi_R}$, ϕ_R real, free parameter

Model 2: $\gamma_2 = \eta_B e^{2i\delta_B}$, i.e., S matrix for the background.

For only one open channel the two are identical, since unitarity requires that $e^{i\phi_R} = \eta_B e^{2i\delta_B}$, with $\eta_B = 1$. Model 2 is most likely invalid (see for example Goebel and McVoy[2]) when S_B becomes inelastic. This can be understood by considering the corresponding Argand amplitude:

$$T = T_B + \eta_B e^{2i\delta_B} \frac{x}{\epsilon - i}, \quad \epsilon = \frac{2(M-m)}{\Gamma}, \quad x = \Gamma_{el}/\Gamma.$$

If, for some reason, $\eta_B \approx 0$ when $m \approx M$ and a clear resonant circle were present, than an abnormally large elasticity ($x > 1$) might be obtained. For this reason we included in the listings only those parameters from model 1. Two typical examples of how the parameters depend on the model are shown in Table II. For the rather elastic F_{15} state, the two sets of parameters are in reasonable agreement. However, there is a difference of 12 MeV in the mass, 19 MeV in the width, and .03 in the elasticity, certainly larger than the statistical errors on the data would indicate. This is an excellent example of why we do not average parameters from energy-dependent analyses when errors of ±2 MeV are quoted. The other example is known as $P_{13}(1860)$ in our listings. The results of the two models disagree not only with one another but also with all of the older values. In addition, model 2 seems to require a second P_{13} at ~1896 MeV!

Table II. Two examples of resonance parameters from models 1 and 2 of AYED 70.

		M	Γ	x	ϕ_R
F_{15}	Model 1	1682	109	.59	-.03
	Model 2	1694	128	.62	---
P_{13}	Model 1	1766	182	.149	-1.58
	Model 2	1508	047	.123	---

2. DAVIES 70 (Table I) uses a model similar to model 1 of AYED 70. The main difference between these two analyses is in the procedure: AYED 70 do an energy-independent partial-wave analysis first and then fit the Argand plots so obtained. DAVIES 70 fit the data directly with their model; therefore they obtain smooth Argand plots (Fig. 2 of Note on N's and Δ's). The amplitude is written in a form suggested by Goebel and McVoy,[2] who discuss the multichannel generalization of the Breit-Wigner approximation. In principle[2] α (or ϕ_R) can be constrained through unitarity from the other elements of the S matrix. The resonant parameters of DAVIES 70 are generally quite different from those of AYED 70 (see Table II in "Note on N's and Δ's") possibly because AYED 70 include newer experimental data and use a different fitting procedure as mentioned earlier.

3. HULL 70. This is not strictly a partial-wave analysis, but it does emphasize that useful information on resonances can be obtained from the forward elastic diffraction peak. This was first noted by Damouth et al.[3] and elaborated upon by Levi Setti and co-workers.[4] Essentially, HULL 70 parametrize all background effects and the tails of resonances (outside the region considered) by the diffraction-like background f_B. Through a fit to recent forward $\pi^- p$ data, supplemented by forward polarization data, they were able to establish the spin of the $H_{19}(2220)$. Their resonance parameters are in reasonable agreement with those of the more orthodox analysis of AYED 70.

B. $\overline{K}N$ system. Most of the partial-wave analyses reported in the $\overline{K}N$ system are energy dependent, therefore the resonance parameters are very much dependent upon the parametrization used to fit the experimental data. We report in Table I only a few representative examples of such analyses.

1. BRICMAN 70 uses model 1 of AYED 70 but parametrizes the background with a simple linear dependence in momentum. This simple parametrization, used extensively by the CERN-Heidelberg-Saclay collaboration, has proven quite adequate for discovering many new resonant states in the 1-GeV/c region. It was introduced as an expedient in the belief that background cannot vary too rapidly in an interval of ~200 MeV. In addition the initial paucity of $\overline{K}N$ data could not permit a more elaborate parametrization (AYED 70 have many background parameters).

The following studies, which we discuss, indicate several methods for extending this sort of analysis to include an ever-broader region in energy.

2. GALTIERI 70 uses a background parametrization that tends to have a circular behavior in the Argand plot. The analysis is performed by dividing the overall region into two intervals so far as the background is concerned. Continuity in $|T|$ is required and, of course, the same resonant parameters are used for both regions.

In the first region ($\lesssim$ 1900 MeV), the resonant structure is somewhat better known. The inclusion of the second region in the fit is initially made with only a background contribution (with the exception of the well-known $G_{07}(2100)$ and F_{17} (2020)). If a resulting partial wave (background!?) shows a resonant-like behavior, the fit is repeated with the presence of a Breit-Wigner in that wave. In this manner it was found that both the D_{03} and D_{13} required a second resonant state at higher energy.

3. KIM 71 presents a multichannel K-matrix analysis of $\overline{K}N$ data from threshold to ~ 1880 MeV. In this analysis he parametrizes the S, P, D, and F_{05} waves with the K matrix. In principle this is the ideal manner in which to analyze the $\overline{K}N$ data; however, such an analysis is not immune to problems.

The first problem is the treatment of three-body states. KIM 71 handles them by introducing an additional "junk" or "quasi-two-body" channel. Such an approximation is most likely reasonable if the three-body final states constitute a small part of the total cross section. The additional channel can be to some extent constrained by the measured three-body cross section.

The next problem is the energy dependence used for the K matrix. Kim's approach is to use an effective range expansion of K^{-1}. Beyond ~1500 MeV, he expands K^{-1} in successive intervals of ~100 MeV. In each of these intervals a new set of ranges is determined by a fit, while continuity is ensured at the boundaries of the regions. This method will ensure smooth Argand plots and, very importantly, unitarity is observed. However, finding the resonance parameters by searching for the poles in the K matrix is now impractical (uses K matrix for every 100 MeV) and one has to resort to some other method (reading parameters off the Argand plot).

4. LITCHFIELD 70 first fits the data with each partial wave (except F_{17} and D_{15}) parametrized by the Legendre polynomial expansion (LPE) in Table I. He then looks for counterclockwise ("resonant like") behavior in the resulting Argand plots. Such a behavior usually requires the order N to be 4 or 5; if it exists, the fit is repeated with a lower-order LPE and the addition of a Breit-Wigner amplitude. If the new fit is just as good, he takes this as evidence for a resonant effect.

For N=1 the LPE corresponds to the linear background used by BRICMAN-1 70; for higher orders it can simulate the behavior of GALTIERI 70's background. Thus the LPE attempts to generalize the useful features of these analyses. As a practical point, LITCHFIELD 70 notes that the use of the LPE generally reduces the computer time for reminimization. Since the a_n are relatively uncorrelated, the reduction of N to 1 and the inclusion of a Breit-Wigner would, hopefully, tend to leave a_0 and a_1 unchanged.

References

1. D. Herndon et al., "πN Partial-Wave Amplitudes, a Compilation," UCRL-20030 πN, Feb. 1970.
2. Discussion on the "addition" of background and resonances can be found, among others, in the following papers: R. H. Dalitz, Ann. Rev. Nucl. Sci. 13, 339 (1963); C. J. Goebel and K. W. McVoy, Phys. Rev. 164, 1932 (1967); K. T. R. Davies and M. Baranger, Ann. Phys. (N. Y.) 19, 383 (1962); C. Michael, Phys. Letters 21, 93 (1966); and S. Coleman, in Theory and Phenomenology in Particle Physics, edited by A. Zichichi (Academic Press, New York, 1969).
3. D. E. Damouth, L. W. Jones, and M. L. Perl, Phys. Rev. Letters 11, 287 (1963).
4. R. Levi Setti, T. Lasinski, and E. Predazzi, Phys. Rev. 179, 1429 (1969).

Note on N's and Δ's

There are now complete phase-shift analyses from four different groups: The Saclay group (referred to as BAREYRE 68 and AYED 70), the Berkeley group (JOHNSON 67), the Glasgow group (DAVIES 70), and the CERN group.

The CERN group has performed two phase-shift analyses, using different methods. The CERN I solution is published as DONNACHIE-1 68 for both I spin 1/2 and 3/2. Their figures contain two sorts of results:
1. "Experimental Phase Shifts," i.e., partial-wave amplitudes at each energy at which they used experimental input. In their figures these are plotted as, η and δ at each energy, but not as Argand plots.
2. "Theoretical Fits" using smooth functions based on dispersion-relation theory. These are plotted both as smooth curves of η and δ vs energy, and as Argand plots. Brody et al.[1] have recently criticized the "Theoretical Fits" because it turns out that although the "experimental" amplitudes describe the data as well as (or better than) any other available set, the theoretical fits for some rapidly varying partial waves are too smooth. Because they are so convenient to draw and to remember, we continue to present these smooth Argand plots, having warned the reader of their limitations.

The new solution, CERN II,[2] covers I=3/2 only, and has been published only as Argand plots of "experimental" amplitudes.

The most recent and extensive analysis comes from the Saclay group (AYED 70); it extends up to a mass of 2.5 GeV. They obtain values for M, Γ, x through energy-dependent fits of the Argand plots (see the preceding mini-review).

We reproduce below, in Figs. 1, 2, 3, most of the available Argand diagrams. The Berkeley diagrams, from which the authors do not yet quote resonance parameters, are reproduced here only for $I = 1/2$ partial waves.[3] Table I below is a summary of all the states claimed by the various groups with our evaluation of their significance. We have included in the Baryon Table only states listed as "good" or "fair."

Spread in Values of Resonance Parameters

Values of masses, widths, and branching ratios can be obtained only from phase-shift analyses. In production experiments, in fact, it is seldom clear which of the many states at similar masses is being observed. We now have phase-shift analyses from four different groups, but we are quite far from having reliable masses and widths derived therefrom.

The problem is that the errors on the phase shifts are quite large and it is thus difficult to draw smooth curves on the Argand diagrams. In addition, except for the Glasgow solutions and the results of AYED 70, where energy-dependent fits to the data and phase shifts are done, the resonance parameters are just the result of an "eyeball" fit with the use of different methods. As a result, different authors using the same phase shifts often estimate different values of M, Γ, x. This is the case for the CERN I solution, from which three sets of parameters have been reported. Furthermore, as discussed in the preceding note, different assumptions about background and resonant shapes can often lead to quite dissimilar values for M, Γ, x even in energy-dependent analyses.

In order to make the reader aware of these problems, we present below in Table II all the different values for M, Γ, x. We also present in this table the mean values of these parameters and the "Ind. Ext. Error," or the "external error" of the individual values:

$$\langle \delta x_i \rangle = \sqrt{\frac{1}{N} \sum_i (x_i - \bar{x})^2}.$$

The error $\delta\bar{x}$ of the mean is of course smaller by another factor $1/\sqrt{N}$ but we avoid giving it because we feel that $\bar{x}, \delta\bar{x}$ have little meaning here. In order that the reader may appreciate the spread in the values of M, Γ, x given in Table II, we discuss briefly the different methods used to determine these parameters. AYED 70 analyze their phase-shift results with an energy-dependent background and Breit-Wigner amplitudes. BAREYRE 68 uses two methods to find resonance parameters: 1 (cross section method)--the energy where the total cross section is maximum; 2 (speed method)-- the energy where the speed of variation of the amplitude in the Argand plot is maximum. CERN quotes only one method, usually where the absorption is maximum, but three different sets of values have been given. The Glasgow group (DAVIES 70) uses Breit-Wigner parametrization; A and B differ in the starting values of the minimization (CERN I solution was used for solution B). For some states no parameters have been quoted by the authors. We report in the M column of Table II our evaluation of the status of this resonance as judged on the published Argand plots. Symbols are the same as on Table I.

On the main table of Baryon Resonances we decided not to quote a value with an error, but to quote a range of masses and widths in order to point out the large indeterminancy of these parameters. So the P'_{11} will be $M = 1435$ to 1505 MeV, $\Gamma = 164$ to 400 MeV, etc.

The resonant parameters, of course, depend on the validity of the partial-wave analyses. Several recent experimental results have not been included in the phase-shift analyses summarized here. Regions of disagreement have been noted by Abillon et al.[4] (in the backward direction) and by Albrow et al.[5] (at $M = 2100$ MeV and higher). Future analyses are likely to provide different parameters, especially in the 2-GeV region.

Footnotes and References

1. A. D. Brody, D. W. G. S. Leith, B. G. Levi, B. C. Shen, D. Herndon, R. Longacre, L. Price, A. H. Rosenfeld, and P. Söding, Phys. Rev. Letters 22, 1401 (1969).

2. The CERN II Argand plots have been reported by A. Donnachie, 14th International Conference on High Energy Physics, Vienna, 1968, p. 139.

3. For the complete set of Argand plots including speed versus energy, see UCRL-20030 πN (Feb. 1970) by D. J. Herndon, A. Barbaro-Galtieri, A. H. Rosenfeld. The AYED 70 solutions are not included, since they were not available at the time.

4. J. M. Abillon, A. Borg, M. Crozon, T. Leray, J. P. Mendiburu, and J. Tocqueville, Phys. Letters 32B, 712 (1970).

5. M. G. Albrow, S. Andersson/Almehed, B. Bosnjakovic, C. Daum, F. C. Erne, J. P. Lagnaux, J. C. Sens, F. Udo, Nucl. Phys. B25, 9 (1970).

PARTIAL-WAVE AMPLITUDES FOR CERN I, CERN II, AND BERKELEY SOLUTIONS

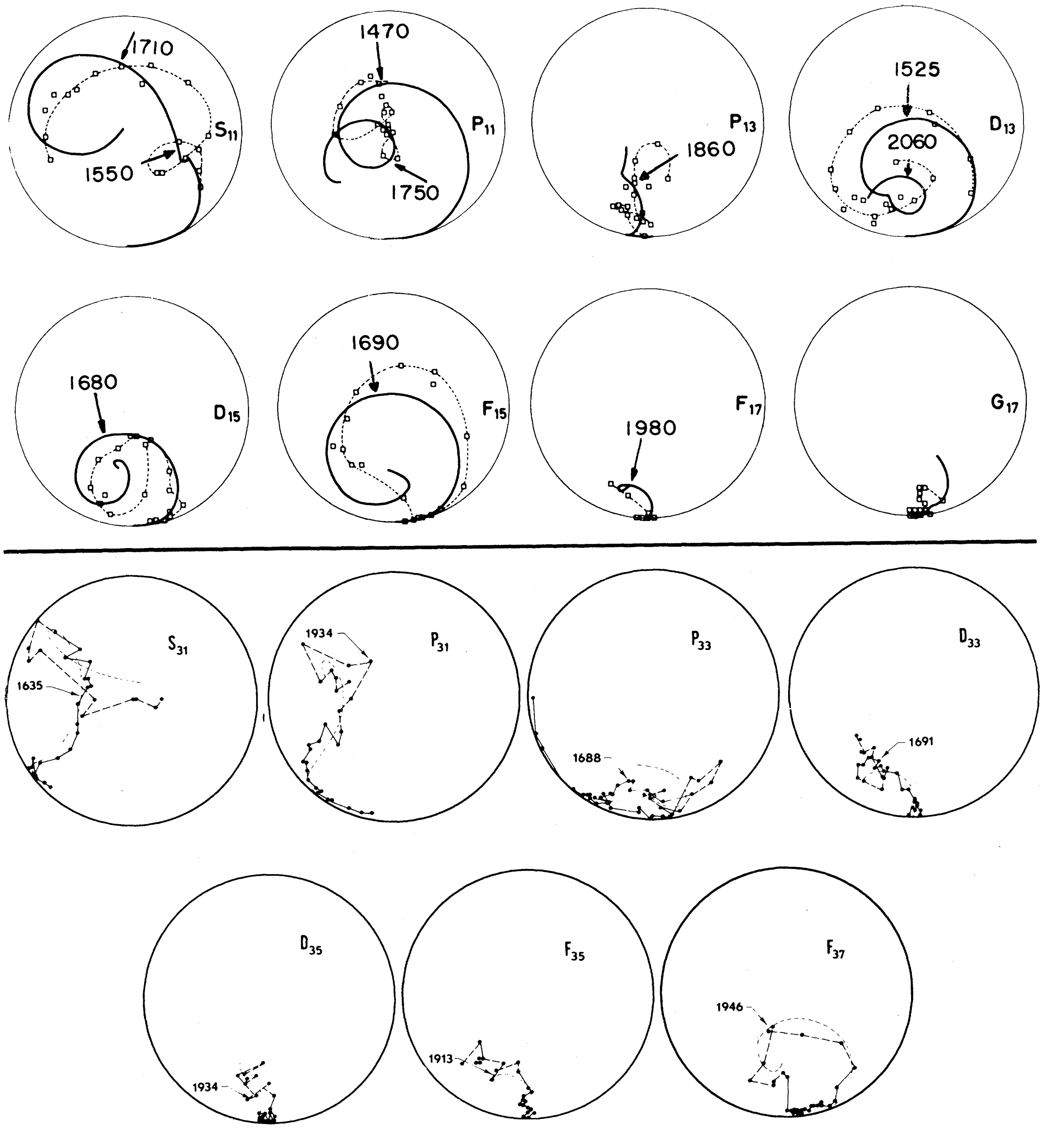

Fig. 1. Results of the phase-shift analyses of the CERN and Berkeley groups. The CERN I results are the smooth curves (dashed in the I = 3/2 diagrams). This analysis used dispersion relations to join and smooth the solutions found at different energies. The arrows in the I = 1/2 diagrams indicate approximate resonance positions; they have been drawn by us. The CERN II solution is shown (as a dot-dash line) only for the I = 3/2 amplitudes since the I = 1/2 are not available. The arrows have been drawn by the authors. The Berkeley solution is shown only for the I = 1/2 state (as empty squares joined by dashes).

Baryons

PARTIAL-WAVE AMPLITUDES FOR GLASGOW SOLUTIONS

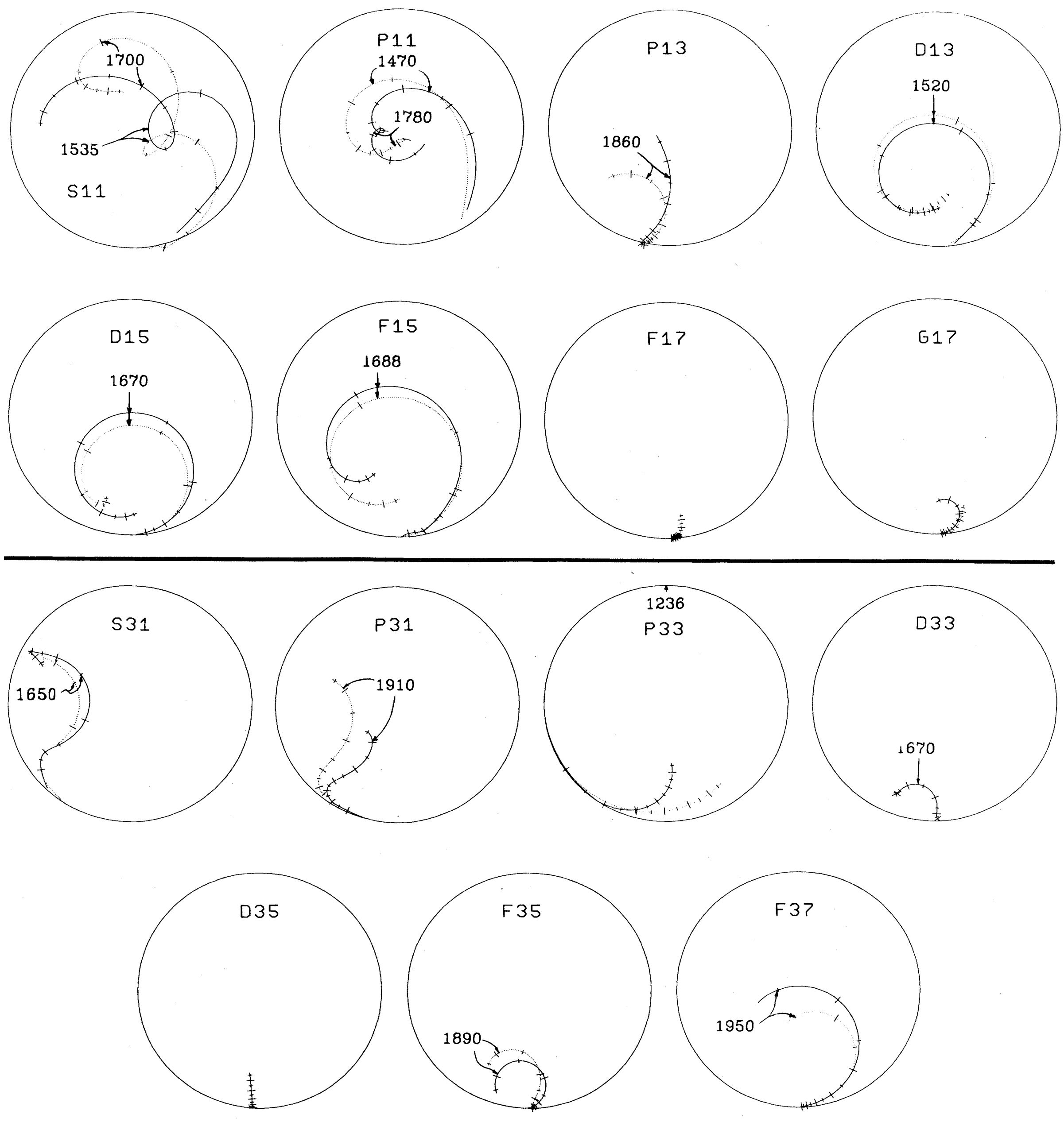

Fig. 2. Phase-shift analysis results of DAVIES 70. The curves plotted here are the results of the energy-dependent analysis. DAVIES A (solid curves) is obtained by starting from the set ot phase shifts that is the best solution of the Glasgow group. DAVIES B (dashed curves) is obtained by starting from the CERN I phase shifts. DAVIES B is not shown when it is very close to DAVIES A. Scale marks are shown every 50 MeV. The first large mark is at M = 1400 MeV, the last large mark at M = 1900 MeV.

Baryons

PARTIAL-WAVE AMPLITUDES FOR SACLAY SOLUTIONS

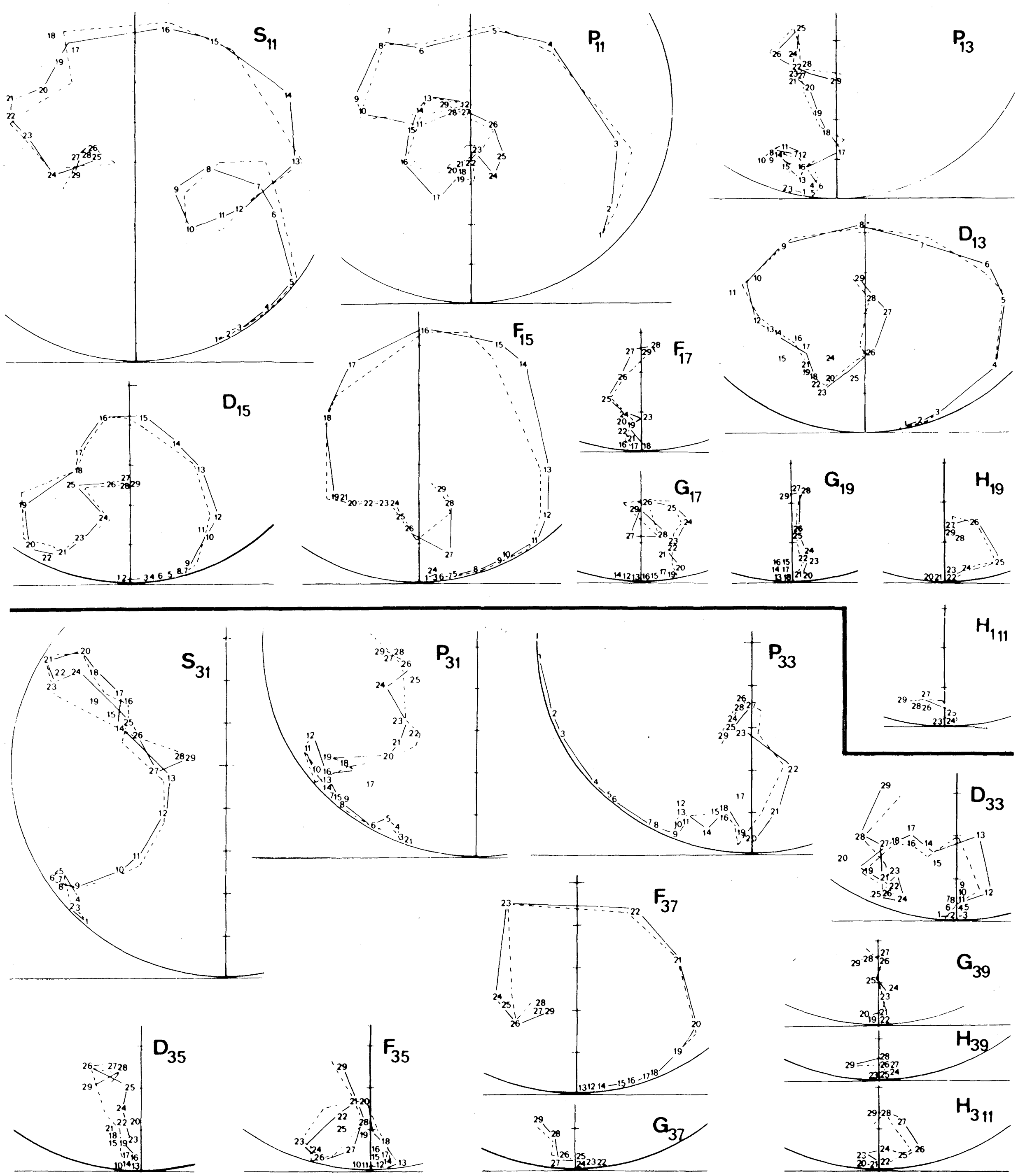

Fig. 3. Latest Saclay phase-shift analysis results [Phys. Letters 31B, 5981 (1970)]. The full and dashed lines connect points of "minimal path" and "minimal surface", respectively.

Baryons

Table I. Our evaluation of the status of all N and Δ resonances as seen in partial-wave analyses. D = definite, Pr = probable, Po = possible, A = ambiguous, No = not present. Notice that in the Glasgow fits the resonance hypothesis is built into the fit, so only the symbols D or No apply, except for one Pr at the upper end.

	Berkeley	CERN I	Saclay[f]	Glasgow	RBD[a]	CERN II	Our evaluation	ηn	$K\Lambda$	$K\Sigma$	$\pi\Delta$	ρN	γN
$P'_{11}(1470)$	D	D	D	D			Good				D		
$D'_{13}(1520)$	D	D	D	D			Good				D		D
$S'_{11}(1535)$	D	D	D	D			Good	D				D	D
$D_{15}(1670)$	D	D	D	D			Good				D		
$F_{15}(1688)$	D	D	D	D			Good				D		D
$S''_{11}(1700)$	D	D	D	D			Good	Po	D				D
$D''_{13}(1700)$	Po	Po	A	No			Poor		Po				
$P''_{11}(1780)$	Pr	Pr	Pr	D			Fair	Po	D				D
$P'_{13}(1860)$	A[c]	A	Po	Pr	Pr		Fair		Po				
$F_{17}(1990)$	c	Pr	A	e	A		Poor						
$D'''_{13}(2040)$	c	Pr	A	c	A		Poor						
$G_{17}(2190)$	c	D	D	c	Pr		Good						
$H_{19}(2220)$	c	c	D	c	c		Good						
$P'_{33}(1236)$							Good						D
$S''_{31}(1650)$	D	D	D	D		D	Good				Po[b]		
$P''_{33}(1690)$	Po	A	Po[g]	No		A	Poor				Po[b]		
$D_{33}(1670)$	A	D	D	D		D	Fair				Po[b]		
$F_{35}(1890)$	Pr	Pr	Pr	D		Pr	Fair			Po			
$P_{31}(1910)$	Pr[c]	Pr	Po	D		D	Fair						
$D_{35}(1960)$	c	A	No	c	Po	A	Poor						
$F_{37}(1950)$	D	D	D	D		D	Good			D	D	D	D
$P'''_{33}(2160)$	Po[c]	Po	No	c		d	Poor						
$H_{3\,11}(2420)$	c	c	D	c			Good						

a. RBD = LEA 69 (Lea et al., Ruth, Bristol, Daresbury) and APLIN 70.
b. For these references see DONNACHIE-2, the latter part of the article.
c. This state is very close to or beyond their highest energy.
d. We can't say anything.
e. Glasgow A has a G_{17} state, Glasgow B may have an F_{17}. However, this region is very close to their highest energy.
f. Evaluation based on new analysis (AYED 70).
g. Around 1800 MeV, however.

Baryons

Table II. Mean Values of Resonance Parameters for N's and Δ's.

● P'_{11} (1470)

			Method	M	Γ	x
1	Ayed	70		1461	164	0.56
2	Bareyre	68	σ	1470	255	0.68
3	Bareyre	68	Speed	1505	205	0.68
4	Berkeley	67		D		
5	Donnachie-1	68	Abs.	1466	211	0.658
6	Donnachie-2	68	Abs.	1470	211	0.66
7	Kirsopp	68	Abs.	1466	211	0.66
8	Glasgow	68	A	1462	391	0.49
9	Glasgow	68	B	1436	224	0.46
Average				1467	234	0.61
± Ind. ext. error				±18	±64	±.08

● D'_{13} (1520)

			Method	M	Γ	x
1	Ayed	70		1523	131	0.59
2	Bareyre	68	σ	1510	125	0.54
3	Bareyre	68	Speed	1515	110	0.54
4	Berkeley	67		1526[a]	114[a]	0.57[a]
5	Donnachie-1	68	Abs.	1541	149	0.509
6	Donnachie-2	68	Abs.	1520	114	0.57
7	Kirsopp	68	Abs.	1526	115	0.57
8	Glasgow	68	A	1512	106	0.45
9	Glasgow	68	B	1512	125	0.49
Average				1521	121	0.54
± Ind. ext. error				±9	±12	±.04

● S'_{11} (1535)

			Method	M	Γ	x
1	Ayed	70		1534	96	0.40
2	Bareyre	68	σ	1535	155	—
3	Bareyre	68	Speed	1515	105	—
4	Berkeley	67		1548[a]	116[a]	0.326[a]
5	Donnachie-1	68	Abs.	1591	(268)	0.696
6	Donnachie-2	68	Abs.	1550	116	0.33
7	Kirsopp	68	Abs.	1540	160	0.3
8	Glasgow	68	A	1502	(36)	0.36
9	Glasgow	68	B	1499	53	0.35
Average				1535	114	0.40
± Ind. ext. error				±27	±34	±.13

● D_{15} (1670)

			Method	M	Γ	x
1	Ayed	70		1675	143	0.39
2	Bareyre	68	σ	1680	135	0.41
3	Bareyre	68	Speed	1655	105	0.41
4	Berkeley	67		D		
5	Donnachie-1	68	Abs.	1678	173	0.391
6	Donnachie-2	68	Abs.	1680	173	0.391
7	Kirsopp	68	Abs.	1678	175	0.391
8	Glasgow	68	A	1669	115	0.50
9	Glasgow	68	B	1667	115	0.43
Average				1673	142	0.41
± Ind. ext. error				±8	±27	±.04

● F_{15} (1688)

			Method	M	Γ	x
1	Ayed	70		1682	109	0.59
2	Bareyre	68	σ	1690	110	0.64
3	Bareyre	68	Speed	1680	105	0.64
4	Berkeley	67		1692[a]	132[a]	0.68[a]
5	Donnachie-1	68	Abs.	1687	177	0.56
6	Donnachie-2	68	Abs.	1690	132	0.68
7	Kirsopp	68	Abs.	1692	130	0.68
8	Glasgow	68	A	1685	104	0.54
9	Glasgow	68	B	1684	123	0.54
Average				1688	125	0.62
± Ind. ext. error				±4	±21	±.06

● S''_{11} (1700)

			Method	M	Γ	x
1	Ayed	70		1689	166	0.64
2	Bareyre	68	σ	1710	260	—
3	Bareyre	68	Speed	1665	110	—
4	Berkeley	67		1709[a]	300[a]	0.786[a]
5	Donnachie-1	68	Abs.	—	—	—
6	Donnachie-2	68	Abs.	1710	300	0.79
7	Kirsopp	68	Abs.	1709	300	0.79
8	Glasgow	68	A	1766	404	0.56
9	Glasgow	68	B	1671	121	0.51
Average				1704	245	0.68
± Ind. ext. error				±29	±96	±.12

● D''_{13} (1700)

			Method	M	Γ	x
1	Ayed	70		A		
2	Bareyre	68	σ			
3	Bareyre	68	Speed	Po		
4	Berkeley	67		Po		
5	Donnachie-1	68	Abs.	—	—	—
6	Donnachie-2	68	Abs.	1730		
7	Kirsopp	68	Abs.	1680		
8	Glasgow	68	A	No		
9	Glasgow	68	B	No		
Average				1705		
± Ind. ext. error				±25		

● P''_{11} (1780)

			Method	M	Γ	x
1	Ayed	70		1645	50	0.15
2	Bareyre	68	σ	Pr		
3	Bareyre	68	Speed	Pr		
4	Berkeley	67		Pr		
5	Donnachie-1	68	Abs.	1751	327	0.32
6	Donnachie-2	68	Abs.	1750	327	0.32
7	Kirsopp	68	Abs.	1860	270	0.32
8	Glasgow	68	A	1770	445	0.43
9	Glasgow	68	B	(1867)	(525)	0.30
Average				1755	284	0.31
± Ind. ext. error				±68	±130	±.08

● P'_{13} (1860)

			Method	M	Γ	x
1	Ayed	70		1766	182	0.15
2	Bareyre	68	σ	A[b]		
3	Bareyre	68	Speed	A[b]		
4	Berkeley	67		A[b]		
5	Donnachie-1	68	Abs.	1863	296	0.207
6	Donnachie-2	68	Abs.	1860	296	0.21
7	Kirsopp	68	Abs.	1900	325	0.25
8	Glasgow	68	A	1844	449	0.40
9	Glasgow	68	B	1854	307	0.26
10	Lea	69		1860	—	—
Average				1849	309	0.25
± Ind. ext. error				±38	±78	±.08

● F_{17} (1990)

			Method	M	Γ	x
1	Ayed	70		No		
2	Bareyre	68	σ	b		
3	Bareyre	68	Speed	b		
4	Berkeley	67		b		
5	Donnachie-1	68	Abs.	1983	225	0.128
6	Donnachie-2	68	Abs.	—	—	—
7	Kirsopp	68	Abs.	1995	250	0.09
8	Glasgow	68	A	c		
9	Glasgow	68	B	c		
10	Lea	69		~2000	—	—
Average				1993	238	0.109
± Ind. ext. error				±7	±13	±.019

● D'''_{13} (2040)

			Method	M	Γ	x
1	Ayed	70		No		
2	Bareyre	68	σ	b		
3	Bareyre	68	Speed	b		
4	Berkeley	67		b		
5	Donnachie-1	68	Abs.	2057	293	0.26
6	Donnachie-2	68	Abs.	2030	290	0.11
7	Kirsopp	68	Abs.	2040	240	0.15
8	Glasgow	68	A	b		
9	Glasgow	68	B	b		
10	Lea	69		2030	—	—
Average				2039	274	0.17
± Ind. ext. error				±11	±24	±.06

● G_{17} (2190)

			Method	M	Γ	x
1	Ayed	70		2158	325	0.15
2	Bareyre	68	σ	b		
3	Bareyre	68	Speed	b		
4	Berkeley	67		b		
5	Donnachie-1	68	Abs.	2265	298	0.349
6	Donnachie-2	68	Abs.	2190	300	0.35
7	Kirsopp	68	Abs.	2265	300	0.35
8	Glasgow	68	A	(1906)[c]	(319)[c]	(0.14)[c]
9	Glasgow	68	B	c		
10	Lea	69		~2000		
Average				2176	306	0.30
± Ind. ext. error				±97	±11	±.09

● S_{31} (1650)

			Method	M	Γ	x
1	Ayed	70		1614	142	0.32
2	Bareyre	68	σ	1695	250	—
3	Bareyre	68	Speed	1650	130	—
4	Berkeley	67		D		
5	Donnachie-1	68	Abs.	1635	177	0.284
6	Donnachie-2	68	Abs.	1640	177	0.28
7	Kirsopp	68	Abs.	1635	180	0.28
8	Glasgow	68	A	1617	141	0.28
9	Glasgow	68	B	1623	140	0.25
Average				1639	167	0.28
± Ind. ext. error				±24	±36	±.02

● P''_{33} (1690)

			Method	M	Γ	x
1	Ayed	70		1801	598	0.14
2	Bareyre	68	σ	A		
3	Bareyre	68	Speed	A		
4	Berkeley	67		Po		
5	Donnachie-1	68	Abs.	1688	281	0.098
6	Donnachie-2	68	Abs.	1690	281	0.1
7	Kirsopp	68	Abs.	1690	240	0.08
8	Glasgow	68	A	No		
9	Glasgow	68	B	No		
Average				1717	350	0.10
± Ind. ext. error				±48	±144	±.02

● D_{33} (1670)

			Method	M	Γ	x
1	Ayed	70		1722	258	0.22
2	Bareyre	68	σ	Po		
3	Bareyre	68	Speed	Po		
4	Berkeley	67		A		
5	Donnachie-1	68	Abs.	1691	269	0.14
6	Donnachie-2	68	Abs.	1690	269	0.14
7	Kirsopp	68	Abs.	1690	300	0.13
8	Glasgow	68	A	1649	188	0.12
9	Glasgow	68	B	1650	174	0.13
Average				1682	243	0.15
± Ind. ext. error				±26	±46	±.03

● F_{35} (1890)

			Method	M	Γ	x
1	Ayed	70		1837	198	0.15
2	Bareyre	68	σ	Po		
3	Bareyre	68	Speed	Po		
4	Berkeley	67		Pr		
5	Donnachie-1	68	Abs.	1913	350	0.16
6	Donnachie-2	68	Abs.	1910	350	0.16
7	Kirsopp	68	Abs.	1910	380	0.15
8	Glasgow	68	A	1841	136	0.2
9	Glasgow	68	B	1852	150	0.19
Average				1877	261	0.17
± Ind. ext. error				±34	±102	±.02

● P_{31} (1910)

			Method	M	Γ	x
1	Ayed	70		1783	308	0.13
2	Bareyre	68	σ	A[b]		
3	Bareyre	68	Speed	A[b]		
4	Berkeley	67		Pr[b]		
5	Donnachie-1	68	Abs.	1934	339	0.30
6	Donnachie-2	68	Abs.	1930	339	0.3
7	Kirsopp	68	Abs.	1930	425	0.25
8	Glasgow	68	A	1914	290	0.18
9	Glasgow	68	B	1834	231	0.24
Average				1888	322	0.23
± Ind. ext. error				±58	±59	±.06

● D_{35} (1960)

			Method	M	Γ	x
1	Ayed	70		No		
2	Bareyre	68	σ	A[b]		
3	Bareyre	68	Speed	A[b]		
4	Berkeley	67		b		
5	Donnachie-1	68	Abs.	1954	311	0.154
6	Donnachie-2	68	Abs.	—	—	—
7	Kirsopp	68	Abs.	1970	400	0.12
8	Glasgow	68	A	b		
9	Glasgow	68	B	b		
10	Lea	69		1950	—	—
Average				1958	356	0.14
± Ind. ext. error				±9	±45	±.02

● F_{37} (1950)

			Method	M	Γ	x
1	Ayed	70		1931	197	0.50
2	Bareyre	68	σ	1975	180	0.57
3	Bareyre	68	Speed	1980	140	—
4	Berkeley	67		D		
5	Donnachie-1	68	Abs.	1946	221	0.386
6	Donnachie-2	68	Abs.	1950	221	0.39
7	Kirsopp	68	Abs.	1946	220	0.39
8	Glasgow	68	A	1935	196	0.51
9	Glasgow	68	B	1935	212	0.39
Average				1950	198	0.45
± Ind. ext. error				±17	±26	±.07

● P'''_{33} (2160)

			Method	M	Γ	x
1	Ayed			No		
2	Bareyre	68	σ	b		
3	Bareyre	68	Speed	b		
4	Berkeley	67		Po[b]		
5	Donnachie-1	68	Abs.			
6	Donnachie-2	68	Abs.			
7	Kirsopp	68	Abs.	2160	260	0.25
8	Glasgow	68	A	b		
9	Glasgow	68	B	b		
Average				2160	260	0.25
± Ind. ext. error				—	—	—

( ) Values in parentheses have not been used in the averages.

a. Values quoted by Lovelace, rapporteur talk at Heidelberg Conference (1967), p. 109.

b. This state is very close to or beyond their highest energy.

c. Glasgow A has a G_{17} state at this mass, Glasgow B may have an F_{17} and a G_{17}; however, this energy region is very close to their highest energy.

For notation, see illustrated key at beginning of data card listings.

```
CODE EVENTS QUANTITY  ERROR+  ERROR-  REFERENCE YR TECN SIGN COMMENTS  DATE
      ABOVE                                                        PUNCHED
   BACKGROUND

****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
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p

```
             16  PROTON  (938, J=1/2)  I=1/2
             SEE LISTINGS OF STABLE PARTICLES

****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
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n

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             17  NEUTRON  (939, J=1/2)  I=1/2
             SEE LISTINGS OF STABLE PARTICLES

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N(1470) **P'_{11}**

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             61  N*1/2(1470, JP=1/2+) I=1/2
             FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
             ABOVE

   THE MASS AND WIDTH ARE BEST DETERMINED FROM PHASE-SHIFT ANALYSES.  WE
   LIST PRODUCTION EXPERIMENTS SEPARATELY--SEE BELOW.

-----------------  61  N*1/2(1470) MASS (MEV)   ------------------------

M        (1380.0)                  ROPER     65 RVUE   PHASE-SHIFT ANAL  9/66
M        (1370.0)                  BRANDSEN  65 RVUE   PHASE-SHIFT ANAL  9/66
M   1    (1470.0)                  BAREYRE   68 RVUE   PHASE-SHIFT ANAL 11/67
    1         WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M   2    (1505.0)                  BAREYRE   68 RVUE   PHASE-SHIFT ANAL 11/67
    2         WHERE SPEED IS GREATEST - EYEBALL FIT
M   3    (1466.0)                  DONNACH1  68 RVUE   PHASE-SHIFT ANAL  6/68
M   3    (1470.)                   DONNACH2  68 RVUE   PHAS.SHIFT-CERN1 10/69
M   3    (1466.)                   KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69
    3  WHERE MAX. ABSORPTION IS -DONNACH1, 2  ,KIRSOPP EYEBALL FIT CERN 1  10/69
M   4    (1462.0)                  DAVIES    70 RVUE   P-S ANAL  SOL A   8/69
M   5    (1436.0)                  DAVIES    70 RVUE   P-S ANAL  SOL B   8/69
    5  SOL B IS E.D FIT TO SAME DATA START FROM CERN I EXPER. (DONNACH1 68)
M   6    (1461.0)                  AYED      70 IPWA                     1/71*
    6  FROM ENER. DEP. FIT OF ARGAND DIAGRAM

-----------------  61  N*1/2(1470) WIDTH (MEV)  ------------------------

W   1    (255.0)                   BAREYRE   68 RVUE                    11/67
W   2    (205.0)                   BAREYRE   68 RVUE                    11/67
W   3    (211.0)                   DONNACH1  68 RVUE                     6/68
W   3    (211.)                    DONNACH2  68 RVUE   PHAS.SHIFT-CERN1 10/69
W   3    (210.)                    KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69
W   4    (391.)                    DAVIES    70 RVUE   P-S ANAL  SOL A   8/69
W   5    (224.)                    DAVIES    70 RVUE   P-S ANAL  SOL B   8/69
W   6    (164.0)                   AYED      70 IPWA                     1/71*
     SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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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 SIGMA (SIGMA MESON)    938+ 410
P3          N*1/2(1470) INTO N*3/2(1236) PI          1236+ 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 (PIPI, I=1)        938+ 765

-----------------  61  N*1/2(1470) BRANCHING RATIOS   ------------------

R1          N*1/2(1470) INTO (PI N)/TOTAL                (P1)/TOTAL
R1  1         (0.68)                BAREYRE   68 RVUE                    11/67
R1  3         (0.658)               DONNACH1  68 RVUE                     6/68
R1  3          (.66)                DONNACH2  68 RVUE   PHAS.SHIFT-CERN1 10/69
R1  3          (.66)                KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69
R1  4         (0.49)                DAVIES    70 RVUE   P-S ANAL  SOL A   8/69
R1  5         (0.46)                DAVIES    70 RVUE   P-S ANAL  SOL B   8/69
R1  6         (0.564)               AYED      70 IPWA                     1/71*
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
    A AND B CORRESPOND TO THE 2 BEST SOLUTIONS. ANALYSIS IS DONE ON THREE
    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 SIGMA)/TOTAL              (P2)/TOTAL
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  A         (0.30)    (0.20)         SAXON     70 HBC                      6/70
R2  B         (0.20)    (0.12)         SAXON     70 HBC                      6/70
    A AND B CORRESPOND TO THE 2 BEST SOLUTIONS, SEE NOTE IN R1.
R2  D         (0.16)                   DIEM      70 IPWA    3 BODY ANALYSIS  1/71*
    D       ASSUMING  R1= 0.61

R3          N*1/2(1470) INTO (N*3/2(1236) PI)/TOTAL       (P3)/TOTAL
R3  A         (0.03)    (0.20)         SAXON     70 HBC                      6/70
R3  B         (0.22)    (0.12)         SAXON     70 HBC                      6/70
    A AND B CORRESPOND TO THE 2 BEST SOLUTIONS, SEE NOTE IN R1.
R3  D         (0.17)                   DIEM      70 IPWA    3 BODY ANALYSIS  1/71*
    D       ASSUMING  R1= 0.61

R4       N*1/2(1470) INTO (GAMMA N)/(PI N)              (P5)/(P1)
R4         SOME INDICATION             LODI-RIZZ 70 DBC     GAM-N TO PI-P    7/70

R5          N*1/2(1470) INTO (N RHO )/TOTAL               (P6)/TOTAL
R5  D         (0.07)                   DIEM      70 IPWA    3 BODY ANALYSIS  1/71*
    D       ASSUMING  R1= 0.61

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                         REFERENCES -- N*1/2(1470)
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ROPER    65 PR 138 B190        LD ROPER,RM WRIGHT,BT FELD   (LRL-LVMR,MIT)IJP
BRANDSEN 65 PR 139 B1566       +ODONNELL, MOORHOUSE          (DURHAM,RTHFD)IJP
THURNAUE 65 PRL 14 985         P G THURNAUER                         (ROCH)
NAMYSLOW 66 PR 157 1328        NAMYSLOWSKI,RAZMI,ROBERTS   (STAN,EDINB,IC)
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
DONNACH2 68 VIENNA 139         DONNACHIE  RAPPORTEUR.S TALK           (GLAS)
KIRSOPP  68 THESIS             R G KIRSOPP                            (EDIN)
MORGAN   68 PR 166 1731        D MORGAN                              (RTHFD)

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)
LODI-RIZ 70 LNC  3 697         +FIORE,PIAZZA+...  (PAVIA+ROMA+CNEN+NAPOLI)
SAXON    70 PR D2 1790         SAXON, MULVEY, CHINOWSKY            (OXF,LRL)

                               PAPERS NOT REFERRED TO IN DATA CARDS.

