Nucleon-nucleon partial-wave analysis to 1 GeV

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Comprehensive analyses of nucleon-nucleon elastic-scattering data below 1 GeV laboratory kinetic energy are presented. The data base from which an energy-dependent solution and 20 single-energy solutions are obtained consists of 5207 *pp* data below 1.2 GeV and 5283 *np* data below 1.1 GeV. The solutions are characterized by tightly constrained "resonancelike" structure in the $^1D_2$ and $^3F_3$ partial waves. No other partial waves exhibit such structure below 1 GeV; in particular, we see no isoscalar resonances. We describe how the full data base and solution files can be accessed through a computer interactive dial-in system [scattering analyses interactive dial-in (SAID)] at VPI&SU, which also exists at several institutions around the world and which can be transferred to any site with a suitable computer system. The SAID system can be used to modify solutions, plan experiments, and obtain any of the multitude of predictions which derive from our partial-wave analyses of the world data base.

I. INTRODUCTION

Since our last report[1] on nucleon-nucleon scattering analyses, we have been using a dial-in interactive computing facility [scattering analyses interactive dial-in (SAID)] to communicate our latest results to other investigators. The usage level of SAID has been high, sometimes involving more than ten dial-ins per day from off-campus users into the VPI&SU computers. Some of these regular users requested that we transfer SAID to their local computers, which we have now done for ten other sites with VAX computers in North America and Europe.

Despite the success of our interactive computer programs at communicating our analyses' results, it is now necessary to publish a comprehensive paper about our nucleon-nucleon analyses in order to list the data currently being used, expound on the current parametrization, and provide the details about our current solutions for those who are not able to use a computer terminal to study them.

Section II contains our latest parametrization for the amplitudes. In Sec. III, the data that have appeared since our last paper are discussed and data charts are shown. The results of the analyses, both single-energy and energy-dependent, are given in Sec. IV. The SAID facility is described in Sec. V.

II. PARAMETRIZATION OF THE AMPLITUDES

The amplitudes used in our analyses are related to those used by Bystricky *et al.*[2] and by Hoshizaki[3] as indicated in Table I.

The relationships of these amplitudes to a number of other choices which have appeared in the literature are given by Bystricky.[2] The H's are expanded in partial waves according to the formulas

$$H_1=\sum_j (2j+1)T_jP_j\ ,$$
$$H_2=\sum_j [(2j+1)T_{jj}F_j+D_{j-}G_j]\ ,$$
$$H_3=\sum_j [(2j+1)T_{jj}G_j+D_{j-}F_j]\ , \tag{1}$$
$$H_4=\sum_j D_{j0}G_js\ ,$$

and

$$H_5=\sum_j D_{j+}P_j\ ,$$

where

$P_j=P_j(z)$=Legendre polynomial ,

$G_j=P_j^1(z)/j(j+1)$,

$P_j^1(z)$=associated Legendre function of order 1 ,

TABLE I. Amplitude relations. k=center-of-mass momentum, $z=\cos\theta$, $s=\sin\theta$, and θ=center-of-mass scattering angle.

H's	Bystricky (Ref. 2)	Hoshizaki (Ref. 3)
$2H_1/k$	$B-C$	$A_h-M_h-2G_h$
$2H_2/k$	$B+C$	$A_h-M_h+2G_h$
$2H_3/k$	$Az+iE_s-D$	$(A_h+M_h)z+2iC_hs+2H_h$
$2H_4/k$	$As-iEz$	$(A_h+M_h)s-2iC_hz$
$2H_5/k$	$Az+iEs+D$	$(A_h+M_h)z+2iC_hs-2H_h$

$$F_j = P_j - G_j z \ ,$$

$$D_{j-} = (j+1)T_{j-} + jT_{j+} - 2[j(j+1)]^{1/2}T_{j0} \ ,$$

$$D_{j0} = j(j+1)[T_{j-} - T_{j+}] + [j(j+1)]^{1/2}T_{j0} \ ,$$

and

$$D_{j+} = jT_{j-} + (j+1)T_{j+} + 2[j(j+1)]^{1/2}T_{j0} \ .$$

The partial-wave amplitudes are

T_j = singlet

(e.g., $^1S_0, ^1P_1, ^1D_2, \ldots$),

T_{jj} = triplet uncoupled

(e.g., $^3P_1, ^3D_2, \ldots$), and

T_{j-}, T_{j0}, T_{j+} = triplet coupled

(e.g., $^3S_1, \epsilon_1, ^3D_1, \ldots$).

One-pion exchange is included through partial-wave contributions to the unsearched waves for $j < 11$, and by adding a closed-form piece to the H's for $j > 10$. All analyses use an unsearched value of 14.5 for $G_\pi{}^2$, the pion-nucleon coupling constant.

The H's also contain a direct Coulomb contribution (H_C), given by the one-photon-exchange amplitudes of Lechanoine *et al.*[4] In addition to this, the Coulomb phase ϕ changes the amplitudes for *pp* scattering. For ϕ we use the form which Breit[5] has shown corrects for relativistic effects:

$$\phi = -\eta \ln(\tfrac{1}{2}\sin^2\theta) \ , \tag{2}$$

where $\eta = \alpha c / V_L$, α = fine-structure constant, θ = center-of-mass scattering angle, and V_L = velocity of incident nucleon in the laboratory frame. For *pp* scattering, the partial-wave summation includes only allowed ($I=1$) states, namely,

$$T_j \ (j \text{ even}), \quad T_{jj} \ (j \text{ odd}) \ ,$$

$$T_{j\pm} \ (j \text{ even}), \quad T_{j0} \ (j \text{ even}) \ .$$

In each member of the right-hand side of Eq. (1) these states are modified by a multiplicative factor of 2 and by a Coulomb "rotation" factor:

$$\begin{aligned} T_j &\to 2T_j \exp(2i\phi_j) \ , \\ T_{jj} &\to 2T_{jj} \exp(2i\phi_j) \ , \\ T_{j\pm} &\to 2T_{j\pm} \exp(2i\phi_{j\pm 1}) \ , \\ T_{j0} &\to 2T_{j0} \exp(\phi_{j+1} + \phi_{j-1}) \ , \end{aligned} \tag{3}$$

where

$$\phi_j = \sum_{n=1}^{j} \tan^{-1}(\eta/n), \ \eta = \alpha c / V_L, \ \phi_0 = 0 \ .$$

Normalization of the H's is such that

$$d\sigma/d\Omega = \left[\sum_{j=1}^{5} |H_i|^2 + |H_4| \right] / k^2 \ ,$$

where k = center-of-mass momentum of either nucleon.

Scattering observables, including relativistic spin corrections, are as described by Bystricky.[2] Printouts and plots of these observables are available through the interactive dial-in system (SAID; see below) and, therefore, are not presented here.

There is a certain amount of charge splitting between the $I=1$ waves used in *pp* and in *np* scattering. It is obtained in the energy-dependent combined ($I=1$ and 0) analysis by multiplying the expansion bases used to obtain the T matrix by an appropriate barrier-penetration factor for *pp* observables.[1] The single-pion-exchange mass used for *np* (136.5 MeV) is also slightly different than the mass used for *pp* (135.04 MeV). The recipe is *ad hoc*, but does manage to give the necessary Coulomb suppression to low-energy *pp* phases.[1] The exact amount of charge splitting can be obtained by comparison of the $I=1$ waves, listed in Table III for *pp* scattering, to the corresponding *np* entries from Table IV. The single-energy analyses were performed with the charge splitting fixed at the energy-dependent solution's values.

The phase parameters used for single-energy analyses were given a linear energy slope being taken from the energy-dependent solution. The slope parameters are especially important at higher energies where, because of paucity of the data, we were required to use very broad energy bins.

Phase parameters are as described by Arndt and Roper.[6] For uncoupled waves, the S matrix is given by

$$S = \frac{1 - K_i + iK_r}{1 + K_i - iK_r} = \eta \exp(2i\delta_s) \ , \tag{4}$$

where

$$K_r = \tan\delta, \quad K_i = \tan^2\rho \ ,$$

$$\eta^2 = \frac{1 + K^2 - 2K_i}{1 + K^2 + 2K_i} \ ,$$

$$K^2 = K_r{}^2 + K_i{}^2 \ ,$$

and

$$\delta = \tfrac{1}{2}\{\tan^{-1}[K_r/(1-K_i)] + \tan^{-1}[K_r/(1+K_i)]\} \ .$$

For elastic scattering ($\rho = 0$), $\delta = \delta_s$ and $\eta = 1$.

For spin-coupled waves S is expanded in a K matrix:

$$S = (1 + iK)/(1 - iK) \ .$$

K (a 2×2 matrix) can be written as

$$K = \begin{bmatrix} K_{r_-} & K_{r_0} \\ K_{r_0} & K_{r_+} \end{bmatrix} + i \begin{bmatrix} \tan^2\rho_- & \tan\rho_- \tan\rho_+ \cos\phi \\ \tan\rho_- \tan\rho_+ \cos\phi & \tan^2\rho_+ \end{bmatrix} . \tag{5}$$

The real part of K (viz., K_r) is expanded in the usual Stapp[7] parameters

$$K_{r_\pm}=\frac{\sin(\delta_+ +\delta_-)\pm\cos(2\epsilon)\sin(\delta_+ -\delta_-)}{\cos(\delta_+ +\delta_-)+\cos(2\epsilon)\cos(\delta_+ -\delta_-)}\ ,\quad K_{r_0}=\frac{\sin 2\epsilon}{\cos(\delta_+ +\delta_-)+\cos(2\epsilon)\cos(\delta_+ -\delta_-)}\ . \tag{6}$$

The diagonal elements of the S matrix are

$$S_+ =[1+d_k -i(K_+ -K_-)]/D_k\ ,\quad S_- =[1+d_k -i(K_- -K_+)]/D_k\ , \tag{7}$$

and the off-diagonal elements are

$$S_0 = 2iK_0/D_k\ ,$$

where $D_k = 1-d_k -i(K_+ +K_-)$ and $d_k = K_+K_- +K_0{}^2$.

For elastic scattering ($\rho_\pm = 0$), we get an elastic S matrix of the Stapp[7] form:

$$S=\begin{bmatrix} \cos(2\epsilon)\exp(2i\delta_-) & i\sin(2\epsilon)\exp[i(\delta_+ +\delta_-)] \\ i\sin(2\epsilon)\exp[i(\delta_+ +\delta_-)] & \cos(2\epsilon)\exp(2i\delta_+) \end{bmatrix}\ . \tag{8}$$

The representation in terms of phase shifts (δ) and coupling parameters (ϵ) that we use here is the same as the Stapp[7] representation at low energies, but does not correspond to any previous representation when inelasticity occurs at higher energies. Other representations have been used that have flaws.[6] In an age of computers, the exact representation used, as long as it does not violate the basic general principles, is immaterial if it is explicit and computer programs are available for using it (see Secs. IV and V). Analyses using the other representations are available on our dial-in computing system (see Sec. V). Also, we shall present tables below of the amplitudes for our solution, as well as tables for the δ's, ϵ's, and ρ's of our representation. One can construct any representation from such tables.

The energy dependence for our parametrization is as described in our previous work.[1]

III. THE DATA BASE

Figure 1 illustrates the kinematical (energy and angle) distribution of several common types of data used in these analyses. The data of Fig. 1 are displayed as "old" (pre-1978) and "new" (post-1977). The pre-1978 data were used in the last comprehensive analyses of nucleon-nucleon scattering below 500 MeV by the VPI&SU group.[1]

In addition to the data displayed in Fig. 1, we used 58 total cross sections below 200 MeV, 60 polarized total cross sections ($\Delta\sigma_L$,$\Delta\sigma_T$), 473 data above 1000 MeV up to 1194 MeV. The dispersion-theory quantities of Grein and Kroll[8] were also included as weakly constraining data. The following arbitrary errors were used, as indicated in the parentheses

pp quantities at 14 energies from 295 to 1181 MeV:

σ_T (0.5), $\Delta\sigma_L$ (1), $\Delta\sigma_T$ (1), α (0.05),

Ref_2 (0.5), Ref_3 (0.5) .

np quantities at 13 energies from 295 MeV to 1092 MeV:

σ_T (1), $\Delta\sigma_L$ (5), $\Delta\sigma_T$ (5), α (0.05),

Ref_2 (0.5), Ref_3 (0.5) .

The uncertainty units are mb for cross sections (σ_T,$\Delta\sigma_L$,$\Delta\sigma_T$) and fm for amplitudes (Ref_2,Ref_3), and α is dimensionless. These 162 data were included more for reference than for the constraints they afforded. In fact, these quantities did not compare well with the partial-wave predictions above 600 MeV and for *np* quantities at all energies.