BAREYRE  64 PL 8 137           +BRICMAN,VALLADAS,VILLET, +   (SACLAY,CAEN) IJ
BAREYPE  65 PL 18 342          +BRICMAN, STIRLING, VILLET          (SACLAY)IJP
DALITZ   65 PL 14 159          R H DALITZ, R G MOORHOUSE          (OXF,RTHFD)
JOHNSON  67 UCRL-17683 THESIS C H JOHNSON                              (LRL)
DONNACHI 69 NP 108 433         A DONNACHIE, R KIRSOPP              (GLAS+EDIN)
AYED     70 PL 31B 598         +BAREYRE,VILLET                        (SACLAY)
BERARDO  70 PRL 24 419         +HADDOCK,NEFKENS,...,PARSONS+..     (UCLA+LRL)

         FOR PHOTONIC COUPLINGS SEE
MOORHOUSF70 NP B23,181         +RANKIN                                 (GLAS)
WALKER   69 PR 182,1729        R.L.WALKER                              (CALT)

      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

N(1470) BUMPS

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             61 N*(1470)    PROD. EXP.

             IT IS NOT CLEAR THAT THE BUMP SEEN IN PRODUCTION EXPE-
             RIMENTS AT LOW INVARIANT MASS CORRESPONDS TO THE P11
             RESONANT STATE.  DIFFRACTION SCATTERING SEEMS TO BE THE
             DOMINANT FEATURE IN THIS MASS REGION- SEE GELLERT 66,
             WALKER 68 AND CLEGG 68 FOR DISCUSSION OF THIS POINT.
        WE LIST VALUES OF MASSES AND WIDTHS FROM THESE EXPERIMENTS FOR
        THE READER'S CONVENIENCE- THE LIST MAY NOT BE COMPLETE.
        THE CNTR AND SPRK EXPERIMENTS SEE A BUMP IN THE MISSING MASS
        PLOT. THE HBC EXPERIMENTS SEE A BUMP IN THE PPPI MASS PLOT. TAN
        68, SHAPIRA 68 SEE A BUMP IN PI P - PRODUCTION OF THIS STATE
        IN GAMMA-P OR GAMMA-D IS VERY SMALL, SEE ALBERI 68.

----------------    N*1/2(1470)  MASS (MEV)  PROD. EXPE. ------------------

M          (1425.)    APPROX          ADELMAN    65 HBC  +  K-P 1.45 GEV/C     7/66
M          (1400.)    APPROX          COCCONI    64 CNTR +  PP 3.6-12 GEV/C
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 DBC     INTO PPI,PN 7.0   10/69
M   S    TAN 68, SHAPIRA 68 ARE ONLY PRODUCTION EXPERIMENT TO SEE PPI DECAY
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*

----------------    N*1/2(1470) WIDTH (MEV)  PROD. EXPE. ------------------

W           (100.)                    BELL       68 HBC     PI+- P AND PP      6/68
W   S   175 (198.)     (40.)          SHAPIRA    68 DBC                       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*

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----------------    N*1/2(1470) BRANCHING RATIOS  PROD. EXP.  ------------

R1          N*1/2(1470) INTO (PI P)/TOTAL       PRODUC. EXPER.
R1            (.66)                   TAN        68 HBC     PP TO PIP, 6.1    10/69

R2          N*1/2(1470) INTO (N*3/2(1236) PI)/TOTAL   PROD. EXP.
R2               PROBABLY SEEN        LAMSA      68 HBC     PI-P 8 BEV/C      11/68
R2               PROBABLY SEEN        JESPERSEN  68 HBC     PP 22 BEV/C       11/68

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                      REFERENCES -N*1/2(1470)-  PROD. EXP.
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COCCONI  64 PL   8 134       +LILLETHUN,SCANLON,STAHLBRANDT, +        (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,COLLINS,FUJII,+              (BNL,CARN)
BLAIR    66 PRL 17  789      +TAYLOR,CHAPMAN,+  (HARWELL,QUEENMARY,RHEL)
GELLERT  66 PRL 17 884       +SMITH,VOJCICKI,COLTON,SCHLEIN + (LRL,UCLA)

FOLEY    67 PRL 19  397      +JONES,LINDENBAUM,LOVE,OZAKI+             (BNL)
ALBERI   68 PR 176 1631      +APPEL,BUDNITZ,CHEN,DUNNING,GOITEIN+ (HARV)
ALMEIDA  68 PR 174 1638      +RUSHBROOKE,SCHARENGUIVEL+        (CAVE,DESY)
BELL     68 PRL 20  164      +CRENNELL,HOUGH,KARSHON,LAI+       (BNL,CCNY)
CLEGG    68  PREPRINT        A B CLEGG                               (LANC)
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,CHINOWSKY +  (SLAC+LRL+UCI)
WALKER   68 PPL 20 133       +THOMPSON,ROBERTSON,OH,LEE,HARTUNG,+ (WISC)
RHODE    69 PR 187 1844      RHODE, LEACOCK, KERNAN, JESPERSEN,+  (AMES)
ANDERSON 70 PRL 25,699       +BLESER,BLIEDEN,COLLINS++          (BNL,CARN)
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                    END PRODUCTION EXPERIMENTS

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For notation, see illustrated key at beginning of data card listings.

N(1520) D'_{13}

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62   N*1/2(1520, JP=3/2-) I=1/2

FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
PRECEDING N*1/2(1470).

----------------   62   N*1/2(1520) MASS (MEV)   -------------------------

M        (1536.0)                      ROPER      65 RVUE    PHASE-SHIFT ANAL  9/66
M        (1530.0)                      BRANDSEN   65 RVUE    PHASE-SHIFT ANAL  9/66
M   1    (1510.0)                      BAREYRE    68 RVUE    PHASE-SHIFT ANAL 11/67
    1           WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M   2    (1515.0)                      BAREYRE    68 RVUE    PHASE-SHIFT ANAL 11/67
    2           WHERE SPEED IS GREATEST - EYEBALL FIT
M   3    (1541.0)                      DONNACH1   68 RVUE    PHASE-SHIFT ANAL  6/68
M   3    (1520.)                       DONNACH2   68 RVUE    PHAS.SHIFT-CERN1 10/69
M   3    (1526.)                       KIRSOPP    68 RVUE    PHASE SHIFT ANAL 10/69
    3  WHERE MAX. ABSORPTION IS -DONNACH1, 2  ,KIRSOPP EYEBALL FIT CERN I   10/69
M   4    (1512.0)                      DAVIES     70 RVUE    P-S ANAL  SOL A   8/69
M   5    (1512.0)                      DAVIES     70 RVUE    P-S ANAL  SOL B   8/69
    5  SOL B IS E.D FIT TO SAME DATA START FROM CERN I EXPER. (DONNACH1 68)
M   6    (1523.0)                      AYED       70 IPWA                      1/71*
    6  FROM ENER. DEP. FIT OF ARGAND DIAGRAM

----------------   62   N*1/2(1520) WIDTH (MEV)   -----------------------

W   1    (125.0)                       BAREYRE    68 RVUE                     11/67
W   2    (110.0)                       BAREYRE    68 RVUE                     11/67
W   3    (149.0)                       DONNACH1   68 RVUE                      6/68
W   3    (114.)                        DONNACH2   68 RVUE    PHAS.SHIFT-CERN1 10/69
W   3    (115.)                        KIRSOPP    68 RVUE    PHASE SHIFT ANAL 10/69
W   4    (106.0)                       DAVIES     70 RVUE    P-S ANAL  SOL A
W   5    (125.0)                       DAVIES     70 RVUE    P-S ANAL  SOL B   8/69
W   6    (131.0)                       AYED       70 IPWA                      1/71*
      SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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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(1236) PI              1236+ 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 SIGMA (SIGMA MESON)        939+ 410
P8        N*1/2(1520) INTO N RHO ( PIPI, I=1)           938+ 765

----------------   62   N*1/2(1520) BRANCHING RATIOS   ------------------

R1        N*1/2(1520) INTO (PI N)/TOTAL                       (P1)/TOTAL
R1  1        (0.54)                    BAREYRE    68 RVUE                     11/67
R1  3        (0.509)                   DONNACH1   68 RVUE                      6/68
R1  3         (.57)                    DONNACH2   68 RVUE    PHAS.SHIFT-CERN1 10/69
R1  3         (.57)                    KIRSOPP    68 RVUE    PHASE SHIFT ANAL 10/69
R1  4        (0.45)                    DAVIES     70 RVUE    P-S ANAL  SOL A   8/69
R1  5        (0.49)                    DAVIES     70 RVUE    P-S ANAL  SOL B   8/69
R1  6        (0.593)                   AYED       70 IPWA                      1/71*
     SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

    ALMOST THE ENTIRE INELASTICITY IS IN N PI PI (ONLY N ETA COULD COMPETE,
    AND IT DOESNT).  THE N PI PI SEEMS TO BE MAINLY N*3/2(1236) PI, IN BOTH
    S AND D WAVES.

R2        N*1/2(1520) INTO (N*3/2(1236) PI)/TOTAL          (P4)/TOTAL
R2           DOMINANT INEL DECAY       OLSSON     66 RVUE    PI P TO PI PI N   9/66
R2           0.20       0.05           KIRZ       66 HBC  0  ASSUMING R1=0.72  9/66
R2  D        (0.40)                    DIEM       70 IPWA    3 BODY ANALYSIS   1/71*
    D     ASSUMING  R1= 0.5

R3        N*1/2(1520) INTO (N*3/2(1236) 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 SIGMA) / TOTAL               (P7)/TOTAL
R4          PROBABLY PRESENT             MORGAN   68 RVUE    ISOBAR MODEL      6/68
R4  D        (0.02)                    DIEM       70 IPWA    3 BODY ANALYSIS   1/71*
    D     ASSUMING  R1= 0.5

R5        N*1/2(1520) INTO (N ETA)/TOTAL                   (P6)/TOTAL
R5  D        (0.006)    APPROX         DAVIES     67 RVUE                     11/67
     DAVIES 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+ RESON.    5/70
R5  B        (0.002)OR 0.004           CARRERAS   70 MPWA    T POLE+ RESON.    5/70
R5  B    PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R6        N*1/2(1520) INTO (N RHO )/TOTAL                  (P8)/TOTAL
R6  D        (0.07)                    DIEM       70 IPWA    3 BODY ANALYSIS   1/71*
    D     ASSUMING  R1= 0.5

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                        REFERENCES -- N*1/2(1520)

          SEE A PREVIOUS EDITION (RMP 37, 633, 1965) FOR EARLIER REFERENCES.

BRANDSEN 65 PR 139 B1566     +DONNELL, MOORHOUSE          (DURHAM,RTHFD)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 FROM DATA DISCUSSED IN KIRZ 63.
NAMYSLOW 66 PR 157 1328      NAMYSLOWSKI,RAZMI,ROBERTS    (STAN,EDINB,IC)
OLSSON   66 PR 145 1309      M G OLSSON, G B YODH                (WISC,MD)
DAVIES   67 NC 52A 1112      A T DAVIES, R G MOORHOUSE    (GLASGOW,RTHFD)
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 DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
DONNACH2 68 VIENNA 139       DONNACHIE  RAPPORTEUR.S TALK           (GLAS)
KIRSOPP  68 THESIS           R G KIRSOPP                            (EDIN)
MORGAN   68 PR 166 1731      D MORGAN                              (RTHFD)
BOTKE    69 PR 180 1417      J C BOTKE                              (UCSB)
DEANS    69 PR 185 1797      S DEANS, J WOOTEN              (UNIV S FLORIDA)

CARRERAS 70 NP 16B 35        B CARRERAS, A DONNACHIE           (DARE,MCHS)
DAVIES   70 NP B21 359       A DAVIES                               (GLAS)
AYED     70 KIEV CONF        R AYED,P BAREYRE, G VILLET          (SACL)IJP
DIEM     70 KIEV CONF.       + SMADJA, CHAVANON, DELER, DOLBEAU+    (SACL)

                       PAPERS NOT REFERRED TO IN DATA 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 VALLADAS              (SACLAY)
      -- THE ABOVE PAPERS DISCUSS INELASTIC CHANNELS NEAR THE RESONANCE.
JOHNSON  67 UCRL-17683 THESIS C H JOHNSON                            (LRL)
DEANS    69 PRL 177 2623     S R DEANS                           (FLORIDA)
DONNACHI 69 NP 10B 433       A DONNACHIE, R KIRSOPP          (GLAS+EDIN)
AYED     70 PL 31B 598       +BAREYRE+VILLET                      (SACLAY)

             FOR PHOTONIC COUPLINGS SEE
MOORHOUSE70 NP B23,181       +RANKIN                                (GLAS)
WALKER   69 PR 182,1729      R.L.WALKER                             (CALT)

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N(1535) S'_{11}

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63   N*1/2(1535, JP=1/2-) I=1/2

FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
PRECEDING N*1/2(1470).

-------------------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
    1           WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M   2    (1515.0)                      BAREYRE    68 RVUE    PHASE-SHIFT ANAL 11/67
    2           WHERE SPEED IS GREATEST - EYEBALL FIT
M   3    (1591.0)                      DONNACH1   68 RVUE    PHASE-SHIFT ANAL  6/68
M   3    (1550.)                       DONNACH2   68 RVUE    PHAS.SHIFT-CERN1 10/69
M   3    (1440.)                       KIRSOPP    68 RVUE    PHASE SHIFT ANAL 10/69
    3  WHERE MAX. ABSORPTION IS -DONNACH1, 2  ,KIRSOPP EYEBALL FIT CERN I   10/69
M        (1535.0)    (10.0)            DELCOURT   69 CNTR    PHOTOPRODUCT.     8/69
M   4    (1502.0)                      DAVIES     70 RVUE    P-S ANAL  SOL A   8/69
M   5    (1499.0)                      DAVIES     70 RVUE    P-S ANAL  SOL B   8/69
    5  SOL B IS E.D FIT TO SAME DATA START FROM CERN I EXPER. (DONNACH1 68)
M   6    (1534.0)                      AYED       70 IPWA                      1/71*
    6  FROM ENER. DEP. FIT OF ARGAND DIAGRAM

----------------   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   2    (105.0)                       BAREYRE    68 RVUE                     11/67
W   3    (268.0)     APPROX            DONNACH1   68 RVUE                      6/68
W   3    (116.)                        DONNACH2   68 RVUE    PHAS.SHIFT-CERN1 10/69
W   3    (160.)                        KIRSOPP    68 RVUE    PHASE SHIFT ANAL 10/69
W        (120.0)                       DELCOURT   69 CNTR    PHOTOPRODUCT.     8/69
W   4     (36.0)                       DAVIES     70 RVUE    P-S ANAL  SOL A   8/69
W   4     (36.0)                       DAVIES     70 RVUE    P-S ANAL  SOL A   8/69
W   6     (96.0)                       AYED       70 IPWA                      1/71*
      SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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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 SIGMA (SIGMA MESON)        938+ 410
P5        N*1/2(1535) INTO D(1236) PI                  1236+ 139
P6        N*1/2(1535) INTO N RHO (PI PI, I=1)           938+ 765

----------------   63   N*1/2(1535) BRANCHING RATIOS   ------------------

R1        N*1/2(1535) INTO (PI N)/TOTAL                       (P1)/TOTAL
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  3         (.33)                    DONNACH2   68 RVUE    PHAS.SHIFT-CERN1 10/69
R1  3         (.3)                     KIRSOPP    68 RVUE    PHASE SHIFT ANAL 10/69
R1           (0.33)                    DELCOURT   69 CNTR                      8/69
R1  4        (0.36)                    DAVIES     70 RVUE    P-S ANAL  SOL A   8/69
R1  5        (0.35)                    DAVIES     70 RVUE    P-S ANAL  SOL B   8/69
R1  6        (0.397)                   AYED       70 IPWA                      1/71*

R2        N*1/2(1535) INTO (N ETA)/TOTAL                      (P2)/TOTAL
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 ON MASS  9/66
R2           (0.69)  OR   0.45         DAVIES     67 RVUE    PIP TO N ETA,B,C 11/67
R2           (0.66)                    DELCOURT   69 MPWA                      8/69
R2  B        (0.4)      (0.1)          DEANS      69 MPWA    T POLE+ RESON.    5/70
R2  B        (0.69)OR  0.696           CARRERAS   70 MPWA    T POLE+ RESON.    5/70
R2  B    PARAMETRIZATION USED 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 (D(1236) PI)/TOTAL                 (P4)/TOTAL
R3  D        (0.07)                    DIEM       70 IPWA    3 BODY ANALYSIS   1/71*
    D     ASSUMING  R1= 0.34

R4        N*1/2(1535) INTO (N SIGMA)/TOTAL                    (P5)/TOTAL
R4  D        (0.26)                    DIEM       70 IPWA    3 BODY ANALYSIS   1/71*
    D     ASSUMING  R1= 0.34

R5        N*1/2(1535) INTO (N RHO )/TOTAL                     (P6)/TOTAL
R5  D        (0.20)                    DIEM       70 IPWA    3 BODY ANALYSIS   1/71*
    D     ASSUMING  R1= 0.34

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                        REFERENCES -- N*1/2(1535)

HENDRY   65 PL 18 171        A W HENDRY, R G MOORHOUSE             (RTHFD)
     --  REVIEWS EARLY PHASE-SHIFT-ANALYSIS RESULTS AND PI- P TO ETA N
         EXPERIMENTS.  WE TAKE NUMBERS FROM THE SOLUTION USING BRANDSEN 65.
MICHAEL  66 PL 21 93         C MICHAEL                               (OXF)
UCHIYAMA 66 PR 149 1220      F UCHIYAMA-CAMPBELL, R K LOGAN       (ILL)IJP
DAVIES   67 NC 52A 1112      A T DAVIES, R G MOORHOUSE    (GLASGOW,RTHFD)
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Baryons

For notation, see illustrated key at beginning of data card listings.


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BAREYRE   68 PR 165 1731        P BAREYRE, C BRICMAN, G VILLET      (SACLAY)IJP
DONNACHI  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)
DELCOURT  69 PL 29B 75          DELCOURT,LEFRANCOIS,PEREZ-Y-JORBA,+     (ORSA)
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)
DIEM      70 KIEV CONF.         + SMADJA, CHAVANON, DFLER, DOLBEAU+     (SACL)

                                PAPERS NOT REFERRED TO IN DATA CARDS.

BRANDSEN  65 PR 139 B1566       +ODONNELL, MOORHOUSE          (DURHAM,RTHFD)IJP
      --  BASIS OF NUMBERS WE QUOTE FROM HENDRY 65.
BAREYRE   65 PL 18 342          + BRICMAN, STIRLING, VILLET         (SACLAY)IJP
LOVELACE  67 HEIDELBERG C. 79   C LOVELACE                            (CERN)IJP
JOHNSON   67 UCRL-17683 THESIS C H JOHNSON                              (LRL)
DONNACHI  69 NP 10B 433         A DONNACHIE, R KIRSOPP             (GLAS+EDIN)
AYED      70 PL 31B 598         +BAREYRE+VILLET                       (SACLAY)

          FOR PHOTONIC COUPLINGS SEE
MOORHOUSE70 NP B23,181          +RANKIN                                 (GLAS)
WALKER    69 PR 182,1729        R.L.WALKER                              (CALT)
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THE FOLLOWING ARTICLES DEAL WITH THE REACTIONS 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 AMPLITUDE AS DETERMINED IN PI P PHASE-SHIFT ANALYSES. FURTHER REFFRENCES MAY BE FOUND IN THEM.


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          MAINLY EXPERIMENTAL --
BULOS     64 PRL 13 486         +          (BROWN,BRANDEIS,HARVARD,MIT,PADOVA) I
RICHARDS  66 PRL 16 1221        +CHIU,EANDI,HELMHOLZ,KENNEY,+  (LRL,HAWAII) IJ
JONES     66 PL 23 597          +BINNIE,DUANE,HORSEY,MASON,+ (IMPCOL,RTHFD)
BACCI     66 NC 45A 983         +PENSO,SALVINI,MENCUCCINI,+ (ROME,FRASCATI)IJP
PREPOST   67 PRL 18 82          R PREPOST, D LUNDQUIST, D QUINN  (STANFORD)
BLOOM     68 PRL 21 1100        +HEUSCH, PRESCOTT, ROCHESTER       (CALTECH)
BULOS     69 PR 187 1827        +LANOU,BORONER,BASTIEN +     (BU+HAR+MIT+PA)
HEUSCH    70 PRL 25,1381        +PRESCOTT,ROCHESTER,WINSTEIN          (CALT)
          MAINLY THEORETICAL --
DOBSON    66 PR 146 1022        P N DOBSON                          (HAWAII)
MINAMI    66 PR 147 1123        S MINAMI                             (OSAKA)
BALL      66 PR 149 1191        J S BALL                              (UCLA)
LOGAN     67 PR 153 1634        R K LOGAN, F UCHIYAMA-CAMPBELL         (ILL)
MENCUCCI  67 NC 48A 579         C MENCUCCINI, A REALE             (FRASCATI)
DEANS     67 PR 161 1465        S R DEANS, W G HOLLADAY        (VANDERBILT)
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         +LFRUSTE                               (CDF)
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N(1520) BUMPS

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1520 MEV REGION - PRODUCTION EXPERIMENTS

8 N*(1520)   PRODUCTION EXPERIMENTS

THIS INFORMATION REFERS TO EITHER THE D13 OR THE S11
STATE SEEN AT THIS MASS

----------------  8  N*(1520)  MASS (MEV)     PROD. EXP.  ---------------

M         1503.      6.               ANDERSON  70 MMS   - PI- P TO PI- MMS  2/71*

----------------  8  N*(1520)  WIDTH(MEV)     PROD. EXP.  ---------------

W          120.      10.              ANDERSON  70 MMS   - PI- P TO PI- MMS  2/71*

----------------  8  N*(1520)  BRANCHING RATIOS    PROD. EXP. -----------

R1        N*(1520)  INTO   (N PI)/TOTAL    PRODUCTION EXPERIMENTS
R1           0.78      0.24           BASSOMPIE 67 HBC  +  K+P TO K* N*    11/68

R2        N*(1520) INTO (NEUTRON PI+)/(P PI+ PI-)
R2           0.77      0.45           ALEXANDER 67 HBC  +  PP 5.5 BEV/C     9/66

R3        N*(1520) INTO (N PI)/(N PI PI)
R3           1.25      0.44      0.71 A-BORELLI 67 HBC  0  PBAR P 5.7 BEV/C 9/66

R4        N*(1520)  INTO   (N*3/2(1236) PI)/(N PI PI)   PROD. EXP.
R4           0.00      0.09           A-BORELLI 67 HBC                      9/66

R5        N*(1520) INTO (N PI PI)/TOTAL
R5          (0.08)     OR LESS        BASSOMPIE 67 HBC  +  K+P TO K* N*    11/68

R6        N*(1520)  INTO   (N ETA)/TOTAL         PROD. EXP.
R6           0.22      0.14           BASSOMPIE 67 HBC  +  K+P TO K* N*    11/68

R7        N*1/2(1520) INTO (PI N)/(PI N*3/2(1236))
R7          (0.42)     OR LESS        LEE        67 HBC     PI-P 3.6  GEV/C 11/67

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                                REFERENCES  -N*(1520)-    PROD. EXP.

A-BORELL  67 NC 47 232          ALLES-BORELLI,FRENCH,FRISK,MICHEJDA  (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)

ANDERSON  70 PRL 25,699         +BLESER,BLIEDEN,COLLINS++          (BNL,CARN)
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                       END PRODUCTION EXPERIMENTS

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N(1670) D_{15}

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64  N*1/2(1670, JP=5/2-) I=1/2

FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
PRECEDING N*1/2(1470).

----------------   64  N*1/2(1670) MASS (MEV)    ------------------------

M          (1650.0)       APPROX      BRANDSEN  65 RVUE    PHASE-SHIFT ANAL  7/66
M          (1674.0)                   DUKE      68 CNTR    PI-P EL + POL     6/68
M    1     (1680.0)                   BAREYRE   68 RVUE    PHASE-SHIFT ANAL 11/67
     1          WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M    2     (1655.0)                   BAREYRE   68 RVUE    PHASE-SHIFT ANAL 11/67
     2          WHERE SPEED IS GREATEST - EYEBALL FIT
M    3     (1678.0)                   DONNACH1  68 RVUE    PHASE-SHIFT ANAL  6/68
M    3     (1680.)                    DONNACH2  68 RVUE    PHAS.SHIFT-CERN1 10/69
M    3     (1678.)                    KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
     3    WHERE MAX. ABSORPTION IS -DONNACH1, 2  ,KIRSOPP EYEBALL FIT CERN 1  10/69
M    4     (1669.0)                   DAVIES    70 RVUE    P-S ANAL  SOL A   3/69
M    5     (1667.0)                   DAVIES    70 RVUE    P-S ANAL  SOL B   8/69
     5    SOL B IS E.D FIT TO SAME DATA START FROM CERN I EXPER. (DONNACHI 68)
M    6     (1675.0)                   AYED      70 IPWA                      1/71*
     6    FROM ENER. DEP. FIT OF ARGAND DIAGRAM

----------------   64  N*1/2(1670) WIDTH (MEV)    -----------------------

W    1     (135.0)                    BAREYRE   68 RVUE                     11/67
W    2     (105.0)                    BAREYRE   68 RVUE                     11/67
W    3     (173.0)                    DONNACH1  68 RVUE                      6/68
W    3     (173.)                     DONNACH2  68 RVUE    PHAS.SHIFT-CERN1 10/69
W    3     (175.)                     KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
W    4     (115.0)                    DAVIES    70 RVUE     SOL A AND B      8/69
W    6     (143.0)                    AYED      70 IPWA                      1/71*
     SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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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  LAMBDA K                  1115+ 497
P4          N*1/2(1670)  INTO N*3/2(1236) PI             1236+ 139
P5          N*1/2(1670)  INTO N PI PI                    939+ 139+ 139

----------------   64  N*1/2(1670) BRANCHING RATIOS    ------------------

R1          N*1/2(1670)  INTO (PI N)/TOTAL                    (P1)/TOTAL
R1   1        (0.41)                  BAREYRE   68 RVUE                     11/67
R1   3        (0.391)                 DONNACH1  68 RVUE                      6/68
R1   3        (.39)                   DONNACH2  68 RVUE    PHAS.SHIFT-CERN1 10/69
R1   3        (.39)                   KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
R1   4        (0.50)                  DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
R1   5        (0.43)                  DAVIES    70 RVUE    P-S ANAL  SOL B   8/69
R1   6        (0.392)                 AYED      70 IPWA                      1/71*
     SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

R2          N*1/2(1670)  INTO (N ETA)/TOTAL                   (P2)/TOTAL
R2            (0.025)     OR LESS     TRIPP     67 RVUE                      8/67
R2   B        (0.018)                 BOTKE     69 MPWA    T POLE + RESON.  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)/TOTAL
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    70 IPWA    PI-P TO K LAMB    1/71*

R4          N*1/2(1670) INTO (N*3/2 PI)/TOTAL              (P4)/TOTAL
R4 E 12600     0.63       0.1         BRODY     71  HBC    PI-P--2PI N,PWA   6/70
   F          ASSUMES ELASTIC BRANCHING RATIO 0.42+-0.04

   SEE NOTE PRECEDING THE N*1/2(1688) INELASTIC DECAY MODE MEASUREMENTS.

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                                REFERENCES -- N*1/2(1670)

BRANDSEN 65 PL 19 420           +ODONNELL, MOORHOUSE          (DURHAM,RTHFD)IJP
TRIPP     67 NP B3 10           + LEITH, +     (LRL,SLAC,CERN,HEIDEL,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
DONNACH2  68 VIENNA 139         DONNACHIE  RAPPORTEUR.S TALK            (GLAS)
DUKE      68 PR 166 1448        +JONES,KEMP,MURPHY,THRESHER, +  (RTHFD,OXF)IJP
      --  INSIGHTFUL QUALITATIVE ARGUMENTS CONCERNING EXISTENCE AND IJP.
KIRSOPP   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)

CARRERAS  70 NP 16B 35          B CARRERAS, A DONNACHIE            (DARE,MCHS)
DAVIES    70 NP B21 359         A DAVIES                                (GLAS)
AYED      70 KIEV CONF          R AYED,P BAREYRE, G VILLET            (SACL)IJP
WAGNER    70 PREPRINT TH 1227   F WAGNER, C LOVELACE                    (CERN)
BRODY     71 SUBM. TO PRL       +CASHMORE+..+HERNDON+..             (SLAC+LRL)

                                PAPERS NOT REFERRED TO IN DATA CARDS.

DUKE      65 PRL 15 468         +JONES,KEMP,MURPHY,PRENTICE, +  (RTHFD,OXF)IJP
BAREYRE   65 PL 18 342          + BRICMAN, STIRLING, VILLET         (SACLAY)IJP
JOHNSON   67 UCRL-17683 THESIS C H JOHNSON                              (LRL)
DEANS     69 PRL 177 2623       S R DEANS                            (FLORIDA)
DONNACHI  69 NP 10B 433         A DONNACHIE, R KIRSOPP             (GLAS+EDIN)
AYED      70 PL 31B 598         +BAREYRE+VILLET                       (SACLAY)

          FOR PHOTONIC COUPLINGS SEE
WALKER    69 PR 182,1729        R.L.WALKER                              (CALT)
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For notation, see illustrated key at beginning of data card listings.

N(1688) F_{15}

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65  N*1/2(1688, JP=5/2+) I=1/2

FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
PRECEDING N*1/2(1470).

----------------  65  N*1/2(1688) MASS (MEV)  -----------------------

M        (1680.0)                 BRANDSEN  65 RVUE   PHASE SHIFT ANAL  7/66
M        (1682.0)                 DUKE      68 CNTR   PI-P EL + POL     6/68
M   1    (1690.0)                 BAREYRE   68 RVUE   PHASE-SHIFT ANAL 11/67
    1          WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M   2    (1680.0)                 BAREYRE   68 RVUE   PHASE-SHIFT ANAL 11/67
    2          WHERE SPEED IS GREATEST - EYEBALL FIT
M   3    (1687.0)                 DONNACH1  68 RVUE   PHASE-SHIFT ANAL  6/68
M   3    (1690.)                  DONNACH2  68 RVUE   PHAS.SHIFT-CERN1 10/69
M   3    (1692.)                  KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69
    3  WHERE MAX. ABSORPTION IS -DONNACH1, 2 ,KIRSOPP EYEBALL FIT CERN 1 10/69
M   4    (1685.0)                 DAVIES    70 RVUE   P-S ANAL  SOL A   8/69
M   5    (1684.0)                 DAVIES    70 RVUE   P-S ANAL  SOL B   8/69
    5  SOL B IS E.D FIT TO SAME DATA START FROM CERN I EXPER. (DONNACH1 68)
M   6    (1682.0)                 AYED      70 IPWA                     1/71*
    6  FROM ENER. DEP. FIT OF ARGAND DIAGRAM

----------------  65  N*1/2(1688) WIDTH (MEV)  ----------------------

W   1     (110.0)                 BAREYRE   68 RVUE                    11/67
W   2     (105.0)                 BAREYRE   68 RVUE                    11/67
W   3     (177.0)                 DONNACH1  68 RVUE                     6/68
W   3     (132.)                  DONNACH2  68 RVUE   PHAS.SHIFT-CERN1 10/69
W   3     (130.)                  KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69
W   4     (104.0)                 DAVIES    70 RVUE   P-S ANAL  SOL A   8/69
W   5     (123.0)                 DAVIES    70 RVUF   P-S ANAL  SOL B   8/69
W   6     (109.0)                 AYED      70 IPWA                     1/71*
     SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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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) INTO N*3/2(1236) PI        1236+ 139
P5         N*1/2(1688) INTO N PI PI                938+ 139+ 139

----------------  65  N*1/2(1688) BRANCHING RATIOS  ------------------

R1         N*1/2(1688) INTO (PI N)/TOTAL                   (P1)/TOTAL
R1  1        (0.64)               BAREYRE   68 RVUE                    11/67
R1  3        (0.560)              DONNACH1  68 RVUE                     6/68
R1  3         (.68)               DONNACH2  68 RVUE   PHAS.SHIFT-CERN1 10/69
R1  3         (.68)               KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69
R1  4        (0.54)               DAVIES    70 RVUE     SOL A AND B     8/69
R1  6        (0.593)              AYED      70 IPWA                     1/71*
     SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

    MORE INFORMATIONS 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)/TOTAL
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)/TOTAL
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           (0.0016)  OR LESS CL=.63 WAGNER  70 IPWA   PI-P TO K LAMB    1/71*

R5         N*1/2(1688) INTO (N*3/2 PI)/TOTAL              (P4)/TOTAL
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
   E        ASSUMES ELASTIC BRANCHING RATIO 0.62+-0.06

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                        REFERENCES -- N*1/2(1688)

        SEE A PREVIOUS EDITION (RMP 37, 633, 1965) FOR EARLIER REFERENCES.

BRANDSEN 65 PL 19 420          +ODONNELL, MOORHOUSE          (DURHAM,RTHED)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,HEIDEL,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
DONNACH2 68 VIENNA 139         DONNACHIE  RAPPORTEUR.S TALK             (GLAS)
DUKE     68 PR 166 1448        +JONES,KEMP,MURPHY,THRESHER, +  (RTHED,OXF)IJP
KIRSOPP  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)

CARRERAS 70 NP 16B 35          B CARRERAS, A DONNACHIE           (DARE,MCHS)
DAVIES   70 NP B21 359         A DAVIES                                 (GLAS)
AYED     70 KIEV CONF          R AYED,P BAREYRE, G VILLET            (SACL)IJP
WAGNER   70 PREPRINT TH 1227   F WAGNER, C LOVELACE                     (CERN)
BRODY    71 SUBM. TO PRL       +CASHMORE+..+HERNDON+..              (SLAC+LRL)

                               PAPERS NOT REFERRED TO IN DATA CARDS.

DUKE     65 PRL 15 468         +JONES,KEMP,MURPHY,PRENTICE, +  (RTHED,OXF)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 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
JOHNSON  67 UCRL-17683 THESIS  C H JOHNSON                               (LRL)
DEANS    69 PR  177 2623       S R DEANS                             (FLORIDA)
DONNACHI 69 NP 10B 433         A DONNACHIE, R KIRSOPP              (GLAS+EDIN)
AYED     70 PL 31B 598         +BAREYRE+VILLET                        (SACLAY)

      FOR PHOTONIC COUPLINGS SEE
WALKER   69 PR 182,1729        R.L.WALKER                               (CALT)

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N(1700) S''_{11}

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66  N*1/2(1700, JP=1/2-) I=1/2

FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
PRECEDING N*1/2(1470).

----------------  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
    1          WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M   2    (1665.0)                 BAREYRE   68 RVUE   PHASE-SHIFT ANAL 11/67
    2          WHERE SPEED IS GREATEST - EYEBALL FIT
M   3    (1710.0)                 DONNACH1  68 RVUE   PHASE-SHIFT ANAL  8/68
M   3    (1710.)                  DONNACH2  68 RVUE   PHAS.SHIFT-CERN1 10/69
M   3    (1709.)                  KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69
    3  WHERE MAX. ABSORPTION IS -DONNACH1, 2 ,KIRSOPP EYEBALL FIT CERN 1 10/69
M        (1705.0)   (10.0)        ORITO     69 RVUF   K LAMBDA PS ANAL  8/69
M   4    (1766.0)                 DAVIES    70 RVUE   P-S ANAL  SOL A   8/69
M   5    (1671.0)                 DAVIES    70 RVUE   P-S ANAL  SOL B   8/69
    5  SOL B IS E.D FIT TO SAME DATA START FROM CERN I EXPER. (DONNACH1 68)
M   6    (1689.0)                 AYED      70 IPWA                     1/71*
    6  FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M   A    (1685.0)                 WAGNER    70 IPWA   PI-P TO K LAMB    1/71*
    A  THERE ARE 3 SIMILAR SOLUTIONS

----------------  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   2     (110.0)                 BAREYRE   68 RVUE                    11/67
W   3     (300.0)                 DONNACH1  68 RVUE                     8/69
W   3     (300.)                  DONNACH2  68 RVUE   PHAS.SHIFT-CERN1 10/69
W   3     (300.)                  KIRSOPP   68 RVUF   PHASE SHIFT ANAL 10/69
W         (104.0)   (15.0)        ORITO     69 RVUE                     8/69
W   4     (404.0)                 DAVIES    70 RVUE   P-S ANAL  SOL A   8/69
W   5     (121.0)                 DAVIES    70 RVUE   P-S ANAL  SOL B   8/69
W   6     (166.0)                 AYED      70 IPWA                     1/71*
W   A     (110.0)OR(140.0)        WAGNER    70 IPWA   PI-P TO K LAMB    1/71*
     SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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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) INTO N ETA                  939+ 548
P3         N*1/2(1700) INTO LAMBDA K              1115+ 497
P4         N*1/2(1700) INTO N GAMMA                938+   0

----------------  66  N*1/2(1700)  BRANCHING RATIOS  -----------------

R1         N*1/2(1700) INTO (PI N)/TOTAL                   (P1)/TOTAL
R1           (1.0)       APPROX    MICHAEL   66 RVUE                     7/66
R1  3        (0.79)                DONNACH1  68 RVUE                     8/69
R1  3         (.79)                DONNACH2  68 RVUE   PHAS.SHIFT-CERN1 10/69
R1  3         (.79)                KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69
R1  4        (0.56)                DAVIES    70 RVUE   P-S ANAL  SOL A   8/69
R1  5        (0.51)                DAVIES    70 RVUE   P-S ANAL  SOL B   8/69
R1  6        (0.642)               AYED      70 IPWA                     1/71*

R2    N*1/2(1700) INTO (LAMBDA K)*(PI N)/TOTAL**2          (P3*P1)/TOTAL**2
R2            0.039     0.019      ORITO     69 RVUE                     8/69
R2  A        (0.043)OR 0.054       WAGNER    70 IPWA   PI-P TO K LAMB    1/71*

R3         N*1/2(1700) INTO (LAMBDA K)/TOTAL               (P3)/TOTAL
R3  B        (0.028)     APPROX.   RUSH      68 MPWA   T POLE + RESON.   8/69
R3  B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R4         N*1/2(1700) INTO (N ETA)/TOTAL                  (P2)/TOTAL
R4  B        (0.013)               BOTKE     69 MPWA   T POLE + RESON.  10/69
R4  B        (0.03)   (0.02)       DEANS     69 MPWA   T POLE + 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) INTO (N GAMMA)/TOTAL  (PERCENT)     (P4)/TOTAL
R5           (0.0065)              ORITO2    69 CNTR   K-LAM. PHOTOPRO.  5/70

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                        REFERENCES -- N*1/2(1700)

BRANDSEN 65 PL 19 420          +ODONNELL, MOORHOUSE          (DURHAM,RTHED)IJP
MICHAEL  66 PL 21 93           C MICHAEL                                 (OXF)
BAREYRE  68 PR 165 1731        P BAREYRE, C BRICMAN, G VILLET      (SACLAY)IJP
DONNACH1 58 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)
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)

CARRERAS 70 NP 16B 35          B CARRERAS, A DONNACHIE           (DARE,MCHS)
DAVIES   70 NP B21 359         A DAVIES                                 (GLAS)
AYED     70 KIEV CONF          R AYED,P BAREYRE, G VILLET            (SACL)IJP
WAGNER   70 PREPRINT TH 1227   F WAGNER, C LOVELACE                     (CERN)

                               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                             (FLORIDA)
DONNACHI 69 NP 10B 433         A DONNACHIE, R KIRSOPP              (GLAS+EDIN)
AYED     70 PL 318 598         +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

FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
PRECEDING N*1/2(1470).

----------------  18  N*1/2(1700) MASS  (MEV)  ----------------------

M   3    (1680.)                  KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69
M   3    (1730.)                  DONNACH2  68 RVUE   PHAS.SHIFT-CERN1 10/69
    3  WHERE MAX. ABSORPTION IS -DONNACH1, 2 ,KIRSOPP EYEBALL FIT CERN 1 10/69
M   A    (1780.0)                 WAGNER    70 IPWA   PI-P TO K LAMB    1/71*
    A  D13 RESONATES ONLY IN ONE OUT OF 3 POSSIBLE SOL.
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Baryons

For notation, see illustrated key at beginning of data card listings.

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----------------  18  N*1/2(1700) WIDTH (MEV)     ------------------------

----------------  18  N*1/2(1700) PARTIAL DECAY MODES      ----------------

                                                        DECAY MASSES
P1          N*1/2(1700) INTO PI N                      139+ 938

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                         REFERENCES -- N*1/2(1700)

DONNACH2  68 VIENNA 139        DONNACHIE  RAPPORTEUR.S TALK      (GLAS)
KIRSOPP   68 THESIS            R G KIRSOPP                       (EDIN)
WAGNER    70 PREPRINT TH 1227  F WAGNER, C LOVELACE              (CERN)

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                  1700 MEV REGION -PRODUCTION EXPERIMENTS
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N(1700) BUMPS

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                  20  N*(1700) PRODUCTION EXPERIMENTS

   PARTIAL WAVE ANALYSIS REQUIRES AT LEAST FOUR I=1/2 STATES IN THE 1670 T
   1780 REGION (D15, F15, S11, P11) AND AT LEAST ONE I=3/2 STATE (D33).
   OBVIOUSLY DIFFERENT EXPERIMENTS ARE SEEING DIFFERENT STATES AND OFTEN I
   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.

----------------  20  N* (1700)   MASS (MEV)    -------------------------

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    B  190(1693.)   (15.)           RHODE     69 HBC    PP 22 GEV/C      10/69
M    B  JP IS PROBABLY 5/2+
M    1    (1712.0)    (6.0)          BARNES    69  HBC   K-P TO K-P 2PI    7/70
     1      (JP 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    (1719.0)    (6.0)          WILLMANN  70 HBC  + PI+P 13. GEV      5/70
     A        J CONSISTENT WITH 5/2 OR 7/2
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          . . . . . . . . . . .
M    AVG   1697.1       7.5     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.1)

----------------  20  N* (1700)   WIDTH (MEV)    ----------------------

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    B  190 (235.)   (50.)           RHODE     69 HBC    PP 22 GEV/C      10/69
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           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           . . . . . . . . . .
W    AVG    121.5     11.9     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
       SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

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----------------  20  N*(1700)    BRANCHING RATIOS        ---------------

R1         N*   (1700) INTO (PI N)/(PI N*3/2(1236))        PROD. EXP.
R1           (0.77)     OR LESS        LEE       67 HBC    PI-P 3.6 GEV/C  11/67
R1   A       (9.0)     OR MORE         BENVENUTI 69 DBC    0                5/70

R2      N*   (1700) INTO (N ETA)/(N PI + N PI PI)           PROD. EXP.
R2           (0.025)      OR LESS      KRAEMER   64 DBC  + PI+D 1.23 BEV/C  9/66
R2           (0.042)OR LESS (95PC CL)  A-BORELLI 67 HBC  + PBAR P 5.7 BEV/C 9/69

R3         N*   (1700) INTO (LAMBDA K)/(P PI+ PI-)         PROD. EXP.
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*   (1700) INTO (LAMBDA K)/(N PI + N PI PI)        PROD. EXP.
R4           (0.013)OR LESS (95PC CL)  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   A       LESS THAN 0.025           WILLMANN  70  HBC   PI+P TO 3PI P    6/70
R4      25     0.025     0.005         CRENNELL  70 HBC  +                  1/71*

R5         N*   (1700) INTO (N PI)/(N PI PI)               PROD. EXP.
R5           (1.26)OR LESS (95PC CL.)  A-BORELLI 67 HBC  +                  8/67
R5             0.025      0.13         CRENNELL  70 HBC  +                  1/71*

R6         N*   (1700) INTO (N*3/2(1236) PI)/(N PI PI)    PROD. EXP.
R6             NO EVIDENCE             A-BORELLI 67 HBC  +                  8/67
           SEE MERLO 66 FOR A REVIEW.

R7         N*   (1700) INTO (NEUTRON PI+)/(P PI+ PI-)      PROD. EXP.
R7             0.67       0.40         ALEXANDER 67 HBC  + PP 5.5 BEV/C    11/67
R7             0.47       0.25         A-BORELLI    HBC    PBAR P 5.5 GEV/C 7/70
R7           . . . . . . . . . .
R7   AVG       0.53       0.21     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R8         N*   (1700) INTO (N*(1236)++ PI-)/(P PI+ PI-) PROD. EXP.
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

R9      N*(1700) INTO (SIG K)/(LAMB K)                  PROD. EXP.
R9           LESS THAN .20             COOPER    70 HBC  + PI+P, 5.5 GEV/C  2/71*

     SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

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                     REFERENCES -- N* IN PRODUCT EXPERIMENTS

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, +          (CAVNDSH,DESY(CERN))
CHINOWSK  68 PR 165 1466        CHINOWSKY,KINSEY,KLEIN, +         (LRL,SLAC)
KAYAS     68 NP B5 169          +GUYADER,SENE,YIOU,ALITTI,+  (ORSAY,SACLAY)
GALLOWAY  68 PL 27B 250         GALLOWAY,ALYEA,CRITTENDEN,PRICKETT,+  (IND)
BARNES    69 PRL 23 1516        +BASSANO+CHUNG+EISNER+FLAMINTO+KINSON (BNL)IJ
RHODE     69 PR 187 1844        RHODE, LEACOCK, KERNAN, JESPERSEN,+  (AMES)
BENVENUT  69 PR 187 1852        BENVENUTI, MARQUIT, OPPENHEIMER (MINN,COLO)

ANDERSON  70 PRL 25,699         +BLESER,BLIEDEN,COLLINS++        (BNL,CARN)
CIRBA     70 NP B23,533         +VANDERHAGEN+     (EPOL,DURH,NIJM,TORI,PIUB)
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                  (PURO)IJ

                     PAPERS NOT REFERRED TO IN DATA CARDS.

MERLO     66 P ROY SOC 289 489 J P MERLO, G VALLADAS               (SACLAY)

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                    END PRODUCTION EXPERIMENTS

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N(1780)

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          14  N*1/2(1780, JP=1/2+) I=1/2
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P''_{11}

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          FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
          PRECEDING N*1/2(1470).

----------------  14  N*1/2(1780) MASS (MEV)    -----------------------

M    3      (1751.0)                  DONNACH1   68 RVUE    PHASE-SHIFT ANAL  8/69
M    3      (1750.)                   DONNACH2   68 RVUE    PHAS.SHIFT-CERN1 10/69
M    3      (1860.)                   KIRSOPP    68 RVUE    PHASE SHIFT ANAL 10/69
     3   WHERE MAX. ABSORPTION IS -DONNACH1, 2  ,KIRSOPP EYEBALL FIT CERN 1  10/69
M           (1640.0)    (70.0)        ORITO      69 RVUE    K LAMBDA PS ANAL  9/69
M    4      (1770.0)                  DAVIES     70 RVUE    P-S ANAL   SOL A  8/69
M    5      (1867.0)                  DAVIES     70 RVUE    P-S ANAL   SOL B  8/69
     5   SOL B IS E.D FIT TO SAME DATA START FROM CERN I EXPER. (DONNACH1 68)
M    6      (1645.0)                  AYED       70 IPWA                      1/71*
     6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M    A      (1685.0)OR(1740.0)        WAGNER     70 IPWA    PI-P TO K LAMB    1/71*
     A   THERE ARE 3 SIMILAR SOLUTIONS

----------------  14  N*1/2(1780) WIDTH (MEV)    ----------------------

W    3      (327.0)                   DONNACH1   68 RVUE                      8/69
W    3      (327.)                    DONNACH2   68 RVUE    PHAS.SHIFT-CERN1 10/69
W    3      (270.)                    KIRSOPP    68 RVUE    PHASE SHIFT ANAL 10/69
W           (310.0)     (50.0)        ORITO      69 RVUE                      8/69
W    4      (445.0)                   DAVIES     70 RVUE               SOL A  8/69
W    5      (525.0)                   DAVIES     70 RVUE               SOL B  8/69
W    6       (50.0)                   AYED       70 IPWA                      1/71*
W    A      (160.0)OR(220.0)          WAGNER     70 IPWA    PI-P TO K LAMB    1/71*
         SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.P EY

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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) INTO  LAMBDA K                   1115+ 497
P3          N*1/2(1780) INTO  N ETA                       939+ 548
P4          N*1/2(1780) INTO N GAMMA                      938+   0

----------------  14  N*1/2(1780) BRANCHING RATIOS     -------------------

R1          N*1/2(1780) INTO (PI N)/TOTAL                 (P1)/TOTAL
R1   3        (0.32)                  DONNACH1   68 RVUE                      8/69
R1   3         (.32)                  DONNACH2   68 RVUE    PHAS.SHIFT-CERN1 10/69
R1   3         (.32)                  KIRSOPP    68 RVUE    PHASE SHIFT ANAL 10/69
R1   4        (0.43)                  DAVIES     70 RVUE               SOL A  8/69
R1   5        (0.30)                  DAVIES     70 RVUE               SOL B  8/69
R1   6        (0.149)                 AYED       70 IPWA                      1/71*

R2    N*1/2(1780) INTO (LAMBDA K)*(PI N)/TOTAL**2         (P2*P1)/TOTAL**2
R2              0.004      0.003      ORITO      69 RVUE                      8/69
R2   A        (0.025)OR 0.043         WAGNER     70 IPWA    PI-P TO K LAMB    1/71*

R3    N*1/2(1780) INTO (LAMBDA K)/TOTAL                   (P2)/TOTAL
R3          N*1/2(1780) INTO (LAMBDA K)/TOTAL             (P2)/TOTAL
R3   B        (0.003)TO 0.065         RUSH       68 MPWA    T POLE + RESON.   8/69
R3   B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R4          N*1/2(1780) INTO (N ETA)/TOTAL                (P3)/TOTAL
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) INTO (N GAMMA)/TOTAL  (PERCENT)   (P4)/TOTAL
R5            (0.0096)                ORITO2     69 CNTR    K-LAM. PHOTOPRO.

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                        REFERENCES -- N*1/2(1780)

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)
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)

CARRERAS 70 NP 16B 35           B CARRERAS, A DONNACHIE          (DARE,MCHS)
DAVIES   70 NP B21 359          A DAVIES                              (GLAS)
AYED     70 KIEV CONF           R AYED,P BAREYRE, G VILLET         (SACL)IJP
WAGNER   70 PREPRINT TH 1227    F WAGNER, C LOVELACE                  (CERN)

                     PAPERS NOT REFERRED TO IN DATA CARDS.

DEANS    69 PR  177 2623        S R DEANS                          (FLORIDA)
DONNACHI 69 NP 10B 433          A DONNACHIE, R KIRSOPP           (GLAS+EDIN)
AYED     70 PL 31B 598          +BAREYRE+VILLET                     (SACLAY)

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Baryons

For notation, see illustrated key at beginning of data card listings.

N(1860) P_{13}

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15   N*1/2(1860, JP=3/2+) I=1/2

FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
PRECEDING N*1/2(1470).

-----------------   15   N*1/2(1860) MASS (MEV)   -------------------------

M   3      (1860.0)                    DONNACH1   68 RVUE    PHASE-SHIFT ANAL  6/68
M   3      (1860.)                     DONNACH2   68 RVUE    PHAS.SHIFT-CERN1 10/69
M   3      (1900.)                     KIRSOPP    68 RVUE    PHASE SHIFT ANAL 10/69
    3   WHERE MAX. ABSORPTION IS -DONNACH1, 2 ,KIRSOPP EYEBALL FIT CERN 1     10/69
M   4      (1844.0)                    DAVIES     70 RVUE    P-S ANAL  SOL A   8/69
M   5      (1854.0)                    DAVIES     70 RVUE    P-S ANAL  SOL B   8/69
    5   SOL B IS E.D FIT TO SAME DATA START FROM CERN I EXPER. (DONNACH1 68)
M   X      (1860.0)       APPROX       LEA        69 CNTR    PI-P ELASTIC      8/69
    X   SEE ALSO APLIN 70
M   6      (1766.0)                    AYED       70 IPWA                      1/71*
    6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M   A      (1800.0)                    WAGNER     70 IPWA    PI-P TO K LAMB    1/71*
    A   P13 RESONATES ONLY IN ONE OUT OF 3 POSSIBLE SOLUTIONS

-----------------   15   N*1/2(1860) WIDTH (MEV)   ------------------------

W   3      (296.00)                    DONNACH1   68 RVUE                      8/69
W   3      (296.)                      DONNACH2   68 RVUE    PHAS.SHIFT-CERN1 10/69
W   3      (325.)                      KIRSOPP    68 RVUE    PHASE SHIFT ANAL 10/69
W   4      (449.0)                     DAVIES     70 RVUE               SOL A  8/69
W   5      (307.0)                     DAVIES     70 RVUE               SOL B  8/69
W   6      (182.0)                     AYED       70 IPWA                      1/71*
W   A      (220.0)                     WAGNER     70 IPWA    PI-P TO K LAMB    1/71*
           SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

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-----------------   15   N*1/2(1860) PARTIAL DECAY MODES   ----------------

                                                     DECAY MASSES
P1          N*1/2(1860) INTO  PI N                  139+ 938
P2          N*1/2(1860) INTO  LAMBDA K             1115+ 497
P3          N*1/2(1860) INTO N ETA                  939+ 548
P4          N*1/2(1860) INTO N PI PI                939+ 139+ 139

-----------------   15   N*1/2(1860) BRANCHING RATIOS   -------------------

R1          N*1/2(1860) INTO (PI N)/TOTAL                (P1)/TOTAL
R1  3         (0.21)                   DONNACH1   68 RVUE                      8/69
R1  3          (.21)                   DONNACH2   68 RVUE    PHAS.SHIFT-CERN1 10/69
R1  3          (.25)                   KIRSOPP    68 RVUE    PHASE SHIFT ANAL 10/69
R1  4         (0.40)                   DAVIES     70 RVUE               SOL A  8/69
R1  5         (0.26)                   DAVIES     70 RVUE               SOL B  8/69
R1  6         (0.149)                  AYED       70 IPWA                      1/71*

R2          N*1/2(1860) INTO (LAMBDA K)/TOTAL            (P2)/TOTAL
R2  B         (0.014)TO 0.16           RUSH       68 MPWA    T POLE + RESON.   8/69
R2  B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R3          N*1/2(1860) INTO (N ETA)/TOTAL               (P3)/TOTAL
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 POLE + RESON.   5/70
R3  B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R4    N*1/2(1860) INTO (LAMBDA K)*(PI N)/TOTAL**2        (P2*P1)/TOTAL**2
R4  A         (0.015)                  WAGNER     70 IPWA    PI-P TO K LAMB    1/71*

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                              REFERENCES -- N*1/2(1860)

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)
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)
LEA      69 PL 29B 584         LEA,OADES,WARD,COWAN,+  (RHEL,BRISTOL,DARE)
APLIN    70 RPPIH/67           +COWAN,GIBSON,GILMORE++      (RHEL,BRISTOL)
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)
WAGNER   70 PREPRINT TH 1227   F WAGNER, C LOVELACE                  (CERN)

                               PAPERS NOT REFERRED TO IN DATA CARDS.

DEANS    69 PR  177 2623       S R DEANS                          (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(1990) F_{17}

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17   N*1/2(1990, JP=7/2+) I=1/2

FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
PRECEDING N*1/2(1470).

-----------------   17   N*1/2(1990) MASS (MEV)   -------------------------

M   3      (1983.0)                    DONNACH1   68 RVUE    PHASE-SHIFT ANAL
M   3      (1995.)                     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      (2000.0)       APPROX       LEA        69 CNTR    PI-P ELASTIC      8/69
M   X   SEE ALSO APLIN 70

-----------------   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

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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

---------------   17 N*1/2(1990) BRANCHING RATIOS   -------------------

R1          N*1/2(1990) INTO (PI N)/TOTAL                (P1)/TOTAL
R1  3          (.09)                   KIRSOPP    68 RVUE    PHASE SHIFT ANAL 10/69

R2          N*1/2(1990) INTO (N ETA)/TOTAL               (P3)/TOTAL
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

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                              REFERENCES -- N*1/2(1990)

DONNACH1 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)
DEANS    69 PR 185 1797        S DEANS, J WOOTEN          (UNIV S FLORIDA)
APLIN    70 RPPIH/67           +COWAN,GIBSON,GILMORE++      (RHEL,BRISTOL)

                               PAPERS NOT REFERRED TO IN DATA CARDS.

DEANS    69 PR  177 2623       S R DEANS                          (FLORIDA)
AYED     70 PL 31B 598         +BAREYRE,VILLET                     (SACLAY)

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N(2040) D'''_{13}

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16   N*1/2(2040, JP=3/2-) I=1/2

FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
PRECEDING N*1/2(1470).

-----------------   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 70

-----------------   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
        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

---------------   16 N*1/2(2040) BRANCHING RATIOS   ---------------------

R1          N*1/2(2040) INTO (PI N)/TOTAL                (P1)/TOTAL
R1  3          (.26)                   DONNACH2   68 RVUE    PHAS.SHIFT-CERN1 10/69
R1  3          (.15)                   KIRSOPP    68 RVUE    PHASE SHIFT ANAL 10/69

R2          N*1/2(2040) INTO (N ETA)/TOTAL               (P3)/TOTAL
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

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                              REFERENCES -- 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)
APLIN    70 RPPIH/67           +COWAN,GIBSON,GILMORE++      (RHEL,BRISTOL)
CARRERAS 70 NP 16B 35          B CARRERAS, A DONNACHIE          (DARE,MCHS)

                               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)

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N(2190) G_{17}

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71   N*1/2(2190, JP=7/2-) I=1/2

FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
PRECEDING N*1/2(1470).

-----------------   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 RVUF    PHASE-SHIFT ANAL  6/68
M   3      (2190.)                     DONNACH2   68 RVUE    PHAS.SHIFT-CERN1 10/69
M   3      (2265.)                     KIRSOPP    68 RVUF    PHASE SHIFT ANAL 10/69
    3   WHERE MAX. ABSORPTION IS -DONNACH1, 2 ,KIRSOPP EYEBALL FIT CERN 1     10/69
M          (2000.0)       APPROX       LEA        69 CNTR    PI-P ELASTIC      8/69
M   6      (2158.0)                    AYED       70 IPWA                      1/71*
    6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M           2180.      25.             ANDERSON   70 MMS   - PI- P TO PI- MMS  2/71*
M          (2260.0)                    HULL       70 MPWA    SMALL ANGLE PI-P  1/71*

-----------------   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      (299.0)                     DONNACH1   68 RVUE                      6/68
W   3      (300.)                      DONNACH2   68 RVUE    PHAS.SHIFT-CERN1 10/69
W   3      (300.)                      KIRSOPP    68 RVUE    PHASE SHIFT ANAL 10/69
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*
        SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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Baryons

For notation, see illustrated key at beginning of data card listings.

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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) INTO LAMBDA K                     1115+ 497
P3         N*1/2(2190) INTO N PI PI                       938+ 139+ 139

----------------  71  N*1/2(2190) BRANCHING RATIOS   -----------------

R1         N*1/2(2190) INTO (PI N)/TOTAL                  (P1)/TOTAL
R1           (0.3)       APPROX       DIDDENS    63 CNTR                         7/66
R1           (0.3)       APPROX       YOKOSAWA   66 CNTR                         7/66
R1   3       (0.349)                  DONNACH1   68 RVUE                         6/68
R1   3        (.35)                   DONNACH2   68 RVUE    PHAS.SHIFT-CERN1    10/69
R1   3        (.35)                   KIRSOPP    68 RVUE    PHASE SHIFT ANAL    10/69
R1   6       (0.150)                  AYED       70 IPWA                         1/71*
R1           (0.09)                   HULL       70 MPWA    SMALL ANGLE PI-P     1/71*

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                    REFERENCES -- 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         (ARG,CHI) JP
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)

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)

          QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN DATA CARDS.

CARROLL   66 PRL 16 288      +CORBETT,DAMERELL,MIDDLEMAS, +  (RTHFD,OXF)J-L
CARROLL   66 PRL 17 1274     +CORBETT,DAMERELL,MIDDLEMAS, +  (RTHFD,OXF)J-L
      --  ERRATUM CHANGING THE RATHER WEAK DETERMINATION OF J-L TO +1/2.
KORMANYO  66 PRL 16 709      KORMANYOS,KRISCH,OFALLON, +         (MICH,ARG) P
BARGER    66 PRL 16 913      V BARGER, D CLINE                       (WISC) P
BUSZA     67 NC 52A 331      +DAVIS,DUFF,HEYMANN, +    (UNICOL,WESTFIELD)

                    PAPERS NOT REFERRED TO IN DATA CARDS.

AYED      70 PL 31B 598      +BAREYRE,VILLET                         (SACLAY)

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N(2220)

H_{19}

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90  N*1/2(2220, JP=9/2+) I=1/2

FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
PRECEDING N*1/2(1470).

----------------  90  N*1/2(2220) MASS (MEV)   ----------------------

    6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M        (2200.)    APPROX.           BUSZA      67 OSPK    LEG.POLYN.ANAL.    2/71*
M   6    (2221.0)                     AYED       70 IPWA                       1/71*
M        (2245.0)                     HULL       70 MPWA    SMALL ANGLE PI-P   1/71*

----------------  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*

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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

----------------  90 N*1/2(2220) BRANCHING RATIOS   -------------------

R1         N*1/2(2220) INTO (PI N)/TOTAL                (P1)/TOTAL
R1  6       (0.140)                   AYED       70 IPWA                       1/71*
R1          (0.15)                    HULL       70 MPWA    SMALL ANGLE PI-P   1/71*

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                    REFERENCES -- N*1/2(2220)

AYED      70 KIEV CONF       R AYED,P BAREYRE, G VILLET             (SACL)IJP
BUSZA     67 NC 52A 331      +DAVIS,DUFF,HEYMANN,NIMMON +       (UCL+WCL)
HULL      70 PR D2 1783      J HULL, R LEACOCK                         (ISU)

                    PAPERS NOT REFERED TO IN DATA CARDS

AYED      70 PL 31B 598      +BAREYRE,VILLET                         (SACLAY)

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M > 2200 MEV – PRODUCTION AND σ_{TOTAL} EXPERIMENTS

BUMPS

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N(2650)

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72  N*1/2(2650, JP=   -) I=1/2
----------------  72  N*1/2(2650) MASS (MEV)   ----------------------

M        (2700.0)                     ALVAREZ    64 CNTR    PI PHOTOPROD
M        (2600.0)      APPROX         WAHLIG     64 OSPK O  PI-P CH EX
M        (2660.0)                     HOHLER     64 RVUE    DATA + DISP REL
M         2649.0    10.0              CITRON     66 CNTR    PI+- P TOTAL       7/66
M        (2633.0)                     BARGER     66 FIT     TOTAL + CH EX     11/67

----------------  72  N*1/2(2650) WIDTH (MEV)   ----------------------

W         (100.0)                     ALVAREZ    64 CNTR
W         (200.0)                     HOHLER     64 RVUE                       7/66
W          360.0    20.0              CITRON     66 CNTR                       7/66
W         (425.0)                     BARGER     66 FIT     TOTAL + CH EX     11/67

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----------------  72  N*1/2(2650) PARTIAL DECAY MODES   ---------------

                                                           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

----------------  72  N*1/2(2650) BRANCHING RATIOS   -----------------

R1         N*1/2(2650) INTO (PI N)/TOTAL                (P1)/TOTAL
R1     ONLY (J+1/2)*( PI N/TOTAL) MEASURED FOR THIS STATE
R1            0.436    0.028          CITRON     66 CNTR    TOTAL CROSS-SEC.  11/67
R1   B       (0.456)  (0.019)         BARGER     66 RVUE    TOTAL + CH EXC.   11/67
R1   B       (0.30)                   BARGER     67 RVUE    USES KORMANYOS67  11/67
     B  USES REGGE AMP.+RESON. TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGRE
     B  FOR CRITICISM OF THIS METHOD, SEE DOLEN 68.
R1   D       (0.24)                   DIKMEN     67 RVUE    USES KORMANYOS66  11/67
     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 -- N*1/2(2650)

ALVAREZ   64 PRL 12 710      +BAR-YAM,KERN,LUCKEY,OSBORNE, +    (MIT,CEA)
WAHLIG    64 PRL 13 103      +MANNELLI,SODICKSON,FACKLER,WARD, +    (MIT)
HOHLER    64 PL 12 149       G HOHLER, J GIESECKE             (KARLSRUHE) I
CITRON    66 PR 144 1101     +GALBRAITH,KYCIA,LEONTIC,PHILLIPS, +  (BNL) I
BARGER    66 PR 151 1123     V BARGER, M OLSSON                      (WISC)
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,ARG) P
DOLEN     68 PR 166 1768     R DOLEN, D HORN, C SCHMID          (CAL TECH)

                    PAPERS NOT REFERRED TO IN DATA CARDS.

BAACKE    67 NC 51A 761      J BAACKE, M YVERT          (KARLSRUHE,ORSAY)J-L
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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N(3030)

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73  N*1/2(3030, JP=     ) I=1/2
----------------  73  N*1/2(3030) MASS (MEV)   ----------------------

M        (3080.0)                     HOHLER     64 RVUE    DATA + DISP REL    7/66
M        (3030.0)                     CITRON     66 CNTR    PI+- P TOTAL       7/66

----------------  73  N*1/2(3030) WIDTH (MEV)   ----------------------

W         (400.0)                     CITRON     66 CNTR                       7/66

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----------------  73  N*1/2(3030) PARTIAL DECAY MODES   ---------------

                                                           DECAY MASSES
P1         N*1/2(3030) INTO PI N                          139+ 938
P2         N*1/2(3030) INTO N PI PI                       939+ 139+ 139

----------------  73  N*1/2(3030) BRANCHING RATIOS   -----------------

R1         N*1/2(3030) INTO (PI N)/TOTAL                (P1)/TOTAL
R1     ONLY (J+1/2)*( PI N/TOTAL) MEASURED FOR THIS STATE
R1           (0.048)                  CITRON     66 CNTR    TOTAL CROS.SEC.   11/67
R1   B       (0.088)  (0.016)         BARGER     66 RVUE    TOTAL + CH EXC.   11/67
R1   B       (0.12)                   BARGER     67 CNTR    USES KORMANYOS66  11/67
     B  USES REGGE AMP.+RESON. TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGRE
     B  FOR CRITICISM OF THIS METHOD, SEE DOLEN 68.
R1   D       (0.016)                  DIKMEN     67 RVUE    USES KORMANYOS67  11/67
     D  USES ONLY RESONANCES TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGREES

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                    REFERENCES -- N*1/2(3030)

HOHLER    64 PL 12 149       G HOHLER, J GIESECKE             (KARLSRUHE) I
CITRON    66 PR 144 1101     +GALBRAITH,KYCIA,LEONTIC,PHILLIPS, +  (BNL) I
BARGER    66 PR 151 1123     V BARGER, M OLSSON                      (WISC)
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,ARG) P
DOLEN     68 PR 166 1768     R DOLEN, D HORN, C SCHMID          (CAL TECH)

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$N_?(3245)$

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74  N*   (3245, JP=    +)

EXISTENCE NOT CONCLUSIVELY ESTABLISHED.  I-SPIN
NOT DETERMINED, BUT THE NARROW WIDTH PRECLUDES
IDENTIFICATION WITH THE N*3/2(3230).  OMITTED
FROM TABLE.

----------------  74  N* /2(3245) MASS (MEV)   ----------------------

M          3245.0    10.0             KORMANYOS 67 CNTR     PI-P 180 DEG EL    6/68

----------------  74  N* /2(3245) WIDTH (MEV)   ----------------------

W          (35.0)    OR LESS          KORMANYOS 67 CNTR
     86

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----------------  74  N* /2(3245) PARTIAL DECAY MODES   ---------------

                                                           DECAY MASSES
P1         N* /2(3245) INTO PI N                          139+ 938

----------------  74  N* /2(3245) BRANCHING RATIOS   -----------------
      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 -- N* /2(3245)

KORMANYO 67 PR 164 1661      KORMANYOS, KRISCH, OFALLON, +     (MICH,ARG) P

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For notation, see illustrated key at beginning of data card listings.

N(3690)

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                     75  N*1/2(3690, JP=      ) I=1/2

                      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)    ------------------------

M         3690.0     10.0          BARTKE    67 HBC   + PI+P 8 PRONGS    8/67
----------------     75  N*1/2(3690) WIDTH (MEV)    -----------------------

W           50.0     30.0          BARTKE    67 HBC   +                  8/67
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----------------     75  N*1/2(3690) PARTIAL DECAY MODES    ---------------

                                                           DECAY MASSES
PI        N*1/2(3690) INTO N + 7 PIS                     0
****** ********* ********* ********* ********* ********* ********* ********

                        REFERENCES -- N*1/2(3690)

BARTKE   67 PL 248 118        +CZYZEWSKI,DANYSZ,+          (CRACOW,ORSAY) I
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N? (3755)

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                     76  N* /2(3755, JP=      )

                      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.
----------------     76  N* /2(3755) MASS (MEV)    ------------------------

M         3755.0      8.0          EHRLICH   68 HBC  +  PI+ P P PBAR     6/68
----------------     76  N* /2(3755) WIDTH (MEV)    -----------------------

W           40.0     20.0          EHRLICH   68 HBC  +                   6/68
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----------------     76  N* /2(3755) PARTIAL DECAY MODES    ---------------

                                                           DECAY MASSES
PI        N* /2(3755) INTO PI+ P P PBAR
****** ********* ********* ********* ********* ********* ********* ********

                        REFERENCES -- N* /2(3755)

EHRLICH  68 PRL 20 686        R EHRLICH,R J PLANO,J B WHITTAKER (RUTGERS)
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                      END PRODUCTION EXPERIMENTS

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Δ(1236) **P'33**

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                     33  N*3/2(1236, JP=3/2+) I=3/2

                     CARTER 70 REPORT NEW PRECISE CROSS SECTION MEASURE-
                     MENTS FOR PI+P,PI-P AND CHARGE EXCHANGE. THEIR ANALYSIS
                     COMBINES TOTAL CROSS SECTION DATA WITH THE PHASE SHIFTS
                     OF DONNACHIE 68 (USED FOR THE BACKGROUND UNDER THE P33)
   THE CHARGE EXCHANGE DATA WERE NOT USED.
   OLSON 65 HAS DONE A SIMILAR ANALYSIS ON OLDER DATA, USING ROPER 65 PHASE
   SHIFTS WITH A FREE OVERALL NORMALIZATION.
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Comments on the Mass and Width of Δ(1236)

In a paper submitted to the Kiev Conference, CARTER 70 present new data on the $\pi^{\pm}p$ total cross sections and the charge exchange cross sections in the region of Δ(1236). The same group also has data on the differential cross sections, but they have not yet been fully analyzed. The data of CARTER 70 seem both statistically and systematically much better than the older results (which date back to the early 50's). When compared with the previous measurements, the most interesting feature of the new data is an apparent small shift of the peak values of the cross sections to lower momenta.

CARTER 70 then calculate the δ_{33} phase shift from the total $\pi^{+}p$ cross-section data. This they do by using the phase-shift solutions of DONNACHIE 68 for the S_{31} and P_{31} partial waves, which they subtract to obtain the δ_{33} phases. The errors assigned to the phases do not include uncertainties in the background subtraction.

The δ_{33} phase shifts were next fit by CARTER 70 with the so-called Layson form of the resonance line shape:

$$\tan\delta_R = \frac{\Gamma(E_\pi)}{2(E_{\pi 0}-E_\pi)}\,,\quad \Gamma(E_\pi) = \frac{4m_p(qR)^3\gamma^2}{(E_\pi+E_{\pi 0})[1+(qR)^2]}\,,$$

where E_π is the pion c. m. energy and an additional subscript 0 denotes the resonant value. The mass M at resonance, reduced width γ^2, and range R are determined by a fit to the data. The width at resonance is given by $\Gamma(E_{\pi 0})M/(M-E_{\pi 0})$. The results are shown in the accompanying table (the values quoted in the

Comparison of analyses of the δ_{33} phase shifts which CARTER 70 obtain from their $\pi^{+}p$ total cross section data. a_{33} is the background scattering length; a dash indicates no background was permitted.

	"Breit-Wigner"	a_{33} $(1/m_\pi^3)$	M (MeV)	Γ_0 (MeV)	R (fermi)	χ^2 (14 points)	N_{param}
CARTER 70	Layson	-	1231±0.6	111±3	?	?	?
Our studies	Standard	-	1231	109	1.09	48	3
	Layson	-	1231	110	0.92	35	3
	Standard	0.0100	1234	120	0.89	9.7	4
	Layson	0.0099	1234	120	0.75	10	4
	Standard with two radii	-	1231.4	112	0.83, 0.62	12.8	4
	3-parameter polynomial	-	1230.8	110	-	35	3
	4-parameter polynomial	-	1231.4	112	-	12.3	4

listing are slightly different because the additional Coulomb correction has been applied to obtain the final values).

The results of this fit are considerably lower than the values we had quoted earlier. These were the results of OLSON 65 who did the same type of analysis on the old data, using the ROPER 65 phase shift for S_{31} and P_{31} with an additional overall constant scaling factor for the background. How much of the disagreement between CARTER 70 and OLSON 65 is due to the difference in the data and how much to the difference in the background is not clear to us at this time.

There is, however, an additional problem, which we now discuss. We have repeated the fit of CARTER 70 to their δ_{33}'s with both the Layson and what we shall call the Standard Breit-Wigner form:

$$\tan \delta_R = \frac{M\Gamma(E_{CM})}{M^2 - E^2_{CM}},\ \Gamma(E_{CM}) = \Gamma_0 \left(\frac{q}{q_0}\right)^3 \left[\frac{1+(q_0R)^2}{1+(qR)^2}\right].$$

As seen in the table, our results for the Standard and Layson forms agree with those of CARTER 70. We conclude from this that there is little difference between three-parameter resonant forms so far as the values of masses and widths are concerned.

While we obtain the same low values as do CARTER 70, the disturbing feature of these fits is the poor χ^2. This shortcoming can be removed by permitting a small background in the P_{33} partial wave itself:

$$\tan \delta_B = a_{33} \left(\frac{q}{m_\pi}\right)^3.$$

We have then added δ_R and δ_B as required by unitarity, assuming the π^+p channel is perfectly elastic. Thus the overall amplitude becomes

$$T = T_B + e^{2i\delta_B}\, T_R,$$

where $T = 1/(\cot\delta - i)$, with similar expressions for T_B and T_R. As shown in the table, a small 33 background scattering length yields an excellent χ^2. The contribution of T_B to the total cross section ($8\pi\lambda\!\!\!^{-2}\ \mathrm{Im}T_B$) is less than ~1 mb from threshold to ~1300 MeV. The primary effect of the background is to rotate the resonance in a counterclockwise sense in the Argand plot. What is surprising is that the mass and width of the $\Delta(1236)$ are much closer to the older values we gave in our tables. (Olson's scaling factor in the background tends to move M, Γ in the same direction as our background.)

It is not clear to us at the moment if such a background is needed or if simply the Breit-Wigner form used is not adequate to fit the data, now that very precise experiments are available. We illustrate this point by replacing the width in the Standard form by a parametrization in terms of two radii:

$$\Gamma(E_{CM}) = \Gamma_0 \left(\frac{q}{q_0}\right)^3 \left[\frac{1+(q_0R_1)^2+(q_0R_2)^4}{1+(qR_1)^2+(qR_2)^4}\right].$$

Both statistically and in view of the manner in which the experimental phases were obtained, the χ^2 of 12.8 obtained with this form should be considered quite good (see the table). Finally we have used the following "polynomial" expression to fit the δ_{33} phases:

$$q^3 \cot\delta = \sum_{n=1}^{N} a_n q^{2n-2}.$$

In this case the resonant mass corresponds to the energy ($s = E_{CM}{}^2 = M^2$) where $q^3 \cot\delta = 0$. The width is given by

$$\Gamma_0 = \frac{q_0^3}{M} \left[\frac{d}{ds}\,(q^3 \cot\delta)\right]^{-1}_{s=M^2}.$$

As seen from the table, the three-parameter fit (N=3) yields a poor χ^2, whereas the four-parameter fit has a reasonable χ^2 and gives essentially the same mass and width as the "two radii" Standard form.

The central problem we have raised is how seriously we should take the usual energy dependence of the width (other than $q^{2\ell+1}$). In the fits that combine background and resonance, it should be noted that $q^3 \cot(\delta_B + \delta_R)$ passes through zero at precisely the same mass as the four-parameter "polynomial" fit. Thus the inclusion of background assumes, in the context of these simple fits, that the parametrization of the widths in either the Layson or Standard forms is correct. At the very least, an analysis of the forthcoming angular distributions of Carter et al. will determine the precise energy at which $\cot\delta_{33} = 0$. More optimistically, it may put to rest the problem of parameters for the senior citizen of resonances.

We conclude that mass and width of $\Delta(1236)$ are in a state of flux; therefore we do not quote any errors in the table.

	33 N*3/2(1236) MASS (MEV)				
M	(1234.)		ROPER	65 DPWA 0++ PHASE SHIFT AN.	
M++	1230.0	0.6	CARTER	70 MPWA ++ PI+P SIG. TOTAL	1/71*
M++	1236.0	0.55	OLSSON	65 RVUE ++ TOTAL-SIGMA DATA	
M++	. . . .				
M++ AVG	1233.3	3.0	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 7.4)		
MO	1232.9	0.6	CARTER	70 MPWA 0 PI-P SIG. TOTAL	1/71*
MO	1236.45	0.65	OLSSON	65 RVUE 0	
MO	. . . .				
MO AVG	1234.5	1.8	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 4.0)		
	33 N*3/2(1236) WIDTH (MEV)				
W	(120.)		ROPER	65 DPWA 0++ PHASE SHIFT AN.	
W++	112.8	3.0	CARTER	70 MPWA ++ PI+P SIG TOT.	1/71*
W++	120.0	2.0	OLSSON	65 RVUE ++	
W++	. . . .				
W++ AVG	117.8	3.3	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.0)		
WO	114.7	3.0	CARTER	70 MPWA 0 PI-P SIG TOT.	1/71*
WO	119.6	2.4	OLSSON	65 RVUE 0	
WO	. . . .				
WO AVG	117.7	2.4	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)		

For notation, see illustrated key at beginning of data card listings.

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-----------------   33  N*(0) - N*(++) MASS DIFFERENCE (MEV)    -----------

D    R       (0.45)    (0.85)         OLSSON     65 RVUE
D    R       (2.9)     (0.85)         CARTER     70 MPWA    PI+- P SIG.TOT.   2/71*
D    R     REDUNDANT WITH DATA IN MASS LISTING.

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----------------   33  N*3/2(1236) PARTIAL DECAY MODES    ----------------

                                                         DECAY MASSES
P1     N*3/2(1236) INTO N PI                            938+ 139
P2     N*3/2(1236) INTO N GAMMA                         938+   0
P3     N*3/2(1236) INTO N PI PI                         938+ 139+ 139

----------------   33  N*3/2(1236) BRANCHING RATIOS  --------------------

R1     N*3/2(1236) INTO (N GAMMA)/(N PI)  (PERCENT)       (P2)/(P1)
R1             0.55       0.02           DALITZ    66 RVUE                       7/68

R2         N*3/2(1336) O INTO (N PI)/TOTAL               (P1)/TOTAL
R2          (0.99)                       CARTER     70 MPWA O  PI-P FORM. EXPER  1/71*

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                            REFERENCES -- N*3/2(1236)

OLSSON    65 PRL 14 118        M G OLSSON                          (WISC)
DALITZ    66 PR 146 1180       DALITZ,SUTHERLAND                 (OXFORD)
CARTER    70 KIEV CONF.        +WILLIAMS, BUGG, BUSSEY, DANCE  (CAVE,RHEL)

                               PAPERS NOT REFERRED TO IN DATA CARDS.

      FOR EXTENSIVE REFERENCES TO DATA AND PHASE-SHIFT ANALYSES TILL 1965,
      SEE ROPER 65, ESPECIALLY APPENDIX II.
ROPER     65 PR 138 B190       L D ROPER, R M WRIGHT, B T FELD   (LRL+MIT)IJP
DONNACHI 68 PL 26B 161         DONNACHIE,LOVELACE,KIRSOPP            (CERN)

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Δ(1236) BUMPS

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               81  N*3/2(1236, JP=3/2+)  I=3/2       PROD. EXP.

--------------     81  N*3/2(1236) MASS (MEV)     ------------------------

M          1217.        8.          ANDERSON  70 MMS    - PI- P TO PI- MMS  2/71*
M++       (1232.0)    (6.0)         FERRO-LUZ 65 HBC   ++ K+P TO KO P PI+
M++       (1233.4)    (4.4)         GIDAL     66 DBC   ++ D D TO NN(NN) PI  7/66
M++       (1236.0)                  DEANS     66 RVUE ++ PI+P TOTAL         7/66
M++       (1224.0)    (2.0)         HABER     70  DBC     K-D TO 4 BOD(P)   7/70
M-        (1241.3)    (5.1)         GIDAL     66 DBC   -                    7/66

----------------   81  N*(-) - N*(++) MASS DIFFERENCE (MEV)    -----------

D             7.9       6.8         GIDAL     66 DBC

----------------   81  N*3/2(1236) WIDTH (MEV)     -----------------------

W          115.         5.          ANDERSON  70 MMS    - PI- P TO PI- MMS  2/71*
W++       (125.0)    (30.0)         FERRO-LUZ 65 HBC   ++
W++       (124.0)    (14.0)         GIDAL     66 DBC   ++                   7/66
W++       (121.0)                   DEANS     66 RVUE ++                    7/66
W++       (120.0)     (8.0)         HABER     70  DBC     K-D TO 4 BOD(P)   7/70
W-        (149.0)    (18.0)         GIDAL     66 DBC   -                    7/66

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                        REFERENCES -- N*3/2(1236)  PROD. EXPERIMENTS

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)

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Δ(1650) S31

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               82  N*3/2(1650, JP=1/2-) I=3/2

               FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
               PRECEDING N*1/2(1470).

----------------   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
     1           WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M    2    (1650.0)                  BAREYRE   68 RVUE    PHASE-SHIFT ANAL 11/67
     2           WHERE SPEED IS GREATEST - EYEBALL FIT
M    3    (1635.0)                  DONNACH1  68 RVUE    PHASE-SHIFT ANAL  6/68
M    3    (1640.)                   DONNACH2  68 RVUE    PHAS.SHIFT-CERN1 10/69
M    3    (1635.)                   KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
     3  WHERE MAX. ABSORPTION IS -DONNACH1, 2  ,KIRSOPP EYEBALL FIT CERN 1  10/69
M    4    (1617.0)                  DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
M    5    (1623.0)                  DAVIES    70 RVUE    P-S ANAL  SOL B   8/69
     5  SOL B IS E.D FIT TO SAME DATA START FROM CERN I EXPER. (DONNACH1 68)
M    6    (1614.0)                  AYED      70 IPWA                      1/71*
     6  ENER. DEP. FIT OF ARGAND DIAGRAM

----------------   82  N*3/2(1650) WIDTH (MEV)    ------------------------

W    1     (250.0)                  BAREYRE   68 RVUE                     11/67
W    2     (130.0)                  BAREYRE   68 RVUE                     11/67
W    3     (177.0)                  DONNACH1  68 RVUE                      6/68
W    3     (177.)                   DONNACH2  68 RVUE    PHAS.SHIFT-CERN1 10/69
W    3     (180.)                   KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
W    4     (141.0)                  DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
W    5     (140.0)                  DAVIES    70 RVUE    P-S ANAL  SOL B   8/69
W    6     (142.0)                  AYED      70 IPWA                      1/71*
     SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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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

----------------   82  N*3/2(1650) BRANCHING RATIOS    -----------------

R1        N*3/2(1650) INTO (PI N)/TOTAL                  (P1)/TOTAL
R1   3      (0.284)                 DONNACH1  68 RVUE                      6/68
R1   3       (.28)                  DONNACH2  68 RVUE    PHAS.SHIFT-CERN1 10/69
R1   3       (.28)                  KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
R1   4      (0.28)                  DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
R1   5      (0.25)                  DAVIES    70 RVUE    P-S ANAL  SOL B   8/69
R1   6      (0.317)                 AYED      70 IPWA                      1/71*

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                            REFERENCES -- 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
DONNACH2  68 VIENNA 139        DONNACHIE  RAPPORTEUR.S TALK           (GLAS)
KIRSOPP   68 THESIS            R G KIRSOPP                            (EDIN)
DAVIES    70 NP B21 359        A DAVIES                               (GLAS)
AYED      70 KIEV CONF         R AYED,P BAREYRE, G VILLET           (SACL)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 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(1670) D33

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               10  N*3/2(1670, JP=3/2-) I=3/2

               FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
               PRECEDING N*1/2(1470).

----------------   10  N*3/2(1670) MASS (MEV)    ------------------------

M    3    (1691.0)                  DONNACH1  68 RVUE    PHASE-SHIFT ANAL  8/69
M    3    (1690.)                   DONNACH2  68 RVUE    PHAS.SHIFT-CERN1 10/69
M    3    (1690.)                   KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
     3  WHERE MAX. ABSORPTION IS -DONNACH1, 2 ,KIRSOPP EYEBALL FIT CERN 1   10/69
M    4    (1649.0)                  DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
M    5    (1650.0)                  DAVIES    70 RVUE    P-S ANAL  SOL B   8/69
     5  SOL B IS E.D FIT TO SAME DATA START FROM CERN I EXPER. (DONNACH1 68)
M    5    (1722.0)                  AYED      70 IPWA                      1/71*
     6  ENER. DEP. FIT OF ARGAND DIAGRAM

----------------   10  N*3/2(1670) WIDTH (MEV)    ------------------------

W    3     (269.0)                  DONNACH1  68 RVUE                      8/69
W    3     (269.)                   DONNACH2  68 RVUE    PHAS.SHIFT-CERN1 10/69
W    3     (300.)                   KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
W    4     (188.0)                  DAVIES    70 RVUE               SOL A  8/69
W    5     (174.0)                  DAVIES    70 RVUE               SOL B  8/69
W    6     (258.0)                  AYED      70 IPWA                      1/71*
     SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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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

----------------   10  N*3/2(1670) BRANCHING RATIOS    -----------------

R1        N*3/2(1670) INTO (PI N)/TOTAL                  (P1)/TOTAL
R1   3      (0.14)                  DONNACH1  68 RVUE                      8/69
R1   3       (.14)                  DONNACH2  68 RVUE    PHAS.SHIFT-CERN1 10/69
R1   3       (.13)                  KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
R1   4      (0.12)                  DAVIES    70 RVUE               SOL A  8/69
R1   5      (0.13)                  DAVIES    70 RVUE               SOL B  8/69
R1   6      (0.217)                 AYED      70 IPWA                      1/71*

R2        N*3/2(1670) INTO (K SIGMA)/TOTAL               (P3)/TOTAL
R2   1     LESS THAN 0.00002        FEUERBACH 70 RVUE     PI P TO K+ SIG+  7/70
     1    ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
     1    MODEL USED MAY DOUBLE COUNT.

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                            REFERENCES -- N*3/2(1670)

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)
FEUERBAC 70 NP 16B 85          FEUERBACHER+HOLLADAY             (VANDERBILT)
DAVIES   70 NP B21 359         A DAVIES                               (GLAS)
AYED     70 KIEV CONF          R AYED,P BAREYRE, G VILLET           (SACL)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)
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

               FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
               PRECEDING N*1/2(1470).

----------------   19  N*3/2(1690) MASS  (MEV)    -----------------------

M    3    (1690.)                   DONNACH2  68 RVUE    PHAS.SHIFT-CERN1 10/69
M    3    (1690.)                   KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
     3  WHERE MAX. ABSORPTION IS -DONNACH1, 2 ,KIRSOPP EYEBALL FIT CERN 1   10/69
M    6    (1801.0)                  AYED      70 IPWA                      1/71*
     6  ENER. DEP. FIT OF ARGAND DIAGRAM
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For notation, see illustrated key at beginning of data card listings.

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-----------------   19  N*3/2(1690) WIDTH (MEV)     ------------------------

W   3      (281.)                     DONNACH2  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*

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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

-----------------   19  N*3/2(1690) BRANCHING RATIOS    -------------------

R1          N*3/2(1690) INTO (PI N)/TOTAL                 (P1)/TOTAL
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*

R2          N*3/2(1690) INTO (K SIGMA)/TOTAL              (P2)/TOTAL
R2  1        LESS THAN 0.00002         FEUERBACH 70 RVUE    PI P TO K+ SIG+   7/70
    1       ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
    1       MODEL USED MAY DOUBLE COUNT.

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                              REFERENCES -- N*3/2(1690)

DONNACH2 68 VIENNA 139        DONNACHIE  RAPPORTEUR.S TALK            (GLAS)
KIRSOPP  68 THESIS            R G KIRSOPP                             (EDIN)
FEUERBAC 70 NP 168 85         FEUERBACHER+HOLLADAY              (VANDERBILT)
AYED     70 KIEV CONF         R AYED,P BAREYRE, G VILLET             (SACL)IJP

                              PAPERS NOT REFERRED TO IN DATA CARDS.