Figure 1 reveals an abundance of differential cross sections which are well distributed for *pp* [Fig. 1(a)], but which have a large gap for *np* [Fig. 1(d)] above 500 MeV and forward of 90°; in fact, most of the *np* differential cross-section data are charge-exchange back-angle data.

Polarization data are in fairly good supply for both *pp* [Fig. 1(b)] and *np* [Fig. 1(e)], although *np* polarization data above 800 MeV are quite skimpy. The distribution plots in Fig. 1 do not illustrate relative accuracy, and some of the older polarization data are rather imprecise.

The "other" spin observables are characterized by a fair amount of *pp* data [Fig. 1(c)], but a very skimpy assortment of *np* data [Fig. 1(f)] with essentially nothing above 700 MeV and a near void for angles forward of 70°.

The *pp* angular observables at angles θ greater than 90° are shown at $180°-\theta$, for convenience.

Reaction cross sections in Fig. 2 are those of VerWest and Arndt[9] obtained through a phenomenological parametrization of the isotopic reaction cross sections, the parameters of which were adjusted to fit the world data base of charge-channel reaction cross sections. The curves in the total cross-section plots are predictions of the energy-dependent solution SP82.

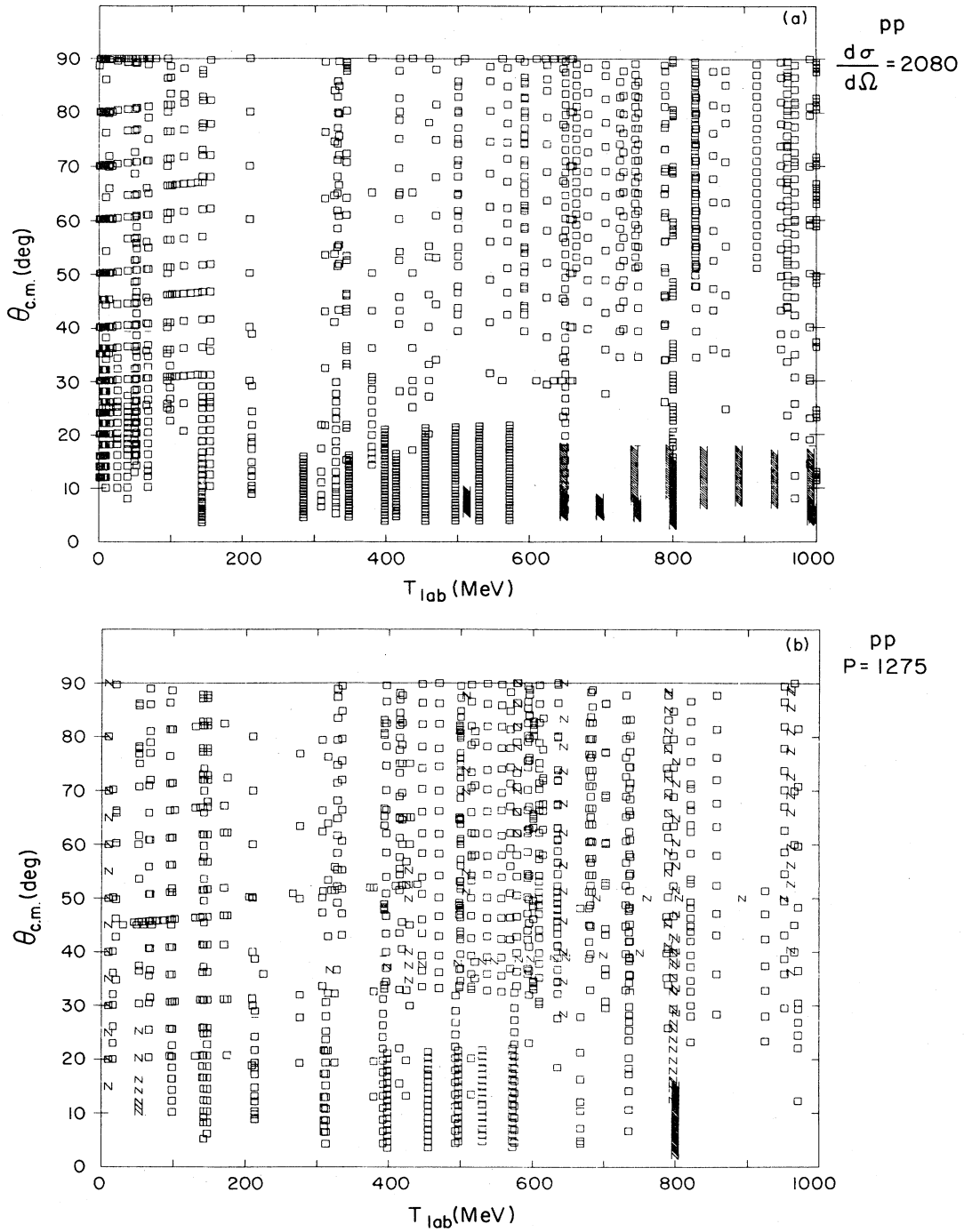

FIG. 1. Nucleon-nucleon scattering data base for 0—1000 MeV laboratory kinetic energy. These graphs are for the purpose of giving an indication of the density of data as a function of energy. The boxes indicate "old" data (pre-1978) and the *N*'s indicate "new" data (post-1977). (a) Differential cross sections for *pp*. (b) Polarization for *pp*. (c) Other spin observables for *pp*. (d) Differential cross sections for *np*. (e) Polarization for *np*. (f) Other spin observables for *np*.

IV. RESULTS

In Table II, we summarize the data base, χ^2, and the number of searched parameters for each solution. The energy-dependent solution is labeled SP82; the rest of the solutions are "single-energy" solutions which are fitted to data within the specified range of energies. Single-energy solutions starting with C were obtained by searching both $I=0$ and $I=1$ partial waves (*pp* and *np* data); solutions starting with P were obtained by searching only $I=1$, al-

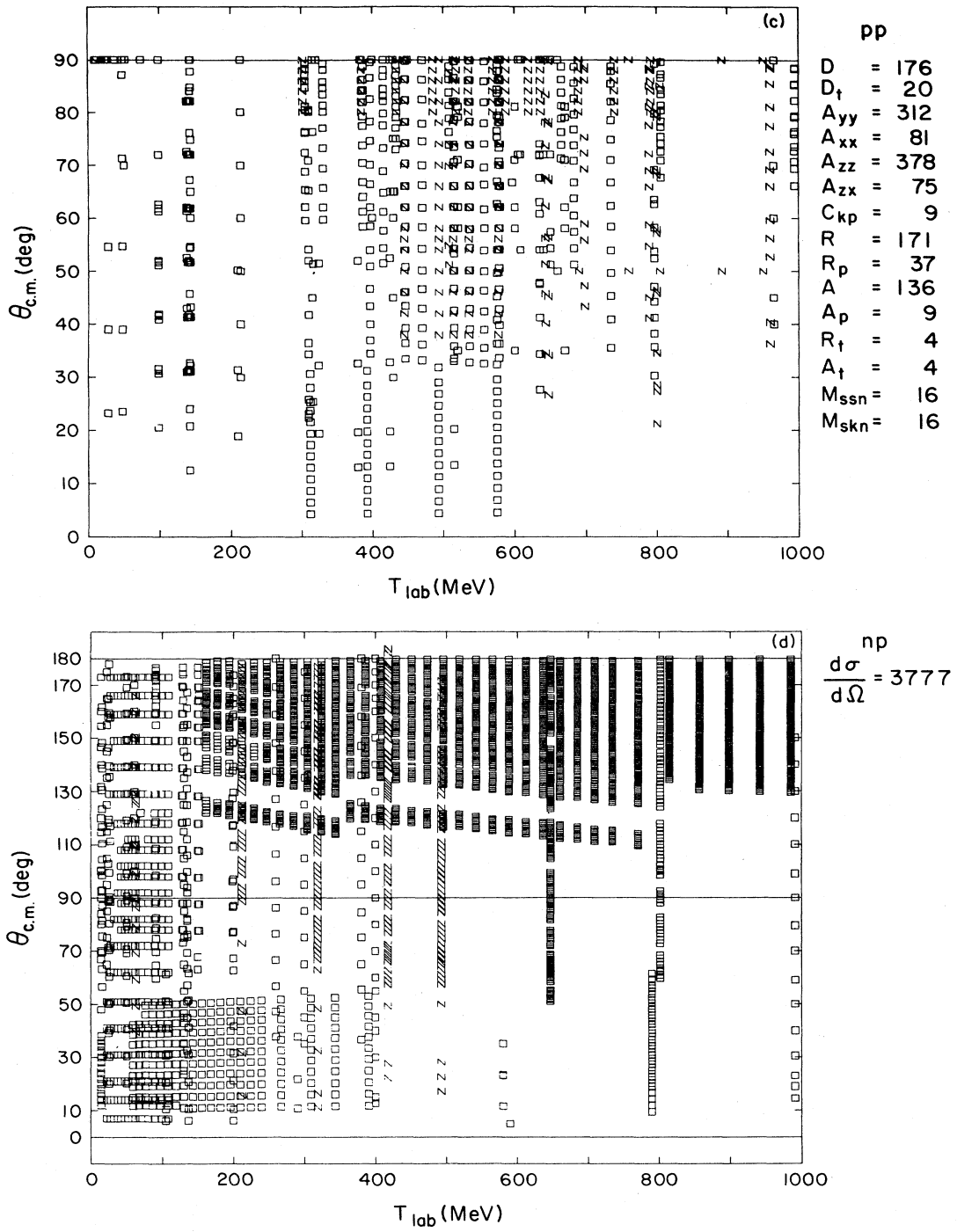

FIG. 1. *(Continued.)*

though the data base included *np* data as well as *pp*. In this case, unsearched partial-wave parameters and the energy slopes of the searched partial-wave parameters were taken from solution SP82.

There are several reasons for the high ratios of χ^2 to number of data for the higher energies in Table II: The higher-energy data have not been carefully pruned over a long period, as have the lower-energy data; and the linear-energy-dependence approximation may not be as valid over the energy ranges used at higher energies as it is at lower energies.

In Tables III and IV we list the partial-wave parameters derived from the energy-dependent solution SP82. Charge splitting between $I=1$ (*pp*) and $I=1$ (*np*) states can be

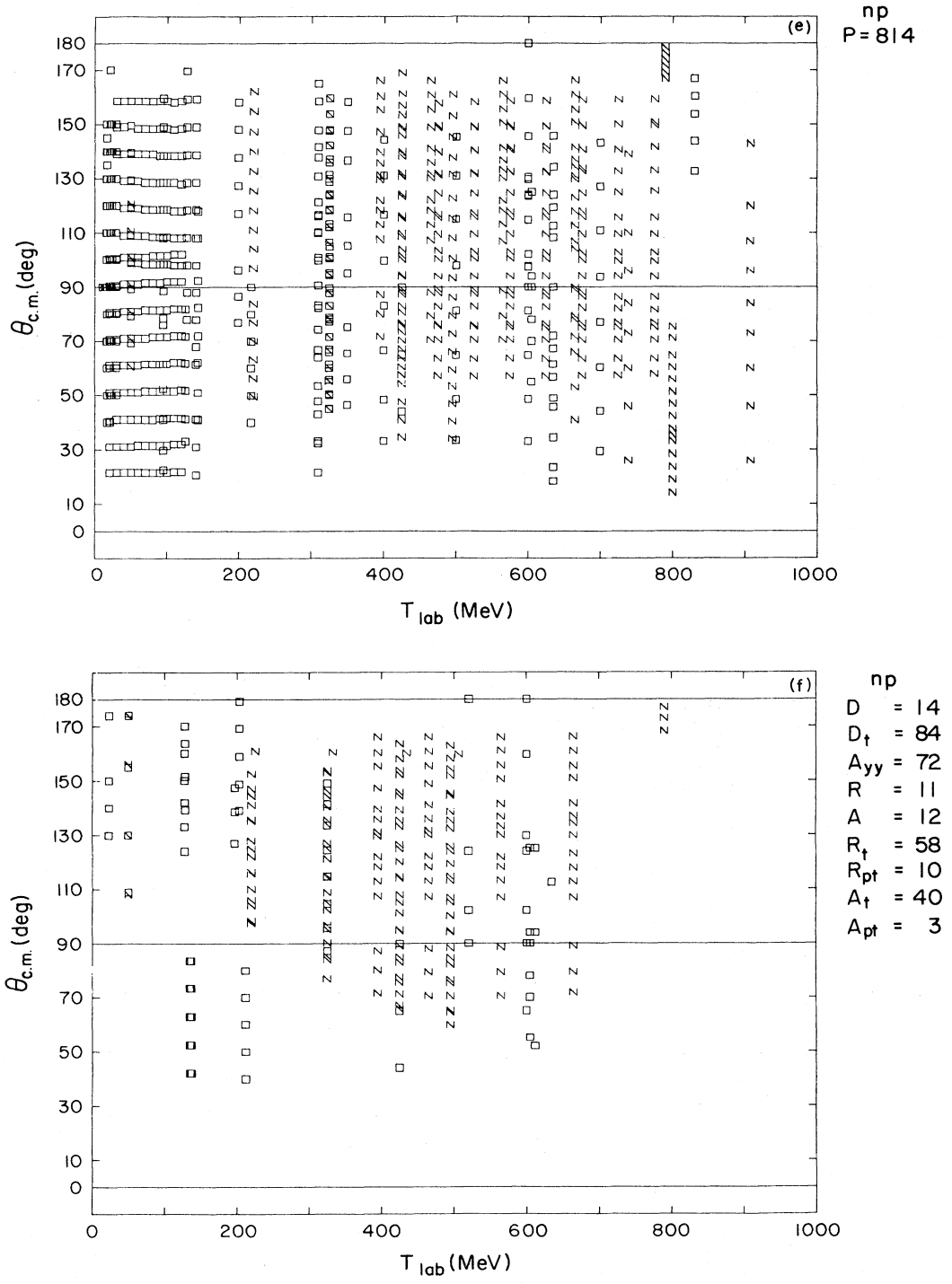

FIG. 1. (*Continued.*)

obtained by differencing Tables III and IV. In Table V are the *np* partial-wave parameters for the single-energy solutions, along with errors and the charge splitting used in these analyses.