AYED     70 PL 318 598        +BAREYRE,VILLET                          (SACLAY)
BOWLER   70 NP 178 331        +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

            FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
            PRECEDING N*1/2(1470).

----------------    11  N*3/2(1890) MASS (MEV)    -------------------------

M   3      (1913.0)                   DONNACH1  68 RVUE    PHASE-SHIFT ANAL  8/69
M   3      (1910.)                    DONNACH2  68 RVUE    PHAS.SHIFT-CERN1 10/69
M   3      (1910.)                    KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
    3   WHERE MAX. ABSORPTION IS -DONNACH1, 2 ,KIRSOPP EYEBALL FIT CERN 1   10/69
M   4      (1841.0)                   DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
M   5      (1852.0)                   DAVIES    70 RVUE    P-S ANAL  SOL B   8/69
    5  SOL B IS E.D FIT TO SAME DATA START FROM CERN I EXPER. (DONNACH1 68)
M   6      (1837.0)                   AYED      70 IPWA                     1/71*
    6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M          (1924.0)                   MEHTANI   70 MPWA    PI+P TO (1236)PI  1/71*

----------------    11  N*3/2(1890) WIDTH (MEV)    ------------------------

W   3       (350.0)                   DONNACH1  68 RVUE                      8/69
W   3       (350.)                    DONNACH2  68 RVUE    PHAS.SHIFT-CERN1 10/69
W   3       (380.)                    KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
W   4       (136.0)                   DAVIES    70 RVUE               SOL A  8/69
W   5       (150.0)                   DAVIES    70 RVUE               SOL B  8/69
W   6       (198.0)                   AYED      70 IPWA                     1/71*
W           (177.0)                   MEHTANI   70 MPWA    PRELIMINARY      1/71*
         SEE NOTES ACCOMPANYING MASSES QUOTED AS FOR N*1/2(1910)

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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) INTO N PI PI                       938+ 139+ 139
P3          N*3/2(1890) INTO K SIGMA                       493+1189
P4          N*3/2(1890) INTO D(1236) PI                   1236+ 139

----------------    11  N*3/2(1890) BRANCHING RATIOS    -------------------

R1          N*3/2(1890) INTO (PI N)/TOTAL                 (P1)/TOTAL
R1  3         (0.16)                  DONNACH1  68 RVUE                      8/69
R1  3          (.16)                  DONNACH2  68 RVUE    PHAS.SHIFT-CERN1 10/69
R1  3          (.15)                  KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
R1  4         (0.20)                  DAVIES    70 RVUE               SOL A  8/69
R1  5         (0.19)                  DAVIES    70 RVUE               SOL B  8/69
R1  6         (0.147)                 AYED      70 IPWA                     1/71*

R2          N*3/2(1890) INTO (K SIGMA)/TOTAL              (P3)/TOTAL
R2  1        LESS THAN 0.008          FEUERBACH 70 RVUE    PI P TO K+ SIG+   7/70
    1       ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
    1       MODEL USED MAY DOUBLE COUNT.

R3          N*3/2(1890) INTO (SIGMA K)*(PI N)/TOTAL**2   (P3*P1)/TOTAL**2
R3           LESS THAN 0.0016         KALMUS    70 DPWA    PI+P TO K+ SIG+  1/71*

R4          N*3/2(1890) INTO (D(1236) PI)*(PIN)/TOTAL**2 (P4*P1)/TOTAL**2
R4           (0.025)                  MEHTANI   70 MPWA    PRELIMINARY      1/71*

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                              REFERENCES -- N*3/2(1890)

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)
FEUERBAC 70 NP 168 85         FEUERBACHER+HOLLADAY              (VANDERBILT)
DAVIES   70 NP B21 359        A DAVIES                                (GLAS)
KALMUS   70 PR D2 1824        G KALMUS, G BORREANI, J LOUIE            (LRL)
AYED     70 KIEV CONF         R AYED,P BAREYRE, G VILLET             (SACL)IJP
MEHTANI  70 KIEV CONF.        +FUNG, KERNAN +             (UCR,LRL,U N.HAMP)

                              PAPERS NOT REFERRED TO IN DATA CARDS.

AYED     70 PL 318 598        +BAREYRE+VILLET                          (SACLAY)

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Δ(1910)

P_{31}

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            12  N*3/2(1910, JP=1/2+) I=3/2

            FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
            PRECEDING N*1/2(1470).

-----------------   12  N*3/2(1910) MASS (MEV)    ------------------------

M   3      (1934.0)                   DONNACH1  68 RVUE    PHASE-SHIFT ANAL  8/69
M   3      (1930.)                    DONNACH2  68 RVUE    PHAS.SHIFT-CERN1 10/69
M   3      (1930.)                    KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
    3   WHERE MAX. ABSORPTION IS -DONNACH1, 2 ,KIRSOPP EYEBALL FIT CERN 1   10/69
M   4      (1914.0)                   DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
M   5      (1834.0)                   DAVIES    70 RVUE    P-S ANAL  SOL B   8/69
    5  SOL B IS E.D FIT TO SAME DATA START FROM CERN I EXPER. (DONNACH1 68)
M   6      (1783.0)                   AYED      70 IPWA                     1/71*
    6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M          (1866.0)                   MEHTANI   70 MPWA    PI+P TO (1236)PI  1/71*

-----------------   12  N*3/2(1910) WIDTH (MEV)    ------------------------

W   3       (339.0)                   DONNACH1  68 RVUE                      8/69
W   3       (339.)                    DONNACH2  68 RVUE    PHAS.SHIFT-CERN1 10/69
W   3       (425.)                    KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
W   4       (290.)                    DAVIES    70 RVUE               SOL A  8/69
W   5       (231.0)                   DAVIES    70 RVUE               SOL B  8/69
W   6       (308.0)                   AYED      70 IPWA                     1/71*
W           (124.0)                   MEHTANI   70 MPWA    PRELIMINARY      1/71*
        SEE NOTES ACCOMPANYING MASSES QUOTED

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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) INTO D(1236) PI                   1236+ 139

-----------------   12  N*3/2(1910) BRANCHING RATIOS    -------------------

R1          N*3/2(1910) INTO (PI N)/TOTAL                 (P1)/TOTAL
R1  3         (0.30)                  DONNACH1  68 RVUE                      8/69
R1  3          (.30)                  DONNACH2  68 RVUE    PHAS.SHIFT-CERN1 10/69
R1  3          (.25)                  KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
R1  4         (0.18)                  DAVIES    70 RVUE               SOL A  8/69
R1  5         (0.24)                  DAVIES    70 RVUE               SOL B  8/69
R1  6         (0.128)                 AYED      70 IPWA                     1/71*

R2          N*3/2(1910) INTO (K SIGMA)/TOTAL              (P3)/TOTAL
R2  1        LESS THAN 0.008          FEUERBACH 70 RVUE    PI P TO K+ SIG+   7/70
    1       ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
    1       MODEL USED MAY DOUBLE COUNT.

R3          N*3/2(1910) INTO (D(1236) PI)*(PIN)/TOTAL**2 (P4*P1)/TOTAL**2
R3            (0.20)                  MEHTANI   70 MPWA    PRELIMINARY      1/71*

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                              REFERENCES -- N*3/2(1910)

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)
FEUERBAC 70 NP 168 85         FEUERBACHER+HOLLADAY              (VANDERBILT)
DAVIES   70 NP B21 359        A DAVIES                                (GLAS)
AYED     70 KIEV CONF         R AYED,P BAREYRE, G VILLET             (SACL)IJP
MEHTANI  70 KIEV CONF.        +FUNG, KERNAN +             (UCR,LRL,U N.HAMP)

                              PAPERS NOT REFERRED TO IN DATA 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)

F_{37}

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            83  N*3/2(1950, JP=7/2+) I=3/2

            FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
            PRECEDING N*1/2(1470).

-----------------   83  N*3/2(1950) MASS (MEV)    ------------------------

M          (1920.0)                   DUKE      65 CNTR    PI-P EL + POL     6/68
M          (1950.0)      APPROX       YOKOSAWA  66 CNTR    PI- P DSIG + POL  7/66
M   1      (1975.0)                   BAREYRE   68 RVUE    PHASE-SHIFT ANAL 11/67
    1             WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M   2      (1980.0)                   BAREYRE   68 RVUE    PHASE-SHIFT ANAL 11/67
    2             WHERE SPEED IS GREATEST - EYEBALL FIT
M   3      (1946.0)                   DONNACH1  68 RVUE    PHASE-SHIFT ANAL  6/68
M   3      (1950.)                    DONNACH2  68 RVUE    PHAS.SHIFT-CERN1 10/69
M   3      (1946.)                    KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
    3   WHERE MAX. ABSORPTION IS -DONNACH1, 2 ,KIRSOPP EYEBALL FIT CERN 1   10/69
M   4      (1935.0)                   DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
M   5      (1935.0)                   DAVIES    70 RVUE    P-S ANAL  SOL B   8/69
    5     SOL B IS A FIT TO DONNACHIE 68 SOLUTION
M   6      (1931.0)                   AYED      70 IPWA                     1/71*
    6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M          (1950.0)   (30.0)          KALMUS    70 DPWA    PI+P TO K+ SIG+  1/71*
M          (1924.0)                   MEHTANI   70 MPWA    PI+P TO (1236)PI  1/71*

-----------------   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   2       (140.0)                   BAREYRE   68 RVUE                     11/67
W   3       (221.0)                   DONNACH1  68 RVUE                      6/68
W   3       (221.)                    DONNACH2  68 RVUE    PHAS.SHIFT-CERN1 10/69
W   3       (220.)                    KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
W   4       (221.0)                   DAVIES    70 RVUE               SOL A  8/69
W   5       (212.0)                   DAVIES    70 RVUE               SOL B  8/69
W   6       (197.0)                   AYED      70 IPWA                     1/71*
      SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.
W           (300.0)   (60.0)          KALMUS    70 DPWA    PI+P TO K+ SIG+  1/71*
W           (163.0)                   MEHTANI   70 MPWA    PRELIMINARY      1/71*

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For notation, see illustrated key at beginning of data card listings.

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----------------  83  N*3/2(1950) PARTIAL DECAY MODES    ---------------

                                                         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(1236) PI                1236+ 139
P4        N*3/2(1950) INTO Y*1(1385) K                   1385+ 493
P5        N*3/2(1950) INTO N*3/2(1236) RHO               1236+ 765
P6        N*3/2(1950) INTO NEUTRON PI+ PI+                939+ 139+ 139
P7        N*3/2(1950) INTO N*3/2(1236) PI PI (NOT RHO)   1236+ 139+ 139

----------------  83  N*3/2(1950) BRANCHING RATIOS   ------------------

R1        N*3/2(1950) INTO (PI N)/TOTAL                  (P1)/TOTAL
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)                   DONNACH1  68 RVUE                     6/68
R1   3      (.39)                     DONNACH2  68 RVUE   PHAS.SHIFT-CERN1 10/69
R1   3      (.39)                     KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69
R1   4      (0.51)                    DAVIES    70 RVUE              SOL A  8/69
R1   5      (0.39)                    DAVIES    70 RVUE              SOL B  8/69
R1   6      (0.496)                   AYED      70 IPWA                     1/71*
       SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

R2        N*3/2(1950) INTO (SIGMA K)*(PI N)/TOTAL**2  (P2*P1)/TOTAL**2
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
     1    ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
     1    MODEL USED MAY DOUBLE COUNT.
R2          0.0081   0.0013           KALMUS    70 DPWA   PI+P TO K+ SIG+   1/71*

R3        N*3/2(1950) INTO (D(1236) PI)*(PIN)/TOTAL**2 (P3*P1)/TOTAL**2
R3          0.23     0.04             FUNG      68 HBC ++ PI+P TO PI+PIO P 11/68
R3          (0.034)                   MEHTANI   70 MPWA   PRELIMINARY       1/71*

    MORE INFORMATIONS ON INELASTIC DECAY MODES OF BUMPS, SEEN IN PRODUCTION
    EXPERIMENTS AROUND 1950 MEV, MAY BE FOUND IN THE NEXT ENTRY

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                          REFERENCES -- N*3/2(1950)

DUKE     65 PRL 15 468       +JONES,KEMP,MURPHY,PRENTICE, +  (RTHFD,OXF)IJP
YOKOSAWA 66 PRL 16 714       +SUWA, HILL, ESTERLING, BOOTH     (ARG,CHI)IJP
BAREYRE  68 PR 165 1731      P BAREYRE, C BRICMAN, G VILLET    (SACLAY)IJP
BORREANI 68 UCRL 18350        BORREANI,KALMUS                       (LRL)
DONNACH1 68 PL 26B 161       A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
DONNACH2 68 VIENNA 139       DONNACHIE  RAPPORTEUR.S TALK          (GLAS)
FUNG     68 VIENNA CONF.     FUNG, KERNAN, KALMUS, BIRGE (RIVERSIDE,LRL)
KIRSOPP  68 THESIS           R G KIRSOPP                           (EDIN)

FEUERBAC 70 NP 16B 85        FEUERBACHER+HOLLADAY            (VANDERBILT)
DAVIES   70 NP B21 359       A DAVIES                              (GLAS)
KALMUS   70 PR D2 1824       G KALMUS, G BORREANI, J LOUIE          (LRL)
AYED     70 KIEV CONF        R AYED,P BAREYRE, G VILLET          (SACL)IJP
MEHTANI  70 KIEV CONF.       +FUNG, KERNAN +           (UCR,LRL,U N.HAMP)

                             PAPERS NOT REFERRED TO IN DATA CARDS.

LAYSON   63 NC 27 724        W M LAYSON                          (CERN) IJ
HOHLER   63 NP 48 470        G HOHLER, G EBEL                (KARLSRUHE) I
AUVIL    64 NC 33 473        P AUVIL, C LOVELACE               (IMPCOL)IJP
HOHLER   64 PL 12 149        G HOHLER, J GIESECKE            (KARLSRUHE) I
HELLAND  64 PR 134 B1062     +DEVLIN,HAGGE,LONGO,MOYER,WOOD       (LRL) IJ
HOLLADAY 65 PR 139 B1348     W G HOLLADAY                    (VANDERBILT)
JOHNSON  67 UCRL-17683 THESIS C H JOHNSON                           (LRL)
DONNACHI 69 NP 10B 433       A DONNACHIE, R KIRSOPP           (GLAS+EDIN)
AYED     70 PL 31B 598       +BAREYRE+VILLET                     (SACLAY)

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Δ(1960) — D_{35}

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                 13  N*3/2(1960, JP=5/2-) I=3/2

                 FOR DISCUSSION CONCERNING RESONANT PARAMETERS,SEE NOTE
                 PRECEDING N*1/2(1470).

----------------  13  N*3/2(1960) MASS (MEV)    ------------------------

M   3    (1954.0)                     DONNACH1  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
    X  SEE ALSO APLIN 70
    3   WHERE MAX. ABSORPTION IS -DONNACH1, 2 ,KIRSOPP EYEBALL FIT CERN 1  10/69
M        (1932.0)                     MEHTANI   70 MPWA   PI+P TO (1236)PI  1/71*

----------------  13  N*3/2(1960) WIDTH (MEV)   ------------------------

W   3      (311.00)                   DONNACH1  68 RVUE                     8/69
W   3      (400.)                     KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69
W          (182.0)                    MEHTANI   70 MPWA   PRELIMINARY       1/71*

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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
P4        N*3/2(1960) INTO D(1236) PI                    1236+ 139

----------------  13  N*3/2(1960) BRANCHING RATIOS   ------------------

R1        N*3/2(1960) INTO (PI N)/ TOTAL                 (P1)/TOTAL
R1   3      (.154)                    DONNACH1  68 RVUE   PHASE SHIFT ANA. 10/69
R1   3      (.12)                     KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69

R2        N*3/2(1960) INTO (K SIGMA)/TOTAL               (P2)/TOTAL
R2   1     (0.013)  (0.01)            FEUERBACH 70 RVUE   PI P TO K+ SIG+   7/70
     1    ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
     1    MODEL USED MAY DOUBLE COUNT.

R3        N*3/2(1960) INTO (D(1236) PI)*(PIN)/TOTAL**2 (P4*P1)/TOTAL**2
R3         (0.029)                    MEHTANI   70 MPWA   PRELIMINARY       1/71*

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                          REFERENCES -- 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,DAR)
APLIN    70 RPPIH/67         +COWAN,GIBSON,GILMORE++       (RHEL,BRISTOL)
FEUERBAC 70 NP 16B 85        FEUERBACHER+HOLLADAY            (VANDERBILT)
MEHTANI  70 KIEV CONF.       +FUNG, KERNAN +           (UCR,LRL,U N.HAMP)

                             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)

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Δ(1950) BUMPS

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                 70  N* (1950)                             PROD. EXP.

----------------  70  N* (1950)   MASS (MEV)   ----------------------

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
     N     THIS BUMP IS NOT SEEN BY CHUNG 68 AT 3.2 GEV/C

----------------  70  N* (1950)   WIDTH (MEV)   ---------------------

W          (256.0)    (39.0)         DEVLIN    65 CNTR
W            40.0      20.0          YOON      67 HBC +                    8/67

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----------------  70  N* (1950)   BRANCHING RATIOS       -------------

R1         N*   (1950) INTO (PI N)/TOTAL                   PROD. EXP.
R1            (0.57)   (0.12)         DEVLIN    65 CNTR

R2         N*   (1950) INTO (SIGMA K)/(PI N)               PROD. EXP.
R2            0.059    0.024          CHINOWSKY 68 HBC ++ PP TO P SIG K    11/68

R3         N*   (1950) INTO N*3/2(1236) PI PI (NOT RHO)
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*   (1950) INTO (PI N)/(N*3/2(1236) PI)        PROD. EXP.
R4            LESS THAN 0.55          LEE       67 HBC    PI-P 3.63 BEV/C  11/67

R5     N*   (1950) INTO ((PI N)*(NEUTRON PI+ PI+))/TOTAL   PROD. EXP.
R5            0.05     0.013          GALLOWAY  68 RVUE ++ PI+P TO N 2PI+   6/68

R6         N*   (1950) INTO (Y*1(1385) K)/(PI N)           PROD. EXP.
R6            0.035    0.015          CHINOWSKY 68 HBC ++ PP TO P LAM K PI 11/68

R7         N*   (1950) INTO (N*3/2(1236) RHO)/(PI N)       PROD. EXP.
R7            (0.45)   APPROX         CHINOWSKY 68 HBC ++ PP TO (P 3PI) N  11/68
      THIS INCLUDES CORRECTION FOR UNSEEN DECAY (ISPIN FACTOR 5/3).

R8         N*   (1950) INTO (N*3/2(1236) RHO)/TOTAL
R8                SEEN                YOON      67 HBC +                    8/67
R8            NOT SEEN                BOGGILD   70  HBC   PP TO N3PI(NTRL)  6/70

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                        REFERENCES -- N* IN PRODUCT EXPERIMENTS

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+  (COP+HELS+OSLO+STOCK)

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                    END PRODUCTION EXPERIMENTS

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Δ(2160) — P'''_{33}

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                 9  N*3/2(2160,JP=3/2+) I=3/2

                 FOR DISCUSSION CONCERNING RESONANT PARAMETERS,
                     SEE NOTE PRECEDING N*1/2(1470)

----------------   9  N*3/2(2160) MASS  (MEV)    ----------------------

M   3    (2160.)                      KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69

----------------   9  N*3/2(2160) WIDTH (MEV)    ----------------------

W   3    (260.)                       KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69

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----------------   9  N*3/2(2160) PARTIAL DECAY MODES    ---------------

                                                         DECAY MASSES
P1        N*3/2(2160) INTO PI N                           139+ 938

----------------   9  N*3/2(2160) BRANCHING RATIOS    -----------------

R1        N*3/2(2160) INTO (PI N)/TOTAL                  (P1)/TOTAL
R1   3      (.25)                     KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69

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                          REFERENCES -- N*3/2(2160)

KIRSOPP  68 THESIS           R G KIRSOPP                           (EDIN)

                             PAPERS NOT REFERRED TO IN DATA CARDS.

DONNACHI 69 NP 10B 433       A DONNACHIE,R KIRSOPP            (GLAS+EDIN)

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For notation, see illustrated key at beginning of data card listings.

Δ(2420) $H_{3\ 11}$

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                  84  N*3/2(2420, JP=11/2+)  I=3/2

----------------- 84  N*3/2(2420) MASS (MEV)  -------------------------

M   6    (2312.0)                  AYED      70 IPWA                 1/71*
    6  FROM ENER. DEP. FIT OF ARGAND DIAGRAM

----------------- 84  N*3/2(2420) WIDTH (MEV)  ------------------------

W   6    (347.0)                   AYED      70 IPWA                 1/71*

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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

----------------- 84  N*3/2(2420) BRANCHING RATIOS  -------------------

R1         N*3/2(2420) INTO (PI N)/TOTAL             (P1)/TOTAL
R1  6        (0.113)               AYED      70 IPWA                 1/71*

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                       REFERENCES -- N*3/2(2420)

AYED     70 KIEV CONF          R AYED,P BAREYRE, G VILLET         (SACL)IJP

                       PAPERS NOT REFERRED TO IN DATA CARDS.

BELLAMY  67 PRL 19 476         +BUCKLEY,DOBINSON, +     (WESTFIELD,UNICOL) JP
AYED     70 PL 31B 598         +BAREYRE+VILLET                     (SACLAY)

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M > 2200 MEV – PRODUCTION AND σ_{TOTAL} EXPERIMENTS

BUMPS

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Δ(2420)

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                  84  N*3/2(2420 )            I=3/2

----------------- 84  N*3/2(2420) MASS (MEV)  -------------------------

M        (2360.0)                  DIDDENS   63 CNTR   PI+ P TOTAL
M        (2520.0)  (40.0)          ALVAREZ   64 CNTR   PI PHOTOPROD      7/66
M        (2400.0)     APPROX       WAHLIG    64 OSPK 0 PI-P CH EX
M        (2440.0)                  HOHLER    64 RVUE   DATA + DISP REL
M         2423.0    10.0           CITRON    66 CNTR   PI+ P TOTAL       7/66
M   B    (2452.0)                  BARGER    66 RVUE   TOTAL + CH EX    11/67
    B  USES REGGE AMP.+RESON. TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGRE
    B  FOR CRITICISM OF THIS METHOD, SEE DOLEN 68.

----------------- 84  N*3/2(2420) WIDTH (MEV)  ------------------------

W        (200.0)                   DIDDENS   63 CNTR
W        (245.0)                   HOHLER    64 RVUE                     7/66
W         310.0     20.0           CITRON    66 CNTR                     7/66
W   B    (275.0)                   BARGER    66 RVUE   TOTAL + CH EX    11/67

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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
P3         N*3/2(2420) INTO N*3/2(1236) PI           1236+ 139
P4         N*3/2(2420) INTO NEUTRON PI+ PI+           939+ 139+ 139

----------------- 84  N*3/2(2420) BRANCHING RATIOS  -------------------

R1         N*3/2(2420) INTO (PI N)/TOTAL             (P1)/TOTAL
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
    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) (P1*P4)/TOTAL**2
R2            0.0195   0.0048      GALLOWAY  68 RVUE                     6/68

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                       REFERENCES -- N*3/2(2420)

DIDDENS  63 PRL 10 262         +JENKINS, KYCIA, RILEY                 (BNL) I
ALVAREZ  64 PRL 12 710         +BAR-YAM,KERN,LUCKEY,OSBORNE, +   (MIT,CEA)
WAHLIG   64 PRL 13 103         +MANNELLI,SODICKSON,FACKLER,WARD, +   (MIT)
HOHLER   64 PL 12 149          G HOHLER, J GIESECKE             (KARLSRUHE) I
CITRON   66 PR 144 1101        +GALBRAITH,KYCIA,LEONTIC,PHILLIPS, +  (BNL) I
BARGER   66 PR 151 1123        V BARGER, M OLSSON                    (WISC)

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,ARG) P
DOLEN    68 PR 166 1768        R DOLEN, D HORN, C SCHMID        (CAL TECH)
GALLOWAY 68 PL 26B 334         K F GALLOWAY                       (INDIANA) I

                       PAPERS NOT REFERRED TO IN DATA CARDS.

DOBROWOL 67 PL 24B 203         DOBROWOLSKI,GUSKOV,LIKHACHEV, +   (DUBNA) P
BAACKE   67 NC 51A 761         J BAACKE, M YVERT          (KARLSRUHE,ORSAY)J-L
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)

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                  85  N*3/2(2850, JP=    +) I=3/2

----------------- 85  N*3/2(2850) MASS (MEV)  -------------------------

M        (2700.0)     APPROX       WAHLIG    64 OSPK 0 PI-P CH EX
M        (2870.0)                  HOHLER    64 RVUE   DATA + DISP REL
M         2850.0    12.0           CITRON    66 CNTR   PI+ P TOTAL       7/66
M        (2850.0)                  BARDADIN  66 HBC ++ N* TO P + 3 PIS   7/66

----------------- 85  N*3/2(2850) WIDTH (MEV)  ------------------------

W         400.0     40.0           CITRON    66 CNTR                     7/66
W        (150.0)                   BARDADIN  66 HBC ++                   7/66

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----------------- 85  N*3/2(2850) PARTIAL DECAY MODES  ----------------

                                                      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

----------------- 85  N*3/2(2850) BRANCHING RATIOS  -------------------

R1         N*3/2(2850) INTO (PI N)/TOTAL             (P1)/TOTAL
R1     ONLY (J+1/2)*( PI N/TOTAL) MEASURED FOR THIS STATE
R1            0.261    0.048       CITRON    66 CNTR   TOTAL CROSS.SEC. 11/67
R1  B        (0.224)  (0.016)      BARGER    66 RVUE   TOTAL + CH EXC.  11/67
R1  B        (0.40)                BARGER    67 RVUE   USES KORMANYOS66 11/67
    B  USES REGGE AMP.+RESON. TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGRE
    B  FOR CRITICISM OF THIS METHOD, SEE DOLEN 68.
R1  D        (0.49)                DIKMEN    67 RVUE   USES KORMANYOS67 11/67
    D  USES ONLY RESONANCES TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGREES
R1           (0.10)                KORMANYOS 67 CNTR   PI-P AT 180 DEG. 11/67
R1           (0.39)                DOBROWOLS 67 CNTR   PI+P AT 180 DEG

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                       REFERENCES -- N*3/2(2850)

WAHLIG   64 PRL 13 103         +MANNELLI,SODICKSON,FACKLER,WARD, +   (MIT)
HOHLER   64 PL 12 149          G HOHLER, J GIESECKE             (KARLSRUHE) I
CITRON   66 PR 144 1101        +GALBRAITH,KYCIA,LEONTIC,PHILLIPS, +  (BNL) I
BARDADIN 66 PL 21 357          BARDADIN-OTWINOWSKA,DANYSZ, +       (WARSAW)
BARGER   66 PR 151 1123        V BARGER, M OLSSON                    (WISC)

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,ARG) P
DOLEN    68 PR 166 1768        R DOLEN, D HORN, C SCHMID          (CAL TECH)

                       PAPERS NOT REFERRED TO IN DATA CARDS.

BAACKE   67 NC 51A 761         J BAACKE, M YVERT          (KARLSRUHE,ORSAY)J-L
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)

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                  86  N*3/2(3230, JP=     ) I=3/2

----------------- 86  N*3/2(3230) MASS (MEV)  -------------------------

M        (3230.0)                  CITRON    66 CNTR   PI+ P TOTAL       7/66

----------------- 86  N*3/2(3230) WIDTH (MEV)  ------------------------

W        (440.0)                   CITRON    66 CNTR                     7/66

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----------------- 86  N*3/2(3230) PARTIAL DECAY MODES  ----------------

                                                      DECAY MASSES
P1         N*3/2(3230) INTO PI N                      139+ 938
P2         N*3/2(3230) INTO N PI PI                   938+ 139+ 139

----------------- 86  N*3/2(3230) BRANCHING RATIOS  -------------------

R1     ONLY (J+1/2)*( PI N/TOTAL) MEASURED FOR THIS STATE

R1           (0.06)                CITRON    66 CNTR   TOTAL CROS. SEC. 11/67
R1  B        (0.03)   (0.01)       BARGER    66 RVUE   TOTAL + CH EXC.  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
R2  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

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                       REFERENCES -- N*3/2(3230)

CITRON   66 PR 144 1101        +GALBRAITH,KYCIA,LEONTIC,PHILLIPS, +  (BNL) I
BARGER   66 PR 151 1123        V BARGER, M OLSSON                    (WISC)
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,ARG) P
DOLEN    68 PR 166 1768        R DOLEN, D HORN, C SCHMID          (CAL TECH)

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                       END PRODUCTION EXPERIMENTS

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EXOTIC NUCLEONS

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CROSS SECTIONS LIMITS FOR EXOTIC NUCLEONS

       THIS IS NOT A COMPLETE LIST. WE WILL TABULATE EXOTICS FROM NOW ON

CS   LT. 40 MB  I=5/2, M=1540-1750   BANNER   70 OSPK +++ PI+P,1.9 GEV/C   7/70

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                       REFERENCES --- EXOTIC NUCLEONS

BANNER   70 NP B15 205         +CHEZE,HAMEL,TEIGER,ZACCONE +        (SACLAY)

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For notation, see illustrated key at beginning of data card listings.

EX(1640)

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92 EX(1640,JP=   )I=

-----------------  92 EX(1640) MASS (MEV)  ------------------------------
M   A   29(1627.)   (12.)          PRICE     70 DBC  -- K-D AT 4.91GEV/C  3/71*
7   A  FOUR S. D. EFFECT

-----------------  92 EX(1640) WIDTH (MEV)  ------------------------------

W   B   29  30.  OR LESS .90 CL    PRICE     70 DBC  -- PI-PI-N BUMP      3/71*
W   B  CROSS SECTION 13.0+-3.9 MICROBARNS

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                         REFERENCES -- EX(1640)

PRICE    70 PL 33B,533        +BERG,SALANT,WATERS,WEBSTER,WEINBERG (VAND)

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Note on Possible Z^*'s

Although much work has been done on the strangeness +1 reactions during the past year, it is not yet clear whether the peaks seen in total KN cross sections near 1 GeV/c are resonances; see Fig. 1. Since positive-strangeness baryons cannot be made from three quarks, it is very important to find out if these peaks are resonances.

(a) I = 0 System. New total-cross-section data have been reported by the Arizona group in the 0.36 to 0.72 GeV/c region (BOWEN 70). The old K^+p and K^+d total cross sections have been reanalyzed by ABRAMS 69. They made a new unfolding of the isospin-0 total cross section and found that the well-known peak in this cross section just above 1.0 GeV/c ($M \sim 1865$ MeV) has a companion at about 0.8 GeV/c ($M \sim 1780$ MeV). COOL 70 adds the new data of BOWEN 70 to the analysis and obtains the two possible results shown in Fig. 2a for the I = 0 cross section. DOWELL 70 also reports similar results. The choice of two possibilities depends mostly on the disagreement between the data and very little on the method of unfolding, as discussed by LYNCH 70.

Until the K^+p and K^+d cross sections are remeasured in this region, the lower peak, though probable, cannot be considered definitely established. There is, however, no doubt about there being a large broad peak in the isospin-0 elastic cross section. The inelastic cross section is very small until the K^*N threshold at 1.08 GeV/c is approached, then it rises rapidly (HIRATA 68 and HIRATA 70), as shown in Fig. 2c. Subtracting this from total cross sections gives the two possible results of Fig. 2b. (The elastic cross section has not been independently measured.)

The $Z_0^*(1780)$ in the listings below is the result of fitting the elastic peak with a Breit-Wigner resonance form. The width is anomalously large, nearly 600 MeV. The resonance (if it exists) must be nearly entirely elastic because the inelastic cross section is small at the peak. If J were greater than 1/2, the resonant peak would exceed the observed height of $4\pi\lambda\!\!\!^-{}^2$. This fixes the spin as 1/2, and means that there is little cross section left over for other partial waves. Of course it is quite possible that in fact the peak is not caused by a resonance at all.

Phase shift analyses of the elastic scattering data in the I = 0 state have been done only up to 810 MeV/c;[1] therefore it is not clear whether the structure (either double-peaked or not) is associated with a definite resonance-like structure in one or more partial waves.

(b) I = 1 System. New K^+p data have been reported by REBKA 70 from 1.54 to 1.71 GeV/c and by BARBER 70 from 1.4 to 2.3 GeV/c. As for new analyses at the Duke Conference on Hyperons, a total of nine partial-wave analyses were presented. Each of these analyses gets more than one solution to choose from, which indicates that the data are not good enough to eliminate some of the possibilities. Certainly new data and the simultaneous analysis of elastic and inelastic channels (copious inelastic data is desirable at the moment) could improve the understanding of this system.

The P_{13} amplitude still remains the best candidate for a resonance in the K^+p system. The preferred P_{13} Argand plots obtained by the various groups are shown in Fig. 3. Each analysis in one way or another gets at least one solution with a counterclockwise P_{13} amplitude. Resonant P_{13} is claimed by REBKA 70, KATO 70, ERNE 70, and GIACOMELLI 70; the results of the other five analyses are not so clear cut. AYED 70 claim that the speed of variation of the amplitude as a function of the energy is nearly as well fit by a smoothly varying background as by a broad (500-MeV) Breit-Wigner amplitude superimposed on a background. For this reason they claim one is not obliged to invoke a resonance. BENNETT 70 got two solutions: the preferred one shows no resonant behavior; the other one might be resonant, but the errors on the amplitudes are too large to believe any circle drawn among them.

CARRERAS-1 70 get a P_{13} amplitude similar to that found in other analyses, which can be interpreted

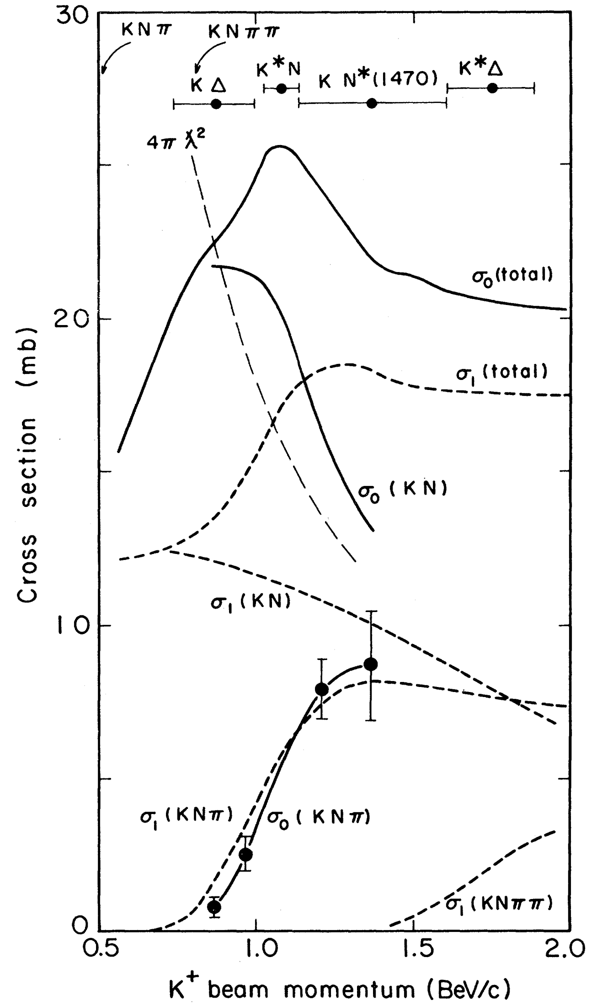

Fig. 1.

KN total and partial cross sections. Subscripts indicate isospin. Total cross sections are from CARTER 68, which uses data from COOL 66 and BUGG 68. Isospin-1 partial cross sections are adapted from a compilation made by BLAND 68. Isospin-0 partial cross sections are from HIRATA 68. Thresholds for various processes are indicated at the top.

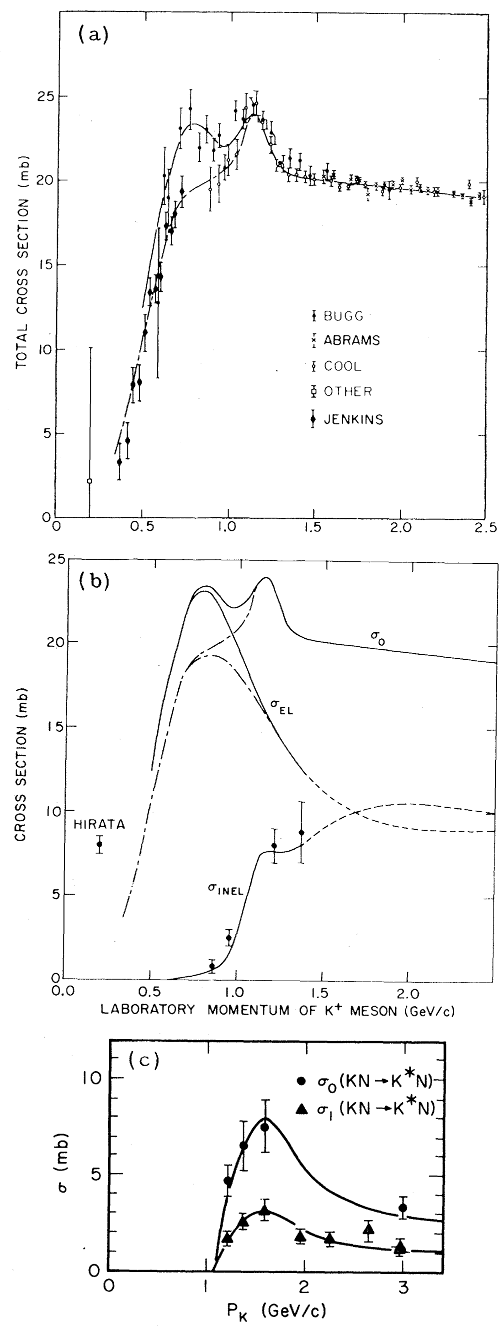

Fig. 2.

(a) The I = 0 KN cross section evaluated by COOL 70. The new data of Jenkins are reported in BOWEN 70.

(b) The I = 0 cross sections as obtained by the two possible interpretations of the data. This shows the uncertainties in the 0.8 to 1.2 GeV/c region.

(c) Energy dependence of the I-spin 0 and I-spin 1 cross sections for the reaction KN→ K^*N

Baryons

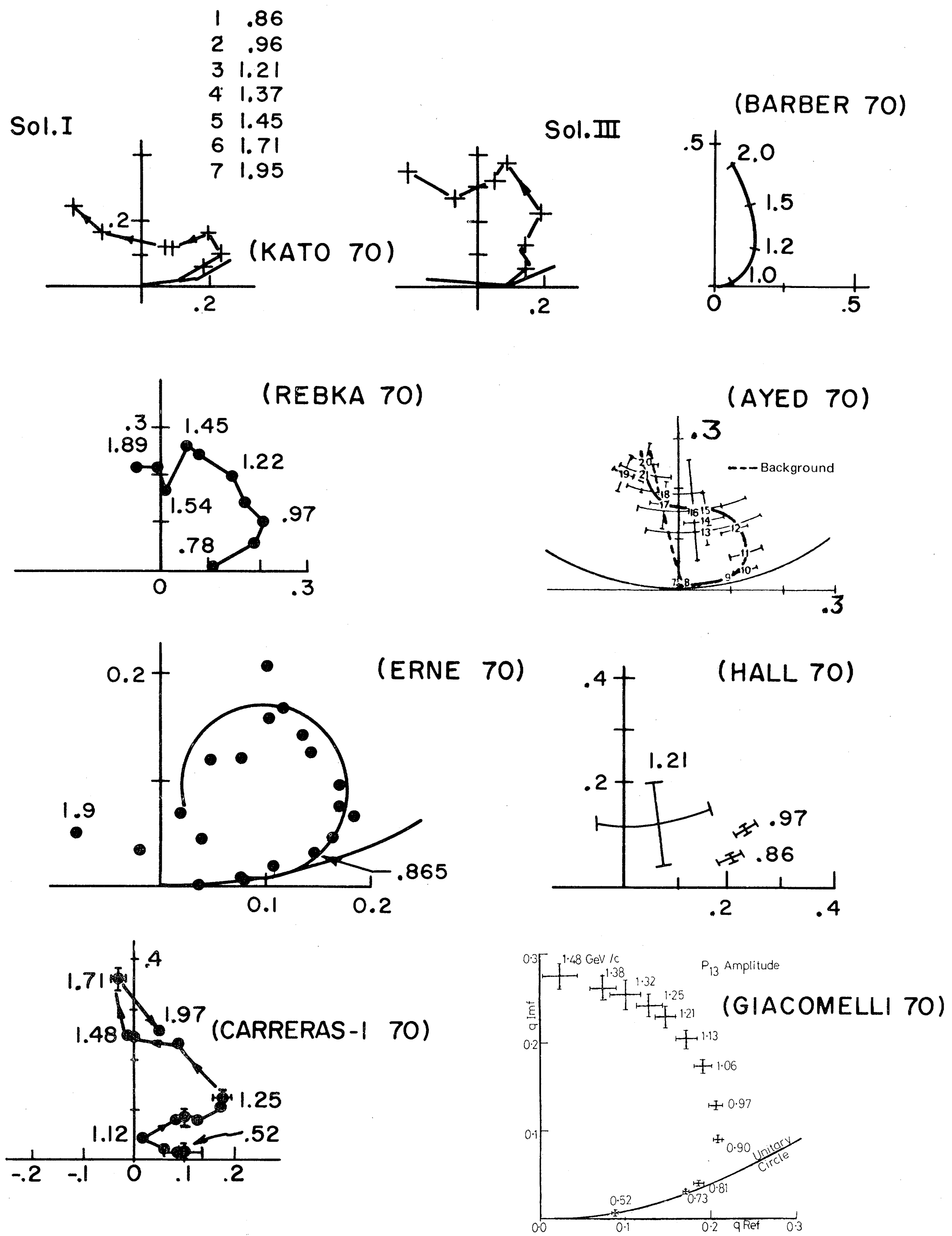

Fig. 3. Argand plots for the P_{13} partial wave as obtained in partial-wave analyses performed by the authors indicated. (CARRERAS-1 70 plotted by us from η, δ.)

as having resonant behavior, but do not feel that the resonance interpretation is compelling.

BARBER 70 include the new data up to 2.3 GeV/c. Their preferred solution is shown in Fig. 3 and shows no structure in the speed. They also report a second solution which resembles the Argonne solution I (KATO 70 in Fig. 3) below 1.8 GeV/c.

HALL 70 have presented an analysis that includes the elastic and inelastic data. The analysis was done at three momenta, and the P_{13} amplitude of their best solution is shown in Fig. 3. Here again the errors are really too large to detect any possible Breit-Wigner behavior.

The S_{11} amplitude. It should be mentioned that AYED 70 find a solution with the P_{13} negative and moving clockwise, and the S_{11} positive and moving counterclockwise. In this solution the S wave is essentially zero below 520 MeV/c, and a negative P_{11} wave rather than S wave would fit the angular distributions at low energy. The trouble with this solution is that the P_{11} phase shifts do not show the q^3 dependence at low energy as required from a P wave. CARRERAS 70 report an attractive S wave at low energy. This is in contradiction with the constructive interference between the elastic and Coulomb scattering suggested by the data. CARRERAS-1 70 mention the possibility that S and P_{11} waves contribute equally at low energy (below 300 MeV/c). This is also contradicted by the data, which do not show the required SP interference term. See GOLDHABER 70 for more discussions on the sign of the S_{11}.

Threshold effects. Another possible way to describe the P_{13} amplitude would be in terms of a coupled-channel threshold effect: the KN amplitude becomes rapidly absorptive as it feeds the rapidly increasing $K\Delta$ channel. The main question still remains: Is it also a resonance? If it is, its elasticity is small ($\approx$ 0.2) and it decays mainly into $K\Delta$. But a definite conclusion has yet to be made and awaits much more data.

One more comment on exotic resonances is that, as pointed out by ERNE 70, the present upper limits for the cross sections for production of broad exotic resonances are not very small; that is, they are of the same order as cross sections for Y^* or N^* production.

Conclusions. The existence of exotic resonances is still an open question. It looks to us that the following are needed:

1) More high-precision data in the critical region where the peak is seen.

2) The fit to the data should extend over a very wide region, down to threshold and up to 2 GeV/c as already done by ERNE 70, BARBER 70, and AYED 70.

3) Simultaneous study of elastic and inelastic channels should certainly help.

4) More emphasis on the speed plot.[2]

5) For the I = 0 states it would be very useful, however difficult it may be, to measure the elastic cross section.

References

1. V. J. Stenger, W. E. Slater, D. H. Stork, H. K. Ticho, G. Goldhaber, and S. Goldhaber, Phys. Rev. 134, B1111 (1964).

2. See the January 1970 edition of the Review of Particle Properties for some earlier speed plots and definitions.

$Z_0(1780)$

```
95  Z*0(1780, JP=1/2 ) I=0
THIS EFFECT, 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.

----------------   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 RVUE                     7/70
M   D    SEE ALSO DISCUSSION OF LYNCH 70                            7/70

----------------   95  Z*0(1780) WIDTH (MEV)   -------------------------

W        (565.0)               COOL     70 CNTR +  K+P, D TOTAL     1/71*

----------------   95  Z*0(1780) PARTIAL DECAY MODES   -----------------

                                                  DECAY MASSES
P1       Z*0(1780) INTO K N                      493+ 939

----------------   95  Z*0(1780) BRANCHING RATIOS   --------------------

R1       Z*0(1780) INTO (K N)/TOTAL              (P1)/TOTAL
RI         (0.95)              COOL     70 CNTR +  K+P, D TOTAL     1/71*

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                    REFERENCES -- Z*0(1780)

                SEE REFERENCES FOR THE Z*1(1900)

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$Z_0(1865)$

```
96  Z*0(1865, JP=    ) I=0
THIS EFFECT IS STRONGLY ASSOCIATED WITH THE K* N
THRESHOLD.  SEE HIRATA 68 AND 70.

----------------   96  Z*0(1865) MASS (MEV)   --------------------------

M        (1868.0)  (10.0)      KYCIA    67 CNTR   K+P, D TOTAL      8/67
M        (1860.0)  (15.0)      CARTER   67 THEO   DISPERSION REL.   8/67

----------------   96  Z*0(1865) WIDTH (MEV)   -------------------------

W        (160.0)   (30.0)      KYCIA    67 CNTR                     8/67
W        (200.0)   (50.0)      CARTER   67 THEO                     8/67

----------------   96  Z*0(1865) PARTIAL DECAY MODES   -----------------

                                                  DECAY MASSES
P1       Z*0(1865) INTO K N                      493+ 939
P2       Z*0(1865) INTO N K*(890)                938+ 892

----------------   96  Z*0(1865) BRANCHING RATIOS   --------------------

R1       Z*0(1865) INTO (K N)/TOTAL              (P1)/TOTAL
R1         (0.40)   (0.05)     KYCIA    67 CNTR   IF J=1/2          8/67
R1         (0.31)   (0.05)     CARTER   67 THEO   IF J=1/2          8/67

R2       Z*0(1865) INTO N K*(890)                (P2)
R2          MAIN INELASTIC DECAY     HIRATA   68 HBC                11/68

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                    REFERENCES -- Z*0(1865)

                SEE REFERENCES FOR THE Z*1(1900)

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Baryons

For notation, see illustrated key at beginning of data card listings.

$Z_1(1900)$

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97  Z*1(1900, JP=     ) I=1

THIS EFFECT IS STRONGLY ASSOCIATED WITH THE K N*
THRESHOLD.  IF A RESONANCE, THE SPIN-PARITY IS ALMOST
CERTAINLY 3/2+.

----------------  97  Z*1(1900) MASS (MEV)  -------------------------

M         1900.0     10.0        COOL      70 CNTR ++ K+P TOTAL         1/71*
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
     1     THREE SOLNS IN ORDER OF DECREASING SIGNIFICANCE. THOUGH AYED 70
     1     GIVE PARAMETERS,THEY CONCLUDE RESONANT INTERPRETATION DOUBTFUL.
M    2   (1840.0)                BARNETT   70 IPWA    P13,SOLN III      7/70
     2    RESONANCE SIGNAL BARELY ABOVE BACKGROUND DUE TO THE LARGE ERRORS
     2    IN THE AMPLITUDES RESULTING FROM THE ANALYSIS
M        (1959.0)                ERNE      70 IPWA    P13               6/70
M        (1880.0)   (90.0)       KATO      70 IPWA    P13 IN SOLN I     6/70
M        (1950.)   (100.)        KATO      70 IPWA    SOL. III          7/70

----------------  97  Z*1(1900) WIDTH (MEV)  -------------------------

W         (240.0)                COOL      70 CNTR ++ K+P TOTAL         1/71*
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)                AYED      70 IPWA    K+P               6/70
W    2     (80.0)                BARNETT   70         K+P EIPWA         7/70
W         (251.0)                ERNE      70 IPWA    K+P               6/70
W         ABOUT 130.0            KATO      70 IPWA    P13 IN SOLN I     6/70
W         (180.)   APPROX.       KATO      70 IPWA    SOL. III          7/70
      SEE THE NOTES ACCOMPANYING MASSES QUOTED.

----------------  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(1236) K              1236+ 493

----------------  97  Z*1(1900) BRANCHING RATIOS  --------------------

R1        Z*1(1900) INTO (K N)/TOTAL                   (P1)/TOTAL
R1          (0.10)      OR LESS      CARTER    67 THEO    DISPERSION REL.   8/67
R1          (0.12) (ASSUMING J=3/2)  COOL      70 CNTR ++ K+P TOTAL         1/71*
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          (0.15)                   ERNE      70 IPWA                      6/70
R1        ABOUT 0.1                  KATO      70 IPWA    P13 IN SOLN I     6/70
R1          (0.28) APPROX.           KATO      70 IPWA    SOL. III          7/70
R1   2      (0.09)                   BARNETT    70        K+P EIPWA         7/70

      SEE NOTES ACCOMPANYING THE MASSES QUOTED.

R2        Z*1(1900) INTO K N*3/2(1236)                 (P2)
R2            MAIN INELASTIC DECAY   BLAND     67 HBC ++                    8/67

---------------    Z*1 CROSS SECTION LIMITS (MICROBARNS)   -------------

      SEE MINIREVIEW PRECEDING Z*0

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 -- Z*1(1900)

    TOTAL-CROSS-SECTION EXPERIMENTS  ---
COOL      66 PRL 17 102         +GIACOMELLI,KYCIA,LEONTIC,LI,LUNDBY,+ (BNL) I
    --  SLIGHTLY REVISED RESULTS FROM KYCIA 67 REPLACE COOL 66 --
KYCIA     67 PRIVATE COMM.      T F KYCIA                             (BNL) I
ABRAMS    67 PRL 19 259         +COOL,GIACOMELLI,KYCIA,LEONTIC,LI, +  (BNL)
BUGG      68 PR 168 1466        +GILMORE,KNIGHT, +    (RTHFD,BRMGHM,CVNDSH) I
    --  COOL 66, ABRAMS 67, AND ABRAMS 69 ARE SUPERCEDED BY COOL 70 AND
        ABRAMS 70.
ABRAMS    69 PL 30B 564         +COOL, GIACOMELLI, KYCIA, LI, MICHAEL (BNL)IJ
ABRAMS    70 PR D1 1917         +COOL, GIACOMELLI, KYCIA, LEONTIC, +  (BNL) I
BOWEN     70 PR D2 2599         +CALDWELL, DIKMEN, JENKINS, KALBACH,+(ARIZ) I
COOL      70 DUKE CONF 47       R L COOL                              (BNL)
COOL 1    70 PR D1 1887         +GIACOMELLI, KYCIA, LEONTIC, LI, +    (BNL) I
DOWELL    70 DUKE 53            J.D. DOWELL                          (BIRM)
LYNCH     70 DUKE 9             G LYNCH (REVIEWER OF CR.SEC. DATA)    (LRL)

    DISPERSION-RELATION CALCULATION USING TOTAL-CROSS-SECTION DATA  ---
CARTER    67 PRL 18 801         A A CARTER                      (CAVENDISH)
CARTER    68 PREPRINT           A A CARTER                      (CAVENDISH)

    A K-MATRIX ANALYSIS OF SOME OF THE EARLY K+P DATA ---
HITE      67 THESIS             G E HITE                         (ILLINOIS)

    A REGGE-POLE ANALYSIS EXTENDED TO LOW ENERGIES --
CARRERAS 70 NP B19 349          B CARRERAS, A DONNACHIE  (DARESBURY,MANCH)

    EXPERIMENTS MAINLY ABOUT INELASTIC CHANNELS ---
BLAND     67 PRL 18 1077        +BOWLER,BROWN,G+S GOLDHABER,SEEGER,+  (LRL)
BLAND     68 UCRL-18131 THESIS R W BLAND                              (LRL)
HIRATA    68 PRL 21 1485        HIRATA, WOHL, GOLDHABER, TRILLING     (LRL)
BLAND     69 NP B13 595         +BOWLER, BROWN, KADYK, GOLDHABER, +   (LRL)
BLAND     70 NP B18 537         +BOWLER, BROWN, GOLDHABER,            (LRL)
    --  BLAND 69 AND BLAND 70 REPLACE BLAND 67 AND BLAND 68.
HIRATA    70 DUKE   429         +GOLDHABER,SEEGER,TRILLING+WOHL       (LRL)
BGRT      70 KIEV CONF            (BOLOGNA, GLASGOW, ROME, TRIESTE COLLAB) I

    THE MAIN ELASTIC-SCATTERING AND POLARIZATION EXPERIMENTS AND PHASE-SHIFT
    ANALYSES --
CARROLL   68 PRL 21 1282        +FISCHER, LUNDBY, PHILLIPS, +    (BNL,ROCH)
ANDERS-1  69 PL 28B 611         ANDERSSON, DAUM, ERNE, LAGNAUX, +    (CERN)
ASBURY    69 PRL 23 194         +DOWELL, KATO, LUNDQUIST, NOVEY, + (ARG,MD)
BLAND     69 PL 29B 618         R W BLAND, G GOLDHABER, G H TRILLING  (LRL)
ANDERS-2  69 PL 30B 56          ANDERSSON, DAUM, ERNE, LAGNAUX, +    (CERN)

AYED      70 PL 32B 404         +BAREYRE, FELTESSE, VILLET         (SACLAY)IJP
BARBER    70 PL 32B 214         +BROOME, DUFF, HEYMANN, IMRIE,+ (LOUC,RHEL)IJP
BARNETT   70 DUKE   443         +GOLDMAN,LAASANEN,STEINBERG      (MARYLAND)IJP
CARRERA1  70 NP B23 525         B CARRERAS, A DONNACHIE              (DARE)IJP
  ALSO    70 DUKE 447           +DONNACHIE,KIRSOPP        (DARE+MCHS+U.EDINB)
ERNE      70 DUKE   375         +SENS,WAGNER                         (CERN)IJP
GIACOMEL  70 NP B20 301         GIACOMELLI, GRIFFITHS,(BGNA,GLAS,ROMA,TRST)IJP
HALL      70 DUKE   435         +BLAND,GOLDHABER,TRILLING             (LRL)
KATO      70 PRL 24 615         +KOEHLER, NOVEY, YOKOSAWA, +     (ARG,NWES)IJP
REBKA     70 PRL 24 160         +ROTHBERG, ETKINS, GLODIS, +         (YALE)IJP

    EARLIER ANALYSES THAT DO NOT INCLUDE RECENT POLARIZATION DATA --
LEA       68 PR 165 1770        LEA, MARTIN, OADES           (PTHFD,BNL,CERN)
MARTIN    68 PRL 21 1286        B R MARTIN                              (BNL)
HALL      69 UCRL-19231         HALL, BLAND, GOLDHABER, TRILLING        (LRL)
LEA       69  LUND PAPER 362    LEA,MARTIN,OADES                   (RHEL+UCL)
CUTKOSKY 70 PR D1 2547          R E CUTKOSKY, B B DEO    (CARNEGIE-MELLON) I

    PRODUCTION EXPERIMENTS THAT LOOK FOR A Z* ---
TYSON     67 PRL 19 255         +GREENBERG,HUGHES,LU,MINEHART,MORI,  (YALE)
BASSOMPI 68 PL 27B 468          BASSOMPIERRE, +              (CERN,BRUXELLES)
MORI      68 PL 28B 152         +GREENBERG,HUGHES,LU,ROTHBERG, +      (YALE)
ANDERSON 69 PL 29B 136          +BLESER, BLIEDEN, COLLINS, + (BNL,CARNEGIE)
MORI      69 PR 185 1687        +GREENBERG, HUGHES, LU, MINEHART, +  (YALE)
    --  MORI 69 REPLACES TYSON 67 AND MORI 68.

    LATEST REVIEW TALKS
LEVISETT 69 LUND CONF 341       R LEVI SETTI  (RAPPORTEUR)        (CHICAGO)
GOLDHABE 70 DUKE   407          G.GOLDHABER (REVIEWER)                (LRL)

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Note on Y^*'s

The number of known or suspected Y^* states has increased considerably in the last few years, following closely a similar increase in the number of N^* states. Just as the recently discovered N^*'s are only weakly coupled in the $\pi N \to \pi N$ reaction, so also are the recently discovered Y^*'s only weakly coupled in the $\bar{K}N \to \bar{K}N$, $\bar{K}N \to \Lambda\pi$, and $\bar{K}N \to \Sigma\pi$ reactions. The older, well-established resonances are usually clearly visible as peaks in cross sections, as characteristic variations of angular distributions of 2-body final states, and (or) as peaks in invariant-mass distributions of subsets of particles in 3-or-more-body final states. Although some of the newer and less-well-established resonances are seen as small peaks in invariant-mass distributions, many of them make no direct appearance at all, often because there are many states at the same mass and it is not clear which ones (or how many) are being observed. Rather when the 2-body reactions are partial-wave analyzed, some of the amplitudes are found to traverse resonance-like counterclockwise circles. Clearly the results of partial-wave analysis give the J^P information, whereas a peak seen in an invariant mass distribution or a total cross section usually cannot be analyzed for its quantum numbers. We will keep information coming from formation experiments and from production experiments separate, whenever necessary.

Production experiments. These types of experiments are often difficult to analyze. Information on I = 0 states is possible only when there is no I = 1 state at similar mass. The main controversies at the present time concern resonances in the 1600 to 1700 MeV region. See the mini-reviews on $\Sigma(1620)$ and on $\Sigma(1670)$ in the listings. A good review is given by MILLER 70.[1] Also, the branching ratios of $\Sigma(1915)$ F_{15} as measured in formation and productions experiments do not agree. This is probably due to two facts: 1) the elasticity is small, 2) the nearby $D_{13}(1940)$ may contribute to production experiments.

Formation experiments. Partial-wave analyses have been performed on $\overline{K}N$, $\Lambda\pi$, $\Sigma\pi$ and ΞK 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. Usually many solutions are found and even when it is required that solutions at neighboring energies join smoothly, it is not possible to select a unique overall solution. To overcome this, one specifies the form of the energy dependence of some or all of the partial-wave amplitudes. Analyses in which the energy dependence of all the amplitudes is specified are called energy dependent. When referring to results of this type of analysis, the technique listed is DPWA. Thus an amplitude known to resonate will be given a Breit-Wigner form, whereas an amplitude not *a priori* known to resonate may be tried alternately with a resonance form and with some simple nonresonant form, the choice between these then being made by comparing the goodness-of-fit for the two fits. See the Note on Resonance Parameters preceding the Baryon listings for additional discussion of DPWA and of the K-Matrix parametrization of KIM 71.

Analyses in which most of the amplitudes are left unspecified are called (not quite correctly) energy independent. The technique used for these analyses is listed as IPWA. Figure 1 shows results of such an analysis of the reaction $K^-p\to\Lambda\pi$ by ARMENTEROS 70. The D_{15} amplitude was fixed as the $\Sigma(1765)$, with resonance parameters obtained from an earlier energy-dependent analysis. This amplitude acts as an analyzer for the other amplitudes, which were allowed to vary freely. The S_{11} and D_{13} amplitudes appear to resonate. Figure 2 shows results of a similar analysis, also by ARMENTEROS 70, of the reaction $K^-p\to\Sigma\pi$. Here the $D_{03}\Lambda(1520)$, $D_{13}\Sigma(1670)$, $D_{03}\Lambda(1690)$, $D_{15}\Sigma(1765)$, $F_{05}\Lambda(1820)$, and $F_{15}\Sigma(1910)$ were fixed. It appears that several of the other amplitudes may resonate too. It should be clear from the figures that it is not always possible to decide whether or not an amplitude resonates. Neither is it possible to determine very accurately the parameters of the amplitudes that do resonate, nor to assign meaningful errors to the parameters. The state of knowledge of the newer Y^*'s is rather more qualitative than quantitative.

Partial-wave analyses above 1.1 GeV/c. One of us[2] has reviewed this energy region at the Duke Conference on Hyperon Resonances. The $\Lambda\pi$ channel has been analyzed by five groups, using different sets of data points that are in very good agreement with each other. LITCHFIELD 70 has used all the data, which plotted together show absolutely no discrepancies. In spite of this fact the five analyses agree only on three of the eight partial waves used to fit the data! And all five groups claim to obtain a good fit. Table I, taken from Ref. 2, shows the resonances included in the fits; the other partial waves were parametrized as background amplitudes with the indicated number of parameters. The three partial waves where agreement was found were D_{15}, F_{15}, F_{17}.

The problem here, more than insufficient data, is that the $\Lambda\pi$ channel alone is not constrained very much and a large number of solutions can be found. For the $\Sigma\pi$ channel, where two I-spin states are present, the interference terms certainly help to reduce the number of possible solutions. Table II, again taken from Ref. 2, is a summary of the states claimed above 1.1 GeV/c where, in view of the above difficulties, most of the new states have been classified "wait". The signs of the amplitudes at resonance follow the convention advocated by Levi Setti.[3] Clearly, resonances have to show up very strongly in at least one channel before they are accepted without reservation.

Errors on masses and widths. Often the quoted errors are only statistical, but, as discussed in the Note on Resonance Parameters, at the beginning of the Baryon listings, the values of masses and widths can change well above 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.

Recently it has become the custom to quote errors as obtained by inspection of various fits done with different hypotheses [see for example BERTHON 70 and GALTIERI 70 under $\Sigma(1915)$]. These errors are probably more realistic. In conclusion, we chose not to give errors on masses and widths determined in partial-wave analyses, but, whenever necessary, we give a range of values.

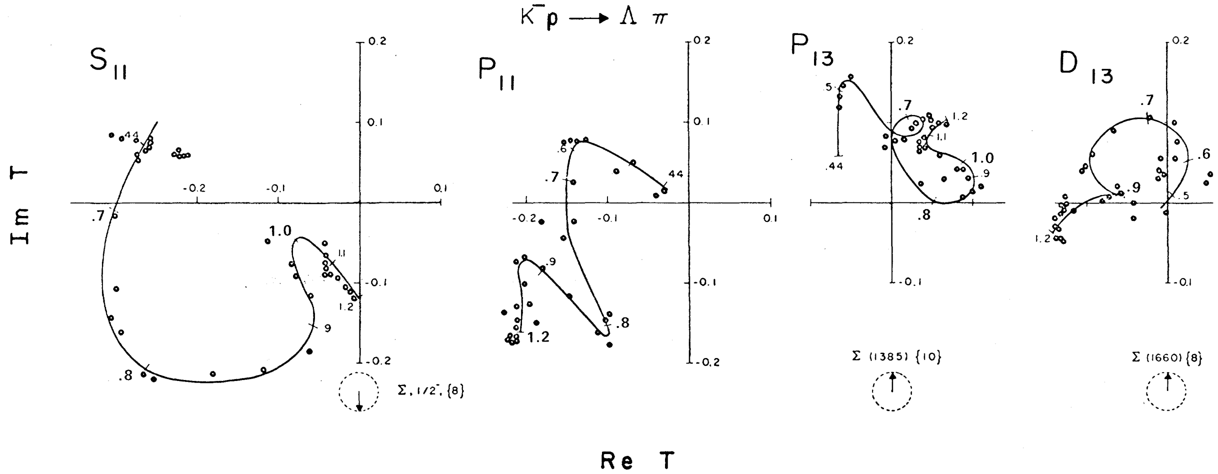

Fig. 1. Partial-wave amplitudes for the reaction $K^-p \rightarrow \Lambda\pi$, as determined in the energy-independent analysis of ARMENTEROS 69. The K^- laboratory momenta are indicated. The arrows in a circle, drawn in the lower part of the imaginary axes, fix the sign convention used. See LEVI SETTI 69. Notice that the sign convention used here is different from the one of the Argand plots of our 1969 edition [Rev. Mod. Phys. 41, 109 (1969)].

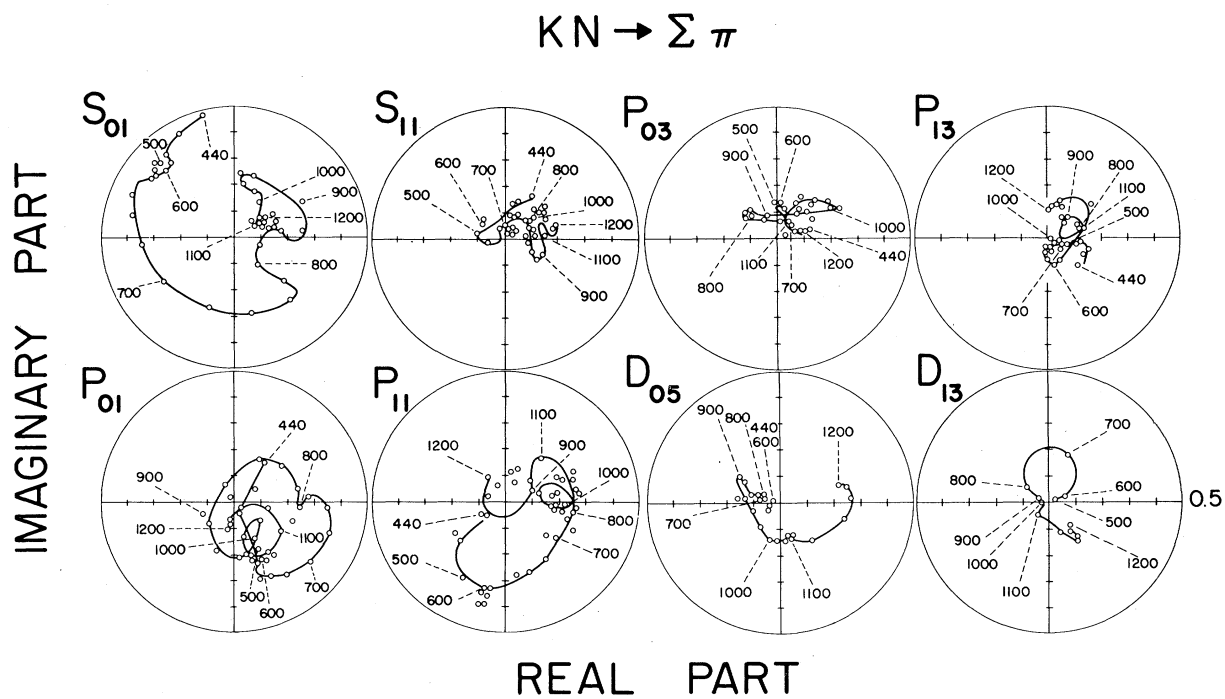

Fig. 2. Partial-wave amplitudes for the reaction $K^-p \rightarrow \Sigma\pi$, as determined in the energy-independent analysis of ARMENTEROS 70. The K^- laboratory momenta are indicated. Here again the sign convention follows LEVI SETTI 69.

Baryons

Table I. Results of partial-wave analyses in the $\Lambda\pi$ channel. In the second column N = 50 means that 50 parameters were used in the overall fit. In the first row to the right, N_{par} indicates how many parameters were used for that partial wave. R(4) means that the resonant amplitude included four parameters (M, Γ, |t|, Φ).

		N_{par}	P_{11}	P_{13}	D_{13}	F_{15}	F_{17}	G_{17}	[d] G_{19}
[a]SMART 66	$\Lambda\pi^-$, $\Lambda\pi^0$	N_{par}	4+R(4)	6	6	4+R(4)	R(4)	3	3
	.75-1.9 GeV/c	M	1882±40			1902±11	2032±6		
	N=50	Γ	222±150			52±25	160±16		
	χ^2/DF =418/390	t	-.11±.03			-.08±.02	.21±.01		
BERTHON 70	$\Lambda\pi^0$	N_{par}	4	8	4	8+R(4)	R(3)	4	---
	1.134-1.84 GeV/c	M				1910±20	2030±10		
	N=39	Γ				60±20	165^{+30}_{-15}		
	χ^2/DF =319/295	t				-.10±.02	.20±.02		
[b]COX 70	$\Lambda\pi^-$	N_{par}	6	3+R(3)	3	3+R(3)	R(3)	3	3
	1.18 -1.71 Gev/c	M		[b]2100±20		1903±10	2027±6		
	N=40	Γ		87±20		77±27	158±16		
	χ^2/DF =258/199	t		-.16±.03		-.09±.02	.19±.01		
[b]LITCHFIELD 70	$\Lambda\pi^-$, $\Lambda\pi^0$	N_{par}	5+R(3)	4+R(3)	4+R(3)	5+R(3)	R	7	---
	1.0 -1.85 GeV/c	M	1920±30	2070±30	1940±30	1895±10	2022±4		
	N=54	Γ	170±40	250±40	280±40	70±15	170±15		
	χ^2/DF =705/636	t	-.14±.03	-.09±.03	-.14±.03	-.070±.015	.200±.008		
[e]GALTIERI 70	$\Lambda\pi^0$	N_{par}	4+R(4)	4	R(4)	4+R(4)	R(3)	R(3)	R(1)
	1.0 -1.85 GeV/c	M	1950±50		1940±50	1905±30	2010±15	2060±20	[2250]
	N=38	Γ	200±50		200±50	70±20	115±15	70±30	[140]
	χ^2/DF =299/245	t	-.09±.04		-.12±.04	-.11±.03	.16±.03	-.07±.02	-.18

a. The D_{15} state $\Sigma(1765)$ was also included in the analysis; the following parameters were found: M = 1775±7, Γ = 146±9, t = -.266±.017.

b. Parameters reported here are the ones of fit 13, except for the P_{13} where mass and errors have been estimated by us, examining the various fits reported by the authors. The other errors are only statistical.

c. The results quoted are the ones from fit A.

d. $\Sigma(2250)$, G_{19} is really outside the range of most analysis, but its lower tail can be included instead of a G_{19} background.

e. Quantities in square brackets have been kept fixed. This paper also reports a fit from 0.61 to 1.85 GeV/c.

Table II. Summary of the results obtained for eleven states above 1800 MeV. For the $\overline{K}N$ channel, the elasticity x is listed. For the other channels, the quantity listed is t, the amplitude at resonance ($t = \sqrt{x_e x}$). The last column is our rating for the resonance.

		M (MeV)	Γ (Mev)	$\overline{K}N$ x	$\Lambda\pi$ t	$\Sigma\pi$ t	ΞK t	Status
$\Lambda(1870)$	F_{07}?	1870	40	.10				Poor
$\Lambda(2015)$	F_{07}	2020	160			-.15		Wait
$\Lambda(2040)$	D_{03}	2010	130			-.20	(?)[a]	Wait
$\Lambda(2100)$	G_{07}	2100	60-145	.29		.06	seen[b]	Good
$\Sigma(1900)$	P_{11}	~1900	200		-.11			Poor
$\Sigma(1915)$	F_{15}	1905	60	.10	-.09	-.09	.008	Fair
$\Sigma(1940)$	D_{13}	1940	200		-.13	-.12	(?)[a]	Wait
$\Sigma(2020)$	F_{17}	2020	100-170	.1-.25	.19	-.05	.023	Good
$\Sigma(2070)$	P_{13}	~2100	87-250		-.12			Poor
$\Sigma(2120)$	G_{17}	~2100	~100		-.07	.13		Wait
[c]$\Sigma(2250)$	G_{19}?	2040	~160	.05	(-.18)[c]	(.07)[c]		Fair

a. The analysis of BURGUN 68 suggests a J = 3/2 state with either I-spin in this mass region.
b. The two analysis of the ΞK channel do not agree on this value (see BURGUN 68 and MULLER 69).
c. This state is really outside the region where the analyses have been done. Here it has been assumed to be a G_{19} state, as suggested by the analysis of DAUBER 66.

Conclusions. Table III 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 definitely are many new resonances underlying those we are more familiar with.

Changes in format. When determining branching ratios from partial wave analyses, the quantity most accessible is the so-called "amplitude at resonance". This is essentially the diameter of the resonant circle in the Argand plot. For a resonance going from channel 1 to channel 2, this is simply $i\sqrt{x_1 x_2}$

For notation, see illustrated key at beginning of data card listings.

in the notation in the main text (section IV. C). Thus while an analysis of $K^-p \rightarrow \Sigma\pi$ data could give a reliable value for $\sqrt{x_{\overline{K}N} x_{\pi\Sigma}}$, a determination of $x_{\pi\Sigma} = \Gamma_{\pi\Sigma}/\Gamma_{tot}$ would require a value of the elasticity ($x_{\overline{K}N}$) which is often unavailable or not so well known.

For these reasons we now give the amplitudes at resonance in place of the two body inelastic branching ratios. Where explicit, the sign of these amplitudes is according to the SU(3) convention advocated by Levi Setti[3], and shown here in Figure 3 to avoid confusion.

SU(3) RELATIVE SIGN OF RESONANT AMPLITUDES

$$T_{RES} \sim \phi\,(g_{N\bar{K}Y^*} \cdot g_{Y\pi Y^*})/(E_R - E - i\,\Gamma/2)$$

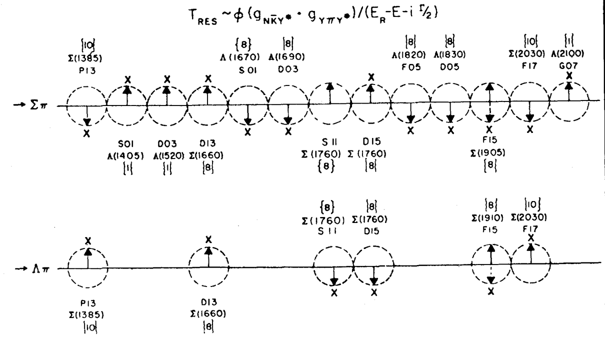

Fig. 3. Plot reproduced from Levi Setti[3] showing the sign convention adopted here for the $\Sigma\pi$ and $\Lambda\pi$ amplitudes. Once the signs of one I = 0 and one I = 1 amplitude are fixed, the others can be measured relative to these two. Arrows here indicate signs predicted by SU(3); X marks indicate the observed phases.

As noted above, errors quoted for parameters are often statistical only. On the other hand, the value of the parameter itself may be consistent with other determinations and often may even be the best available value. In such circumstances we put only the error in parentheses to remind the reader of the additional uncertainty due to model dependent assumptions. For two states, Λ(1820) and Σ(1765), there is enough data available to perform an overall fit of the type discussed in the main text (section V. C). 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.

References

1. D. H. Miller, in Proceedings of the Duke Conference on Hyperon Resonances (1970), p. 229.
2. A. Barbaro-Galtieri, in Proceedings of the Duke Conference on Hyperon Resonances (1970), p. 173.
3. For a recent review of Y* resonances see R. Levi Setti, rapporteur talk at the Lund International Conference on Particle Physics (Lund, June 1969).

Table III. STATUS OF THE Y* RESONANCES. THOSE WITH AN OVERALL STATUS OF *** OR **** ARE INCLUDED IN THE MAIN BARYON TABLE.

			STATUS AS SEEN IN --				
PARTICLE	LIJ	OVERALL STATUS	TOTAL≠ CR. SEC.	KBAR N	LAM PI	SIG PI	OTHER CHANNELS
LAM(1115)	P01	****					WEAK TO N PI
LAM(1330)		*					LAM GAM
LAM(1405)	S01	****			F	****	
LAM(1520)	D03	****	****	****	O	****	LAM 2PI,LAM GA
LAM(1670)	S01	****		***	R	***	LAM ETA
LAM(1690)	D03	****	****	****	B	****	LAM 2PI,SIG 2P
LAM(1750)	P01	**		**	I	**	
LAM(1815)	F05	****	****	****	D	****	SIG(1385) PI
LAM(1830)	D05	***		**	D	****	
LAM(1860)	P03	**	*	**	E	*	
LAM(1870)	S01	**		**	N		
LAM(2010)	D03	**			F	**	
LAM(2020)	F07	**			O	**	
LAM(2100)	G07	****	****	****	R	***	
LAM(2110)	F05	*			B	*	
LAM(2350)		****	****	****	I		
LAM(2585)		**	**	*	D		
SIG(1190)	P11	****					WEAK TO N PI
SIG(1385)	P13	****			****	****	
SIG(1440)	PE	*			*		
SIG(1480)	PE	*		*	*	*	
SIG(1620)	S11	**		**		*	
SIG(1620)	P11	**		*		**	
SIG(1620)	PE	**			**		LAM 2-PI
SIG(1670)	D13	****	**	**	***	****	SEVERAL OTHERS
SIG(1670)	PE	**					LAM(1405) PI
SIG(1690)	PE	**	*		**		LAM 2-PI
SIG(1750)	S11	***		**	**		SIG ETA
SIG(1765)	D15	****	****	****	****	**	SEVERAL OTHERS
SIG(1880)	P11	**		**	**		
SIG(1915)	F15	***	***	**	***	**	
SIG(1940)	D13	**			**	**	
SIG(2030)	F17	****	****	****	****	**	
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 CONFIRMATION.
* WEAK.

≠ ATTRIBUTED TO THE STATE CLOSEST TO WHERE THE CROSS SECTION PEAKS.

Λ

18 LAMBDA (1115,JP=1/2+) I=0

SEE LISTINGS OF STABLE PARTICLES

****** ********* ********* ********* ********* ********* ********* ********
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Λ(1330) BUMPS

87 Y*0(1330, JP=) I=0

SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

A PEAK IS SEEN NEAR 1330 MEV IN THE LAMBDA GAMMA SPECTRUM IN THREE PI- PROPANE EXPERIMENTS (YUNG-CHANG 64, BUBELEV 67, AND BOZOKI 68). IN THE FIRST TWO, THIS WAS TAKEN AS INDIRECT EVIDENCE FOR THE Y*0(1670) DECAYING TO LAMBDA ETA, WITH THE ETA DECAYING TO TWO GAMMAS. IN THE THIRD EXPERIMENT THIS INTERPRETATION HAS BEEN RULED OUT. BOZOKI 68 MENTION THE POSSIBILITY OF THERE BEING A Y*0(1330) WITH A NARROW WIDTH (LT 25 MEV), BUT DEFER SERIOUS CONSIDERATION OF IT UNTIL THERE IS MORE DATA.

SHOULD SUCH A RESONANCE EXIST, IT SHOULD BE SEEN IN PI- P TO KO + (MISSING MASS). DAHL 67 FOUND NO EVIDENCE FOR IT.

A SEARCH FOR A NEW Y*0 NEAR THE LAMBDA OR SIGMA MASS WAS MADE BY TAN 69. NONE WAS FOUND.
ANOTHER SEARCH BY MAYEUR 70 REVEALED NO EVIDENCE FOR THIS STATE.

****** ********* ********* ********* ********* ********* ********* *******

REFERENCES -- Y*0(1330)

Y-CHANG	64 DUBNA CONF I 615	YUNG-CHANG, IN, KLADNITSKAYA, +	(DUBNA)
BUBELEV	67 PL 24B 246	+CHADRAA, CHUVILO, +	(JINR,BUCHAREST,CERN)
DAHL	67 PR 163 1377	DAHL, HARDY, HESS, 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)

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****** ********* ********* ********* ********* ********* ********* *******

Λ(1405) BUMPS

37 Y*0(1405, JP=1/2-) I=0 **S_{01}**

THIS RESONANCE CAN BE IDENTIFIED WITH THE VIRTUAL BOUND STATE IN THE KBAR-N SYSTEM FOUND IN THE ANALYSIS OF LOW ENERGY K-P INTERACTION. WE LIST SUCH EXPERIMENTS SEPARATELY BELOW. WE USE ONLY PRODUCTION EXPERIMENTS FOR AVERAGING OF MASSES AND WIDTHS -

37 Y*0(1405) MASS (MEV)

M		(1405.0)		ALSTON	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		1400.0	24.0	MUSGRAVE	65 HBC	PBAR P 3-4 BEV/C	7/66
M		(1382.0)	(8.0)	ENGLER	65 HDBC	PI-P, PI+D 1.68	7/66
M	67	1400.0	5.0	BIRMINGHA	66 HBC	3.5 K- P	9/67
M	120	1405.0	5.0	GALTIERI	68 DBC	K-D 2.1-2.7BEV/C	6/68
M		. . . .					
M	AVG	1402.4	3.5	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)			

For notation, see illustrated key at beginning of data card listings.

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----------------   37  Y*0(1405) WIDTH (MEV)   --------------------------

W          (20.0)                  ALSTON     61 HBC                      7/66
W           35.0      5.0          ALEXANDER  62 HBC
W          (50.0)                  ALSTON     62 HBC
W           60.0     20.0          MUSGRAVE   65 HBC                      7/66
W          (89.0)   (20.0)         ENGLER     65 HDBC                     7/66
W      67   50.0     10.0          BIRMINGHA  66 HBC     3.5 K- P         9/67
W     120   35.0      8.0          GALTIERI   68 DBC     K-D 2.1-2.78EV/C 6/68
W            . . . . . . . . . .
W   AVG     38.1      3.9      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

----------------   37  Y*0(1405) PARTIAL DECAY MODES   ------------------

                                                         DECAY MASSES
P1         Y*0(1405) INTO SIGMA PI                      1197+ 139

****** ********* ********* ********* ********* ********* ********* ********

                             REFERENCES -- Y*0(1405)

ALSTON    61 PRL 6 698          +ALVAREZ,EBERHARD,GOOD,GRAZIANO, +      (LRL) I
ALEXANDE  62 PRL 8 447          ALEXANDER,KALBFLEISCH,MILLER,SMITH      (LRL) I
ALSTON    62 CERN CONF 311      +ALVAREZ,FERRO-LUZZI,ROSENFELD, +       (LRL) I
MUSGRAVE  65 NC 35 735          +PETMEZAS,+ (BIRMGHM,CERN,EP,IMPCOL,SACLAY)
ENGLER    65 PRL 15 224         +FISK,KRAEMER,MELTZER,WESTGARD,+ (CRNG,BNL) IJ

BIRMINGH  66 PR  152  1148      BIRMINGHAM,GLASGOW,I.C., OXFORD,RUTHERFORD
GALTIERI  68 PRL 21 573         BARBARO-GALTIERI,CHADWICK +         (LRL,SLAC)

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Λ(1405) EXTRAPOLATION BELOW THRESHOLD

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                 SEE NOTE IN Y*0(1405) PRODUCTION EXPERIMENTS -THE DIF-
                 FICULTIES IN EXTRAPOLATING FROM THE PHYSICAL REGION TO
                 THE RESONANCE LOCATION ARE DISCUSSED BY DALITZ 67.

----------------   37  Y*0(1405)  MASS (MEV)   --------------------------

M          1410.7     (1.0)        KIM        65 HBC     0-EFF-RANGE FIT   7/66
M          1409.6     (1.7)        SAKITT     65 HBC     0-EFF-RANGE FIT   7/66
M                       DATA OF SAKITT ARE USED IN FIT BY KITTEL.
M          1407.5     (1.2)        KITTEL     66 HBC     0-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

----------------   37  Y*0(1405) 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

****** ********* ********* ********* ********* ********* ********* ********

                      REFERENCES -- Y*0(1405) FROM EXTRAPOLATIONS

KIM       65 PRL 14 29          J K KIM                           (COLUMBIA)IJP
SAKITT    65 PR 139 B719        +DAY,GLASSER,SEEMAN,FRIEDMAN, +     (MD,LRL)IJP
KITTEL    66 PL 21 349          W KITTEL, G OTTER, I WACEK          (VIENNA)IJP
KIM       67 PRL 19 1074        J KIM                                 (YALE)JP
MARTIN    69 PR 183 1352        B R MARTIN, M SAKITT               (UCL+BNL)
MARTIN    70 NP B16 479         A D MARTIN, G G ROSS                (DURHAM)IJP

                      PAPERS NOT REFERRED TO IN DATA CARDS

ABRAMS    65 PR 139 B454        G S ABRAMS, B SECHI-ZORN                (MD)IJP
DALITZ    67 PR 153 1617        DALITZ, WONG, RAJASEKARAN   (OXFORD,BOMBAY)
DONALD    66 PL 22 711          + EDWARDS, LYS, NISAR, MOORE   (LIVERPOOL)
KADYK     66 PRL 17 599         +OREN, G+S GOLDHABER, TRILLING       (LRL)IJP
      --   ABRAMS 65, KADYK 66, AND DONALD 66 SUPPORT THOSE EFFECTIVE-RANGE-
           FIT SOLUTIONS GIVING AN I=0 S1/2 RESONANCE.

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                    END -EXTRAPOLATION BELOW THRESHOLD-

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Λ(1520)   38 Y*0(1520, JP=3/2-) I=0 D'_{03}

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               PRODUCTION AND FORMATION EXPERIMENTS AGREE QUITE WELL
               WITH EACH OTHER ,THEREFORE THEY HAVE NOT BEEN SEPARATED
               FOR THIS PARTICLE

----------------   38  Y*0(1520) MASS (MEV)   ---------------------------

M          1519.4      2.0         WATSON     63 HBC     K-P ALL CHANNELS
M      145 1517.2      3.0         GALTIERI   63 DBC     K-D 1.51 BEV/C
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      3.5 K- P         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 DISAGREEMENT 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            . . . . . . . . . . .
M   AVG    1517.85     0.95    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

---------------   38  Y*0(1520) WIDTH (MEV)   ---------------------------

W            16.4      2.0         WATSON     63 HBC
W           (19.0)   (19.0)        MUSGRAVE   65 HBC                       7/66
W       30  (50.0)   (10.0)        BIRMINGHA  66 HBC     3.5 K- P          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            . . . . . . . . . .
W   AVG      15.5      1.3     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

----------------   38  Y*0(1520) PARTIAL DECAY MODES   ------------------

                                                         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 SIGMA0 GAMMA                 1192+   0
P6         Y*0(1520) INTO SIGMA PI PI                  1197+ 139+ 139
P7         Y*0(1520) INTO (Y*1(1385)+PI)               1385+ 139

----------------   38  Y*0(1520) PARTIAL WIDTHS (MEV)   -----------------

W1         Y*0(1520) INTO KBAR N                               (P1)
W1  0        (4.8)     (0.5)          WATSON     63 HBC
W1  0   FOR NEW RESULTS SEE GALTIERI 69 AND BURKHARD 69 BELOW

W2         Y*0(1520) INTO SIGMA PI                             (P2)
W2  0        (9.0)     (1.0)          WATSON     63 HBC
W2  0   FOR NEW RESULTS SEE GALTIERI 69 AND BURKHARD 69 BELOW

----------------   38  Y*0(1520) BRANCHING RATIOS   ---------------------

R1      Y*0(1520) INTO (SIGMA PI)/(KBAR N)                (P2)/(P1)
R1           1.72      .78          MUSGRAVE  65 HBC                      8/67
R1           0.73      0.11         DAUBER    67 HBC    K-P AT 2.GEV/C    8/67
R1           0.96      0.20         DAHL      67 HBC    PI-P 1.6-4 GEV/C  9/66
R1           1.06      .14          SCHEUER   68 DBC   0 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            . . . . . . . . . . .
R1  AVG      0.851     0.064    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
R1  FIT      0.891     0.037   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2      Y*0(1520) INTO (LAMBDA PI PI)/(KBAR N)            (P3)/(P1)
R2           0.21      0.18         DAUBER    67 HBC    K-P AT 2.GEV/C    8/67
R2           0.17      0.05         DAHL      67 HBC    PI-P 1.6-4 GEV/C  9/66
R2            .19       .04         SCHEUER   68 DBC   0 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            . . . . . . . . . . .
R2  AVG      0.202     0.021    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2  FIT      0.210     0.017   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

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      3.5 K- P        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  FIT      4.24      0.35    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4      Y*0(1520) INTO (LAMBDA GAMMA)/TOTAL  (PERCENT)   (P4)/TOTAL
R4     238   0.80      0.14         MAST      68 HBC   0 USING ELAST=.45  11/68
R4            . . . . . . . . . . .
R4  FIT      0.80      0.14    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R5      Y*0(1520) INTO (SIGMA0 GAMMA)/TOTAL  (PERCENT)   (P5)/TOTAL
R5   S       2.0        .35         MAST      68 HBC      SEE NOTE S     10/69
R5   S    RATIOS CALCULATED FROM R4,ASSUMING SU(3). NEEDED TO CONSTRAIN
R5   S    ALL THE Y*0(1520) BRANCHING RATIOS TO BE UNITY.
R5            . . . . . . . . . . .
R5  FIT      2.00      0.35    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R6          Y*0(1520) INTO (KBAR N)/TOTAL                 (P1)/TOTAL
R6            .447     .018         GALTIERI  69 HBC    K- P .28-.45 G/C 10/69
R6           (0.45)                 KIM       71 DPWA   K-MATRIX ANAL.   3/71*
R6            . . . . . . . . . . .
R6  FIT      0.4579    0.0097  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R7          Y*0(1520) INTO (SIGMA PI)/TOTAL       69 HBC  (P2)/TOTAL
R7           0.418     .017         GALTIERI  69 HBC   0 K-P .28-.45GEV/C  6/69
R7          (0.46)                  KIM       71 DPWA   K-MATRIX ANAL.   3/71*
R7          WHERE EXPLICIT, THE SIGN IS IN THE LEVI SETTI CONVENTION.
R7          SEE THE NOTE AT THE START OF THE Y* LISTINGS.
R7            . . . . . . . . . . .
R7  FIT      0.4078    0.0099  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R8          Y*0(1520) INTO (SIGMA PI PI)/TOTAL            (P6)/TOTAL
R8            .010     .0015        GALTIERI  69 HBC   0 K-P .28-.45GEV/C 10/69
R8            . . . . . . . . . . .
R8  FIT      0.0100    0.0015  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R9          Y*0(1520) INTO (Y*1(1385)+PI)/(LAM PI PI)    (P7)/(P3)
R9            0.39     0.10         BURKHARDT 70 HBC      LAMB.3PI PROD.  3/71*
R9          GREATER THAN 0.10       CLINE     70  DBC    K-D TO 2PI LAM N  9/69

R10         Y*0(1520) INTO (Y*1(1385)+PI)/TOTAL           P7/TOTAL
R10           0.039    0.011        CHAN       70 HBC    K-P TO LAM 2PI   3/71*
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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  .458+-.010
 P 2    -.704     .408+-.010
 P 3    -.289       -.361     .096+-.007
 P 4    -.063       -.055       -.034     .008+-.001
 P 5    -.158       -.137       -.085       -.006     .020+-.003
 P 6    -.067       -.059       -.036       -.003       -.006     .010+-.001

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                          REFERENCES -- Y*0(1520)

WATSON    63 PR 131 2248        M B WATSON, M FERRO-LUZZI, R D TRIPP  (LRL)IJP
GALTIERI  63 PL 6 296           A BARBARO-GALTIERI,A HUSSAIN,RD TRIPP (LRL)
ALMEIDA   64 PL 9 204           S P ALMEIDA, G R LYNCH               (CERN)
MUSGRAVE  65 NC 35 735          +PETMEZAS,+ (BIRMGHM,CERN,EP,IMPCOL,SACLAY)
ARMENTER  65 PL 19 338          ARMENTEROS,F-LUZZI, +  (CERN,HEIDEL,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 24B 525         +MALAMUD,SCHLEIN,SLATER,STORK        (UCLA)
UHLIG     67 PR 155 1448        +CHARLTON,CONDON,GLASSER,YODH,+  (MD,USNRL)
MAST      68 PRL 21 1715        MAST,ALSTON,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)
GALTIERI  69  LUND PAPER 91     BARBARO-GALTIERI,BANGERTER,MAST,TRIPP (LRL)
CLINE     70 LNC 2 407          +LAUMANN+MAPP                     (U. WISC.)
KIM       71 HARVARD PREPRINT   J.K.KIM                            (HARV) IJP
  SEE ALSO  DUKE 161            J. K. KIM                          (HARV)IJP
CHAN      70 PREPRINT           +BUT.-SHAFER,HERTZBACH,KOFLER++ (MASS,YALE)
BURKHARDT70 CERN 70/58 SUB.NP   +FILTHUTH,KLUGE,OBERLACK++       (HEID,CERN)

                          PAPERS NOT REFERRED TO IN DATA CARDS

BERLEY    70 PR D1,1996         +YAMIN,KOFLER,MANN,MEISNER+ (BNL,MASS,YALE)IJP

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For notation, see illustrated key at beginning of data card listings.