For those who prefer a different representation of the partial waves than the one we use herein, we list the real and imaginary parts of the partial-wave amplitudes in Tables VI and VII.

The partial-wave parameters are plotted in Fig. 3 with the single-energy values superimposed on the energy-dependent curves. Argand diagrams for the $^1D_2$ and $^3F_3$ partial waves, for which there has been some controversy concerning *NN* resonances,[10,11] are given in Fig. 4. Figure 3 indicates that, generally, there is excellent agreement be-

TABLE II. Data base and fit information for energy-dependent (SP82) and single-energy solutions (C denotes combines $I=0$ and $I=1$ and P denotes $I=1$ only).

Solution	Range (MeV)	*pp* Data	*pp* χ^2	*np* Data	*np* χ^2	Parameters
SP82	0—1000	5207	9199	5283	9103	
C10	8—17	137	127	93	86	6
C25	15—34	65	41	211	167	9
C50	36—63	157	158	282	308	11
C100	85—100	112	85	211	267	11
C150	125—174	229	189	252	313	17
C200	179—225	79	78	272	493	17
C300	285—350	315	333	505	631	22
C400	375—425	331	352	395	641	23
C450	425—473	286	343	338	485	23
C500	450—544	687	932	595	737	29
C550	510—590	700	812	420	417	32
C600	540—665	935	1102	840	1017	32
C650	590—709	710	893	734	859	34
C700	640—760	677	855	598	730	34
C750	700—800	731	1570	404	764	36
C800	750—843	655	1434	341	775	37
C850	775—899	517	1115	313	493	37
P900	825—970	357	555	243	436	23
P950	875—1012	491	943	254	584	23
P999	925—1074	554	1172	317	900	23

tween the energy-dependent and single-energy analyses, which validates our procedure of using energy slopes for the partial-wave parameters from the energy-dependent solution when doing single-energy analyses. We see no compelling evidence in Fig. 3 that the single-energy analyses are predicting structure which is not contained in the energy-dependent solution; the scatter in partial-wave parameters at higher energies in $I=0$ states is, we feel, an indication of paucity in the *np* data base above 500 MeV. Some apparent systematic departures between the single-energy analyses and the energy-dependent solution (e.g., $^3P_0$ between 400 and 600 MeV) might be construed as missing structure in the energy-dependent fit; however we regard this evidence as quite weak considering the large uncertainties in the phase parameters.

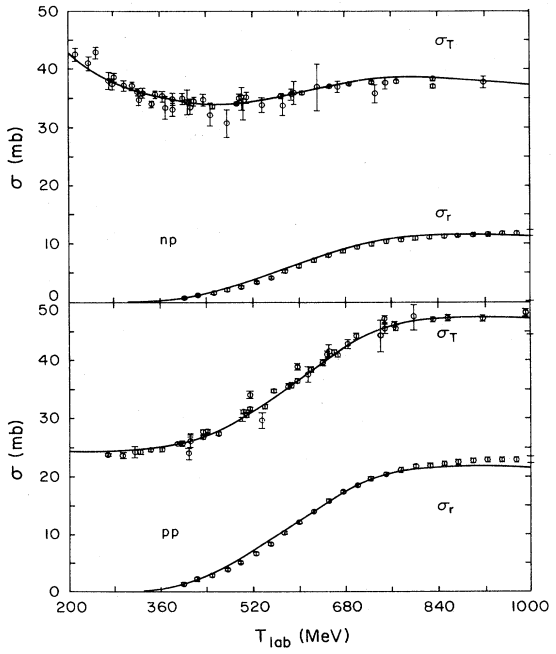

FIG. 2. Total and inelastic *pp* and *np* cross sections from 200 to 1000 MeV. The curves are our energy-dependent (SP82) solution.

Comparison with other partial-wave analyses and with potential models may be obtained through SAID (see Sec. V). In particular, the solutions of Dubois *et al.*,[12] of Hashimoto *et al.*,[13] and the potential model of Lacombe *et al.*[14] are encoded on SAID and may be used thereby to compare to our solution. In Fig. 3, we plot the Dubois and Hashimoto solutions for $I=1$ states, and Dubois solutions for $I=0$ states. The Hashimoto solutions for $I=0$ states differs substantially from ours and are not plotted in Fig. 3. The imaginary parameter for spin-mixing states (ϕ) has not been plotted; it is zero for our solutions and it is about 90° for the Dubois and Hashimoto solutions as a consequence of the way in which they parametrize and then choose the "sixth" parameter to be arbitrarily set to zero. Our solution compares quite well with the Dubois *et al.* solution, but not quite so well with the Hashimoto *et al.* solution.

V. SCATTERING ANALYSES INTERACTIVE DIAL-IN (SAID)

For the last several years the Center for Analysis of Particle Scattering in the Department of Physics at VPI&SU has made available an interactive dial-in computing system to any interested user. This system is called "SAID" for "scattering analyses interaction dial-in." SAID enables a user to dial into the VPI&SU computing

TABLE III. *pp* energy-dependent-analysis phase parameters. For each partial wave the left-hand column is δ (or ϵ) and the right-hand column ρ (or ϕ) in degrees. These are the parameters defined by Eqs. (4)–(6). T_{lab} = laboratory kinetic energy in MeV.

T_{lab}	$^1S_0$		$^1D_2$		$^1G_4$		$^1I_6$		$^3P_0$		$^3P_1$		$^3P_2$	
1	32.65	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.14	0.0	−0.08	0.0	0.01	0.0
5	54.50	0.0	0.04	0.0	0.00	0.0	0.00	0.0	1.60	0.0	−0.88	0.0	0.22	0.0
10	54.57	0.0	0.16	0.0	0.00	0.0	0.00	0.0	3.74	0.0	−2.03	0.0	0.67	0.0
15	52.44	0.0	0.33	0.0	0.01	0.0	0.00	0.0	5.70	0.0	−3.10	0.0	1.21	0.0
20	50.13	0.0	0.51	0.0	0.02	0.0	0.00	0.0	7.36	0.0	−4.04	0.0	1.81	0.0
25	47.95	0.0	0.70	0.0	0.04	0.0	0.00	0.0	8.73	0.0	−4.90	0.0	2.44	0.0
50	38.84	0.0	1.70	0.0	0.15	0.0	0.02	0.0	12.32	0.0	−8.27	0.0	5.57	0.0
75	31.65	0.0	2.71	0.0	0.29	0.0	0.06	0.0	12.66	0.0	−10.92	0.0	8.29	0.0
100	25.39	0.0	3.68	0.0	0.43	0.0	0.10	0.0	11.39	0.0	−13.28	0.0	10.51	0.0
125	19.75	0.0	4.60	0.0	0.56	0.0	0.15	0.0	9.26	0.0	−15.48	0.0	12.30	0.0
150	14.60	0.0	5.45	0.0	0.70	0.0	0.20	0.0	6.68	0.0	−17.56	0.0	13.73	0.0
175	9.90	0.0	6.25	0.0	0.84	0.0	0.25	0.0	3.87	0.0	−19.54	0.0	14.86	0.0
200	5.63	0.0	6.99	0.0	0.98	0.0	0.30	0.0	0.98	0.0	−21.42	0.0	15.76	0.0
225	1.75	0.0	7.66	0.0	1.13	0.0	0.35	0.0	−1.91	0.0	−23.21	0.0	16.47	0.0
250	−1.75	0.0	8.28	0.0	1.27	0.0	0.41	0.0	−4.73	0.0	−24.91	0.0	17.02	0.0
275	−4.91	0.0	8.85	0.0	1.42	0.0	0.46	0.0	−7.45	0.0	−26.52	0.0	17.44	0.0
300	−7.75	0.0	9.37	0.8	1.57	0.0	0.52	0.0	−10.03	0.0	−28.04	0.0	17.76	0.0
325	−10.31	0.3	9.86	2.3	1.71	0.0	0.58	0.0	−12.48	0.0	−29.49	0.5	17.99	0.0
350	−12.61	1.0	10.33	3.9	1.86	0.0	0.63	0.0	−14.78	0.0	−30.85	1.4	18.14	0.3
375	−14.69	2.4	10.81	5.5	2.01	0.0	0.69	0.0	−16.93	0.0	−32.14	2.7	18.24	0.4
400	−16.63	4.3	11.29	7.3	2.16	0.0	0.75	0.0	−18.93	0.8	−33.37	4.3	18.28	0.2
450	−20.72	8.2	12.18	11.3	2.46	0.2	0.87	0.0	−22.66	4.8	−35.80	8.5	18.23	0.7
500	−25.08	9.9	12.61	15.5	2.76	0.6	0.98	0.0	−26.74	10.1	−38.49	12.8	18.06	2.7
550	−29.19	10.5	12.03	19.3	3.06	1.2	1.10	0.0	−31.85	14.7	−41.47	15.9	17.77	5.6
600	−33.09	11.1	10.38	21.9	3.35	2.1	1.21	0.0	−37.64	18.4	−44.39	17.9	17.29	9.0
650	−36.84	12.0	8.23	23.4	3.63	3.2	1.32	0.2	−43.53	21.7	−47.00	19.4	16.51	12.5
700	−40.48	13.1	6.09	24.1	3.90	4.3	1.43	0.3	−49.15	24.9	−49.31	20.7	15.36	15.8
750	−44.00	14.4	4.13	24.4	4.16	5.5	1.54	0.4	−54.31	28.1	−51.36	22.1	13.82	18.6
800	−47.38	15.8	2.32	24.7	4.40	6.7	1.65	0.5	−58.91	31.3	−53.21	23.5	11.93	21.1
850	−50.60	17.3	0.63	24.9	4.64	7.9	1.75	0.5	−62.91	34.4	−54.91	24.9	9.72	23.3
900	−53.64	18.8	−1.00	25.0	4.86	9.1	1.86	0.6	−66.36	37.5	−56.46	26.4	7.26	25.1
950	−56.49	20.4	−2.59	25.2	5.07	10.3	1.96	0.7	−69.30	40.3	−57.90	27.8	4.58	26.7
1000	−59.13	22.0	−4.14	25.3	5.27	11.4	2.06	0.7	−71.79	43.1	−59.24	29.2	1.74	28.1
1050	−61.57	23.6	−5.68	25.5	5.46	12.6	2.15	0.8	−73.91	45.7	−60.48	30.6	−1.21	29.4

TABLE III. (*Continued.*)

T_{lab}	E_2		$^3F_2$		$^3F_3$		$^3F_4$		E_4		$^3H_4$		$^3H_5$		$^3H_6$	
1	−0.00	0.0	0.00	0.0	−0.00	0.0	0.00	0.0	−0.00	0.0	0.00	0.0	−0.00	0.0	0.00	0.0
5	−0.05	0.0	0.00	0.0	−0.00	0.0	0.00	0.0	−0.00	0.0	0.00	0.0	−0.00	0.0	0.00	0.0
10	−0.20	0.0	0.01	0.0	−0.03	0.0	0.00	0.0	−0.00	0.0	0.00	0.0	−0.00	0.0	0.00	0.0
15	−0.40	0.0	0.03	0.0	−0.09	0.0	0.01	0.0	−0.01	0.0	0.00	0.0	−0.00	0.0	0.00	0.0
20	−0.62	0.0	0.06	0.0	−0.16	0.0	0.02	0.0	−0.03	0.0	0.00	0.0	−0.01	0.0	0.00	0.0
25	−0.84	0.0	0.10	0.0	−0.24	0.0	0.03	0.0	−0.05	0.0	0.00	0.0	−0.02	0.0	0.00	0.0
50	−1.81	0.0	0.32	0.0	−0.77	0.0	0.16	0.0	−0.19	0.0	0.03	0.0	−0.09	0.0	0.01	0.0
75	−2.49	0.0	0.58	0.0	−1.30	0.0	0.36	0.0	−0.36	0.0	0.07	0.0	−0.20	0.0	0.02	0.0
100	−2.92	0.0	0.84	0.0	−1.77	0.0	0.61	0.0	−0.52	0.0	0.12	0.0	−0.33	0.0	0.04	0.0
125	−3.17	0.0	1.08	0.0	−2.17	0.0	0.88	0.0	−0.67	0.0	0.19	0.0	−0.47	0.0	0.07	0.0
150	−3.28	0.0	1.28	0.0	−2.50	0.0	1.16	0.0	−0.81	0.0	0.25	0.0	−0.60	0.0	0.10	0.0
175	−3.30	0.0	1.43	0.0	−2.75	0.0	1.44	0.0	−0.92	0.0	0.31	0.0	−0.74	0.0	0.14	0.0
200	−3.26	0.0	1.54	0.0	−2.93	0.0	1.72	0.0	−1.03	0.0	0.37	0.0	−0.86	0.0	0.18	0.0
225	−3.16	0.0	1.59	0.0	−3.06	0.0	1.99	0.0	−1.12	0.0	0.43	0.0	−0.99	0.0	0.23	0.0
250	−3.04	0.0	1.58	0.0	−3.14	0.0	2.26	0.0	−1.20	0.0	0.48	0.0	−1.11	0.0	0.29	0.0
275	−2.89	0.0	1.52	0.0	−3.17	0.0	2.52	0.0	−1.27	0.0	0.53	0.0	−1.22	0.0	0.34	0.0
300	−2.73	0.0	1.41	0.0	−3.16	0.0	2.76	0.0	−1.33	0.0	0.57	0.0	−1.32	0.0	0.40	0.0
325	−2.55	0.0	1.25	0.0	−3.12	0.0	3.00	0.0	−1.38	0.0	0.61	0.0	−1.42	0.0	0.47	0.0
350	−2.37	0.0	1.05	0.3	−3.05	0.4	3.23	0.0	−1.43	0.0	0.64	0.0	−1.51	0.0	0.54	0.0
375	−2.18	0.0	0.80	0.5	−2.95	0.8	3.46	0.0	−1.48	0.0	0.66	0.0	−1.59	0.0	0.61	0.0
400	−2.00	0.0	0.51	0.8	−2.83	1.5	3.67	0.0	−1.51	0.0	0.68	0.0	−1.67	0.0	0.68	0.0
450	−1.63	0.0	−0.19	1.5	−2.51	3.6	4.07	0.0	−1.57	0.0	0.70	0.0	−1.82	0.6	0.83	0.0
500	−1.27	0.0	−1.02	2.4	−2.01	6.5	4.44	0.0	−1.62	0.0	0.70	0.0	−1.94	1.7	0.98	0.2
550	−0.95	0.0	−1.96	3.2	−1.30	10.1	4.78	0.0	−1.66	0.0	0.69	0.0	−2.03	3.3	1.15	0.5
600	−0.69	0.0	−3.00	4.1	−0.56	14.3	5.09	0.7	−1.68	0.0	0.65	0.0	−2.07	5.3	1.31	1.2
650	−0.53	0.0	−4.14	4.7	−0.38	18.7	5.37	1.4	−1.70	0.0	0.60	0.0	−1.98	7.3	1.48	2.0
700	−0.46	0.0	−5.35	5.2	−1.55	22.5	5.60	2.3	−1.72	0.0	0.54	0.0	−1.76	9.0	1.65	3.0
750	−0.48	0.0	−6.60	5.6	−4.14	24.9	5.77	3.2	−1.72	0.0	0.47	0.0	−1.44	10.3	1.82	3.9
800	−0.56	0.0	−7.89	5.9	−7.29	26.0	5.88	4.1	−1.73	0.0	0.39	0.0	−1.10	11.2	1.98	4.8
850	−0.69	0.0	−9.19	6.1	−10.12	26.1	5.92	5.0	−1.73	0.0	0.30	0.0	−0.76	11.9	2.15	5.7
900	−0.86	0.0	−10.49	6.2	−12.37	25.7	5.90	5.8	−1.73	0.0	0.20	0.0	−0.45	12.5	2.32	6.4
950	−1.05	0.0	−11.80	6.3	−14.11	25.2	5.83	6.7	−1.73	0.0	0.10	0.0	−0.17	12.9	2.49	7.1
1000	−1.25	0.0	−13.10	6.4	−15.51	24.7	5.68	7.5	−1.72	0.0	−0.01	0.0	0.09	13.2	2.65	7.7
1050	−1.47	0.0	−14.38	6.5	−16.69	24.3	5.48	8.4	−1.72	0.0	−0.12	0.0	0.32	13.5	2.81	8.3

TABLE IV. *np* energy-dependent-analysis phase parameters. For each partial wave the left-hand column is δ (or ϵ) and the right-hand column ρ (or ϕ) in degrees. These are the parameters defined by Eqs. (4)–(6). T_{lab}=laboratory kinetic energy in MeV.

T_{lab}	$^1S_0$		$^1D_2$		$^1G_4$		$^1I_6$		$^3P_0$		$^3P_1$		$^3P_2$	
1	61.95	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.22	0.0	−0.13	0.0	0.02	0.0
5	63.23	0.0	0.05	0.0	0.00	0.0	0.00	0.0	1.97	0.0	−1.09	0.0	0.28	0.0
10	59.35	0.0	0.19	0.0	0.00	0.0	0.00	0.0	4.34	0.0	−2.36	0.0	0.77	0.0
15	55.88	0.0	0.36	0.0	0.01	0.0	0.00	0.0	6.43	0.0	−3.49	0.0	1.36	0.0
20	52.90	0.0	0.56	0.0	0.03	0.0	0.00	0.0	8.18	0.0	−4.49	0.0	2.00	0.0
25	50.30	0.0	0.76	0.0	0.04	0.0	0.00	0.0	9.61	0.0	−5.38	0.0	2.66	0.0
50	40.38	0.0	1.80	0.0	0.16	0.0	0.02	0.0	13.29	0.0	−8.85	0.0	5.92	0.0
75	32.87	0.0	2.84	0.0	0.30	0.0	0.06	0.0	13.61	0.0	−11.54	0.0	8.73	0.0
100	26.40	0.0	3.83	0.0	0.44	0.0	0.10	0.0	12.28	0.0	−13.92	0.0	11.01	0.0
125	20.57	0.0	4.77	0.0	0.58	0.0	0.15	0.0	10.08	0.0	−16.13	0.0	12.85	0.0
150	15.26	0.0	5.65	0.0	0.72	0.0	0.20	0.0	7.42	0.0	−18.22	0.0	14.31	0.0
175	10.41	0.0	6.47	0.0	0.87	0.0	0.25	0.0	4.53	0.0	−20.21	0.0	15.47	0.0
200	5.99	0.0	7.22	0.0	1.01	0.0	0.31	0.0	1.55	0.0	−22.10	0.0	16.39	0.0
225	1.99	0.0	7.91	0.0	1.15	0.0	0.36	0.0	−1.43	0.0	−23.89	0.0	17.11	0.0
250	−1.63	0.0	8.54	0.0	1.30	0.0	0.42	0.0	−4.34	0.0	−25.59	0.0	17.68	0.0
275	−4.89	0.0	9.12	0.0	1.45	0.0	0.47	0.0	−7.14	0.0	−27.20	0.0	18.11	0.0
300	−7.82	0.0	9.65	0.8	1.60	0.0	0.53	0.0	−9.81	0.0	−28.72	0.0	18.44	0.0
325	−10.46	0.3	10.15	2.4	1.75	0.0	0.59	0.0	−12.33	0.0	−30.17	0.5	18.67	0.0
350	−12.83	1.0	10.64	3.9	1.90	0.0	0.64	0.0	−14.70	0.0	−31.53	1.4	18.83	0.3
375	−14.97	2.4	11.13	5.6	2.05	0.0	0.70	0.0	−16.91	0.0	−32.82	2.7	18.93	0.4
400	−16.98	4.4	11.62	7.4	2.20	0.0	0.76	0.0	−18.98	0.8	−34.05	4.4	18.98	0.3
450	−21.17	8.3	12.53	11.4	2.50	0.2	0.88	0.0	−22.81	4.8	−36.47	8.7	18.94	0.7
500	−25.62	10.0	12.98	15.7	2.81	0.6	0.99	0.0	−26.99	10.2	−39.16	13.0	18.77	2.7
550	−29.82	10.6	12.39	19.5	3.10	1.2	1.11	0.0	−32.22	14.9	−42.15	16.1	18.48	5.7
600	−33.77	11.3	10.71	22.1	3.40	2.1	1.23	0.0	−38.10	18.6	−45.07	18.1	17.99	9.1
650	−37.56	12.1	8.52	23.6	3.68	3.2	1.34	0.2	−44.06	21.9	−47.68	19.6	17.20	12.7
700	−41.23	13.2	6.33	24.3	3.95	4.4	1.45	0.3	−49.72	25.1	−49.98	21.0	16.03	16.0
750	−44.76	14.5	4.33	24.7	4.22	5.5	1.56	0.4	−54.88	28.4	−52.03	22.4	14.46	18.9
800	−48.14	16.0	2.48	24.9	4.47	6.7	1.67	0.5	−59.45	31.6	−53.87	23.8	12.52	21.4
850	−51.35	17.5	0.75	25.1	4.70	7.9	1.78	0.5	−63.43	34.8	−55.55	25.3	10.25	23.6
900	−54.37	19.0	−0.91	25.3	4.93	9.1	1.88	0.6	−66.84	37.8	−57.10	26.7	7.72	25.4
950	−57.19	20.6	−2.53	25.4	5.14	10.3	1.98	0.7	−69.74	40.7	−58.53	28.2	4.97	27.1
1000	−59.80	22.3	−4.13	25.6	5.35	11.5	2.08	0.7	−72.19	43.4	−59.85	29.6	2.05	28.5
1050	−62.21	23.9	−5.70	25.8	5.54	12.7	2.18	0.8	−74.28	46.0	−61.08	31.0	−0.99	29.7

TABLE IV. (*Continued.*)