Λ(1670)

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40  Y*0(1670, JP=1/2-) I=0                S'01

SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

 THIS RESONANCE IS WELL ESTABLISHED.
 (SEE THE NOTE FOR THE Y*0(1330)).

----------------  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 THRESHOLD, 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   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   A     1674.0     (5.0)          ARMENT-3  69 HBC  0  MULTICHANNEL      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   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 FROM THE RESTRICTIVE PARAMETERIZATION FORCED ON
M      THE PARTIAL-WAVE AMPLITUDES ARE NOT INCLUDED, AND CAN BE LARGE.

----------------  40  Y*0(1670) WIDTH (MEV)  -------------------------

W  M       (22.0)OR(15.0)           BERLEY    65 HBC  0  SEE NOTE M ABOVE  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*
          SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

----------------  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

----------------  40  Y*0(1670) BRANCHING RATIOS  --------------------

      BELOW X1 = (PARTIAL-WIDTH 1)/TOTAL WIDTH, ETC. A SIGN WHERE
      EXPLICIT, IS IN THE CONVENTION DISCUSSED IN THE Y* MINI-REVIEW.

R1      Y*0(1670) INTO (KBAR N)/TOTAL                     X1
R1  P        (0.14)    (0.04)       ARMENT-1  68 HBC  0  OLD DATA         11/68
R1  P         0.14     (0.04)       ARMENT-4  69 HBC  0  NEW DATA          9/69
R1            0.17                  ARMENT-3  69 HBC  0                    9/69
R1  A        (0.39)    (0.05)       CONFORTO  70 HBC  0  K-P,ELAST,CEX     6/70
R1            0.28                  KIM       71 DPWA    K-MATRIX ANAL.    3/71*
R1  A     EFFECT BELOW REGION ANALYSED. VALUE OF .18 DOES NOT
R1  A    AFFECT FIT OR VALUES OF OTHER 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) INTO (KBAR N)*(LAMBDA ETA)/TOTAL**2     (P1*P2)/TOTAL**2
R2  M        (0.039)OR 0.053        BERLEY    65 HBC  0  SEE NOTE M ABOVE  7/66
R2           (0.066)                ARMENT-3  69 HBC  0                    9/69
R2           (0.24)                 KIM       71 DPWA    K-MATRIX ANAL.    3/71*
      SEE THE NOTES ACCOMPANYING MASSES QUOTED

R3      Y*0(1670) FROM KBAR N TO SIGMA PI                SQRT(X1*X3)
R3          (-0.25)    (0.06)       ARMENT-2  68 HBC  0  OLD DATA
R3           -0.27                  ARMENT-3  69 HBC  0                    9/69
R3           -0.30     (0.03)       ARMENT-4  69 HBC  0  NEW DATA          9/69
R3           -0.27                  BERLEY    69 HBC  0  K-P TO SIGMA PI   6/70
R3           -0.29     (0.03)       GALTIERI  70 HBC  0  SIG PI,EDPWA      7/70
R3           -0.38                  KIM       71 DPWA    K-MATRIX ANAL.    3/71*

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                              REFERENCES -- 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
     --  ARMENTEROS 3 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
CONFORTO 70 EFI 70-28(SUB NP)  +HARMSEN+LASINSKI++               (EFI+HEID)
GALTIERI 70 DUKE 173           A. BARBARO GALTIERI                     (LRL)IJP
KIM      71 HARVARD PREPRINT   J.K.KIM                                (HARV) IJP
  SEE ALSO  DUKE 161           J. K. KIM                              (HARV)IJP

                               PAPERS NOT REFERRED TO IN DATA CARDS

BIRMING- 66 PR 152 1148        (BIRMINGHAM,GLASGOW,IMPCOL,OXFORD,RUTHERFD)
LEVISETT 69 LUND 339           R LEVI SETTI  (RAPPORTEUR)            (CHICAGO)

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Λ(1690)

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55  Y*0(1690, JP=3/2-) I=0                D''03

SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

 THIS RESONANCE IS WELL ESTABLISHED.

----------------  55  Y*0(1690) MASS (MEV)  --------------------------

M          1695.0     (4.0)         BUGG      68 CNTR 0  K-P, D TOTAL      7/68
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   M     (1697.0)    (2.0)         CONFORTO  68 HBC  0  ELASTIC, CH EXCH 11/68
M          1701.0     (4.0)         BERTANZA  69 HBC  0  ELASTIC, CH EXCH  9/69
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          1688.0     (3.0)         CONFORTO  70 HBC  0  K-P,ELAST,CEX     6/70
M          1680.0     (5.0)         GALTIERI  70 HBC  0  SIG PI,EDPWA      7/70
M          1690.                    KIM       71 DPWA    K-MATRIX ANAL.    3/71*
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.

----------------  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          40.0      (7.0)          BUGG      68 CNTR 0                    7/68
W          48.      (15.)           BARTLEY   68 DBC   0 K-P AND K-D DATA 11/68
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          28.0      (8.0)          BERTANZA  69 HBC  0                    9/69
W          57.0                     BERLEY    69 HBC  0  K-P TO SIGMA PI   6/70
W          85.0     (10.0)          GALTIERI  70 HBC  0  SIG PI,EDPWA      7/70
W          64.0      (5.0)          CONFORTO  70 HBC  0  K-P,ELAST,CEX     6/70
W          55.                      KIM       71 DPWA    K-MATRIX ANAL.    3/71*
          SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

----------------  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                  1139+ 139+ 139

----------------  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.

     BELOW X1 = (PARTIAL-WIDTH 1)/TOTAL WIDTH, ETC. A SIGN WHERE
     EXPLICIT, IS IN THE CONVENTION DISCUSSED IN THE Y* MINI-REVIEW.

R1     Y*0(1690) INTO (KBAR N)/TOTAL                        X1
R1           (0.23)                 BUGG      68 CNTR 0  ASSUMING J=3/2    7/68
R1           (0.18)    (0.03)       ARMENT-1  68 HBC  0                   11/68
R1  M        (0.22)    (0.03)       CONFORTO  68 HBC  0  SEE NOTE M ABOVE 11/68
R1            0.28     (0.04)       BERTANZA  69 HBC  0                    9/69
R1            0.18     (0.02)       ARMENT-4  69 HBC  0  NEW DATA          9/69
R1  N        (0.34)    (0.02)       CONFORTO  70 HBC  0  K-P,ELAST,CEX     6/70
R1            0.22                  KIM       71 DPWA    K-MATRIX ANAL.    3/71*
R1  N  EFFECT IS AT END OF REGION ANALYZED. THIS COULD AFFECT VALUE OF X1.

R2     Y*0(1690) FROM KBAR N TO SIGMA PI                   SQRT(X1*X2)
R2          (-0.33)    (0.02)       ARMENT-3  68 HBC  0  OLD DATA         11/68
R2           -0.36     (0.02)       ARMENT-4  69 HBC  0  NEW DATA          9/69
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*

R3     Y*0(1690) FROM KBAR N TO LAMBDA PI PI               SQRT(X1*X3)
R3            0.25     (0.02)       BARTLEY   68 HDBC 0  K-N TO LAM PI PI 11/68

R4     Y*0(1690) FROM KBAR N TO SIGMA PI PI                SQRT(X1*X4)
R4           (0.21)                 ARMENT-2  68 HDBC 0  K-N TO SIG PI PI 11/68

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                              REFERENCES -- Y*0(1690)

DAVIES   67 PRL 18 62          +DOWELL, +           (BRMNGHM,CVNDSH,RTHFRD) I
    --   REPLACED BY BUGG 68.
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,FLOR ST,BRANDEIS) I
BUGG     68 PR 168 1466        +GILMORE, KNIGHT, + (RTHFRD,BRMNGHM,CVNDSH) I
CONFORTO 68 NP B8 265          +HARMSEN, LASINSKI, +      (CHICAGO,HEIDEL)IJP

ARMENT-4 69 NP B14 91          ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
BERTANZA 69 PR 177 2036        +BIGI,CARRARA,CASALI, +       (PISA,BNL,YALE)IJP
BERLEY   69 PL 30B 430         + HART, RAHM, WILLIS, YAMAMOTO          (BNL)IJP
CONFORTO 70 EFI 70-28(SUB NP)  +HARMSEN+LASINSKI++               (EFI+HEID)IJP
GALTIERI 70 DUKE 173           A. BARBARO GALTIERI                     (LRL)IJP
KIM      71 HARVARD PREPRINT   J.K.KIM                                (HARV) IJP
  SEE ALSO  DUKE 161           J. K. KIM                              (HARV)IJP

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Λ(1750)

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77  Y*0(1750, JP=1/2+) I=0                P''01

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 BEHAVIOR OF THE P01 AMPLITUDE WHEN IT
WAS PARAMETRIZED AS A TWO-STRAIGHT-LINE BACKGROUND.  WHEN IT WAS RE-
PARAMETRIZED AS A RESONANCE SUPERIMPOSED ON A ONE-STRAIGHT-LINE BACK-
GROUND, A BROAD RESONANCE RESULTED (ARMENTEROS 68).  A REANALYSIS OF
ESSENTIALLY THE SAME DATA, BUT THIS TIME WITH THE P01 AMPLITUDE UNCON-
STRAINED, SUGGESTED A MUCH NARROWER RESONANCE AT HIGHER ENERGY (ARMEN-
TEROS 70).

  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 THE ARMENTEROS ANALYSES. FOR THIS REASON WE DO NOT QUOTE ANY
PARAMETERS FOR THE OTHER PARTIAL WAVES OBTAINED IN THIS ANALYSIS.

  ARMENTEROS 70, GALTIERI 70, AND KIM 71 PRESENT EVIDENCE FOR A
P01 STATE IN THE SIGMA PI CHANNEL. IN ADDITION THE ANALYSIS OF KIM 71
INDICATES A SECOND POSSIBLE P01 STATE AT ABOUT 1570. WE TENTATIVELY
LIST THESE EFFECTS TOGETHER.
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Baryons

For notation, see illustrated key at beginning of data card listings.

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-----------------   77  Y*0(1750) MASS (MEV)   ----------------------------

M   D     (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   1     (1570.)                       KIM       71 DPWA    K-MATRIX ANAL.    3/71*
M   1  POSSIBLE EFFECT IN SIGMA PI AND KBAR N CHANNELS.
M   0  OLD ANALYSIS, USING OLD DATA.

-----------------   77  Y*0(1750) 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   1       (50.)                       KIM       71 DPWA    K-MATRIX ANAL.    3/71*
        SEE THE NOTES ACCOMPANYING MASSES QUOTED

-----------------   77  Y*0(1750) PARTIAL DECAY MODES   -------------------

                                                         DECAY MASSES
P1        Y*0(1750) INTO KBAR N                          497+ 939
P2        Y*0(1750) INTO SIGMA PI                       1197+ 139

-----------------   77  Y*0(1750) BRANCHING RATIOS   ----------------------

      BELOW, X1 = (PARTIAL-WIDTH 1)/TOTAL WIDTH, ETC.  A SIGN, WHERE
      EXPLICIT, IS IN THE CONVENTION DISCUSSED IN THE Y* MINI-REVIEW.

R1    Y*0(1750) INTO (KBAR N)/TOTAL                  X1
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*

R2    Y*0(1750) FROM KBAR N INTO SIGMA PI            SQRT(X1*X2)
R2          (+0.20)                     ARMENTERO 70 DPWA 0  K-P TO SIGMA PI   6/70
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*
        SEE THE NOTES ACCOMPANYING MASSES QUOTED

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                         REFERENCES -- Y*0(1750)
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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 CONF 123    ARMENTEROS, BAILLON, +       (CERN, HEIDEL)IJP
GALTIERI 70 DUKE CONF 173    A BARBARO-GALTIERI                      (LRL)IJP
KIM      71 HARVARD PREPRINT J.K.KIM                                (HARV) IJP
  SEE ALSO  DUKE 161         J. K. KIM                              (HARV)IJP
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Λ(1815)

F05

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          39  Y*0(1815, JP=5/2+) I=0

          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 PARAMETERIZATION USED IN THE P.W.A. ARE
    NOT INCLUDED. FOR THIS REASON WE DO NOT CALCULATE WEIGHTED AVERAGES FOR
    MASS AND WIDTH.

-----------------   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  70 DPWA 0  ELASTIC, CH EXCH  6/70
M          1810.                     KIM       71 DPWA    K-MATRIX ANAL.    3/71*
M    N   ERROR STATIST. ONLY- NO ERROR DUE TO PARTICULAR P.W.ANAL. INCLUDED  1/71*

-----------------   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  70 DPWA 0  ELASTIC, CH EXCH  6/70
W           70.                      KIM       71 DPWA    K-MATRIX ANAL.    3/71*
       SEE THE NOTES ACCOMPANYING MASSES QUOTED

-----------------   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                  1385+ 139
P4        Y*0(1815) INTO SIGMA PI PI                   1192+ 139+ 139
P5        Y*0(1815) INTO LAMBDA PI PI                  1115+ 139+ 139

-----------------   39  Y*0(1815) BRANCHING RATIOS   ----------------------

      BELOW, X1 = (PARTIAL-WIDTH 1)/TOTAL WIDTH, ETC.  A SIGN, WHERE
      EXPLICIT, IS IN THE CONVENTION DISCUSSED IN THE Y* MINI-REVIEW.

      ERRORS QUOTED BY EXPERIMENTERS DO NOT INCLUDE UNCERTAINTY DUE
      TO PARAMETRIZATION USED IN THE P.W.A.  THEY SHOULD BE INCREASED.

R1    Y*0(1815) INTO (KBAR N)/TOTAL                  X1
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         (0.9)                     COOL      70 CNTR    K-P, D TOTAL     10/70*
R1          0.63      0.01           CONFORTO  70 DPWA 0  ELASTIC, CH EXCH  6/70
R1         (0.52)                    KIM       71 DPWA    K-MATRIX ANAL.    3/71*
R1        . . . . . . . . . .
R1  AVG     0.624     0.011    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
R1  FIT     0.6241    0.0099 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R2    Y*0(1815) FROM KBAR N INTO SIGMA PI            SQRT(X1*X2)
R2          0.27      0.01           ARMENT-1  67 DPWA 0  K-P TO SIGMA PI   8/67
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        . . . . . . . . . .
R2  AVG MOD 0.2641    0.0094   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
R2  FIT     0.2629    0.0089 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3    Y*0(1815) FROM KBAR N INTO Y*1(1385) PI        SQRT(X1*X3)
R3          0.3       0.05           ARMENT-2  67 HBC  0  K-P TO LAM PI PI  9/69
R3        . . . . . . . . . .
R3  FIT     0.327     0.033  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4    Y*0(1815) INTO (Y*1(1385) PI)/TOTAL            X3
R4          0.20      0.05           BIRGE     65 HBC  0  K-P TO LAM PI PI  7/66
R4        . . . . . . . . . .
R4  FIT     0.171     0.035  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R5    Y*0(1815) INTO (SIGMA PI PI)/TOTAL             X4
R5   P     NO CLEAR SIGNAL                   ARMENT-4  68 HDBC 0  K-N TO SIG PI PI 11/68
R5   P   THERE IS A SUGGESTION OF 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     0.094     0.036  FROM FIT
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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.

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       P 1         P 2         P 3        P 4
 P 1 .624+-.010
 P 2   -.230     .111+-.008
 P 3   -.047       .011     .171+-.035
 P 4   -.181      -.160       -.952     .094+-.036


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                        REFERENCES -- Y*0(1815)
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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, BAILLON, + (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

BRICMAN  70 PL 31B 152         +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
BRICMAN1 70 PL 33B 511         +FERRO-LUZZI,LAGNAUX                  (CERN)
COOL     70 PR 1D 1887         +GIACOMELLI, KYCIA, LEONTIC, LI, +    (BNL) I
GALTIERI 70 DUKE CONF 173      A BARBARO-GALTIERI                     (LPL)IJP
CONFORTO 70 NP (SUBMITTED)     +HARMSEN, LASINSKI, +      (CHICAGO, HEIDEL)IJP
KIM      71 HARVARD PREPRINT   J.K.KIM                               (HARV) IJP
  SEE ALSO  DUKE 161           J. K. KIM                             (HARV)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+ (EFINS,ARGON)
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
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Λ(1830)

D05

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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 APPEARS TO BE WELL ESTABLISHED.

-----------------   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    N     1831.0      (5.0)         CONFORTO  70 DPWA 0  ELASTIC, CH EXCH  6/70
M          1840.0     (15.0)         GALTIERI  70 DPWA 0  K-P TO SIGMA PI   7/70
M          1830.                     KIM       71 DPWA    K-MATRIX ANAL.    3/71*
M    K    (1720.)                    KIM       71 DPWA    K-MATRIX ANAL.    3/71*
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*

-----------------   56  Y*0(1830) 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          104.0     (35.0)          CONFORTO  70 DPWA 0  ELASTIC, CH EXCH  6/70
W          150.0     (30.0)          GALTIERI  70 DPWA 0  K-P TO SIGMA PI   7/70
W           80.                      KIM       71 DPWA    K-MATRIX ANAL.    3/71*
W    K     (20.)                     KIM       71 DPWA    K-MATRIX ANAL.    3/71*
       SEE THE NOTES ACCOMPANYING MASSES QUOTED

-----------------   56  Y*0(1830) PARTIAL DECAY MODES   -------------------

                                                       DECAY MASSES
P1        Y*0(1830) INTO KBAR N                         497+ 939
P2        Y*0(1830) INTO SIGMA PI                      1189+ 139
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Baryons

For notation, see illustrated key at beginning of data card listings.

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-----------------   56  Y*0(1830) BRANCHING RATIOS   ---------------------

      BELOW, X1 = (PARTIAL-WIDTH 1)/TOTAL WIDTH, ETC.  A SIGN, WHERE
      EXPLICIT, IS IN THE CONVENTION DISCUSSED IN THE Y* MINI-REVIEW.

R1    Y*0(1830) INTO (KBAR N)/TOTAL                     X1
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  70 DPWA 0  ELASTIC, CH EXCH  6/70
R1         (0.24)                 KIM       71 DPWA    K-MATRIX ANAL.    3/71*

R2    Y*0(1830) FROM KBAR N INTO SIGMA PI               SQRT(X1*X2)
R2          0.15     (0.02)       ARMENTERO 67 DPWA 0  K-P TO SIGMA PI   8/67
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*

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                         REFERENCES -- 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
    --  CONFORTO 68 IS SUPERSEDED BY CONFORTO 70.
BRICMAN1 70 PL 33B 511        +FERRO-LUZZI,LAGNAUX                  (CERN)
GALTIERI 70 DUKE CONF 173     A BARBARO-GALTIERI                    (LRL)IJP
CONFORTO 70 NP (SUBMITTED)    +HARMSEN, LASINSKI, +     (CHICAGO, HEIDEL)IJP
KIM      71 HARVARD PREPRINT  J.K.KIM                              (HARV) IJP
  SEE ALSO  DUKE 161          J. K. KIM                             (HARV)IJP

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Λ(1860)

P_{03}

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          60  Y*0(1860, JP=3/2+) I=0

          SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

          THE QUANTUM NUMBERS OF THIS STATE ARE PROBABLY 3/2+.
          AN F07 WAS FIRST SUGGESTED IN THE PHASE SHIFT ANALYSIS
          OF THE KBAR-N DATA BY ARMENTEROS 67. THE ISOSPIN-0 TOT.
   CROSS SECTION HAS A SHOULDER ON THE HIGH SIDE OF Y*0(1815) THAT IS
   COMPATIBLE WITH A STATE AT THIS MASS (BUGG 68). THE ARMENTEROS 68 AND
   CONFORTO 68 ANALYSES OF IMPROVED  KBAR-N DATA INCLUDED THE F07 STATE.
   HOWEVER IN THE NEW ANALYSES OF CONFORTO 70 AND,LATER, BRICMAN1 70 THE
   F07 IS NOT REQUIRED BY THE NEW DATA AND A P03 RESONANCE IS ACCEPTABLE.
   IN ADDITION BOTH THESE NEW ANALYSES INCLUDED RECENT POLARIZATION DATA.

-----------------   60  Y*0(1860) MASS (MEV)   --------------------------

M   N      1870.0      5.0         BUGG      68 CNTR 0  K-P TOTAL         7/68
M  A  F07 1864.0      2.0         ARMENTERO 68 DWPA 0  ELASTIC, CH EXCH 11/68
M  A  F07 1877.0      6.0         BRICMAN   70 CNTR 0  TOTAL AND CH EX   6/70
M     P03 1870.0      6.0         BRICMAN1  70 DPWA  0 SIGTOT,ELAS,CHEX  1/71*
M   N P03 1883.0     10.0         CONFORTO  70 DPWA 0  ELASTIC, CH EXCH  6/70
M  1  P03 1710.                   KIM       71 DPWA    K-MATRIX ANAL.    3/71*
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.

-----------------   60  Y*0(1860) WIDTH (MEV)   -------------------------

W   N        40.0     10.0         BUGG      68 CNTR 0  K-P TOTAL         7/68
W  A  F07    39.0      7.0         ARMENTERO 68 DWPA 0  ELASTIC, CH EXCH 11/68
W  A  F07    24.0     15.0         BRICMAN   70 CNTR 0  TOTAL AND CH EX   6/70
W     P03    37.0     10.0         BRICMAN1  70 DPWA  0 SIGTOT,ELAS,CHEX  1/71*
W   N P03    80.0     20.0         CONFORTO  70 DPWA 0  ELASTIC, CH EXCH  6/70
W  1  P03    20.                   KIM       71 DPWA    K-MATRIX ANAL.    3/71*
        SEE THE NOTES ACCOMPANYING MASSES QUOTED

-----------------   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                  1199+ 139

-----------------   60  Y*0(1860) BRANCHING RATIOS   ---------------------

      BELOW, X1 = (PARTIAL-WIDTH 1)/TOTAL WIDTH, ETC.  A SIGN, WHERE
      EXPLICIT, IS IN THE CONVENTION DISCUSSED IN THE Y* MINI-REVIEW.

R1    Y*0(1860) INTO (KBAR N)/TOTAL                     X1
R1       (J+1/2)X = 0.40              BUGG      68 CNTR 0                  7/68
R1  A  F07    0.12      0.02          ARMENTERO 68 HBC  0  ELASTIC, CH EXCH 11/68
R1  A  F07    0.07      0.02          BRICMAN   70 CNTR 0  TOTAL AND CH EX   6/70
R1     P03    0.14      0.02          BRICMAN1  70 DPWA  0 SIGTOT,ELAS,CHEX  1/71*
R1   N P03    0.25      0.03          CONFORTO  70 DPWA 0  ELASTIC, CH EXCH  6/70
        SEE THE NOTES ACCOMPANYING MASSES QUOTED

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   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).

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                         REFERENCES -- Y*0(1860)

ARMENTERO68 NP B8 195         ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
BUGG       68 PR 168 1466     +GILMORE, KNIGHT, + (RTHERD,BRMNGHM,CVNDSH) 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 70 EFI 70-43         +HARMSEN, LASINSKI, +     (CHICAGO, HEIDEL)IJP
KIM      71 HARVARD PREPRINT  J.K.KIM                              (HARV) IJP
  SEE ALSO  DUKE 161          J. K. KIM                             (HARV)IJP

                         PAPERS NOT REFERRED TO IN DATA CARDS

ARMENTER 67 NP B3 592         ARMENTEROS, F-LUZZI, + (CERN,HEIDEL,SACLAY)IJP
    --  ARMENTEROS 67 IS REPLACED BY ARMENTEROS 68 AND CONFORTO 68.
CONFORTO 68 NP B8 265         +HARMSEN, LASINSKI, +      (CHICAGO,HEIDEL)IJP
    -- CONFORTO 68 IS SUPERSEDED BY CONFORTO 70.
LEVISETT 69 LUND 339          R.LEVI SETTI  (RAPPORTEUR)             (EFINS)

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Λ(1870)

S''_{01}

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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 BOTH THE BRICMAN 70 AND KIM 71
          ANALYSES.  THE ELASTICITIES OF THESE TWO ANALYSES ARE
          IN BAD DISAGREEMENT.

-----------------   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*

-----------------   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*

-----------------   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

-----------------   36  Y*0(1870) BRANCHING RATIOS   --------------------

R1        Y*0(1870) INTO (KBAR N)/TOTAL                X1
R1          (0.18)   (0.02)         BRICMAN   70 DPWA   TOT, ELAS, CHEX   1/71*
R1          (0.8)                   KIM       71 DPWA   K-MATRIX ANAL.    3/71*

R2        Y*0(1870) FROM KBAR N TO SIGMA PI            SQRT(X1*X2)
R2          (0.24)                  KIM       71 DPWA   K-MATRIX ANAL.    3/71*

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                       REFERENCES -- Y*0(1870)
BRICMAN  70 PL 33B 511        C BRICMAN, M FERRO-LUZZI, J P LAGNAUX(CERN)IJP
KIM      71 HARVARD PREPRINT  J.K.KIM                              (HARV) IJP
  SEE ALSO  DUKE 161          J. K. KIM                             (HARV)IJP

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Λ(2010)

D'''_{03}

```
          89  Y*0(2010, JP=3/2-) I=0

          SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

          SUCH A RESONANCE IS SUGGESTED BY ONE BUT NOT OTHER
          PARTIAL-WAVE ANALYSES ACROSS THIS REGION.  UNTIL THERE
          IS MORE EVIDENCE, WE OMIT THIS STATE FROM THE MAIN
          BARYON TABLE.

-----------------   89  Y*0(2010)  MASS (MEV)   -------------------------

M        (2010.0)   (30.0)          GALTIERI  70 DPWA 0  K-P TO SIGMA PI   7/70

-----------------   89  Y*0(2010) WIDTH (MEV)   -------------------------

W         (130.0)   (50.0)          GALTIERI  70 DPWA 0  K-P TO SIGMA PI   7/70

-----------------   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

-----------------   89  Y*0(2010) BRANCHING RATIOS   -----------------

      BELOW, X1 = (PARTIAL-WIDTH 1)/TOTAL WIDTH, ETC.  A SIGN, WHERE
      EXPLICIT, IS IN THE CONVENTION DISCUSSED IN THE Y* MINI-REVIEW.

R1    Y*0(2010) FROM KBAR N TO SIGMA PI                 SQRT(X1*X2)
R1          (-0.20)   (0.04)        GALTIERI  70 DPWA 0  K-P TO SIGMA PI   7/70

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                       REFERENCES -- Y*0(2010)

GALTIERI 70 DUKE CONF 173     A BARBARO-GALTIERI                    (LRL)IJP

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Λ(2020)

F_{07}

```
          27  Y*0(2020, JP=7/2+) I=0

          SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

          SUCH A RESONANCE IS SUGGESTED BY ONE BUT NOT OTHER
          PARTIAL-WAVE ANALYSES ACROSS THIS REGION.  UNTIL THERE
          IS MORE EVIDENCE, WE OMIT THIS STATE FROM THE MAIN
          BARYON TABLE.

-----------------   27  Y*0(2020) MASS (MEV)   --------------------------

M        (2020.0)   (20.0)          GALTIERI  70 DPWA 0  K-P TO SIGMA PI   7/70

-----------------   27  Y*0(2020) WIDTH (MEV)   -------------------------

W         (160.0)   (30.0)          GALTIERI  70 DPWA 0  K-P TO SIGMA PI   7/70

-----------------   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

-----------------   27  Y*0(2020) BRANCHING RATIOS   --------------------

      BELOW, X1 = (PARTIAL-WIDTH 1)/TOTAL WIDTH, ETC.  A SIGN, WHERE
      EXPLICIT, IS IN THE CONVENTION DISCUSSED IN THE Y* MINI-REVIEW.

R1    Y*0(2020) FROM KBAR N TO SIGMA PI                 SQRT(X1*X2)
R1          (-0.15)   (0.02)        GALTIERI  70 DPWA 0  K-P TO SIGMA PI   7/70

****** ********* ********* ********* ********* ********* ********* ********

                       REFERENCES -- Y*0(2020)

GALTIERI 70 DUKE CONF 173     A BARBARO-GALTIERI                    (LRL)IJP

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For notation, see illustrated key at beginning of data card listings.

Λ(2100)

41 Y*0(2100, JP=7/2-) I=0 G07

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.

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         2110.0    (20.0)    GALTIERI  70 DPWA 0  K-P TO SIGMA PI    7/70
M         2130.0    (20.0)    BERTHONI  70 DPWA 0  K-P TO SIGMA PI   10/70*
M   A        BURGUN 68 SEE A RESONANCE-LIKE EFFECT IN THIS REGION IN THE
         REACTION K-P TO XI K.  HOWEVER, AS THEY POINT OUT, IT IS NOT CLEAR
         WHETHER IT IS MAINLY THE G07 Y*0(2100) OR INSTEAD A SO FAR OTHERWISE
         UNOBSERVED RESONANCE WITH A SPIN LESS THAN 7/2.
```

41 Y*0(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          60.0     (25.0)    GALTIERI  70 DPWA 0  K-P TO SIGMA PI    7/70
W         140.0     (15.0)    BERTHONI  70 DPWA 0  K-P TO SIGMA PI   10/70*
       SEE THE NOTES ACCOMPANYING MASSES QUOTED
```

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
```

41 Y*0(2100) BRANCHING RATIOS

BELOW, X1 = (PARTIAL-WIDTH 1)/TOTAL WIDTH, ETC. A SIGN, WHERE EXPLICIT, IS IN THE CONVENTION DISCUSSED IN THE Y* MINI-REVIEW.

```
R1     Y*0(2100) INTO (KBAR N)/TOTAL                  X1
R1          (0.25)                  WOHL     66 HBC                        7/66
R1  D       (0.33)                  DAUM     68 CNTR    K-P ELA,POL,SIGT   7/70
R1  D    DAUM 68 ASSUMES (J+1/2)*X VALUE SEEN IN TOTAL CROSS SECTION.

R2     Y*0(2100) FROM KBAR N INTO SIGMA PI            SQRT(X1*X2)
R2          +0.06     (0.03)        GALTIERI 70 DPWA 0  K-P TO SIGMA PI    7/70
R2          +0.15     (0.02)        BERTHONI 70 DPWA 0  K-P TO SIGMA PI   10/70*

R3     Y*0(2100) FROM KBAR N TO XI K                  SQRT(X1*X3)
R3          (0.05)                  TRIPP    67 RVUE 0  K-P TO XI K        8/67
R3  A       (0.09)    (0.01)        BURGUN   68 DPWA 0  K-P TO XI K       10/69
R3          (0.003)                 MULLER   69 DPWA 0                     7/70
       SEE THE NOTES ACCOMPANYING MASSES QUOTED
```

REFERENCES -- 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)
DAUM      68 NP B7 19         +ERNE, LAGNAUX, SENS, STEUER, UDO     (CERN)JP
     --  DAUM 68 CONFIRMS THE SPIN-PARITY ASSIGNMENT.
BURGUN    68 NP B8 447        +MEYER,PAULI, +      (SACLAY,COLFRANCE,RTHFD)
MULLER    69 THESIS,UCRL 19372 R A MULLER                              (LRL)
GALTIERI  70 DUKE CONF 173    A BARBARO-GALTIERI                    (LRL)IJP
BERTHONI  70 NP B24 417       +VRANA, BUTTERWORTH, + (CDEF, RHEL, SACLAY)IJP
```


Λ(2110)

35 Y*0(2110,JP=5/2+)I=0 F'05

35 Y*0(2110) MASS (MEV)

```
M        (2110.)     (10.)        BERTHONI   70 DPWA  - K- P TO SIG PI    1/71*
```

35 Y*0(2110) WIDTH (MEV)

```
W        (185.)      (30.)        BERTHONI   70 DPWA  - K- P TO SIG PI    1/71*
```

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
```

35 Y*0(2110) BRANCHING RATIOS

BELOW, X1 = (PARTIAL-WIDTH 1)/TOTAL WIDTH, ETC. A SIGN, WHERE EXPLICIT, IS IN THE CONVENTION DISCUSSED IN THE Y* MINI-REVIEW.

```
R2       Y*0(2110) FROM KBAR N TO SIGMA PI        SQRT(X1*X2)
R2           (+.17)     (.03)      BERTHONI  70 DPWA  - K- P TO SIG PI    1/71*
```

REFERENCES -- Y*0(2110)


```
BERTHONI 70 NP B24 417       +VRANA,BUTTERWORTH,+      (CDEF,RHEL,SACLAY)IJP
```


M > 2100 MEV - PRODUCTION AND σ_{TOTAL} EXPERIMENTS

BUMPS

Λ(2100)

25 Y*0(2100) CROSS-SECTION AND INVARIANT-MASS PEAKS

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

SEE THE NOTE TO THE G07 Y*0(2100), WHICH PROCEEDS 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*0(2100), BUT MAY CONTAIN A SMALL CONTRIBUTION FROM THE SUGGESTED BUT NOT ESTABLISHED OTHER RESONANCES IN THIS REGION.

25 Y*0(2100) MASS (MEV) -- AS SEEN IN PEAKS

```
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 TOTAL       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*
```

25 Y*0(2100) WIDTH (MEV) -- AS SEEN IN PEAKS

```
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*
```

25 Y*0(2100) PARTIAL DECAY MODES

```
                                                   DECAY MASSES
P1        Y*0(2100) INTO KBAR N                    497+ 939
P2        Y*0(2100) INTO KBAR N PI                 497+ 939+ 139
P3        Y*0(2100) INTO LAMBDA ETA                1115+ 548
P4        Y*0(2100) INTO LAMBDA OMEGA              1115+ 783
```

25 Y*0(2100) BRANCHING RATIOS -- AS SEEN IN PEAKS --

```
R1     Y*0(2100) INTO (KBAR N)/TOTAL                  X1
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(X1*X3)
R3          (0.09) OR LESS          FLATTE 2  67 HBC  0  K-P TO LAM ETA   6/68

R4     Y*0(2100) INTO (LAMBDA OMEGA)/TOTAL            X4
R4          (0.1)  OR LESS          FLATTE 1  67 HBC  0  K-P TO LAM OMEGA 8/67
```

REFERENCES -- Y*0(2100) AS SEEN IN PEAKS


```
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, +    (RTHFD,BRMGHM,CVNDSH) I
BRICMAN   70 PL 31B 152       +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
COOL      70 PR 1D 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
     --  COOL 66 IS SUPERSEDED BY COOL 70.
```


Λ(2350)

42 Y*0(2350, JP=) I=0

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+.

42 Y*0(2350) MASS (MEV)

```
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*
```

42 Y*0(2350) WIDTH (MEV)

```
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*
```

42 Y*0(2350) PARTIAL DECAY MODES

```
                                                   DECAY MASSES
P1        Y*0(2350) INTO KBAR N                    497+ 939
```

42 Y*0(2350) BRANCHING RATIOS

```
R1     Y*0(2350) INTO (KBAR N)/TOTAL                  X1
R1        J IS NOT KNOWN.  THE FOLLOWING IS (J+1/2)*X1.
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*
```

REFERENCES -- Y*0(2350)


```
BUGG      68 PR 168 1466      +GILMORE,KNIGHT, +    (RTHFD,BRMGHM,CVNDSH) 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 1D 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
     --  COOL 66 IS SUPERSEDED BY COOL 70.
```

For notation, see illustrated key at beginning of data card listings.

Λ(2585)

```
7  Y*0(2585, JP=    ) I=0
SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

----------------   7  Y*0(2585) MASS (MEV)   ----------------------------

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*

----------------   7  Y*0(2585) WIDTH (MEV)   ---------------------------

W       (300.0)                     ABRAMS    70 CNTR    K-P, D TOTAL       10/70*
W       (150.0)                     LU        70 CNTR 0  GAMMA P TO K+ Y*    1/71*

----------------   7  Y*0(2585) PARTIAL DECAY MODES   -----------------

                                                         DECAY MASSES
P1     Y*0(2585) INTO KBAR N                             497+ 939.

----------------   7  Y*0(2585) BRANCHING RATIOS   --------------------

R1     Y*0(2585) INTO (KBAR N)/TOTAL                     X1
R1        J IS NOT KNOWN.  THE FOLLOWING IS (J+1/2)*X1.
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    FIT OF TOTAL CROSS SECTION GIVEN BY BRICMAN 70 IN THIS REGION
R1  C    IS POOR.

****** ********* ********* ********* ********* ********* ********* ********

                          REFERENCES -- Y*0(2585)

ABRAMS   70 PR 1D 1917        +COOL, GIACOMELLI, 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,LEONTIC,LUNDBY +    (BNL)I

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Σ^+

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19  SIGMA +    (1189,JP=1/2+)  I=1
SEE LISTINGS OF STABLE PARTICLES

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Σ^-

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20  SIGMA -    (1198,JP=1/2+)  I=1
SEE LISTINGS OF STABLE PARTICLES

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Σ^0

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21  SIGMA 0    (1193,JP=1/2+)  I=1
SEE LISTINGS OF STABLE PARTICLES

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Σ(1385) P_{13}

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43  Y*1(1385, JP=3/2+) I=1

FOR DISCUSSION OF INCONSISTENCY OF ERRORS AND OUR
MODIFICATIONS, SEE NOTE ON K*(890)

FOR THE TABLES WE USE ONLY THE UNSTARRED DATA, WHICH
ATTEMPTS TO OBTAIN THE SEPARATE CHARGE-STATE MASSES AN
WIDTHS.  SEE HOWEVER THE IDEOGRAMS INSERTED IN LISTING
THESE INDICATE SERIOUS 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)                 ALSTON    60 HBC  +- K-P 1.15 BEV/C
M        33(1384.0)                 MARTIN    61 HBC  0+ K20 P .98 BEV/C
M          (1385.0)                 BERGE     61 HBC  +- K-P .4-.85 BEV/C
M          (1392.0)    (7.0)        COLLEY    62 HLBC 0- PI- PRP 2. BEV/C
MO      106(1381.0)    (4.0)        CURTIS    63 OSPK 0  PI-P 1.5 BEV/C
M          (1392.0)   (10.0)        MUSGRAVE  65 HBC  +-OPBAR P 3-4 BEV/C  7/66
M          (1389.0)    (3.0)        BALTAY    65 HBC  +- PBAR P 3.7 BEV/C  7/66

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 LT STATIST.ER.  10/69
M+   S            ERROR OF 1.1 ENLARGED TO 1.9 BY US,BECAUSE LT STATIST.ER.  10/69
M+   B  40 1383.0      4.0          BIRMINGHA 66 HBC   +  3.5 K- P          9/67
M+   B            ERROR OF 2.0 ENLARGED TO 4.0 BY US,BECAUSE LT 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+         . . . . . . . . .
M+   AVG   1382.65     0.72     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
                       (SEE IDEOGRAM BELOW )
M-      93 1382.0      3.0          DAHL      61 DBC  -  K-D 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 LT 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 ENLARGED TO 2.6 BY US,BECAUSE LT STATIST.ER.  10/69
M-   S            ERROR OF 1.4 ENLARGED TO 4.0 BY US,BECAUSE LT STATIST.ER.  10/69
M-         1389.0      9.0          LONDON    66 HBC  -                     7/66
M-     370 1390.7      2.0          SIEGEL    67 HBC  -  K-P AT 2.1 GEV/C  10/69
M-         . . . . . . . . .
M-   AVG   1385.9      1.5      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.2)
                       (SEE IDEOGRAM BELOW )
```

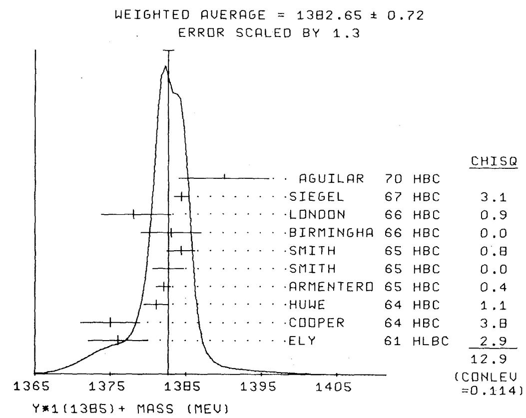

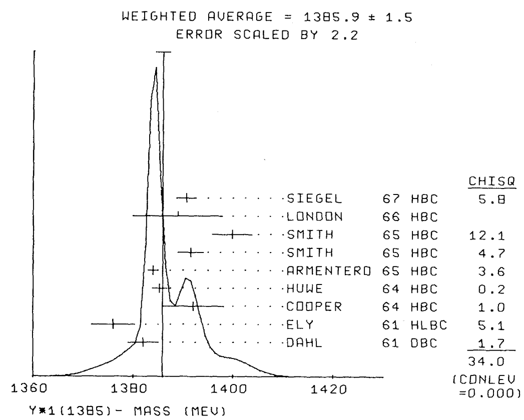


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----------------   43  Y*(-) - Y*(+) MASS DIFFERENCE (MEV)   -------------

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           LONDON    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
     R     REDUNDANT WITH DATA IN MASS LISTING.

----------------   43  Y*1(1385) WIDTH (MEV)   --------------------------

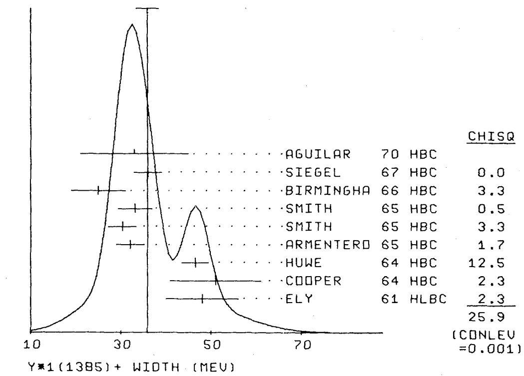
W          (64.0)                   ALSTON    60 HBC  +-
W          (20.0)       OR LESS     MARTIN    61 HBC  0+
W          (40.0)                   BERGE     61 HBC  +-
W          (80.0)   (10.0)          COLLEY    62 HLBC 0-
W          (30.0)    (9.0)          CURTIS    63 OSPK 0
W          (38.0)    (9.0)          MUSGRAVE  65 HBC  +-0                   7/66
W          (26.0)    (5.0)          BALTAY    65 HBC  +-                    7/66

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   +  3.5 K- P          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+         . . . . . . . . .
W+   AVG     35.9     2.6       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)
                      (SEE IDEOGRAM BELOW )
W-          (40.0)                  DAHL      61 DBC  -
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-         . . . . . . . . .
W-   AVG     36.3     6.3       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 3.5)
                      (SEE IDEOGRAM BELOW )
```

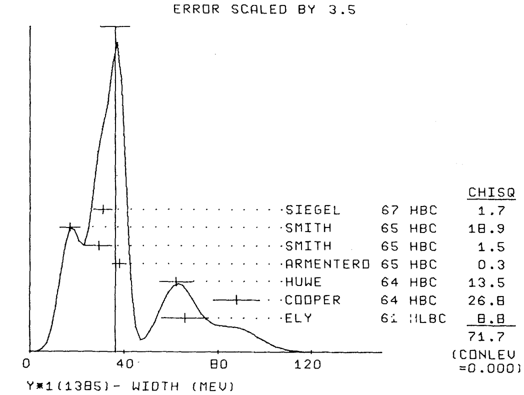
Baryons

For notation, see illustrated key at beginning of data card listings.

WEIGHTED AVERAGE = 35.9 ± 2.6
ERROR SCALED BY 1.9



WEIGHTED AVERAGE = 36.3 ± 6.3
ERROR SCALED BY 3.5



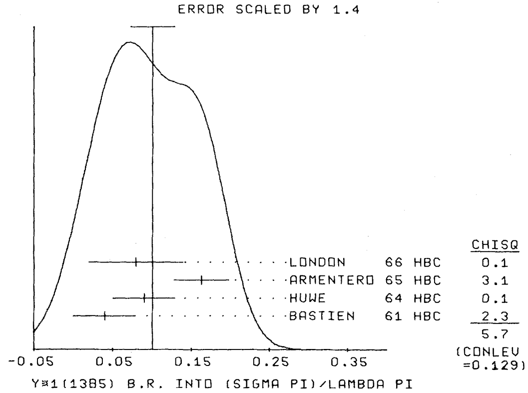
---------------- 43 Y*1(1385) PARTIAL DECAY MODES ----------------

		DECAY MASSES
P1	Y*1(1385) INTO LAMBDA PI	1115+ 139
P2	Y*1(1385) INTO SIGMA PI	1197+ 139

---------------- 43 Y*1(1385) BRANCHING RATIOS ----------------

R1		Y*1(1385) INTO (SIGMA PI)/(LAMBDA PI)					(P2)/(P1)	
R1		0.04	0.04	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	LONDON	66 HBC	+		7/66
R1		. . . .						
R1	AVG	0.101	0.028	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)				
			(SEE IDEOGRAM BELOW)					

WEIGHTED AVERAGE = 0.101 ± 0.028
ERROR SCALED BY 1.4



REFERENCES -- Y*1(1385)

ALSTON	60 PRL 5 520	+ALVAREZ,EBERHARD,GOOD,GRAZIANO, +	(LRL)	I
DAHL	61 PRL 6 142	+HORWITZ,MILLER,MURRAY,WHITE	(LRL)	
MARTIN	61 PRL 6 283	+LEIPUNER,CHINOWSKY,SHIVELY, +	(BNL,YALE)	
BERGE	61 PRL 6 557	+BASTIEN,DAHL,FERRO-LUZZI,KIRZ, +	(LRL)	
BASTIEN	61 PRL 6 702	P BASTIEN,M FERRO-LUZZI,A H ROSENFELD	(LRL)	
ELY	61 PRL 7 461	+FUNG,GIDAL,PAN,POWELL,WHITE	(LRL)	J
ALSTON	62 CERN CONF 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,AMSTR)	
HUWE	64 UCRL-11291 THESIS	D O HUWE	(LRL)	JP
ALSO	69 PR 180 1824	D O HUWE	(LRL)	
MUSGRAVE	65 NC 35 735	+PETMEZAS,+	(BIRMGHM,CERN,EP,IMPCOL,SACLAY)	
ARMENTER	65 PL 19 75	ARMENTEROS, +	(CERN,HEIDEL,SACLAY)	
BALTAY	65 PR 140 B1027	+SANDWEISS,TAFT,CULWICK,KOPP, +	(YALE,BNL)	
SMITH	65 THESIS (UCLA)	L T SMITH	(UCLA)	
BIRMINGH	66 PR 152 1148	BIRMINGHAM,GLASGOW,I.C., OXFORDYRUTHERFORD		
LONDON	66 PR 143 1034	+RAU,SAMIOS,YAMAMOTO,GOLDBERG,+	(BNL,SYCR)	J
SIEGEL	67 UCRL 18041 THESIS	D M SIEGEL	(LRL)	
AGUILAR	70 PRL 25 58	+BARNES, BASSANO, CHUNG, EISNER,+	(BNL,SYR)	

QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN DATA CARDS.

SHAFER	64 PR 134 B1372	J B SHAFER, D O HUWE	(LRL)	JP
MALAMUD	64 PL 10 145	E MALAMUD, P E SCHLEIN	(CERN,UCLA)	JP

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M < 1500 MEV – PRODUCTION EXPERIMENTS

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Σ(1440) BUMPS

80 Y*1(1440, JP=) I=1

SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

CLINE 68 FIND A NARROW PEAK AT 1440 MEV (JUST ABOVE THE KBAR N THRESHOLD) IN THE LAMBDA PI INVARIANT MASS FOR K- D TO LAMBDA PI- P EVENTS. THEY DISCUSS ALTERNATE INTERPRETATIONS -- 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 TO EXPLAIN THE RESULTS OF BOTH EXPERIMENTS WITHOUT INVOKING A NEW RESONANCE.

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REFERENCES -- Y*1(1440)

CLINE	68 PRL 21 1372	D CLINE, R LAUMANN, J MAPP	(WISCONSIN)	I
ALEXANDE	69 PRL 22 483	ALEXANDER, HALL, JEW, +	(LRL,RIVERSIDE)	

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Σ(1480) BUMPS

23 Y*1(1480, JP=) I=1

SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

PEAKS ARE SEEN IN LAMBDA PI AND 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 DISCUSSION OF THIS STATE. HE SUGGESTS A POSSIBLE ALTERNATE EXPLANATION IN TERMS OF A REFLECTION OF N*1/2(1670) DECAY TO LAMBDA K.

---------------- 23 Y*1(1480) MASS (MEV) ----------------

M	O	(1480.0)	(15.0)	YU-LI PAN	69 HBC	+	PI+P TO K PI LAM	9/69
M	O	(1465.0)	(20.0)	YU-LI PAN	69 HBC	+	PI+P TO K PI SIG	9/69
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		. . . .						
M		AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)						

---------------- 23 Y*1(1480) WIDTH (MEV) ----------------

W	O	(35.0)		YU-LI PAN	69 HBC	+	PI+P TO K PI LAM	9/69
W	O	(25.0)		YU-LI PAN	69 HBC	+	PI+P TO K PI SIG	9/69
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		. . . .						
W		AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)						

---------------- 23 Y*1(1480) PARTIAL DECAY MODES ----------------

		DECAY MASSES
P1	Y*1(1480) INTO KBAR N	497+ 939
P2	Y*1(1480) INTO LAMBDA PI	1115+ 139
P3	Y*1(1480) INTO SIGMA PI	1189+ 139

---------------- 23 Y*1(1480) BRANCHING RATIOS ----------------

R1		Y*1(1480) INTO (SIGMA PI)/(LAMBDA PI)					(P3)/(P2)	
R1	O	(0.72)	(0.49)	YU-LI PAN	69 HBC	+		9/69
R1		0.82	0.51	PAN	70 HBC	+		3/71*
R2		Y*1(1480) INTO (PROTON KOBAR)/(LAMBDA PI)					(P1)/(P2)	
R2	O	(0.36)	(0.25)	YU-LI PAN	69 HBC	+		9/69
R2		0.36	0.25	PAN	70 HBC	+		3/71*

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REFERENCES -- Y*1(1480)

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)	
PAN	70 PR D2,449	+FORMAN,KO,HAGOPIAN,SELOVE	(PENN)	

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END PRODUCTION EXPERIMENTS
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For notation, see illustrated key at beginning of data card listings.

Σ(1620) S'_{11}

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32 Y*1(1620,JP=1/2-)I=1
THE K-MATRIX ANALYSIS OF KIM 71 SUGGESTS THIS STATE.
THE ELASTICITY IS REALLY SMALL.

----------------    32  Y*1(1620) MASS (MEV)    ----------------------------

M        (1620.)                 KIM       71 DPWA    K-MATRIX ANAL.    3/71*

----------------    32  Y*1(1620) WIDTH (MEV)   ----------------------------

W        (40.)                   KIM       71 DPWA    K-MATRIX ANAL.    3/71*

----------------    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

----------------    32 Y*1(1620) BRANCHING RATIOS    ----------------------

       BELOW, XI = (PARTIAL-WIDTH 1)/TOTAL WIDTH, ETC.  A SIGN, WHERE
       EXPLICIT, IS IN THE CONVENTION DISCUSSED IN THE Y* MINI-REVIEW.

R1     Y*1(1620) INTO KBAR N                        X1
R1          (0.05)               KIM       71 DPWA    K-MATRIX ANAL.    3/71*

R2     Y*1(1620) FROM KBAR N TO SIGMA PI            SQRT(X1*X2)
R2          (0.08)               KIM       71 DPWA    K-MATRIX ANAL.    3/71*

R3     Y*1(1620) FROM KBAR N TO LAMBDA PI           SQRT(X1*X3)
R3          (0.15)               KIM       71 DPWA    K-MATRIX ANAL.    3/71*

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                        REFERENCES -- Y*1(1620)

KIM       71 HARVARD PREPRINT   J.K.KIM                            (HARV) IJP
  SEE ALSO  DUKE 161            J. K. KIM                          (HARV)IJP

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Σ(1620) P'_{11}

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79  Y*1(1620, 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
ARMENTEROS 70 SUGGESTS SUCH A RESONANCE.  KIM 71 FINDS
A SIGNAL IN BOTH KBAR-N AND SIGMA PI.

----------------    79  Y*1(1520) 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*

----------------    79  Y*1(1620) 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*

----------------    79  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

----------------    79  Y*1(1620) BRANCHING RATIOS    --------------------

       BELOW X1 = (PARTIAL-WIDTH 1)/TOTAL WIDTH, ETC. A SIGN WHERE
       EXPLICIT, IS IN THE CONVENTION DISCUSSED IN THE Y* MINI-REVIEW.

R1     Y*1(1620) FROM KBAR N TO SIGMA PI            SQRT(X1*X2)
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*

R2     Y*1(1620) INTO KBAR N                     X1
R2          (0.14)               KIM       71 DPWA    K-MATRIX ANAL.    3/71*

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                        REFERENCES -- Y*1(1620)

ARMENTER 70 DUKE 123            ARMENTEROS, BAILLON, +       (CERN,HEIDEL)IJP
KIM       71 HARVARD PREPRINT   J.K.KIM                            (HARV) IJP
  SEE ALSO  DUKE 161            J. K. KIM                          (HARV)IJP

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Note on Σ(1620)

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. A good review of the production experiments has been recently given by MILLER 70. We summarize here the situation.

Formation experiments. The CHS energy independent (see note on Y^*'s) partial-wave analysis (ARMENTEROS 70) shows evidence for a P_{11} state at 1620 MeV in the $\Sigma\pi$ channel. They had previously reported evidence for this state in the $\Lambda\pi$ channel (ARMENTEROS 69), which they now disclaim. This is because of the fact that new data have been added at the low-energy end of their previous analysis (i.e., around the 1600-MeV region) and now the preferred solution shows structure at a higher mass, in the $\Lambda\pi$ channel.

Production experiments. 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 Σ(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). The closeness of this mass to 1670 MeV is suggestive that this effect may be related to what goes on in that region (see discussion below).

In conclusion, for Σ(1620) we have to wait for more data and for a complete understanding of the entire mass region 1600 to 1700 MeV. The hope is that the determination of quantum numbers for each of these effects for each decay mode may eventually clarify the situation.

Σ(1620) BUMPS

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78  Y*1(1620, JP=    ) I=1              PROD.EXP.

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.

   THERE WAS AN INDICATION OF A Y*1(1610) IN AN EARLY PHASE-SHIFT
ANALYSIS OF K-P TO LAMBDA PI.  HOWEVER MORE DETAILED ANALYSIS OF
MORE EXTENSIVE DATA BY THE SAME (CERN, HEIDELBERG, SACLAY) GROUP
FAILED TO CONFIRM THIS RESULT. HOWEVER THEY NOW SEE IT IN THE SIGMA PI
CHANNEL (SEE PREVIOUS ENTRY). (OLD LAMBDA PI ANALYSIS LISTED AS
ARMENTEROS 68, NEW ANALYSIS AS ARMENTEROS 70.)

----------------   78  Y*1(1620) MASS (MEV)   ---------------------------

M   N      (1616.0)    (8.0)          CRENNELL  68 DBC  +- K-D 3.9 BEV/C    11/68
    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-P 4.5 GEV/C     6/70
M          . . . . . . . . . .
M   AVG    1619.4       3.8       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)

----------------   78  Y*1(1620) WIDTH (MEV)   --------------------------

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-P 4.5 GEV/C     6/70
W          . . . . . . . . . .
W   AVG       41.3      12.2      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
             SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

----------------   78  Y*1(1620) PARTIAL DECAY MODES   ------------------

                                                    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             1385+ 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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For notation, see illustrated key at beginning of data card listings.

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-----------------  78  Y*1(1620) BRANCHING RATIOS   ---------------------

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-P 4.5 GEV/C    6/70

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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REFFRENCES -- Y*1(1620)


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CRENNELL 68 PRL 21 648         +DELANEY, FLAMINIO, KARSHON, +   (BNL,CCNY) I
BLUMENFF 69 PL 29B 58          BLUMENFELD, KALBFLEISCH              (BNL) I
CRENNELL 69 LUND PAPER 183     +KARSHON, LAI, ONEIL, SCARR, +   (BNL,CCNY) I
     --  CRENNELL 69 RESULTS ARE QUOTED IN LEVI SETTI 69.
AMMANN   70 PRL 24 327         + GARFINKEL, CARMONY, GUTAY,+  (PURDUE,IND)

                               PAPERS NOT REFERRED TO IN DATA CARDS

ARMENTER 68 NP B8 183          ARMENTEROS,BAILLON +        (CERN+HEID+SALAY)
LEVISETT 69 LUND CONF          R LEVI SETTI    (RAPPORTEUR)            EFINS
TRIPP    69 UCPL 19361         R D TRIPP                               (LRL)
SABRE    70 NP B16 201         SABRE COLLAB.    (SACL,AMST,BGNA,REHO,EPOL)
ARMENTER 70 DUKE 123           ARMENTEROS,BAILLON +        (CERN+HEID+SALAY)
MILLER   70 DUKE 229           D H MILLER    (REVIEW TALK)          (PURDUE)
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                  END PRODUCTION EXPERIMENTS
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Note on Σ(1670)

Formation experiments show the presence of only one I = 1 state in this energy region with major decay modes into $\bar{K}N$ (9%), $\Lambda\pi$ (10%), $\Sigma\pi$ (40%) and a very small branching fraction into $\Sigma\pi\pi$. Its quantum numbers are $J^P = 3/2^-$.

Production experiments are more confused. When determined, the most likely quantum numbers are also $3/2^-$ [for $\Sigma\pi$ and $\Lambda(1405)\pi$]. The measured branching ratio $R = \Sigma\pi/\Sigma\pi\pi$ changes with the momentum transfer to the proton. This was first observed by EBERHARD 69 who suggested the existence of 2 Y_1^* 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 now been confirmed by AGUILAR-BENITEZ 70 .

The other difficulty comes from the different $\Lambda\pi/\Sigma\pi$ branching ratios reported by the various experiments. The possibility of a third Y_1^* state with a large $\Lambda\pi/\Sigma\pi$ branching ratio still exists. This large branching ratio is the main justification for this hypothesis and needs confirmation. It relies on the separation between $K^-p \to \Lambda\pi^+\pi^-$ and $K^-p \to \Sigma^0\pi^+\pi^-$ that is experimentally difficult at high energy. These problems are reviewed by MILLER 70.

Two resonances of the same spin and parity have been hypothesized by EBERHARD 69 as the origin of much of the complexity observed in the 1600 to 1700 MeV region in production experiments. See also note on Σ(1620).

Σ(1670) $\boxed{D'_{13}}$

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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-.

-----------------  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    OK-P TO LAM.PI EI  5/70
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          1670.                       KIM       71 DPWA    K-MATRIX ANAL.    3/71*

-----------------  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            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            40.                       KIM       71 DPWA    K-MATRIX ANAL.    3/71*

-----------------  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                   1385+ 139
P7         Y*1(1670) INTO Y*0(1405) PI                   1405+ 139

-----------------  44  Y*1(1670) BRANCHING RATIOS   ---------------------

     BELOW X1 = (PARTIAL-WIDTH 1)/TOTAL WIDTH, ETC. A SIGN WHERE
     EXPLICIT, IS IN THE CONVENTION DISCUSSED IN THE Y* MINI-REVIEW.

R1         Y*1(1670) INTO (KBAR N)/TOTAL                 X1
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*

R2         Y*1(1670) INTO (LAMBDA PI PI)/TOTAL          (P4)/TOTAL
R2           (0.11)      OR LESS       ARMENTE3  68 HBC     K-P (P1=.09)      9/69

R3         Y*1(1670) INTO (SIGMA PI PI)/TOTAL           (P5)/TOTAL
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)/TOTAL
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(X1*X2)
R5           +0.1                      ARMENTER  70HBC      K-P TO LAMB PI    5/70
R5           +0.09    (0.02)           GALTIERI  70 HBC   0 LAM. PI, EDPWA    7/70
R5            0.08                     KIM       71 DPWA    K-MATRIX ANAL.    3/71*

R6      Y(1(1670) FROM KBAR N TO SIGMA PI               SQRT(X1*X3)
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*

R7      Y*1(1670) INTO (Y*1(1385)PI)*(KBAR N)/TOTAL**2  (P6*P1)/TOTAL**2
R7           (0.031)  (0.006)          SIMS      68 DBC  -                   11/68

R8      Y*1(1670) INTO (Y*0(1405)PI)*(KBAR N)/TOTAL**2  (P7*P1)/TOTAL**2
R8           (0.03)  OR LESS           BERLEY    69 HBC   0 K-P .6-.82 BEV/C  5/70

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REFERENCES -- Y*1(1670)


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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+HEIDE+SACLAY)IJP
ARMENTE3 68 PL 28B 521        ARMENTEROS,BAILLON +      (CERN+HEID+SACLAY)I
SIMS     68 PRL 21 1413       SIMS,ALBRIGHT,BARTLEY,MEER+ (FLO+TAFTS+BRA)

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)
GALTIERI 70 DUKE 173          A. BARBARO GALTIERI                    (LRL)IJP
KIM      71 HARVARD PREPRINT  J.K.KIM                               (HARV) IJP
  SEE ALSO  DUKE 161          J. K. KIM                             (HARV)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. TRIPPF            (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)
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For notation, see illustrated key at beginning of data card listings.

Σ(1670) PRODUCTION EXPERIMENTS

Σ(1670) BUMPS

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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.

----------------  44 Y*1(1670) MASS  (MEV) -----PRODUCTION -------------

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, O 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           . . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

----------------  44 Y*1(1670) WIDTH (MEV) -----PRODUCTION -------------

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              SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.
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           . . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 3.4)

----------------  44 Y*1(1670) BRANCHING RATIOS   PROD. EXP.  -----------

R1         Y*1(1670) INTO (KBAR N)/(SIGMA PI) PROD. EXP.(P1)/(P3)
R1       0   (0.19)       OR LESS      ALVAREZ   63 HBC  + K-P AT 1.15 BEV/C
R1           (0.5)+- .25 OR MORE       SMITH     63 HBC  0-
R1           (0.6)        OR LESS      LONDON    66 HBC  + K-P AT 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

R2         Y*1(1670) INTO (LAMB.PI)/(SIG PI) PROD. EXP. (P2)/(P3)
R2     130   (1.20)                    ALVAREZ   63 HBC  + K-P AT 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 AT 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 DECAY TO BE ALL Y*(1690)- SEE BARNES 69 FOR
R2   P   NEW INTERPRATATION OF DATA.(3 TIMES MORE DATA) -
R2            0.45      0.15           BARNES    69 HBC   + K-P 3.9-5 GEV/C  10/69
R2           . . . . . . . . . .
R2   AVERAGE MEANINGLESS (SCALE FACTOR = 1.5)

R3         Y*1(1670) INTO (LAMB. PI PI)/(SIG PI) PROD.  (P4)/(P3)
R3      90   (0.56)                    ALVAREZ   63 HBC  + K-P AT 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) PROD.  (P5)/(P3)
R4     190   (0.56)                    ALVAREZ   63 HBC  + K-P AT 1.15 B5V/C

R5         Y*1(1670) INTO (Y*0(1405) PI)/(SIG PI) PROD. (P7)/(P3)
R5      50    3.         1.6           LONDON    66 HBC  + K-P AT 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

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           LONDON    66 HBC  + K-P AT 2.25 BEV/3  7/66
R6   A     BETWEEN 2.5 AND 0.24        EBERHARD  69 HBC     K-P AT 2.6 GEV/C  9/69
     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       + K-P AT 2.45 BEV/C  7/66

R8         Y*1(1670) INTO (Y*0(1405) PI)/(Y*1(1385) PI)  (P7)/(P6)
R8           (0.8)        OR MORE      EBERHARD  65       + K-P AT 2.45 BEV/C  7/66

R9       Y*1(1670) IN  (LAMBDA 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 (LAMBDA 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 (LAMB PI)/(LAMB PI + SIG PI)  (P2)/(P2+P3)
R11          (0.6)   OR LESS           AGUILAR   70 HBC                       5/70

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                      44 QUANTUM NUMBER DETERMINATION

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-          BUTTON-SH 68 HBC  +- INTO SIGZERO+PI  11/68

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                            REFERENCES -- Y*1(1670)    PRODUC. EXPERIMENTS

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,RUTHERFORD
LONDON   66 PR 143 1034       +RAU,SAMIOS,YAMAMOTO,GOLDBERG,+  (BNL,SYCR) IJ
BARNES   69 BNL 13823         +CHUNG,EISNER,FLAMINIO+           (BNL,SYR)
BUGG     68 PR 168 1466       +GILMORE,KNIGHT,DAVIES+     (BIRMI,CAMB,RUTH)I
BUTTON-S 68 PRL 21 1123       J BUTTON SHAFER              (UNIV.MAS+LRL) JP
PRIMER   68 PRL 20 610        +GOLDBERG,JAEGER,BARNES,DORNAN +  (SYR,BNL)
AGUILAR  70 PRL 25 58         +BARNES, BASSANO, CHUNG, EISNER,+ (BNL,SYR)
EBERHARD 69 PRL 22 200        +FRIEDMAN,PRIPSTEIN,ROSS                (LRL)

                            PAPERS NOT REFERRED TO IN DATA CARDS

LEVEQUE  65 PL 18 69           +     (SACLAY,EP,GLASGOW,IMPCOL,OXF,RTHFD) 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,SWANSON  (LRL,ILL)IJP
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Σ(1690) BUMPS

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58  Y*1(1690, JP=     ) I=1

SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

SEE NOTE PRECEDING Y*1(1670) LISTINGS, SEEN IN PRO.
EXPERIMENTS ONLY, MAIN DECAY MODE IS LAMBDA PI.

----------------  58  Y*1(1690) MASS (MEV)    --------------------------

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          (1700.0)    (20.0)          MOTT      69 HBC  +  K-P 5.5 GEV/C      9/69
M        46(1682.0)     (2.0)          BLUMENFEL 69 HBC  +  KO LONG + PROTON   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.

----------------  58  Y*1(1690) WIDTH (MEV)    -------------------------

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 ABOVE 11/68
W           (130.0)    (25.0)          MOTT      69 HBC  +                     9/69
W        46  (25.0)    (10.0)          BLUMENFEL 69 HBC  +                     9/69
               SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

----------------  58  Y*1(1690) PARTIAL DECAY MODES   ------------------

                                                      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                1385+ 139
P5         Y*1(1690) INTO LAMBDA PI PI (INCLUDING P4)  1115+ 139+ 139

----------------  58  Y*1(1690) BRANCHING RATIOS   --------------------

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 (90 PC CL)  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 OF 2.3)

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  -                    11/68

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                              REFERENCES -- Y*1(1690)

COLLEY   67 PL 24B 489         (BRMGHM,GLASG,IMPCOL,MUNICH,OXFORD,RTHRFRD) I
DERRICK  67 PRL 18 266         +FIELDS, LOKEN, AMMAR, (OARGONNE,NORTHWEST) I
     --  DERRICK 67 IS REPLACED BY MOTT 69.
PRIMER   68 PRL 20 610         +GOLDBERG, JAEGER, BARNES, + (SYRACUSE,BNL) I
SIMS     68 PRL 21 1413        +ALBRIGHT, +          (FLOR ST,TUFTS,BRANDEIS) I

BLUMENFE 69 PL 29B 58          B J BLUMENFELD, G R KALBFLEISCH        (BNL) I
MOTT     69 PR 177 1966        +AMMAR, DAVIS, KROPAC, +(NORTHWEST,ARGONNE) I

                               PAPERS NOT REFERRED TO IN DATA CARDS

AGUILAR  70 PRL 25 58          AGUILAR-BENITEZ,BARNES,BASSANO+    (BNL+SYR)
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                    END Y*1(1670) PRODUCTION EXPERIMENTS

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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.
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THERE IS NOW EVIDENCE IN THREE CHANNELS FOR AN S11 RESONANCE NEAR THIS ENERGY. INTERPRETATION OF THE SIGMA ETA THRESHOLD BUMP ON ITS OWN MERITS IS NOT CONCLUSIVE (CLINE 67) -- MORE DATA ARE NEEDED. BUT BY ANALOGY WITH THE SIMILAR N ETA AND LAMBDA ETA THRESHOLD EFFECTS, WHICH ARE ALMOST CERTAINLY RESONANCES, IT SEEMS VERY LIKELY THAT THIS TOO IS A RESONANCE. SEE THE RAPPORTEUR TALKS OF FERRO LUZZI 66 AND MEYER 67 FOR DISCUSSIONS.

IN THE ENERGY-INDEPENDENT PARTIAL WAVE ANALYSIS OF K- N TO LAMBDA PI, THE S11 AMPLITUDE APPEARS TO RESONATE (ARMENTEROS 69). IN 1968 IT APPEARED TO RESONATE NEAR 1650 MEV (ARMENTEROS 68), AND WAS LISTED HEREIN AS A SEPARATE STATE. NOW IT HAS MOVED CLOSE ENOUGH TO THE OTHER EFFECTS TO BE TENTATIVELY LISTED WITH THEM, BUT THE SIZE OF THE CHANGE IN THE MASS SHOULD BE A HEALTHY WARNING THAT THE PARAMETERS GIVEN FOR RESONANCES IN LOWER PARTIAL WAVES FROM SUCH ANALYSES ARE SUBJECT TO LARGE CHANGE. (ARMENTEROS 70, FROM WHICH THE RESONANCE PARAMETERS ARE QUOTED, IS A SLIGHT UPDATING OF ARMENTEROS 69.)

THERE IS WEAKER EVIDENCE FOR THIS RESONANCE IN AN ENERGY-DEPENDENT PARTIAL-WAVE ANALYSIS OF ELASTIC AND CHARGE-EXCHANGE SCATTERING (CONFORTO 70).

KIM 71 IN A MULTICHANNEL ANALYSIS FINDS A SURPRISINGLY LARGE ELASTICITY (.8), AND SMALLER AMPLITUDE IN THE LAMBDA PI CHANNEL.

IN VIEW OF THESE DISCREPANCIES WE DO NOT QUOTE ANY VALUES FOR THE BRANCHING RATIOS.

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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  70 DPWA 0  ELASTIC, CH EXCH  6/70
M         (1790.)                     KIM       71 DPWA    K-MATRIX ANAL.    3/71*
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For notation, see illustrated key at beginning of data card listings.

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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   70 DPWA 0  ELASTIC, CH EXCH      6/70
W         (50.)                      KIM        71 DPWA    K-MATRIX ANAL.        3/71*

----------------   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

----------------   57  Y*1(1750) BRANCHING RATIOS   --------------------

     BELOW, X1 = (PARTIAL-WIDTH 1)/TOTAL WIDTH, ETC.  A SIGN, WHERE
     EXPLICIT, IS IN THE CONVENTION DISCUSSED IN THE Y* MINI-REVIEW.

R1   Y*1(1750) INTO (KBAR N)/TOTAL                        X1
R1         (0.12)    (0.05)          CONFORTO   70 DPWA 0  ELASTIC, CH EXCH      6/70
R1         (0.8)                     KIM        71 DPWA    K-MATRIX ANAL.        3/71*

R2   Y*1(1750) FROM KBAR N INTO SIGMA ETA                 SQRT(X1*X2)
R2         SEEN                      CLINE      69 DBC  -  THRESHOLD BUMP.       9/69

R3   Y*1(1750) FROM KBAR N INTO LAMBDA PI                 SQRT(X1*X3)
R3         (-0.25)                   ARMENTERO  70 IPWA 0- K-N TO LAMBDA PI      6/70
R3         (0.09)                    KIM        71 DPWA    K-MATRIX ANAL.        3/71*

R4   Y*1(1750) FROM KBAR N TO SIGMA PI                    SQRT(X1*X4)
R4         (0.16)                    KIM        71 DPWA    K-MATRIX ANAL.        3/71*

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                        REFFRENCES -- 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 70 NP (SUBMITTED)          +HARMSEN, LASINSKI, +     (CHICAGO, HEIDEL)IJP
KIM        71 HARVARD PREPRINT      J.K.KIM                             (HARV) IJP
  SEE ALSO  DUKE 161                J. K. KIM                           (HARV)IJP

                        PAPERS NOT REFERRED TO IN DATA 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 CONF PAPER         ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
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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.

----------------   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             1746.0      8.0         FENSTER   66 HBC  0  K-P TO Y*1520 PI   9/66
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      N      1768.0      2.0         ARMENT-1  68 DPWA 0  ELASTIC, CH EXCH  11/68
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         CONFORTO  70 DPWA 0  ELASTIC, CH EXCH   6/70
M            (1765.)                  KIM       71 DPWA    K-MATRIX ANAL.     3/71*
M      N   ERROR STATIST. ONLY- NO ERROR DUE TO PARTICULAR P.W.ANAL. INCLUDED  1/71*
M             . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 1.1)

----------------   45  Y*1(1765) WIDTH (MEV)   --------------------------

W               60.0     10.0         GALTIERI  63 DBC  0
W               70.0     20.0         BELL 2    66 DBC  -                     7/66
W               70.0     20.0         FENSTER   66 HBC  0                     9/66
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              128.0      8.0         ARMENT-1  68 DPWA 0  ELASTIC, CH EXCH  11/68
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  70 DPWA 0  ELASTIC, CH EXCH   6/70
W             (100.)                  KIM       71 DPWA    K-MATRIX ANAL.     3/71*
W              . . . . . . . . .
W    AVG       113.5     10.0      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.9)
                                 (SEE IDEOGRAM BELOW )
```

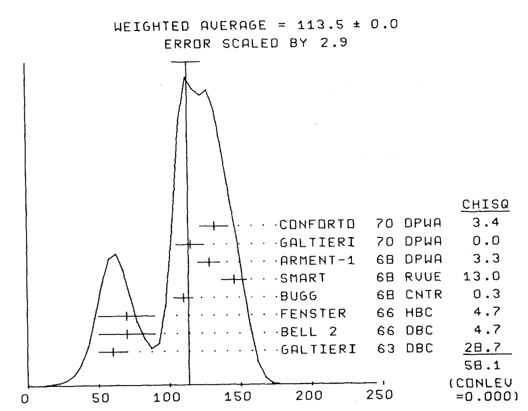


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----------------   45  Y*1(1765) PARTIAL DECAY MODES   ------------------

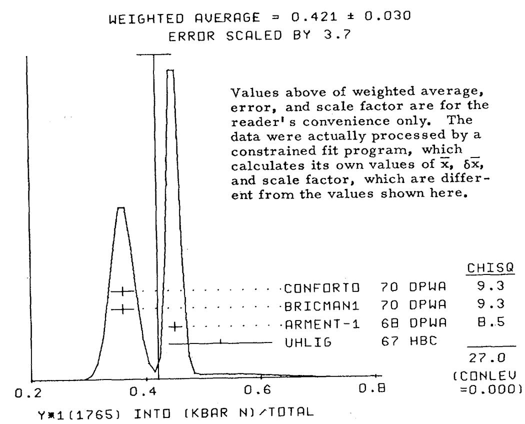
                                                         DECAY MASSES
P1       Y*1(1765) INTO KBAR N                            497+ 939
P2       Y*1(1765) INTO LAMBDA PI                        1115+ 134
P3       Y*1(1765) INTO Y*0(1520) PI                     1520+ 139
P4       Y*1(1765) INTO Y*1(1385) PI                     1385+ 139
P5       Y*1(1765) INTO SIGMA PI                         1197+ 139
P6       Y*1(1765) INTO SIGMA ETA                        1197+ 548
P7       Y*1(1765) INTO SIGMA PI PI                      1197+ 139+ 139

----------------   45  Y*1(1765) BRANCHING RATIOS   --------------------

     BELOW, X1 = (PARTIAL-WIDTH 1)/TOTAL WIDTH, ETC.  A SIGN, WHERE
     EXPLICIT, IS IN THE CONVENTION DISCUSSED IN THE Y* MINI-REVIEW.

     ERRORS QUOTED BY EXPERIMENTERS DO NOT INCLUDE UNCERTAINTY DUE
     TO PARAMETRIZATION USED IN THE P.W.A.  THEY SHOULD BE INCREASED.

R1     Y*1(1765) INTO (KBAR N)/TOTAL                     X1
R1           (0.6)                   GALTIERI  63 HBC  0  K-P RVUE
R1            0.53      0.09         UHLIG     67 HBC  0                         9/66
R1           (0.37)                  BUGG      68 CNTR                          11/66
R1            0.45      0.01         ARMENT-1  68 DPWA 0  ELASTIC, CH EXCH      11/68
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         CONFORTO  70 DPWA 0  ELASTIC, CH EXCH       6/70
R1           (0.42)                  KIM       71 DPWA    K-MATRIX ANAL.         3/71*
R1         . . . . . . . . . .
R1  AVG       0.421     0.030    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 3.7)
R1  FIT       0.424     0.026  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 3.3)
                              (SEE IDEOGRAM BELOW )
```

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R2     Y*1(1765) FROM KBAR N INTO LAMBDA PI                  SQRT(X1*X2)
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         . . . . . . . . . .
R2  AVG MOD  0.255     0.020    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
R2  FIT      0.249     0.013  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R3     Y*1(1765) FROM KBAR N INTO Y*0(1520) PI               SQRT(X1*X3)
R3           0.27      0.03           ARMENTERO  65 HBC  0  K-P TO Y*1520 PI   9/66
R3           0.35      0.05           FENSTER    66 HBC  0  K-P TO Y*1520 PI   9/66
R3         . . . . . . . . . .
R3  AVG      0.291     0.035    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
R3  FIT      0.243     0.021  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R4     Y*1(1765) FROM KBAR N INTO Y*1(1385) PI               SQRT(X1*X4)
R4           0.24      0.03           ARMENT-2   67 HBC  0  K-P TO LAM PI PI   8/67
R4           0.32      0.06           SIMS       68 DBC  -  K-N TO LAM PI PI  11/68
R4         . . . . . . . . . .
R4  AVG      0.256     0.032    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
R4  FIT      0.236     0.023  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R5     Y*1(1765) FROM KBAR N INTO SIGMA PI                   SQRT(X1*X5)
R5           0.07      0.02           ARMENTERO  67 DPWA 0  K-P TO SIGMA PI    8/67
R5          +0.06      0.03           GALTIERI   70 DPWA 0  K-P TO SIGMA PI    7/70
R5          (0.06)                    KIM        71 DPWA    K-MATRIX ANAL.     3/71*
R5         . . . . . . . . . .
R5  AVG      0.067     0.017    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R5  FIT      0.066     0.016  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R6     Y*1(1765) INTO (LAMBDA PI)/(KBAR N)                   (P2)/(P1)
R6           0.33      0.05           UHLIG      67 HBC    0 K-P,.9 GEV/C      9/66
R6         . . . . . . . . . .
R6  FIT      0.344     0.040  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R7     Y*1(1765) INTO (Y*0(1520)/(KBAR N)                    (P3)/(P1)
R7           0.28      0.05           UHLIG      67 HBC    0 K-P,.9 GEV/C      9/66
R7         . . . . . . . . . .
R7  FIT      0.327     0.047  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R8     Y*1(1765) INTO (Y*1(1385)/(KBAR N)                    (P4)/(P1)
R8           0.25      0.09           UHLIG      67 HBC    0 K-P,.9 GEV/C      9/66
R8         . . . . . . . . . .
R8  FIT      0.310     0.061  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R9     Y*1(1765) INTO (SIGMA PI PI)/TOTAL                    (P7)/TOTAL
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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For notation, see illustrated key at beginning of data card listings.

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 6
P 1	.424+-.026					
P 2	-.128	.146+-.014				
P 3	.240	-.031	.139+-.020			
P 4	-.032	.004	-.008	.131+-.024		
P 5	-.095	.012	-.023	.003	.010+-.005	
P 6	-.555	-.252	-.594	-.569	-.068	.149+-.042

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                                  REFERENCES -- 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
FENSTER  66 PRL 17 841             +GELFAND,HARMSEN,L-SETTI,+  (CHI,ARG(CERN))IJP
ARMENTER 67 PL 24B 198             ARMENTEROS,FERRO-LUZZI+  (CERN,HEID,SACLAYI)P
ARMENT-2 67 ZEIT.PHYS.202,486 ARMENTEROS,FERRO-LUZZI+  (CERN,HEID,SACLAY)
UHLIG    67 PR 155 1448            +CHARLTON,CONDON,GLASSER,YODH,+  (MD,USNRL)

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+    (BIRMI,CAMB,RUTH)I
SIMS     68 PRL 21 1413            SIMS,ALBRIGHT,BARTLEY,MEER+ (FLO+TAFTS+BRA)
SMART    68 PR 169 1330            W M SMART                             (LRL)IJP
BRICMAN1 70 PL 33B 511             +FERRO-LUZZI,LAGNAUX                  (CERN)
COOL     70 PR 1D 1887             +GIACOMELLI, KYCIA, LEONTIC, LI, +    (BNL) I
GALTIERI 70 DUKE CONF 173          A BARBARO-GALTIERI                    (LRL)IJP
CONFORTO 70 NP (SUBMITTED)         +HARMSEN, LASINSKI, +     (CHICAGO, HEIDEL)IJP
KIM      71 HARVARD PREPRINT       J.K.KIM                              (HARV) IJP
  SEE ALSO  DUKE 161               J. K. KIM                             (HARV)IJP

                                   PAPERS NOT REFERRED TO IN DATA CARDS

CONFORTO 68 NP B8 265              +HARMSEN, LASINSKI, +      (CHICAGO,HEIDEL)IJP
     --  CONFORTO 68 IS SUPERSEDED BY CONFORTO 70.
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Σ(1880)

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                67  Y*1(1880, JP=1/2+) I=1          P''11

                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.

-----------------  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          1920.0     30.0            LITCHFIEL 70 DPWA 0- K- N TO LAM PI    6/70
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          . . . . . . . . .
M    AVG   1914.5     21.6     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

-----------------  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           170.0     40.0            LITCHFIEL 70 DPWA 0- K- N TO LAM PI    6/70
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          . . . . . . . . .
W    AVG    183.4     30.5     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

-----------------  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

-----------------  67  Y*1(1880) BRANCHING RATIOS     --------------------

      BELOW, X1 = (PARTIAL-WIDTH 1)/TOTAL WIDTH, ETC.  A SIGN, WHERE
      EXPLICIT, IS IN THE CONVENTION DISCUSSED IN THE Y* MINI-REVIEW.

R1      Y*1(1880) INTO (KBAR N)/TOTAL                 X1
R1           (0.22)                   BAILEY    69 DPWA 0  ELASTIC, CH EXCH 10/70*
R1           (0.20)                   ARMENTERO 70 IPWA 0- ELASTIC, CH EXCH  6/70

R2      Y*1(1880) FROM KBAR N INTO LAMBDA PI          SQRT(X1*X2)
R2          -0.11      0.03           SMART     68 DPWA 0- K- N TO LAM PI    7/68
R2          -0.14      0.03           LITCHFIEL 70 DPWA 0- K- N TO LAM PI    6/70
R2          -0.09      0.04           GALTIERI  70 DPWA 0- K- N TO LAM PI    7/70
R2          . . . . . . . . .
R2  AVG MOD   0.117    0.019   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                                  REFERENCES -- Y*1(1880)

SMART    68 PR 169 1330       W M SMART                              (LRL)IJP
BAILEY   69 THESIS UCRL-50617 DAVID SAAL BAILEY              (LRL LIVERMORE)IJP
LITCHFIE 70 NP B22 269        P J LITCHFIELD                   (RUTHERFORD)IJP
ARMENTER 70 DUKE CONF 123     ARMENTEROS, BAILLON, +          (CERN, HEIDEL)IJP
GALTIERI 70 DUKE CONF 173     A BARBARO-GALTIERI                     (LRL)IJP

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Σ(1915)

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              46  Y*1(1915, JP=5/2+) I=1   F'15
              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.

-----------------  46  Y*1(1915) MASS (MEV)   ---------------------------

M          1902.0     11.0          SMART     68 DPWA 0- K-N TO LAMBDA PI   7/68
M          1903.0     10.0          COX       70 DPWA -  K-N TO LAMBDA PI   6/70
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          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    N   ERROR STATIST. ONLY- NO ERROR DUE TO PARTICULAR P.W.ANAL. INCLUDED 1/71*
M          . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

-----------------  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    A   LACK OF DATA PREVENTS FROM DETERMINING UNAMB. THIS AMPLITUDE       11/67
W          . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 1.9)

-----------------  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

-----------------  46  Y*1(1915) BRANCHING RATIOS     --------------------

      BELOW, X1 = (PARTIAL-WIDTH 1)/TOTAL WIDTH, ETC.  A SIGN, WHERE
      EXPLICIT, IS IN THE CONVENTION DISCUSSED IN THE Y* MINI-REVIEW.

R1      Y*1(1915) INTO (KBAR N)/TOTAL                 X1
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  70 DPWA 0  ELASTIC, CH EXCH  6/70

R2      Y*1(1915) FROM KBAR N INTO LAMBDA PI          SQRT(X1*X2)
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

R3      Y*1(1915) FROM KBAR N INTO SIGMA PI           SQRT(X1*X3)
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

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                                  REFERENCES -- 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)
CONFORTO 70 NP (SUBMITTED)    +HARMSEN, LASINSKI, +      (CHICAGO, HEIDEL)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

                              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
     --  SMART 66 IS SUPERSEDED BY SMART 68.
CONFORTO 68 NP B8 265         +HARMSEN, LASINSKI, +      (CHICAGO, HEIDEL)
     --  CONFORTO 68 IS SUPERSEDED BY CONFORTO 70.

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Σ(1900) BUMPS

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              29  Y*1(1900-1950) CROSS-SECTION AND PRODUCTION PEAKS

              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 PROCEED 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 D13 Y*1(1940).

-----------------  29  Y*1(1900-1950) MASS (MEV)   ----------------------

        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          . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 1.7)
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For notation, see illustrated key at beginning of data card listings.

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----------------   29  Y*1(1900-1950) WIDTH (MEV)    --------------------

        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            . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.2)

----------------   29  Y*1(1900-1950) PARTIAL DECAY MODES   ------------

                                                              DECAY MASSES
P1        Y*1(1900-1950) INTO KBAR N                       497+ 939
P2        Y*1(1900-1950) INTO LAMBDA PI                   1115+ 134
P3        Y*1(1900-1950) INTO SIGMA PI                    1197+ 139

----------------   29  Y*1(1900-1950) BRANCHING RATIOS   --------------

R1     Y*1(1900-1950) INTO (KBAR N)/TOTAL                 (P1)/TOTAL
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*

R2     Y*1(1900-1950) INTO (KBAR N)/(SIGMA PI)            (P1)/(P3)
R2          (.37)   OR   LESS            BARNES     69 HBC  +   1 STAN. DEV.    10/69

R3     Y*1(1900-1950) INTO (LAMBDA PI)/(SIGMA PI)         (P2)/(P3)
R3          (.28)   OR   LESS            BARNES     69 HBC  +   1 STAN. DEV.    10/69

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                          REFERENCES -- Y*1(1900-1950)

BOCK      65 PL 17 166           +COOPER,FRENCH,KINSON, +       (CERN,SACLAY) I
COOL      66 PRL 16 1228         +GIACOMELLI,KYCIA,LEONTIC,LI,LUNDBY,+ (BNL) I
      -- COOL 66 IS SUPERSEDED BY COOL 70.
BUGG      68 PR 168 1466         +GILMORE,KNIGHT,DAVIES+    (BIRMI,CAMB,RUTH)I
BARNES    69 PRL 22 479          +FLAMINIO,MONTANET,SAMIOS +        (BNL+SYRA)
BRICMAN   70 PL 31B 152          +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
COOL      70 PR D1 1887          +GIACOMELLI, KYCIA, LEONTIC, LI, +     (BNL) I
AGUILAR   70 PRL 25 58           AGUILAR-BENITEZ, BARNES, +           (BNL, SYR)

                          PAPERS NOT REFERRED TO IN DATA CARDS

PRIMER    68 PRL 20 610          +GOLDBERG,JAEGER,BARNES,DORNAN +  (SYR,BNL)
     --  PRIMER 68 IS SUPERSEDED BY BARNES 69 AND AGUILAR-BENITEZ 70.

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Σ(1940) 98 Y*1(1940, JP=3/2-) I=1 **D''_{13}**

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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.  THIS EFFECT IS PERHAPS ASSOCIATED WITH
THE BUMPS SEEN IN PRODUCTION EXPERIMENTS NEAR THIS
MASS.  SEE THE PRECEDING ENTRY.

----------------   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            . . . . . . . . . .
M    AVG    1940.0     21.6      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

----------------   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            . . . . . . . . . .
W    AVG     235.1     28.1      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)

----------------   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

----------------   98  Y*1(1940) BRANCHING RATIOS    --------------------

      BELOW, X1 = (PARTIAL-WIDTH 1)/TOTAL WIDTH, ETC.  A SIGN, WHERE
      EXPLICIT, IS IN THE CONVENTION DISCUSSED IN THE Y* MINI-REVIEW.