T_{lab}	E_2		$^3F_2$		$^3F_3$		$^3F_3$		E_4		$^3H_4$		$^3H_5$		$^3H_6$	
1	−0.00	0.0	0.00	0.0	−0.00	0.0	0.00	0.0	−0.00	0.0	0.00	0.0	−0.00	0.0	0.00	0.0
5	−0.06	0.0	0.00	0.0	−0.01	0.0	0.00	0.0	−0.00	0.0	0.00	0.0	−0.00	0.0	0.00	0.0
10	−0.23	0.0	0.01	0.0	−0.04	0.0	0.00	0.0	−0.00	0.0	0.00	0.0	−0.00	0.0	0.00	0.0
15	−0.45	0.0	0.04	0.0	−0.09	0.0	0.01	0.0	−0.01	0.0	0.00	0.0	−0.00	0.0	0.00	0.0
20	−0.68	0.0	0.07	0.0	−0.17	0.0	0.02	0.0	−0.03	0.0	0.00	0.0	−0.01	0.0	0.00	0.0
25	−0.91	0.0	0.10	0.0	−0.26	0.0	0.03	0.0	−0.05	0.0	0.00	0.0	−0.02	0.0	0.00	0.0
50	−1.93	0.0	0.34	0.0	−0.81	0.0	0.16	0.0	−0.20	0.0	0.03	0.0	−0.09	0.0	0.01	0.0
75	−2.63	0.0	0.60	0.0	−1.36	0.0	0.37	0.0	−0.38	0.0	0.07	0.0	−0.21	0.0	0.02	0.0
100	−3.08	0.0	0.87	0.0	−1.85	0.0	0.62	0.0	−0.54	0.0	0.13	0.0	−0.34	0.0	0.04	0.0
125	−3.33	0.0	1.11	0.0	−2.26	0.0	0.90	0.0	−0.70	0.0	0.19	0.0	−0.48	0.0	0.07	0.0
150	−3.45	0.0	1.32	0.0	−2.60	0.0	1.18	0.0	−0.83	0.0	0.25	0.0	−0.62	0.0	0.10	0.0
175	−3.47	0.0	1.48	0.0	−2.86	0.0	1.47	0.0	−0.95	0.0	0.32	0.0	−0.75	0.0	0.14	0.0
200	−3.42	0.0	1.60	0.0	−3.05	0.0	1.76	0.0	−1.06	0.0	0.38	0.0	−0.89	0.0	0.19	0.0
225	−3.33	0.0	1.65	0.0	−3.19	0.0	2.04	0.0	−1.15	0.0	0.44	0.0	−1.01	0.0	0.23	0.0
250	−3.20	0.0	1.66	0.0	−3.27	0.0	2.31	0.0	−1.24	0.0	0.50	0.0	−1.13	0.0	0.29	0.0
275	−3.05	0.0	1.61	0.0	−3.31	0.0	2.57	0.0	−1.31	0.0	0.55	0.0	−1.25	0.0	0.35	0.0
300	−2.88	0.0	1.51	0.0	−3.31	0.0	2.82	0.0	−1.37	0.0	0.59	0.0	−1.35	0.0	0.41	0.0
325	−2.70	0.0	1.36	0.0	−3.27	0.0	3.07	0.0	−1.43	0.0	0.63	0.0	−1.45	0.0	0.47	0.0
350	−2.52	0.0	1.16	0.3	−3.21	0.4	3.30	0.0	−1.48	0.0	0.66	0.0	−1.55	0.0	0.54	0.0
375	−2.33	0.0	0.92	0.5	−3.11	0.8	3.53	0.0	−1.52	0.0	0.68	0.0	−1.63	0.0	0.61	0.0
400	−2.14	0.0	0.63	0.8	−2.99	1.5	3.75	0.0	−1.56	0.0	0.70	0.0	−1.72	0.0	0.68	0.0
450	−1.76	0.0	−0.05	1.5	−2.67	3.6	4.15	0.0	−1.63	0.0	0.73	0.0	−1.86	0.6	0.83	0.0
500	−1.40	0.0	−0.86	2.4	−2.17	6.5	4.53	0.0	−1.68	0.0	0.73	0.0	−1.99	1.7	0.99	0.2
550	−1.06	0.0	−1.80	3.3	−1.46	10.2	4.88	0.0	−1.71	0.0	0.72	0.0	−2.09	3.3	1.15	0.5
600	−0.80	0.0	−2.84	4.1	−0.71	14.4	5.20	0.7	−1.74	0.0	0.69	0.0	−2.13	5.3	1.32	1.2
650	−0.63	0.0	−3.97	4.8	−0.53	18.8	5.48	1.4	−1.76	0.0	0.64	0.0	−2.04	7.3	1.48	2.0
700	−0.56	0.0	−5.18	5.3	−1.73	22.6	5.72	2.4	−1.77	0.0	0.58	0.0	−1.82	9.1	1.65	3.0
750	−0.57	0.0	−6.44	5.7	−4.38	25.1	5.90	3.3	−1.78	0.0	0.51	0.0	−1.50	10.3	1.82	3.9
800	−0.66	0.0	−7.73	5.9	−7.58	26.2	6.01	4.2	−1.79	0.0	0.43	0.0	−1.16	11.3	1.99	4.8
850	−0.79	0.0	−9.04	6.1	−10.47	26.3	6.05	5.0	−1.79	0.0	0.34	0.0	−0.82	12.0	2.16	5.7
900	−0.95	0.0	−10.35	6.3	−12.76	26.0	6.04	5.9	−1.79	0.0	0.25	0.0	−0.51	12.5	2.33	6.5
950	−1.14	0.0	−11.67	6.4	−14.54	25.5	5.96	6.7	−1.79	0.0	0.15	0.0	−0.22	12.9	2.50	7.1
1000	−1.35	0.0	−12.97	6.5	−15.96	24.9	5.81	7.6	−1.78	0.0	0.04	0.0	0.03	13.3	2.67	7.8
1050	−1.56	0.0	−14.27	6.5	−17.16	24.5	5.61	8.5	−1.78	0.0	−0.07	0.0	0.26	13.6	2.83	8.4

TABLE IV. (*Continued.*)

T_{lab}	$^1P_1$		$^1F_3$		$^1H_5$		$^3S_1$		E_1		$^3D_1$		$^3D_2$	
1	−0.15	0.0	−0.00	0.0	−0.00	0.0	147.71	0.0	0.14	0.0	−0.00	0.0	0.01	0.0
5	−1.10	0.0	−0.01	0.0	−0.00	0.0	118.08	0.0	0.94	0.0	−0.14	0.0	0.24	0.0
10	−2.05	0.0	−0.07	0.0	−0.00	0.0	102.76	0.0	1.28	0.0	−0.53	0.0	0.91	0.0
15	−2.72	0.0	−0.18	0.0	−0.01	0.0	93.55	0.0	1.22	0.0	−1.06	0.0	1.80	0.0
20	−3.23	0.0	−0.32	0.0	−0.02	0.0	86.92	0.0	1.07	0.0	−1.67	0.0	2.79	0.0
25	−3.66	0.0	−0.47	0.0	−0.03	0.0	81.68	0.0	0.95	0.0	−2.33	0.0	3.82	0.0
50	−5.95	0.0	−1.30	0.0	−0.17	0.0	64.23	0.0	0.84	0.0	−5.67	0.0	8.74	0.0
75	−8.92	0.0	−2.04	0.0	−0.32	0.0	52.64	0.0	1.21	0.0	−8.75	0.0	12.73	0.0
100	−12.23	0.0	−2.66	0.0	−0.47	0.0	43.71	0.0	1.76	0.0	−11.46	0.0	15.78	0.0
125	−15.54	0.0	−3.17	0.0	−0.58	0.0	36.47	0.0	2.36	0.0	−13.84	0.0	18.07	0.0
150	−18.64	0.0	−3.60	0.0	−0.67	0.0	30.44	0.0	2.95	0.0	−15.92	0.0	19.76	0.0
175	−21.44	0.0	−3.96	0.0	−0.75	0.0	25.29	0.0	3.49	0.0	−17.76	0.0	20.99	0.0
200	−23.93	0.0	−4.26	0.0	−0.82	0.0	20.83	0.0	3.97	0.0	−19.39	0.0	21.85	0.0
225	−26.11	0.0	−4.51	0.0	−0.90	0.0	16.89	0.0	4.37	0.0	−20.85	0.0	22.44	0.0
250	−28.00	0.0	−4.72	0.0	−0.98	0.0	13.36	0.0	4.72	0.0	−22.17	0.0	22.80	0.0
275	−29.64	0.0	−4.90	0.0	−1.08	0.0	10.18	0.0	5.00	0.0	−23.36	0.0	22.98	0.0
300	−31.05	0.0	−5.04	0.0	−1.20	0.0	7.27	0.0	5.22	0.0	−24.45	0.0	23.02	0.0
325	−32.27	0.3	−5.16	0.0	−1.33	0.0	4.59	0.0	5.40	0.0	−25.45	0.0	22.93	0.0
350	−33.32	0.8	−5.25	0.0	−1.49	0.0	2.11	0.0	5.53	0.0	−26.37	0.0	22.75	0.0
375	−34.23	1.4	−5.32	0.0	−1.67	0.0	−0.19	0.3	5.62	0.0	−27.23	0.0	22.49	0.3
400	−35.00	2.1	−5.38	0.0	−1.86	0.0	−2.35	0.5	5.68	0.0	−28.03	0.0	22.16	0.5
450	−36.22	3.6	−5.44	0.2	−2.33	0.0	−6.27	0.8	5.70	0.0	−29.49	0.2	21.34	1.4
500	−37.10	5.3	−5.46	0.3	−2.87	0.0	−9.75	1.2	5.64	0.0	−30.80	0.3	20.36	2.7
550	−37.70	6.7	−5.43	0.4	−3.49	0.0	−12.87	1.5	5.51	0.0	−31.98	0.5	19.27	4.3
600	−38.10	7.9	−5.37	0.5	−4.18	0.0	−15.67	1.8	5.33	0.0	−33.07	0.6	18.11	5.8
650	−38.32	8.8	−5.28	0.6	−4.93	0.0	−18.20	2.0	5.12	0.0	−34.07	0.6	16.91	7.3
700	−38.41	9.4	−5.18	0.6	−5.74	0.0	−20.49	2.1	4.89	0.0	−35.01	0.7	15.68	8.4
750	−38.39	9.8	−5.05	0.6	−6.58	0.0	−22.57	2.2	4.65	0.0	−35.88	0.7	14.44	9.3
800	−38.28	10.1	−4.92	0.7	−7.46	0.0	−24.47	2.3	4.40	0.0	−36.70	0.8	13.20	10.0
850	−38.09	10.2	−4.77	0.7	−8.38	0.0	−26.19	2.3	4.14	0.0	−37.47	0.8	11.98	10.5
900	−37.84	10.3	−4.61	0.7	−9.31	0.0	−27.77	2.3	3.89	0.0	−38.20	0.8	10.78	10.9
950	−37.54	10.3	−4.45	0.7	−10.27	0.0	−29.21	2.3	3.64	0.0	−38.89	0.8	9.60	11.3
1000	−37.19	10.4	−4.28	0.7	−11.23	0.0	−30.54	2.3	3.40	0.0	−39.54	0.8	8.45	11.5
1050	−36.81	10.4	−4.11	0.7	−12.21	0.0	−31.76	2.3	3.17	0.0	−40.16	0.9	7.33	11.7

TABLE IV. (*Continued.*)

T_{lab}	$^3D_3$		E_3		$^3G_3$		$^3G_4$		$^3G_5$		E_5		$^3I_5$		$^3I_6$	
1	0.00	0.0	0.00	0.0	−0.00	0.0	0.00	0.0	−0.00	0.0	0.00	0.0	−0.00	0.0	0.00	0.0
5	0.01	0.0	0.01	0.0	−0.00	0.0	0.00	0.0	−0.00	0.0	0.00	0.0	−0.00	0.0	0.00	0.0
10	0.03	0.0	0.09	0.0	−0.00	0.0	0.02	0.0	−0.00	0.0	0.00	0.0	−0.00	0.0	0.00	0.0
15	0.07	0.0	0.22	0.0	−0.02	0.0	0.05	0.0	−0.00	0.0	0.01	0.0	−0.00	0.0	0.00	0.0
20	0.13	0.0	0.40	0.0	−0.03	0.0	0.11	0.0	−0.00	0.0	0.02	0.0	−0.00	0.0	0.01	0.0
25	0.20	0.0	0.60	0.0	−0.06	0.0	0.19	0.0	−0.01	0.0	0.04	0.0	−0.00	0.0	0.01	0.0
50	0.70	0.0	1.71	0.0	−0.28	0.0	0.79	0.0	−0.06	0.0	0.22	0.0	−0.03	0.0	0.10	0.0
75	1.34	0.0	2.75	0.0	−0.59	0.0	1.54	0.0	−0.13	0.0	0.48	0.0	−0.07	0.0	0.26	0.0
100	1.96	0.0	3.64	0.0	−0.94	0.0	2.34	0.0	−0.20	0.0	0.76	0.0	−0.13	0.0	0.46	0.0
125	2.53	0.0	4.39	0.0	−1.30	0.0	3.12	0.0	−0.27	0.0	1.03	0.0	−0.21	0.0	0.70	0.0
150	3.01	0.0	5.02	0.0	−1.66	0.0	3.87	0.0	−0.33	0.0	1.29	0.0	−0.29	0.0	0.94	0.0
175	3.41	0.0	5.56	0.0	−2.02	0.0	4.58	0.0	−0.38	0.0	1.53	0.0	−0.38	0.0	1.19	0.0
200	3.73	0.0	6.02	0.0	−2.37	0.0	5.23	0.0	−0.41	0.0	1.75	0.0	−0.47	0.0	1.45	0.0
225	3.97	0.0	6.41	0.0	−2.71	0.0	5.83	0.0	−0.44	0.0	1.95	0.0	−0.57	0.0	1.71	0.0
250	4.14	0.0	6.76	0.0	−3.04	0.0	6.37	0.0	−0.45	0.0	2.13	0.0	−0.66	0.0	1.96	0.0
275	4.25	0.0	7.06	0.0	−3.36	0.0	6.86	0.0	−0.46	0.0	2.30	0.0	−0.75	0.0	2.22	0.0
300	4.31	0.0	7.32	0.0	−3.67	0.0	7.30	0.0	−0.45	0.0	2.46	0.0	−0.85	0.0	2.47	0.0
325	4.32	0.0	7.56	0.0	−3.97	0.0	7.69	0.0	−0.44	0.0	2.60	0.0	−0.94	0.0	2.72	0.0
350	4.29	0.0	7.77	0.0	−4.26	0.0	8.03	0.0	−0.42	0.0	2.73	0.0	−1.03	0.0	2.96	0.0
375	4.23	0.0	7.95	0.0	−4.54	0.0	8.32	0.0	−0.40	0.0	2.85	0.0	−1.12	0.0	3.20	0.0
400	4.13	0.0	8.12	0.0	−4.81	0.0	8.58	0.0	−0.37	0.0	2.97	0.0	−1.21	0.0	3.43	0.0
450	3.85	0.0	8.41	0.0	−5.32	0.0	8.97	0.0	−0.30	0.0	3.17	0.0	−1.39	0.0	3.89	0.0
500	3.49	0.0	8.64	0.0	−5.80	0.0	9.22	0.0	−0.22	0.0	3.34	0.0	−1.56	0.0	4.32	0.0
550	3.06	0.0	8.84	0.0	−6.25	0.0	9.34	0.0	−0.12	0.0	3.49	0.0	−1.72	0.0	4.74	0.0
600	2.59	0.0	9.00	0.0	−6.67	0.0	9.36	0.0	−0.02	0.0	3.63	0.0	−1.87	0.0	5.15	0.0
650	2.07	0.0	9.14	0.0	−7.06	0.0	9.29	0.0	0.09	0.0	3.75	0.0	−2.02	0.0	5.54	0.0
700	1.53	0.0	9.26	0.0	−7.43	0.0	9.13	0.0	0.20	0.0	3.86	0.0	−2.17	0.0	5.91	0.0
750	0.98	0.0	9.36	0.0	−7.78	0.0	8.90	0.0	0.31	0.0	3.96	0.0	−2.31	0.0	6.27	0.0
800	0.41	0.0	9.45	0.0	−8.11	0.0	8.60	0.0	0.42	0.0	4.05	0.0	−2.44	0.0	6.61	0.0
850	−0.17	0.0	9.52	0.0	−8.43	0.0	8.26	0.0	0.53	0.0	4.14	0.0	−2.57	0.0	6.95	0.0
900	−0.75	0.0	9.58	0.0	−8.72	0.0	7.86	0.0	0.64	0.0	4.21	0.0	−2.69	0.0	7.26	0.0
950	−1.33	0.0	9.64	0.0	−9.01	0.0	7.42	0.0	0.76	0.0	4.29	0.0	−2.81	0.0	7.57	0.0
1000	−1.91	0.0	9.69	0.0	−9.27	0.0	6.94	0.0	0.86	0.0	4.36	0.0	−2.92	0.0	7.87	0.0
1050	−2.48	0.0	9.73	0.0	−9.53	0.0	6.44	0.0	0.97	0.0	4.42	0.0	−3.03	0.0	8.15	0.0

TABLE V. Single-energy-analysis phase parameters. For each partial wave the column labeled δ is δ_{np} or ϵ. The column labeled ρ is ρ or ϕ. δ_{pp}-δ_{np} is the charge splitting. The energy at the top of each group is the laboratory kinetic energy.

State	δ	$\delta_{pp}-\delta_{np}$	ρ
	10.00 MeV		
$^3P_0$	3.897±0.048	−0.595	
$^1P_1$	−3.374±1.076	−0.246	
$^3P_1$	−2.319±0.021	0.325	
$^3S_1$	104.250±0.797	0.029	
$^3D_1$	−0.803±0.034	0.001	
$^3P_2$	0.699±0.015	−0.100	
	25.00 MeV		
$^1S_0$	51.005±0.223	−2.341	
$^3P_0$	8.964±0.141	−0.881	
$^1P_1$	−4.921±0.429	−0.358	
$^3P_1$	−5.307±0.070	0.487	
$^3S_1$	82.192±0.988	0.027	
E_1	0.898±0.482	−0.003	
$^3D_1$	−2.633±0.030	0.002	
$^1D_2$	0.778±0.028	−0.061	
$^3P_2$	2.606±0.039	−0.217	
	50.00 MeV		
$^1S_0$	40.502±0.134	−1.544	
$^3P_0$	12.740±0.236	−0.971	
$^1P_1$	−4.229±0.571	−0.345	
$^3P_1$	−8.810±0.070	0.581	
$^3S_1$	61.756±0.428	0.152	
E_1	0.701±0.854	−0.019	
$^3D_1$	−6.613±0.184	0.003	
$^1D_2$	1.741±0.041	−0.102	
$^3D_2$	10.200±0.284	0.046	
$^3P_2$	6.024±0.049	−0.349	
E_2	−1.835±0.051	0.119	
	100.00 MeV		
$^1S_0$	24.964±0.502	−1.006	
$^3P_0$	11.772±1.408	−0.891	
$^1P_1$	−10.906±1.116	−0.152	
$^3P_1$	−14.752±0.274	0.640	
$^3S_1$	42.745±0.671	0.477	
E_1	0.723±0.976	−0.066	
$^3D_1$	−12.376±0.360	0.006	
$^1D_2$	4.131±0.131	−0.157	
$^3D_2$	16.879±0.762	0.030	
$^3P_2$	10.621±0.172	−0.497	
E_2	−3.120±0.117	0.156	
	150.00 MeV		
$^1S_0$	15.173±0.469	−0.657	
$^3P_0$	6.251±0.447	−0.742	
$^1P_1$	−18.439±1.035	0.058	
$^3P_1$	−18.299±0.143	0.663	
$^3S_1$	27.566±0.550	0.713	
E_1	3.831±0.593	−0.112	
$^3D_1$	−15.352±0.412	0.006	
$^1D_2$	5.633±0.077	−0.197	
$^3D_2$	23.053±0.522	0.021	
	150.00 MeV		
$^3P_2$	14.585±0.097	−0.577	
E_2	−2.993±0.055	0.166	
$^3F_2$	1.107±0.188	−0.043	
$^1F_3$	−2.917±0.310	0.000	
$^3F_3$	−2.153±0.143	0.103	
$^3D_3$	2.265±0.343	−0.253	
E_3	4.506±0.186	0.054	
$^3F_4$	1.055±0.093	−0.028	
	200.00 MeV		
$^1S_0$	7.170±0.431	−0.363	
$^3P_0$	0.260±0.419	−0.571	
$^1P_1$	−23.784±0.803	0.227	
$^3P_1$	−22.400±0.216	0.674	
$^3S_1$	20.446±0.645	0.853	
E_1	4.224±0.364	−0.145	
$^3D_1$	−20.147±0.592	0.001	
$^1D_2$	7.025±0.132	−0.230	
$^3D_2$	22.106±0.538	0.023	
$^3P_2$	15.914±0.143	−0.625	
E_2	−3.156±0.108	0.166	
$^3F_2$	1.629±0.193	−0.059	
$^1F_3$	−4.179±0.253	0.013	
$^3F_3$	−2.723±0.138	0.122	
$^3D_3$	4.092±0.383	−0.309	
E_3	6.249±0.149	0.058	
$^3F_4$	1.994±0.106	−0.039	
	300.00 MeV		
$^1S_0$	−6.167±0.399	0.074	0.0 ±0.0
$^3P_0$	−9.484±0.531	−0.229	0.0 ±0.0
$^1P_1$	−31.038±0.788	0.454	0.0 ±0.0
$^3P_1$	−29.251±0.267	0.680	1.890±2.585
$^3S_1$	4.941±0.728	0.973	0.0 ±0.0
E_1	6.578±0.362	−0.180	0.0 ±0.0
$^3D_1$	−24.859±0.548	−0.018	0.0 ±0.0
$^1D_2$	9.612±0.121	−0.284	0.763±0.0
$^3D_2$	23.160±0.465	0.058	0.0 ±0.0
$^3P_2$	17.311±0.215	−0.678	0.0 ±0.0
E_2	−2.301±0.133	0.156	0.0 ±0.0
$^3F_2$	0.803±0.180	−0.095	0.0 ±0.0
$^1F_3$	−5.877±0.199	0.035	0.0 ±0.0
$^3F_3$	−2.102±0.222	0.149	0.0 ±0.0
$^3D_3$	3.007±0.279	−0.392	0.0 ±0.0
E_3	7.580±0.164	0.064	0.0 ±0.0
$^3G_3$	−4.059±0.283	−0.038	0.0 ±0.0
$^1G_4$	1.472±0.079	−0.032	0.0 ±0.0
$^3G_4$	7.485±0.269	0.035	0.0 ±0.0
$^3F_4$	2.957±0.085	−0.060	0.0 ±0.0
E_4	−1.517±0.065	0.044	0.0 ±0.0
	400.00 MeV		
$^1S_0$	−15.625±0.435	0.344	4.243±0.0
$^3P_0$	−19.816±0.465	0.044	0.824±0.0
$^1P_1$	−34.112±0.807	0.588	2.055±0.0

TABLE V. (*Continued.*)