R1     Y*1(1940) FROM KBAR N INTO LAMBDA PI               SQRT(X1*X2)
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           . . . . . . . . . .
R1  AVG MOD  0.133     0.024     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2     Y*1(1940) FROM KBAR N INTO SIGMA PI                SQRT(X1*X3)
R2          -0.12      0.03              GALTIERI   70 DPWA    K-P TO SIGMA PI    7/70

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                          REFERENCES -- Y*1(1940)

GALTIERI 70 DUKE CONF 173      A BARBARO-GALTIERI                    (LRL)IJP
LITCHFIE 70 NP B22 269         P J LITCHFIELD                (RUTHERFORD)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 DISTRIBUTIONS AROUND 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 NOT YET ATTAINED, AND WE RELY ON BOTH ENTRIES
FOR PARAMETERS GIVEN IN THE MAIN BARYON TABLE.

----------------   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            . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

----------------   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               BERTHON1   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            . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.3)

----------------   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

----------------   47  Y*1(2030) BRANCHING RATIOS   --------------------

R1     Y*1(2030) INTO (KBAR N)/TOTAL                      X1
R1          (0.25)                       WOHL       66 HBC  0  K-P CH EX          7/66
R1           0.17      0.04              CAMPBELL   71 DBC  -  K- NEUTRON ELAST   1/71*
R1  D       (0.11)                       DAUM       68 CNTR    K-P ELA,POL,SIGT   7/70
R1  D   DAUM 68 ASSUMES (J+1/2)*X VALUE SEEN IN TOTAL CROSS SECTION.

R2     Y*1(2030) FROM KBAR N  INTO LAMBDA PI             SQRT(X1*X2)
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          +0.19      0.01              COX        70 DPWA -  K-N TO LAMBDA PI   6/70
R2          +0.2       0.02              BERTHON    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          +0.16      0.03              GALTIERI   70 DPWA 0  K-P TO LAMBDA PI   7/70
R2           . . . . . . . . . .
R2  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R3     Y*1(2030) FROM KBAR N  INTO SIGMA PI              SQRT(X1*X3)
R3          -0.052     0.010             GALTIERI   70 DPWA 0  K-P TO SIGMA PI    7/70
R3          -0.09      0.02              BERTHON1   70 DPWA 0  K-P TO SIGMA PI   10/70*
R3           . . . . . . . . . .
R3  AVERAGE MEANINGLESS (SCALE FACTOR = 1.7)

R4     Y*1(2030) FROM KBAR N INTO XI K                    SQRT(X1*X4)
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

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                          REFERENCES -- Y*1(2030)

WOHL      65 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+CDF+RHEL)
      --  DAUM 68 CONFIRMS THE SPIN-PARITY ASSIGNMENT.
DAUM      68 NP B7 19           +ERNE,LAGNAUX,SENS,STEUER,UDO           (CERN)JP
SMART     68 PR 169 1336        W M SMART                               (LRL)IJP
MULLER    69 THESIS,UCRL 19372 R A MULLER                              (LRL)
COX       70 NP B19 61          +ISLAM, COLLEY, +      (BIRM,EDIN,GLAS,LOIC)IJP
BERTHON   70 NP B20 476         +RANGAN, VRANA, +(COL FRANCE, RHEL, SACLAY)IJP
LITCHFIE  70 NP B22 269         P J LITCHFIELD                  (RUTHERFORD)IJP
GALTIERI  70 DUKE CONF 173      A BARBARO-GALTIERI                      (LRL)IJP
BERTHON1  70 NP B24 417         +VRANA, BUTTERWORTH, + (CDEF, RHEL, SACLAY)IJP
CAMPBELL  71 NP B25 75          +MORTON, NEGUS, GOYAL, MILLER  (GLAS, LOIC)IJP

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Σ(2030) BUMPS 28 Y*1(2030) CROSS-SECTION AND INVARIANT-MASS PEAKS

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SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

SEE THE NOTE TO THE F17 Y*1(2030), WHICH PROCEEDS 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.

----------------   28  Y*1(2030) MASS (MEV) -- AS SEEN IN PEAKS   --------

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)

----------------   28  Y*1(2030) WIDTH (MEV) -- AS SEEN IN PEAKS   -------

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)

----------------   28  Y*1(2030) PARTIAL DECAY MODES   -----------------

                                                              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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For notation, see illustrated key at beginning of data card listings.

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-----------------   28  Y*1(2030) BRANCHING RATIOS -- AS SEEN IN PEAKS  ---

R1      Y*1(2030) INTO (KBAR N)/TOTAL                          X1
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 -- Y*0(2030) AS SEEN IN PEAKS

BLANPIED 65 PRL  14 741          +GREENBERG,HUGHES,KITCHING,LU,+ (YALE(CEA))
COOL     66 PRL  16 1228         +GIACOMELLI,KYCIA,LEONTIC,LI,LUNDBY,+ (BNL) I
      -- COOL 66 IS SUPERSEDED BY COOL 70.
BUGG     68 PR  168 1466         +GILMORE,KNIGHT, +      (RTHFD,BRMGHM,CVNDSH) I
BRICMAN  70 PL  31B 152          +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
COOL     70 PR  1D 1887          +GIACOMELLI, KYCIA, LEONTIC, LI, +     (BNL) I
LU       70 PR  D2 1846          +GREENBERG, HUGHES, MINEHART, MORI,+ (YALE)

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Σ(2070)

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34   Y*1(2070,JP=5/2+)I=1     F''15

THIS STATE HAS BEEN SUGGESTED BY ONLY ONE PARTIAL
WAVE ANALYSIS ACROSS THIS REGION. IT NEEDS CONFIRMATION

-----------------   34   Y*1(2070) MASS (MEV)   ----------------------------

M         (2070.)     (10.)           BERTHONI   70 DPWA  - K- P TO SIG PI    1/71*

-----------------   34   Y*1(2070) WIDTH (MEV)  ----------------------------

W          (140.)     (20.)           BERTHONI   70 DPWA  - K- P TO SIG PI    1/71*

-----------------   34   Y*1(2070) PARTIAL DECAY MODES  --------------------

                                                       DECAY MASSES
P1      Y*1(2070) INTO KBAR N                          497+ 939
P2      Y*1(2070) INTO SIGMA PI                       1197+ 139

        BELOW, X1 = (PARTIAL-WIDTH 1)/TOTAL WIDTH, ETC.   A SIGN, WHERE
        EXPLICIT, IS IN THE CONVENTION DISCUSSED IN THE Y* MINI-REVIEW.

-----------------   34   Y*1(2070) BRANCHING RATIOS  ----------------------

R2      Y*1(2070) FROM KBAR N TO SIGMA                  SQRT(X1*X2)
R2             (+.12)     (.02)        BERTHONI   70 DPWA  - K- P TO SIG PI   1/71*

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                          REFERENCES -- Y*1(2070)

BERTHONI 70 NP B24 417         +VRANA,BUTTERWORTH,+      (COEF,RHEL,SACLAY)IJP

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Σ(2080)

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88   Y*1(2080, JP=3/2+) I=1     P13

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.

-----------------   88   Y*1(2080) MASS (MEV)   ----------------------------

M        (2082.0)    (4.0)          COX        70 DPWA -  K- N TO LAM PI     6/70
M        (2070.0)   (30.0)          LITCHFIEL  70 DPWA 0- K- N TO LAM PI     6/70

-----------------   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

-----------------   88   Y*1(2080) PARTIAL DECAY MODES     --------------- --

                                                       DECAY MASSES
P1          Y*1(2080) INTO KBAR N                       497+ 939
P2          Y*1(2080) INTO LAMBDA PI                   1115+ 139

-----------------   88   Y*1(2080) BRANCHING RATIOS      --------------- --

        BELOW, X1 = (PARTIAL-WIDTH 1)/TOTAL WIDTH, ETC.   A SIGN, WHERE
        EXPLICIT, IS IN THE CONVENTION DISCUSSED IN THE Y* MINI-REVIEW.

R1      Y*1(2080) FROM KBAR N TO LAMBDA PI              SQRT(X1*X2)
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

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                          REFERENCES -- Y*1(2080)

COX       70 NP B19 61          +ISLAM, COLLEY, +      (BIRM,EDIN,GLAS,LOIC)IJP
LITCHFIE  70 NP B22 269         P J LITCHFIELD                 (RUTHERFORD)IJP

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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 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.

-----------------   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

-----------------   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

-----------------   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

-----------------   26   Y*1(2100) BRANCHING RATIOS   ---------------------

        BELOW, X1 = (PARTIAL-WIDTH 1)/TOTAL WIDTH, ETC.   A SIGN, WHERE
        EXPLICIT, IS IN THE CONVENTION DISCUSSED IN THE Y* MINI-REVIEW.

R1      Y*1(2100) FROM KBAR N TO LAMBDA PI              SQRT(X1*X2)
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(X1*X3)
R2           (+0.13)    (0.02)      GALTIERI   70 DPWA 0  K-P TO SIGMA PI    7/70

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                          REFERENCES -- Y*1(2100)

GALTIERI 70 DUKE CONF 173     A BARBARO-GALTIERI                       (LRL)IJP

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M > 2200 MEV – PRODUCTION AND σ_{TOTAL} EXPERIMENTS

BUMPS

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Σ(2250)

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48   Y*1(2250, JP=     ) I=1

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

THE PHASE-SHIFT-ANALYSIS RESULTS ARE TOO WEAK TO
WARRANT SEPARATING THEM FROM THE PRODUCTION AND CROSS-
SECTION EXPERIMENTS. IN AN ANALYSIS OF ELASTIC AND
POLARIZATION DATA, DAUM 68 COULD NOT EXCLUDE ANY
POSSIBILITY FROM JP= 5/2+- TO JP= 11/2+- FOR THIS STATE. BRICMAN 70
SUGGESTS 7/2-.

-----------------   48   Y*1(2250) MASS (MEV)   ----------------------------

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         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         2280.      14.0           AGUILAR    70 HBC  +  K- 3.9-4.6 GEV/C   5/70
M        (2250.0)   (20.0)          LU         70 CNTR 0  GAMMA P TO K+ Y*   1/71*
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.4)

-----------------   48   Y*1(2250) WIDTH (MEV)   ---------------------------

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          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          100.0     20.0           AGUILAR    70 HBC  +  K- 3.9-4.6 GEV/C   5/70
W         (125.0)                   LU         70 CNTR 0  GAMMA P TO K+ Y*   1/71*
W          . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 3.3)

-----------------   48   Y*1(2250) PARTIAL DECAY MODES   ------------------

                                                       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

-----------------   48   Y*1(2250) BRANCHING RATIOS   ---------------------

        BELOW, X1 = (PARTIAL-WIDTH 1)/TOTAL WIDTH, ETC.   A SIGN, WHERE
        EXPLICIT, IS IN THE CONVENTION DISCUSSED IN THE Y* MINI-REVIEW.

R1      Y*1(2250) INTO (KBAR N)/TOTAL                          X1
R1         J IS NOT KNOWN.  THE FOLLOWING IS (J+1/2)*X1.
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 LAMBDA PI              SQRT(X1*X2)
R2         THE FOLLOWING ASSUMES JP=9/2-. DATA INSUF. FOR DETERM. THIS AMP.
R2           (-0.18)                GALTIERI   70 DPWA    K-P TO LAMBDA PI 10/70*

R3      Y*1(2250) FROM KBAR N TO SIGMA PI               SQRT(X1*X3)
R3         THE FOLLOWING ASSUMES JP=9/2-. DATA INSUF. FOR DETERM. THIS AMP.
R3           (+0.07)                GALTIERI   70 DPWA    K-P TO SIGMA PI  10/70*

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 (LAMBDA PI)/(SIGMA PI)           (P2)/(P3)
R5           (0.18) OR LESS         BARNES     69 HBC  +  1 STAN DEV LIMIT 10/69

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                          REFERENCES -- Y*1(2250)

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, +      (RTHFD,BRMGHM,CVNDSH) I
BARNES   69 PRL  22 479          +FLAMINIO,MONTANET,SAMIOS +        (BNL+SYRA)
BRICMAN  70 PL  31B 152          +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
COOL     70 PR  1D 1887          +GIACOMELLI, KYCIA, LEONTIC, LI, +     (BNL) I
GALTIERI 70 DUKE CONF 173        A BARBARO-GALTIERI                    (LRL)IJP
AGUILAR  70 PRL  25 58           AGUILAR-BENITEZ, BARNES, +          (BNL, SYR)
LU       70 PR  D2 1846          +GREENBERG, HUGHES, MINEHART, MORI,+ (YALE)
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For notation, see illustrated key at beginning of data card listings.

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                         PAPERS NOT REFERRED TO IN DATA CARDS
COOL      66 PRL 16 1228        +GIACOMELLI,KYCIA,LEONTIC,LI,LUNDBY,+ (BNL) I
       -- COOL 66 IS SUPERSEDED 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

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Σ(2455)

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     53  Y*1(2455, JP=      ) I=1

     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.

----------------  53  Y*1(2455) MASS (MEV)  ---------------------------

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)

----------------  53  Y*1(2455) WIDTH (MEV)  --------------------------

W           100.0    20.0           BUGG      68 CNTR                     6/68
W           140.0                   ABRAMS    70 CNTR   K-P, D TOTAL     10/70*

----------------  53  Y*1(2455) PARTIAL DECAY MODES  ------------------

                                                       DECAY MASSES
P1        Y*1(2455) INTO KBAR N                         497+ 939

----------------  53  Y*1(2455) BRANCHING RATIOS  ---------------------

R1     Y*1(2455) INTO (KBAR N)/TOTAL                        X1
          J IS NOT KNOWN.  THE FOLLOWING IS (J+1/2)*X1.
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 -- Y*1(2455)

ABRAMS    70 PR 1D 1917         +COOL, GIACOMELLI, KYCIA, LEONTIC, +  (BNL) I
BUGG      68 PR 168 1466        +GILMORE,KNIGHT, +     (RTHFD,BRMGHM,CVNDSH) 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)
       -- ABRAMS 67 IS SUPERSEDED BY ABRAMS 70.
GREENBER  68 PRL 20 221         GREENBERG, HUGHES, LU, MINEHART, +    (YALE)

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Σ(2620)

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     54  Y*1(2620, JP=      ) I=1

     SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

----------------  54  Y*1(2620) MASS (MEV)  ---------------------------

M          2620.0    15.0           ABRAMS    70 CNTR   K-P, D TOTAL     10/70*

----------------  54  Y*1(2620) WIDTH (MEV)  --------------------------

W          (175.0)                  ABRAMS    70 CNTR   K-P, D TOTAL     10/70*

----------------  54  Y*1(2620) PARTIAL DECAY MODES  ------------------

                                                       DECAY MASSES
P1     Y*1(2620) INTO KBAR N                            497+ 939

----------------  54  Y*1(2620) BRANCHING RATIOS  ---------------------

R1     Y*1(2620) INTO (KBAR N)/TOTAL                        X1
R1        J IS NOT KNOWN.  THE FOLLOWING IS (J+1/2)*X1.
R1           0.36     0.12          BRICMAN   70 CNTR 0  TOTAL AND CH EX   6/70
R1          (0.32)                  ABRAMS    70 CNTR   K-P, D TOTAL     10/70*

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                         REFERENCES -- Y*1(2620)

ABRAMS    67 PRL 19 678         +COOL,GIACOMELLI,KYCIA,LEONTIC,LI, +  (BNL)
       -- ABRAMS 67 IS 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)

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Σ(3000)

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     59  Y*1(3000, JP=      ) I=1

     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 KO.  EVIDENCE NOT CONCLUSIVE.  OMITTED FROM
      TABLE.

----------------  59  Y*1(3000) MASS (MEV)  ---------------------------

M         (3000.0)                  EHRLICH   66 HBC  0  PI-P 7.91 BEV/C   9/66

----------------  59  Y*1(3000) PARTIAL DECAY MODES  ------------------

                                                       DECAY MASSES
P1        Y*1(3000) INTO KBAR N                         497+ 939
P2        Y*1(3000) INTO LAMBDA PI                     1115+ 139

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                         REFERENCES -- Y*1(3000)

EHRLICH   66 PR 152 1194        R EHRLICH, W SELOVE, H YUTA      (PENN(BNL)) I

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EXOTIC HYPERONS CROSS SECTION LIMITS (MICROBARNS)

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          THIS IS NOT A COMPLETE LIST. WE WILL TABULATE EXOTICS FROM NOW ON

CR   G        (20.) OR  LESS             GALTIERI   68 DBC    K-N TO SG-PI-PI0   7/70
     G   ABOVE LIMIT FOR MASS LT 2.15 GEV AND GAMMA LT 60 MEV- (2.1 GEV/C K-)   7/70
CR   A        (40.) OR  LESS             GALTIERI   68 DBC  -- K-N TO SG-PI-PI0  7/70
CR   A   ABOVE LIMIT FOR MASS LT 2.3 GEV AND GAMMA LT 120 MEV- (2.7 GEV/C K-)   7/70

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                         REFERENCES --- EXOTIC HYPERONS

GALTIERI 68 PRL 21 573        A.BARBARO-GALTIERI,CHADWICK +      (LRL+SLAC)

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Ξ Resonances

The Ξ resonance situation has long been and will probably long remain unsettled. This is because 1) they can only be produced as part of a final state, $K^- + p \to \Xi^* +$ 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 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 very unclear. 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 meager data available at this time.

STATUS OF THE XI* RESONANCES. THOSE WITH AN OVERALL STATUS OF *** OR **** ARE INCLUDED IN THE MAIN BARYON TABLE. SEE, HOWEVER, THE NOTES FOR THE INDIVIDUAL RESONANCES, PARTICULARLY FOR THE XI(1820) AND XI(1940), FOR ADDITIONAL WARNINGS.

			STATUS AS SEEN IN --				
PARTICLE	LIJ	OVERALL STATUS	XI PI	LAM K	SIG K	XI* PI	OTHER CHANNELS
XI(1320)	P11	****					LAMBDA 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.

For notation, see illustrated key at beginning of data card listings.

Ξ⁻

```
22  XI -     (1321,JP=1/2 )  I=1/2

SEE LISTINGS OF STABLE PARTICLES
```

Ξ⁰

```
23  XI 0     (1314, JP=1/2 )  I=1/2

SEE LISTINGS OF STABLE PARTICLES
```

Ξ(1530)

P13

```
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.

----------------   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
MO        76 1528.7     1.1           LONDON    66 HBC  0  K-P 2.24 GEV/C    7/66

----------------   49  XI*(-)-XI*(0) MASS DIFFERENCE (MEV)   -------------

D              5.7      3.0           PJERROU   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    R     REDUNDANT WITH DATA IN MASS LISTING.
D          . . . . . . . . . .
D    AVG       4.0      2.2      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

----------------   49  XI*1/2(1530) WIDTH (MEV)   -----------------------

W              7.0      2.0           SCHLEIN   63 HBC  0  1.8, 1.95 GEV/C
W              8.5      3.5           LONDON    66 HBC  0  2.24 GEV/C        7/66
W              7.0      7.0           BERGE     66 HBC  0  1.5-1.7 GEV/C     7/66
W          . . . . . . . . . .
W    AVG       7.3      1.7      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

----------------   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.
```


```
                          REFERENCES -- XI*1/2(1530)

PJERROU  52 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, +     (EP,SACLAY,AMSTR) I
PJERROU  65 PRL 14 275       +SCHLEIN,SLATER,SMITH,STORK,TICHO    (UCLA)
BERGE    66 PR 147 945       +EBERHARD,HUBBARD,MERRILL,B-SHAFER,+  (LRL) I
LONDON   66 PR 143 1034      +RAU,SAMIOS,YAMAMOTO,GOLDBERG,+  (BNL,SYCR) IJ
MERRILL  66 UCRL-16455 THESIS D W MERRILL                         (LRL) JP

                          PAPERS NOT REFERRED TO IN DATA CARDS

SHAFER   66 PR 142 883       BUTTON-SHAFER,LINDSEY,MURRAY,SMITH    (LRL) JP
    --  A SPIN-PARITY DETERMINATION.
```


Ξ(1630)

```
21  XI*1/2(1630, JP=     ) I=1/2

THIS IS A 3- OR 4-STANDARD-DEVIATION BUMP SEEN IN ONE
CHANNEL IN ONE EXPERIMENT. BARTSCH 69 SEE A SMALL,BROAD
ENHANCEMENT NEAR 1650 MEV - IT IS NOT CLEAR THAT IT IS
THE SAME PHENOMENON AS BMST 70.
THIS EFFECT NEEDS CONFIRMATION.

----------------   21  XI*1/2(1630) MASS (MEV)   -----------------------

M       40 1635.     10.            BMST       70 HBC   0 INTO  XI- PI+     7/70

----------------   21  XI*1/2(1630) WIDTH (MEV)   ----------------------

W       40   57.     18.            BMST       70 HBC   0

----------------   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.
```


```
                          REFERENCES -- XI*1/2(1630)

BMST     70 DUKE 317         BRANDEIS+MARYLAND+SYRACUSE+TUFTS  COLLAB.

                          PAPERS NOT REFERRED TO IN DATA CARDS

APSELL   69 PRL 23 884       +     (BRANDEIS, MARYLAND, SYRACUSE, TUFTS)
    --  APSELL 69 IS SUPERSEDED BY BMST 70
BARTSCH  69 PL 28B 439       +     (AACHEN, BERLIN, CERN, LONDON, VIENNA)
KALBFLEI 70 DUKE CONF 331    G R KALBFLEISCH                      (BNL) I
    --  KALBFLEISCH 70 SUMMARIZES EVIDENCE FOR ISOSPIN 1/2.
```

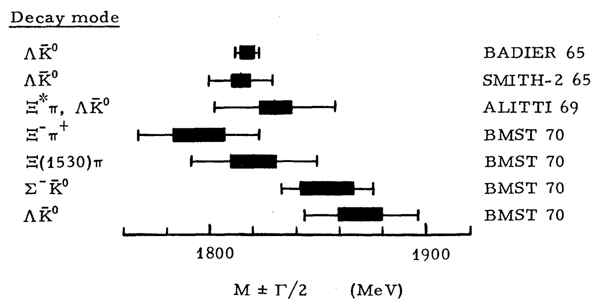

Ξ(1820)

```
50  XI*1/2(1820, JP=    ) I=1/2

                AS THE ACCOMPANYING IDEOGRAMS ILLUSTRATE, THE SITUATION
                IS CONFUSED.  UNTIL SOME FUTURE CLARIFICATION, WE LIST
                UNDER XI(1820) EVERYTHING REPORTED IN THE MASS RANGE
                1750-1875 MEV.  WHEN BRANCHING RATIOS ARE REPORTED, WE
QUOTE THEM, BUT THERE ESPECIALLY ONLY THE MOST QUALITATIVE CONCLUSIONS
(IF ANY AT ALL) ARE JUSTIFIED.
```

Ξ(1820)

Masses and widths of reported enhancements in the Ξ(1820) region (solid rectangles indicate error on mass).

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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    29 1817.0     7.0        SMITH 1   65 HBC  0- LAMBDA KBAR
M    30 1814.0     4.0        BADIER    65 HBC  0  LAMBDA KBAR
M    40 1830.0    10.0        ALITTI    69 HBC  -  LAM, SIG KBAR       9/69
M    25 1830.0    10.0        CRENNELL  70 DBC  0- 3.6, 3.9 GEV/C    10/70*
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       . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 2.4)
          (SEE IDEOGRAM BELOW )
```
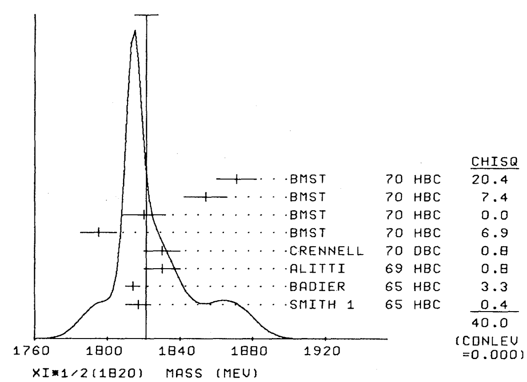
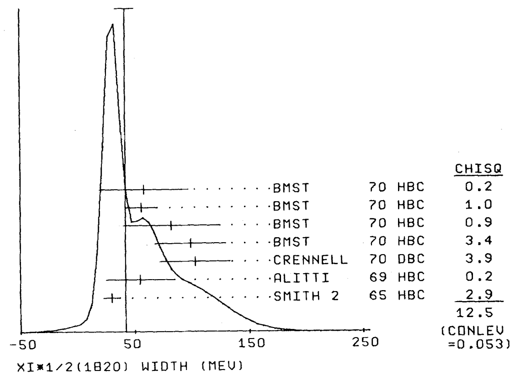




```
----------------   50  XI*1/2(1820) WIDTH (MEV)   -----------------------

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      103.0    38.0   24.0   CRENNELL  70 DBC  0- 3.6, 3.9 GEV/C    10/70*
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       . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.4)
          (SEE IDEOGRAM BELOW )
```

Baryons

For notation, see illustrated key at beginning of data card listings.




```
----------------- 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                1530+ 139
P5    XI*(1820) INTO XI PI PI (XI PI NOT XI*(1530)) 1321+ 139+ 139

----------------- 50 XI*1/2(1820) BRANCHING RATIOS ------------------

R1    XI*1/2(1820) INTO (LAMBDA KBAR)/TOTAL          (P1)/TOTAL
R1       0.3        0.15          ALITTI     69 HBC  -                     9/69

R2    XI*1/2(1820) INTO (XI PI)/TOTAL                (P2)/TOTAL
R2       0.1        0.1           ALITTI     69 HBC  -                     9/69

R3    XI*1/2(1820) INTO (SIGMA KBAR)/TOTAL           (P3)/TOTAL
R3      (0.02)       OR LESS      TRIPP      67 RVUE                       8/67
R3       0.3        0.15          ALITTI     69 HBC  -                     9/69

R4    XI*1/2(1820) INTO (XI*1/2(1530) PI)/TOTAL      (P4)/TOTAL
P4       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(1820) INTO (XI PI)/(LAMBDA KBAR)        (P2)/(P1)
R5       0.20       0.20          BADIER     65 HBC                        7/66

R6    XI*1/2(1820) INTO (XI*(1530) PI)/(LAM KBAR)    (P4)/(P1)
R6       0.26       0.13          SMITH 1    65 HBC

R7    XI*1/2(1820) INTO (XI PI PI)/(LAMBDA KBAR)     (P5)/(P1)
R7      (0.1)        OR MORE      SMITH 1    65 HBC

R8    XI(1820) INTO (XI PI)/(XI(1530) PI)            (P2)/(P4)
R8       1.5        0.6      0.4  APSELL     70 HBC  0                     6/70

R9    XI(1820) INTO (XI PI PI)/(XI(1530) PI)         (P5)/(P4)
R9       0.3        0.5           APSELL     70 HBC  0                     6/70

****** ********* ********* ********* ********* ********* ********* ********
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                          REFFRENCES -- XI*1/2(1820)

HALSTEIN 63 SIFNA CONF 173   HALSTEINSLID,+ (BERGEN,CERN,EP,RTHF,UNICOL) I
SMITH 1  65 PRL 14 25        +LINDSEY,BUTTON-SHAFER,MURRAY          (LRL)IJP
BADIER   65 PL 16 171        +DEMOULIN,GOLDBERG, +      (EP,SACLAY,AMSTR) I
SMITH 2  65 ATHENS CONF 251  G A SMITH, J S LINDSEY                   (LRL)
TRIPP    67 NP B3 10         + LEITH, +     (LRL,SLAC,CERN,HEIDEL,SACLAY)
     -- USES 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)
CRENNELL 70 PR 1D 847        +KARSHON, LAI, ONEALL, SCARR, SCHUMANN(BNL)
APSELL   70 PRL 24 777       +     (BRANDEIS, MARYLAND, SYRACUSE, TUFTS) I
BMST     70 DUKE 317         BRANDEIS+MARYLAND+SYRACUSE+TUFTS  COLLAB.

                             PAPERS NOT REFERRED TO IN DATA 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)
     -- APSELL 69 IS SUPERSEDED BY BMST 70.
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****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
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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.  THE SITUATION IS PERHAPS NOT
QUITE SO UNCLEAR AS IS THE CASE FOR THE XI(1820).

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      21 1955.0    14.0       GOLDWASSE  70 HBC  -  XI PI               10/70*
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          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.7)
                    (SEE IDEOGRAM BELOW )
```
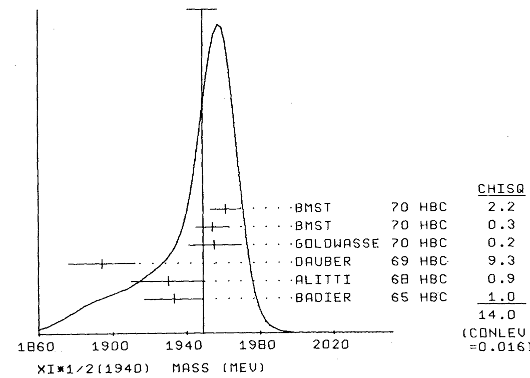
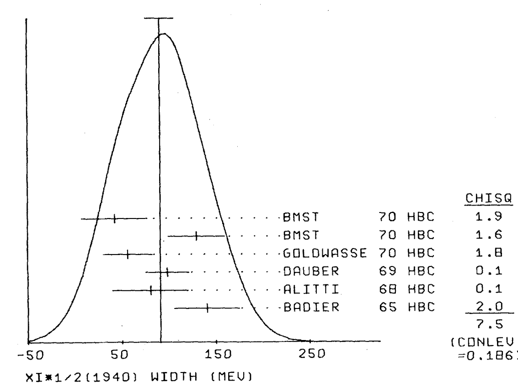




```
----------------- 52 XI*1/2(1940) WIDTH (MEV) -----------------------

W      35  140.0      35.0             BADIER     65 HBC  0  XI- PI+
W      27   80.0      40.0             ALITTI     69 HBC  0  XI- PI+           11/68
W      66   98.0      23.0             DAUBER     69 HBC  -  XI PI             11/68
W      21   56.0      26.0             GOLDWASSE  70 HBC  -  XI PI             10/70*
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          . . . . . . . . . .
W   AVFRAGE MEANINGLESS (SCALE FACTOR = 1.2)
                    (SEE IDEOGRAM BELOW )
```




```
----------------- 52 XI*1/2(1940) PARTIAL DECAY MODES ---------------

                                                       DECAY MASSES
P1    XI(1940) INTO XI PI                              1321+ 139
P2    XI(1940) INTO XI(1530) PI                        1530+ 139
P3    XI(1940) INTO XI PI PI (XI PI NOT XI(1530))      1321+ 139+ 139

----------------- 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.

R2    XI(1940) INTO (XI PI)/(XI(1530) PI)            (P1)/(P2)
R2       2.8        0.7      0.6  APSELL     70 HBC  0                     6/70

R3    XI(1940) INTO (XI PI PI)/(XI(1530) PI)         (P3)/(P2)
R3       0.0        0.3           APSELL     70 HBC  0                     6/70

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                          REFERENCES -- XI*1/2(1940)

BADIER   65 PL 16 171        +DEMOULIN,GOLDBERG, +       (EP,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
GOLDWASS 70 PR 1D 1960       F L GOLDWASSER, P F SCHULTZ       (ILLINOIS)
BMST     70 DUKE 317         BRANDEIS+MARYLAND+SYRACUSE+TUFTS  COLLAB.

                             PAPERS NOT REFERRED TO IN DATA CARDS

APSELL   69 PRL 23 884       +     (BRANDEIS, MARYLAND, SYRACUSE, TUFTS)
     -- APSELL 69 IS SUPERSEDED BY BMST 70.
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****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
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For notation, see illustrated key at beginning of data card listings.

Ξ(2030)

```
68  XI*1/2(2030, JP=    ) I=1/2

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         . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.4)

----------------  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         . . . . . . . . . .
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             1530+ 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 -- XI*1/2(2030)

ALITTI   69 PRL 22 79          +BARNES,FLAMINIO,METZGER, +  (BNL,SYRACUSE) I
BARTSCH  69 PL 28B 439         +    (AACHEN, BERLIN, CERN, LONDON, VIENNA)

****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
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Ξ(2250)

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22  XI*   (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.

----------------  22  XI*   (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         . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

----------------  22  XI*   (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*   (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

****** ********* ********* ********* ********* ********* ********* *******

                    REFERENCES -- XI*   (2250)

BARTSCH  69 PL 28B 439         +    (AACHEN, BERLIN, CERN, LONDON, VIENNA)
GOLDWASS 70 PR 1D 1960         E L GOLDWASSER, P F SCHULTZ       (ILLINOIS)

****** ********* ********* ********* ********* ********* ********* *******
****** ********* ********* ********* ********* ********* ********* *******
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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.

----------------  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         . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 3.1)

----------------  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         . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.6)

----------------  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 LAMBDA KBAR                1115+ 497
P3        XI*1/2(2500) INTO SIGMA KBAR                 1197+ 497
P4        XI*1/2(2500) INTO XI*1/2(1530) PI            1530+ 139
P5        XI*1/2(2500) INTO LAMBDA (OR SIGMA) KBAR PI  1115+ 497+ 139
P6        XI*1/2(2500) INTO XI PI PI                   1321+ 139+ 139

----------------  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 LAMBDA (OR SIGMA) KBAR PI       (P5)
R5           SEEN                     BARTSCH   69 HBC  0-                   9/69

R6    XI*1/2(2500) INTO XI PI PI                        (P6)
R6           SEEN                     BARTSCH   69 HBC  0-                   9/69

****** ********* ********* ********* ********* ********* ********* *******

                     REFERENCES -- XI*1/2(2500)

ALITTI   69 PRL 22 79          +BARNES,FLAMINIO,METZGER, +  (BNL,SYRACUSE) I
BARTSCH  69 PL 28B 439         +    (AACHEN, BERLIN, CERN, LONDON, VIENNA)

****** ********* ********* ********* ********* ********* ********* *******
****** ********* ********* ********* ********* ********* ********* *******
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Ω^-

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24  OMEGA -  (1675, JP=3/2+)  I=0

SEE LISTINGS OF STABLE PARTICLES

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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 below.

Table I. (000) or (+-0) refer to the sign of the pions into which the K decays.

$\Gamma_{K^+_{\ell 3}} = \Gamma_{K^+_{e3}} + \Gamma_{K^+_{\mu 3}}$	$= (6.51\pm.12)\times 10^{6}\ \mathrm{sec}^{-1}$
$\Gamma_{K^+_{\mu 3}} / \Gamma_{K^+_{e3}}$	$= 0.659\pm.022$
$\Gamma_{K^+_{\tau}} / \Gamma_{K^+_{\tau 1}}$	$= 3.329\pm.086$
$\Gamma_{K^0_{\ell 3}} = \Gamma_{K^0_{e3}} + \Gamma_{K^0_{\mu 3}}$	$= (12.71\pm.16)\times 10^{6}\ \mathrm{sec}^{-1}$
$\Gamma_{K^0_{\mu 3}} / \Gamma_{K^0_{e3}}$	$= 0.689\pm.022$
$\Gamma_{K^0(000)} / \Gamma_{K^0(+-0)}$	$= 1.701\pm.072$

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

$$\Gamma_{K^0_{\ell 3}} / 2\Gamma_{K^+_{\ell 3}} = 1.012,$$ a phase-space factor,[2] and

$$\Gamma_{K^0_{\mu 3}} / \Gamma_{K^0_{e3}} = \Gamma_{K^+_{\mu 3}} / \Gamma_{K^+_{e3}} .$$

From Table I,

$$\Gamma_{K^0_{\ell 3}} / 2\Gamma_{K^+_{\ell 3}} = 0.976\pm.022$$

and

$$\frac{\Gamma_{K^0_{\mu 3}}}{\Gamma_{K^0_{e3}}}\left[\frac{\Gamma_{K^+_{\mu 3}}}{\Gamma_{K^+_{e3}}}\right]^{-1} = 1.046\pm.048$$

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 listing 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 and slopes (energy dependence of the Dalitz plot distributions) are used. The $\Delta I = 1/2$ rule gives the following predictions:

$$T_1 = \frac{2}{3}\,\frac{\Gamma_{K^0(000)}}{\phi_1}\left[\frac{\Gamma_{K^0(+-0)}}{\phi_2}\right]^{-1} = 1 ,$$

$$T_2 = \frac{1}{4}\,\frac{\Gamma_{K^+_{\tau}}}{\phi_3}\left[\frac{\Gamma_{K^+_{\tau'}}}{\phi_4}\right]^{-1} = 1 ,$$

$$T_3 = \frac{1}{2}\,\frac{\Gamma_{K^+_{\tau}}}{\phi_3}\left[\frac{\Gamma_{K^0(+-0)}}{\phi_2}\right]^{-1} = 1 ,$$

$$T_4 = \frac{1}{2}\, g_{K^+_{\tau'}} + g_{K^+_{\tau}} = 0 ,$$

$$T_5 = g_{K^0(+-0)} + g_{K^+_{\tau}} - \frac{1}{2} g_{K^+_{\tau'}} = 0,$$

where the ϕ_i are the phase-space factors. These factors have been calculated as described in Mast et al.[3] by use of a relativistic formulation and the masses and slopes from this compilation. 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
$\phi_1(000) =$	1.487	1.487	1.441
$\phi_2(+-0) =$	1.219	1.293	1.278
$\phi_3(++-) =$	1.000	1.000	1.000
$\phi_4(+00) =$	1.247	1.182	1.146

The slopes for the various decays have not been tabulated in the Stable Particles Table. They are as follows:

$$\left.\begin{aligned} g_{K^+_{\tau}} &= -0.206\pm 0.007 \\ g_{K^-_{\tau}} &= -0.194\pm 0.007 \end{aligned}\right\} -0.200\pm 0.005$$

$$g_{K^+_{\tau'}} = 0.527\pm 0.017,$$

$$g_{K^0_L(+-0)} = 0.603\pm 0.028 \quad \text{(Error scaled}\times 3.1)$$

A difference in the τ^+ and τ^- slopes would be an indication of CP violation in this decay. Since no difference is present at this time, we average the two and use this value in T_4.

Using the CNUDP and rates and slopes reported here, we get:

$$T_1 = 1.006\pm0.043,$$
$$T_2 = 0.954\pm0.025,$$
$$T_3 = 1.184\pm0.028,$$
$$T_4 = 0.064\pm0.010,$$
$$T_5 = 0.139\pm0.030.$$

The three-pion final state can be in isospin states I = 1, 2, 3. T_1 and T_2 test the existence of isospin I = 3 in the final state and are consistent with no or very little I = 3. T_4 is related to the I = 2 amplitude in the final state and indicates the presence of I = 2. T_3 and T_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 $\Delta I = 3/2$.

The rate tests T_1, T_2, and T_3 could differ from 1.0 by as much as 10% owing to the π mass differences and the occurrence of big slopes.[5] The error on $g_{K^0_L(+-0)}$ has been scaled by a factor of 3.1 to compensate for the disagreement among the determinations of this parameter. Since this error is the main contribution to the T_5 error, the reader is cautioned to refer to the $g_{K^0_L(+-0)}$ ideogram in the data card listings before interpreting T_5.

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2. N. Brene (CERN), private communication. In our Jan. 1968 edition we had erroneously used 1.04.
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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

There are a few multiplets that have been studied and we report here the results. The relevant formulae are given below.

Mass Formulae

Decuplet	$\Delta - \Sigma = \Sigma - \Xi^* = \Xi^* - \Omega$	GMO	(1)
Octet	$2(N+\Xi) = 3\Lambda + \Sigma$	GMO	(2)
Nonet	$\sin^2\theta = \dfrac{\Lambda - M_8}{\Lambda - \Lambda'}$	Mixing angle†	(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

$$\Gamma \propto \frac{|T|^2 R_2}{M_R}, \tag{5}$$

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 $1/M_R$ (see FEYNMAN 62).

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 factor M_R, cancelling the $1/M_R$. We are then left with

$$\Gamma = \frac{|T|^2 k}{M_R} M_N, \quad \text{for baryons} \tag{5'}$$

$$= \frac{|T|^2 k}{M_R^2} M_N^2, \quad \text{for mesons} \tag{5''}$$

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

$$\left.\begin{matrix}\text{Decuplet}\\ \text{Singlet}\end{matrix}\right\} \Gamma = (cg)^2 B_\ell(k) \frac{M_N}{M_R} k \tag{6}$$

$$\text{Octet} \quad \Gamma = (c_D g_D + c_F g_F)^2 B_\ell(k) \frac{M_N}{M_R} k \tag{7}$$

$$\text{Nonets} \quad \left\{\begin{matrix} G_8 = \Lambda \cos\theta - \Lambda' \sin\theta \\ G_1 = \Lambda \sin\theta + \Lambda' \cos\theta \end{matrix}\right. \tag{8}$$

$$\text{with} \quad \begin{matrix} G_8 = c_D g_D + c_F g_F \\ G_1 = c_1 g_1. \end{matrix} \tag{9}$$

Here c_i are the SU(3) coefficients with the sign convention adopted in this article [see note preceding the table of SU(3) isoscalar coefficients and Fig. 3, "Note on $Y^{*'}$s"]. 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, g_i are the relevant couplings. For the case of singlet-octet mixing, formula (8) has to be used in conjunction 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. In a recent fit of all baryon states into SU(3) multiplets by the CHS collaboration (PLANE 70) two forms have been tried for B_ℓ.

(a) The form $B_\ell = k^{2\ell} D_\ell(kR)$, R being the radius of interaction and D_ℓ the polynomials in kR given by BLATT-WEISSKOPF 52. Usually R is taken to be 1 Fermi (TRIPP 68).

(b) The form $B_\ell = k^{2\ell}$. It turns out that the values of θ and g_F/g_D obtained with the two forms for B_ℓ are the same, although the absolute values of g_F and g_D depend upon the form used.

The relation between g_D, g_F and the D (symmetric) and F (antisymmetric) couplings is as follows:

$$\frac{F}{D} = \sqrt{\frac{5}{3}}\ \frac{g_F}{g_D}\,. \tag{10}$$

Fits of baryon decay rates within SU(3) can be found, among others, in TRIPP 68 and 69 and LEVI SETTI 69.

The most recent published survey is by the CHS collaboration (PLANE 70); we report their results in Table I. A new fit by the BNL group has been reported by Samios at the Kiev Conference‡ (SAMIOS 70). The results of the two analyses are in good agreement, although the procedures used are somewhat different. We refer the reader to these papers for more details. Some comments are given below.

$\frac{1}{2}^-$-Nonet (Baryon - Eta Resonances)

For this nonet relation, (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 axial vector current remains an octet in presence of symmetry breaking) and it was advocated by Graham et al. (GRAHAM 67). For the $1/2^-$ nonet it has been used in this form first by Gell-Mann et al. (GELL-MANN 68).

The two values of F/D are dependent upon what value is used for the decay $N(1525) \to N\eta$. The first value is obtained by using 60% for the $N\eta$ branching ratio, the second value by using ~15%. SAMIOS 70 reports only the second value. However, there are now reservations about the second value (see footnote

Table I. SU(3) baryon multiplets with two or more known members. The coupling constants are those for decay into baryon ($1/2^+$) octet $\otimes$ pseudoscalar meson octet. Values of θ and F/D taken from PLANE 70. The analysis reported by SAMIOS 70 finds similar results.

J^P	Octet members[a]	Singlet	θ(deg)[b]	F/D
$1/2^-$	N'(1535) Λ(1670) Σ(1750) Ξ(1825)	Λ(1405)	18 ± 17	-2.9 -0.21
$3/2^-$	N(1520) Λ(1690) Σ(1670) Ξ(1800)	Λ(1520)	-25 ± 6	2.3
$5/2^-$	N(1670) Λ(1830) Σ(1765)			-0.19
$5/2^+$	N(1688) Λ(1815) Σ(1915)			0.82[d]
	Decuplet members	g_{10}^2 [c]		
$3/2^+$	Δ(1236) Σ(1385) Ξ(1530) Ω^-	0.94 to 2.38		
$7/2^+$	Δ (1950) Σ(2030)	0.25 to 0.97		

a. Masses in parentheses are the nominal masses used in the Baryon Table. For the Ξ members, the value of the mass is the one predicted by SU(3), using the mixing angle calculated by using the rates.
b. Values calculated from the decay rates (Eq. 8).
c. Values taken from TRIPP 68 who uses the convention of Eq. 6 with $B_\ell(k)$ being the BLATT-WEISSKOPF 52 form.
d. SAMIOS 70 finds F/D = 1.5 for this octet.

o to Baryon Table).

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 square 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† for the square 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 in Table II.

Table II. Mixing angles from quadratic SU(3) mass formula. Of the two iso-singlets, the "mainly octet" one is written first, followed by a semicolon.

J^P	Octet members	θ
0^-	possible nonet [π, K, η;η']	10.4±0.2°
0^-	alternative nonet [π, K, η;E]	6.2±0.1°
1^-	[ρ(765±10), K^*, ϕ;ω]	39.5±0.7°
2^+	[A2(1300±20), K_N(1420), f';f]	33.7±3.9°

Footnotes and References

†The formula has been calculated from analogy with the formula for mixing of meson states, first put in this form by S. L. Glashow and R. H. Socolow, Phys. Rev. Letters 15, 329 (1966). For the baryon formula see A. Barbaro-Galtieri, Phenomenology of Resonances and Particle Supermultiplets. UCRL-17054 (1966).

‡This is an updated version of the fits by Flaminio et al., BNL report 14572.

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