State	δ	$\delta_{pp}-\delta_{np}$	ρ
	400.00 MeV		
$^3P_1$	−34.783±0.288	0.676	0.763±5.073
$^3S_1$	−2.086±0.670	0.996	0.0 ±0.0
E_1	5.258±0.385	−0.191	0.0 ±0.0
$^3D_1$	−26.186±0.417	−0.040	0.0 ±0.0
$^1D_2$	11.567±0.101	−0.331	8.548±0.304
$^3D_2$	23.761±0.392	0.120	0.0 ±0.0
$^3P_2$	18.112±0.181	−0.702	0.0 ±0.0
E_2	−1.695±0.138	0.140	0.0 ±0.0
$^3F_2$	0.458±0.154	−0.127	0.793±0.0
$^1F_3$	−5.109±0.192	0.052	0.0 ±0.0
$^3F_3$	−2.664±0.233	0.163	1.486±0.0
$^3D_3$	4.536±0.297	−0.447	0.0 ±0.0
E_3	8.426±0.140	0.070	0.0±0.0
$^3G_3$	−4.818±0.343	−0.039	0.0 ±0.0
$^1G_4$	2.146±0.072	−0.037	0.0 ±0.0
$^3G_4$	7.907±0.275	0.018	0.0 ±0.0
$^3F_4$	3.721±0.059	−0.079	0.0 ±0.0
E_4	−1.904±0.064	0.050	0.0 ±0.0
	450.00 MeV		
$^1S_0$	−20.793±0.591	0.451	8.204±0.0
$^3P_0$	−24.882±0.540	0.152	4.771±0.0
$^1P_1$	−36.667±0.892	0.636	3.637±0.0
$^3P_1$	−36.226±0.323	0.674	6.572±1.504
$^3S_1$	−5.859±0.687	0.995	0.0±0.0
E_1	3.997±0.433	−0.192	0.0±0.0
$^3D_1$	−28.393±0.497	−0.051	0.0±0.0
$^1D_2$	12.938±0.146	−0.354	11.329±0.343
$^3D_2$	22.072±0.474	0.160	1.401±0.0
$^3P_2$	18.881±0.180	−0.707	0.722±0.0
E_2	−2.204±0.183	0.131	0.0±0.0
$^3F_2$	−0.109±0.188	−0.140	1.529±0.0
$^1F_3$	−5.329±0.363	0.059	0.0±0.0
$^3F_3$	−3.065±0.155	0.166	3.581±0.0
$^3D_3$	4.602±0.315	−0.467	0.0±0.0
E_3	8.105±0.212	0.073	0.0±0.0
$^3G_3$	−5.475±0.414	−0.040	0.0±0.0
$^1G_4$	2.563±0.087	−0.040	0.0±0.0
$^3G_4$	8.442±0.364	0.009	0.0±0.0
$^3F_4$	4.162±0.076	−0.087	0.0±0.0
E_4	−1.850±0.098	0.052	0.0±0.0
	500.00 MeV		
$^1S_0$	−23.914±0.619	0.548	0.434±8.451
$^3P_0$	−27.667±0.463	0.257	5.234±2.376
$^1P_1$	−36.699±0.922	0.677	3.251±2.569
$^3P_1$	−39.637±0.296	0.677	8.392±1.320
$^3S_1$	−10.623±0.751	0.989	0.658±0.0
E_1	6.043±0.508	−0.191	0.0±0.0
$^3D_1$	−29.098±0.486	−0.061	0.0±0.0
$^1D_2$	13.146±0.106	−0.367	16.685±0.287
$^3D_2$	20.184±0.477	0.203	2.685±0.0
$^3P_2$	18.960±0.188	−0.710	3.111±1.043
E_2	−1.537±0.164	0.123	0.0±0.0
$^3F_2$	−0.615±0.156	−0.151	2.390±0.0
$^1F_3$	−6.217±0.205	0.065	0.0±0.0
$^3F_3$	−2.051±0.216	0.165	6.278±0.408
$^3D_3$	3.686±0.253	−0.483	0.0±0.0
E_3	8.964±0.200	0.077	0.0±0.0
$^3G_3$	−6.206±0.359	−0.039	0.0±0.0
$^1G_4$	2.922±0.070	−0.043	0.615±0.0
$^3G_4$	9.385±0.275	0.000	0.0±0.0
$^3F_4$	4.360±0.056	−0.096	0.0±0.0
E_4	−1.824±0.064	0.054	0.0±0.0
$^3G_5$	−1.200±0.183	−0.043	0.0±0.0
	550.00 MeV		
$^1S_0$	−30.081±0.506	0.624	7.650±2.606
$^3P_0$	−30.420±0.496	0.367	7.424±2.740
$^1P_1$	−31.545±1.846	0.711	6.890±3.631
$^3P_1$	−43.432±0.358	0.683	15.741±1.054
$^3S_1$	−14.572±1.763	0.982	0.844±0.0
E_1	6.324±1.003	−0.189	0.0±0.0
$^3D_1$	−34.151±1.106	−0.070	0.0±0.0
$^1D_2$	12.808±0.141	−0.360	19.154±0.276
$^3D_2$	19.654±0.931	0.250	4.217±0.0
$^3P_2$	19.553±0.258	−0.709	6.913±0.795
E_2	−0.797±0.177	0.114	0.0±0.0
$^3F_2$	−1.749±0.206	−0.159	3.281±0.0
$^1F_3$	−7.605±0.520	0.070	0.0±0.0
$^3F_3$	−1.538±0.166	0.160	8.502±0.348
$^3D_3$	1.881±0.706	−0.496	0.0±0.0
E_3	9.231±0.342	0.080	0.0±0.0
$^3G_3$	−6.175±0.999	−0.039	0.0±0.0
$^1G_4$	3.423±0.084	−0.046	1.261±0.0
$^3G_4$	10.796±0.459	−0.007	0.0±0.0
$^3F_4$	4.833±0.093	−0.103	0.0±0.0
E_4	−1.630±0.069	0.056	0.0±0.0
$^3H_4$	0.672±0.100	−0.032	0.0±0.0
$^3H_5$	−2.249±0.144	0.055	3.292±0.0
$^3G_5$	−0.376±0.235	−0.047	0.0±0.0
$^3H_6$	1.157±0.060	−0.005	0.0±0.0
	600.00 MeV		
$^1S_0$	−32.599±0.483	0.682	0.332±7.202
$^3P_0$	−34.927±0.557	0.464	8.586±2.577
$^1P_1$	−31.670±1.225	0.743	2.263±7.110
$^3P_1$	−45.884±0.455	0.685	17.328±1.235
$^3S_1$	−18.675±1.024	0.972	0.977±0.0
E_1	6.675±0.620	−0.186	0.0±0.0
$^3D_1$	−34.809±0.791	−0.078	0.0±0.0
$^1D_2$	10.481±0.188	−0.330	21.901±0.278
$^3D_2$	19.243±0.524	0.299	5.788±0.0
$^3P_2$	19.208±0.196	−0.704	11.440±0.627
E_2	−0.328±0.170	0.106	0.0±0.0
$^3F_2$	−2.071±0.182	−0.163	4.107±0.0
$^1F_3$	−7.392±0.358	0.074	0.0±0.0
$^3F_3$	−0.547±0.134	0.153	12.968±0.295
$^3D_3$	2.151±0.414	−0.506	0.0±0.0
E_3	9.366±0.206	0.083	0.0±0.0
$^3G_3$	−4.940±0.435	−0.039	0.0±0.0
$^1G_4$	3.680±0.083	−0.050	3.325±0.856
$^3G_4$	10.983±0.242	−0.014	0.0±0.0

TABLE V. (*Continued.*)

State	δ	$\delta_{pp}-\delta_{np}$	ρ	State	δ	$\delta_{pp}-\delta_{np}$	ρ
	600.00 MeV				700.00 MeV		
$^3F_4$	5.132±0.069	−0.110	0.679±0.0	$^1H_5$	−6.003±0.273	−0.113	0.0±0.0
E_4	−1.511±0.070	0.057	0.0±0.0	$^3H_5$	−1.085±0.206	0.061	9.050±0.0
$^3H_4$	1.108±0.080	−0.035	0.0±0.0	$^3G_5$	−0.302±0.206	−0.060	0.0±0.0
$^1H_5$	−3.744±0.205	−0.100	0.0±0.0	$^3H_6$	1.435±0.059	−0.008	2.990±0.0
$^3G_5$	0.233±0.184	−0.051	0.0±0.0				
	650.00 MeV				750.00 MeV		
$^1S_0$	−35.120±0.931	0.723	11.491±3.250	$^1S_0$	−47.131±1.742	0.759	7.225±12.747
$^3P_0$	−41.502±1.123	0.531	18.146±3.241	$^3P_0$	−55.983±1.622	0.567	26.009±4.939
$^1P_1$	−34.044±1.892	0.771	0.749±11.140	$^1P_1$	−37.497±1.876	0.818	10.121±3.683
$^3P_1$	−49.474±0.859	0.682	21.405±2.123	$^3P_1$	−53.292±0.969	0.667	20.331±3.016
$^3S_1$	−20.308±1.530	0.963	1.110±0.0	$^3S_1$	−18.035±2.438	0.944	1.238±0.0
E_1	7.144±0.944	−0.183	0.0±0.0	E_1	5.410±1.800	−0.175	0.0±0.0
$^3D_1$	−35.477±1.066	−0.085	0.0±0.0	$^3D_1$	−35.552±1.518	−0.096	0.0±0.0
$^1D_2$	9.010±0.397	−0.287	23.245±0.456	$^1D_2$	4.156±0.483	−0.200	24.284±0.364
$^3D_2$	17.393±0.715	0.350	7.202±0.0	$^3D_2$	11.108±1.134	0.457	9.245±0.0
$^3P_2$	17.988±0.396	−0.691	14.595±0.844	$^3P_2$	15.046±0.373	−0.634	19.252±0.648
E_2	−0.061±0.332	0.100	0.0±0.0	E_2	−1.163±0.459	0.093	0.0±0.0
$^3F_2$	−3.022±0.345	−0.166	4.792±0.0	$^3F_2$	−7.049±0.387	−0.163	5.860±0.665
$^1F_3$	−5.435±0.469	0.078	0.0±0.0	$^1F_3$	−5.096±0.556	0.083	0.0±0.0
$^3F_3$	−0.764±0.301	0.155	17.030±0.459	$^3F_3$	−4.308±0.582	0.233	24.585±0.495
$^3D_3$	1.793±0.484	−0.514	0.0±0.0	$^3D_3$	1.324±0.488	−0.523	0.0±0.0
E_3	8.832±0.307	0.086	0.0±0.0	E_3	9.569±0.459	0.093	0.0±0.0
$^3G_3$	−5.983±0.438	−0.038	0.0±0.0	$^3G_3$	−8.378±0.500	−0.036	0.0±0.0
$^1G_4$	4.059±0.152	−0.053	2.977±1.214	$^1G_4$	4.276±0.266	−0.060	5.857±1.028
$^3G_4$	11.155±0.380	−0.020	0.0±0.0	$^3G_4$	9.385±0.526	−0.030	0.0±0.0
$^3F_4$	5.287±0.134	−0.117	1.465±0.0	$^3F_4$	5.957±0.114	−0.127	3.304±0.0
E_4	−1.639±0.149	0.058	0.0±0.0	E_4	−1.836±0.237	0.059	0.0±0.0
$^3H_4$	0.975±0.127	−0.037	0.0±0.0	$^3H_4$	0.425±0.133	−0.041	0.0±0.0
$^1H_5$	−4.627±0.277	−0.107	0.0±0.0	$^1H_5$	−6.351±0.393	−0.118	0.0±0.0
$^3H_5$	−1.267±0.206	0.060	7.341±0.0	$^3H_5$	−1.191±0.222	0.061	8.890±0.476
$^3G_5$	0.107±0.204	−0.056	0.0±0.0	$^3G_5$	0.611±0.165	−0.065	0.0±0.0
$^3H_6$	1.337±0.064	−0.007	2.020±0.0	$^3H_6$	1.814±0.035	−0.009	3.963±0.0
	700.00 MeV				800.00 MeV		
$^1S_0$	−40.728±0.872	0.748	−6.948±5.710	$^1S_0$	−51.637±1.855	0.757	15.442±6.552
$^3P_0$	−49.016±1.008	0.564	28.657±2.708	$^3P_0$	−59.965±1.258	0.549	35.323±3.997
$^1P_1$	−38.288±1.652	0.794	−1.804±32.497	$^1P_1$	−38.418±3.424	0.836	12.625±8.395
$^3P_1$	−54.211±0.898	0.676	28.737±1.765	$^3P_1$	−55.221±0.915	0.657	24.412±2.461
$^3S_1$	−16.208±1.736	0.954	1.188±0.0	$^3S_1$	−20.474±2.855	0.939	1.269±0.0
E_1	9.912±1.252	−0.179	0.0±0.0	E_1	7.049±1.982	−0.170	0.0±0.0
$^3D_1$	−36.000±1.357	−0.091	0.0±0.0	$^3D_1$	−37.772±2.030	−0.101	0.0±0.0
$^1D_2$	5.524±0.395	−0.242	23.054±0.441	$^1D_2$	2.659±0.588	−0.161	24.096±0.442
$^3D_2$	14.631±0.885	0.403	8.354±0.0	$^3D_2$	10.714±1.785	0.511	9.696±4.231
$^3P_2$	16.513±0.388	−0.668	15.832±0.580	$^3P_2$	12.563±0.351	−0.589	21.555±0.661
E_2	0.162±0.333	0.095	0.0±0.0	E_2	−0.992±0.419	0.092	0.0±0.0
$^3F_2$	−4.630±0.329	−0.166	5.310±0.0	$^3F_2$	−8.454±0.371	−0.158	5.286±0.534
$^1F_3$	−4.743±0.392	0.081	0.0±0.0	$^1F_3$	−4.814±0.496	0.085	0.0±0.0
$^3F_3$	−3.643±0.339	0.181	19.580±0.459	$^3F_3$	−7.320±0.579	0.294	25.366±0.462
$^3D_3$	2.105±0.429	−0.519	0.0±0.0	$^3D_3$	0.720±0.507	−0.526	0.0±0.0
E_3	7.967±0.350	0.089	0.0±0.0	E_3	9.158±0.499	0.096	0.0±0.0
$^3G_3$	−8.349±0.537	−0.037	0.0±0.0	$^3G_3$	−9.020±0.493	−0.036	0.0±0.0
$^1G_4$	4.188±0.139	−0.056	6.300±0.755	$^1G_4$	4.531±0.299	−0.063	6.671±1.214
$^3G_4$	10.063±0.395	−0.025	0.0±0.0	$^3G_4$	8.753±0.602	−0.032	0.0±0.0
$^3F_4$	5.915±0.114	−0.122	2.379±0.0	$^3F_4$	5.940±0.118	−0.130	4.204±0.0
E_4	−1.693±0.173	0.058	0.0±0.0	E_4	−1.923±0.189	0.059	0.0±0.0
$^3H_4$	0.664±0.126	−0.039	0.0±0.0	$^3H_4$	0.271±0.123	−0.043	0.0±0.0

TABLE V. (*Continued.*)

State	δ	$\delta_{pp}-\delta_{np}$	ρ
	800.00 MeV		
$^1H_5$	−7.053±0.377	−0.121	0.0±0.0
$^3H_5$	−0.842±0.220	0.060	9.647±0.523
$^3G_5$	0.680±0.170	−0.069	0.0±0.0
$^3H_6$	1.959±0.034	−0.011	4.882±0.0
	850.00 MeV		
$^1S_0$	−52.520±2.302	0.744	21.458±5.791
$^3P_0$	−64.031±1.803	0.518	36.835±4.620
$^1P_1$	−31.280±5.049	0.853	22.773±7.231
$^3P_1$	−54.195±1.131	0.646	21.862±3.253
$^3S_1$	−44.787±2.607	0.932	1.288±0.0
E_1	2.641±2.494	−0.166	0.0±0.0
$^3D_1$	−32.424±4.956	−0.105	0.0±0.0
$^1D_2$	1.016±0.798	−0.123	23.744±0.651
$^3D_2$	1.947±2.422	0.566	0.539±4.809
$^3P_2$	10.125±0.498	−0.533	24.682±0.816
E_2	−2.091±0.528	0.092	0.0±0.0
$^3F_2$	−9.084±0.478	−0.151	4.635±0.963
$^1F_3$	−6.165±0.858	0.086	0.0±0.0
$^3F_3$	−9.358±0.574	0.347	25.050±0.510
$^3D_3$	−4.277±1.434	−0.526	0.0±0.0
E_3	6.332±0.864	0.099	0.0±0.0
$^3G_3$	−8.074±0.698	−0.035	0.0±0.0
$^1G_4$	4.997±0.384	−0.066	9.343±1.116
$^3G_4$	8.902±1.290	−0.034	0.0±0.0
$^3F_4$	6.334±0.192	−0.132	5.081±0.0
E_4	−1.862±0.212	0.060	0.0±0.0
$^3H_4$	0.494±0.194	−0.044	0.0±0.0
$^1H_5$	−8.129±0.521	−0.122	0.0±0.0
$^3H_5$	−0.184±0.323	0.058	11.020±0.647
$^3G_5$	3.187±0.810	−0.074	0.0±0.0
$^3H_6$	2.152±0.069	−0.012	5.726±0.0
	900.00 MeV		
$^1S_0$	−53.961±4.547	0.723	17.036±9.629
$^3P_0$	−64.639±12.237	0.479	16.690±26.546
$^3P_1$	−56.948±7.534	0.635	38.050±6.259
$^1D_2$	−1.053±1.082	−0.087	25.011±0.506
$^3P_2$	6.229±0.984	−0.467	25.447±1.496
E_2	−1.015±4.159	0.092	0.0±0.0
$^3F_2$	−9.692±0.968	−0.143	3.882±7.142
$^3F_3$	−12.327±0.776	0.390	25.609±1.558
$^1G_4$	5.068±0.431	−0.070	10.582±1.346
$^3F_4$	6.261±0.280	−0.132	5.948±0.0
E_4	−0.900±1.313	0.060	0.0±0.0
$^3H_4$	1.104±0.479	−0.046	0.0±0.0
$^3H_5$	−0.820±0.644	0.057	11.451±1.098
$^3H_6$	2.426±0.152	−0.014	6.495±0.0
	950.00 MeV		
$^1S_0$	−58.464±3.610	0.694	19.066±9.286
$^3P_0$	−60.986±1.777	0.439	19.707±14.861
$^3P_1$	−60.601±1.195	0.623	45.221±3.718
$^1D_2$	−4.253±1.148	−0.050	24.979±0.484
$^3P_2$	3.496±0.780	−0.391	26.008±1.110
E_2	−1.431±1.022	0.094	0.0±0.0
$^3F_2$	−11.555±0.687	−0.134	5.317±0.971
$^3F_3$	−14.708±0.755	0.423	25.600±1.233
$^1G_4$	5.257±0.380	−0.073	11.711±0.871
$^3F_4$	5.979±0.220	−0.132	6.812±0.0
E_4	−0.473±0.343	0.060	0.0±0.0
$^3H_4$	0.999±0.269	−0.047	0.0±0.0
$^3H_5$	−0.975±0.369	0.055	12.279±0.925
$^3H_6$	2.413±0.126	−0.016	7.193±0.0
	1000.00 MeV		
$^1S_0$	−58.317±3.016	0.662	15.320±9.665
$^3P_0$	−65.206±4.071	0.400	57.542±2.248
$^3P_1$	−60.256±0.973	0.611	36.273±3.133
$^1D_2$	−3.993±0.807	−0.014	25.341±0.504
$^3P_2$	3.255±0.689	−0.308	27.382±0.893
E_2	−2.037±0.720	0.096	0.0±0.0
$^3F_2$	−13.802±0.447	−0.123	6.194±0.867
$^3F_3$	−15.202±0.647	0.450	25.371±1.028
$^1G_4$	5.444±0.323	−0.076	12.069±0.719
$^3F_4$	5.571±0.209	−0.130	7.678±0.0
E_4	−1.680±0.283	0.060	0.0±0.0
$^3H_4$	0.143±0.222	−0.047	0.0±0.0
$^3H_5$	−0.349±0.279	0.053	13.815±0.664
$^3H_6$	2.710±0.082	−0.017	7.829±0.0

system, using any type of terminal, in order to obtain a large amount of experimental and theoretical information about nucleon-nucleon, π-proton, and K^+-proton scattering below a few GeV.

SAID is basically a system for displaying the partial-wave solutions obtained from analyses of these reactions and for displaying the data bases from which the solutions were derived. Graphical output (on appropriate terminals) of amplitudes and observables is available. Users can also enter their own solutions and/or data and can conduct parameter studies. A manual describing how to dial into and use SAID is available from the VPI&SU authors (R.A.A. and L.D.R.).

Recently, SAID has been converted to run on the VAX11-780/VMS system, and has been redesigned so that it can be sent by tape to other sites with VAX computers. This eliminates the telephone charges and allows faster graphics. Sites to which SAID has been sent to data are LAMPF, TRUIMF, Argonne National Laboratory, University of Texas, University of Geneva, SIN, University of Alberta, University of Maryland, Texas A&M University, and University of Indiana. Other VAX/VMS users can obtain SAID at no cost by contacting the VPI&SU authors (R.A.A. and L.D.R.).

TABLE VI. *pp* energy-dependent-analysis scattering amplitude. For each partial wave the left-hand column in ReT and the right-hand column is ImT. T_{lab}=laboratory kinetic energy in MeV.

T_{lab}	$^1S_0$		$^1D_2$		$^1G_4$		$^1I_6$		$^3P_0$		$^3P_1$		$^3P_2$	
1	0.454	0.291	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000	−0.001	0.000	0.000	0.000
5	0.473	0.663	0.001	0.000	0.000	0.000	0.000	0.000	0.028	0.001	−0.015	0.000	0.004	0.000
10	0.472	0.664	0.003	0.000	0.000	0.000	0.000	0.000	0.065	0.004	−0.035	0.001	0.012	0.000
15	0.483	0.628	0.006	0.000	0.000	0.000	0.000	0.000	0.099	0.010	−0.054	0.003	0.021	0.000
20	0.492	0.589	0.009	0.000	0.000	0.000	0.000	0.000	0.127	0.016	−0.070	0.005	0.032	0.001
25	0.497	0.551	0.012	0.000	0.001	0.000	0.000	0.000	0.150	0.023	−0.085	0.007	0.043	0.002
50	0.488	0.393	0.030	0.001	0.003	0.000	0.000	0.000	0.209	0.046	−0.142	0.021	0.096	0.010
75	0.447	0.275	0.047	0.002	0.005	0.000	0.001	0.000	0.214	0.048	−0.186	0.036	0.142	0.023
100	0.387	0.184	0.064	0.004	0.007	0.000	0.002	0.000	0.194	0.039	−0.224	0.053	0.178	0.036
125	0.318	0.114	0.080	0.006	0.010	0.000	0.003	0.000	0.159	0.026	−0.257	0.071	0.207	0.048
150	0.244	0.064	0.095	0.009	0.012	0.000	0.003	0.000	0.116	0.014	−0.288	0.091	0.229	0.059
175	0.169	0.030	0.108	0.012	0.015	0.000	0.004	0.000	0.067	0.005	−0.315	0.112	0.246	0.069
200	0.098	0.010	0.121	0.015	0.017	0.000	0.005	0.000	0.017	0.000	−0.340	0.133	0.260	0.077
225	0.031	0.001	0.132	0.018	0.020	0.000	0.006	0.000	−0.033	0.001	−0.362	0.155	0.270	0.083
250	−0.031	0.001	0.143	0.021	0.022	0.000	0.007	0.000	−0.082	0.007	−0.382	0.177	0.278	0.088
275	−0.085	0.007	0.152	0.024	0.025	0.001	0.008	0.000	−0.129	0.017	−0.400	0.199	0.284	0.092
300	−0.134	0.018	0.161	0.027	0.027	0.001	0.009	0.000	−0.172	0.030	−0.415	0.221	0.289	0.095
325	−0.176	0.032	0.168	0.031	0.030	0.001	0.010	0.000	−0.211	0.047	−0.428	0.242	0.293	0.097
350	−0.213	0.048	0.175	0.036	0.033	0.001	0.011	0.000	−0.247	0.065	−0.440	0.263	0.295	0.098
375	−0.244	0.066	0.181	0.044	0.035	0.001	0.012	0.000	−0.279	0.085	−0.449	0.284	0.296	0.099
400	−0.271	0.086	0.186	0.053	0.038	0.001	0.013	0.000	−0.307	0.105	−0.456	0.304	0.297	0.099
450	−0.319	0.139	0.191	0.078	0.043	0.002	0.015	0.000	−0.351	0.153	−0.461	0.347	0.297	0.099
500	−0.366	0.195	0.185	0.110	0.048	0.002	0.017	0.000	−0.382	0.217	−0.458	0.395	0.293	0.098
550	−0.404	0.252	0.163	0.140	0.053	0.003	0.019	0.000	−0.406	0.301	−0.453	0.446	0.286	0.100
600	−0.433	0.309	0.133	0.160	0.058	0.005	0.021	0.000	−0.422	0.393	−0.450	0.493	0.271	0.107
650	−0.453	0.368	0.101	0.169	0.063	0.007	0.023	0.001	−0.423	0.484	−0.445	0.534	0.250	0.117
700	−0.464	0.427	0.074	0.173	0.067	0.010	0.025	0.001	−0.411	0.568	−0.437	0.570	0.222	0.130
750	−0.467	0.485	0.049	0.174	0.071	0.014	0.027	0.001	−0.388	0.642	−0.428	0.601	0.190	0.143
800	−0.463	0.540	0.028	0.175	0.074	0.019	0.029	0.001	−0.359	0.704	−0.418	0.629	0.156	0.157
850	−0.453	0.592	0.007	0.177	0.078	0.025	0.031	0.001	−0.327	0.754	−0.406	0.653	0.120	0.172
900	−0.439	0.639	−0.012	0.179	0.080	0.032	0.032	0.001	−0.295	0.795	−0.394	0.675	0.086	0.187
950	−0.422	0.682	−0.030	0.182	0.083	0.039	0.034	0.001	−0.266	0.827	−0.382	0.694	0.052	0.204
1000	−0.403	0.720	−0.048	0.186	0.084	0.047	0.036	0.001	−0.238	0.853	−0.369	0.711	0.020	0.221
1050	−0.382	0.753	−0.066	0.191	0.086	0.055	0.037	0.002	−0.214	0.874	−0.357	0.727	−0.011	0.238

TABLE VI. (*Continued.*)

T_{lab}	E_2		$^3F_2$		$^3F_3$		$^3F_4$		E_4		$^4H_4$		$^3H_5$		$^3H_6$	
1	−0.000	−0.000	0.000	0.000	−0.000	0.000	0.000	0.000	−0.000	−0.000	0.000	0.000	−0.000	0.000	0.000	0.000
5	−0.001	−0.000	0.000	0.000	−0.000	0.000	0.000	0.000	−0.000	−0.000	0.000	0.000	−0.000	0.000	0.000	0.000
10	−0.004	−0.000	0.000	0.000	−0.001	0.000	0.000	0.000	−0.000	−0.000	0.000	0.000	−0.000	0.000	0.000	0.000
15	−0.007	−0.000	0.001	0.000	−0.001	0.000	0.000	0.000	−0.000	−0.000	0.000	0.000	−0.000	0.000	0.000	0.000
20	−0.011	−0.000	0.001	0.000	−0.003	0.000	0.000	0.000	−0.000	−0.000	0.000	0.000	−0.000	0.000	0.000	0.000
25	−0.015	−0.001	0.002	0.000	−0.004	0.000	0.001	0.000	−0.001	−0.000	0.000	0.000	−0.000	0.000	0.000	0.000
50	−0.031	−0.003	0.006	0.001	−0.013	0.000	0.003	0.000	−0.003	−0.000	0.000	0.000	−0.002	0.000	0.000	0.000
75	−0.043	−0.007	0.010	0.002	−0.023	0.001	0.006	0.000	−0.006	−0.000	0.001	0.000	−0.003	0.000	0.000	0.000
100	−0.050	−0.0010	0.015	0.003	−0.031	0.001	0.011	0.000	−0.009	−0.000	0.002	0.000	−0.006	0.000	0.001	0.000
125	−0.054	−0.013	0.019	0.003	−0.038	0.001	0.015	0.000	−0.012	−0.000	0.003	0.000	−0.008	0.000	0.001	0.000
150	−0.055	−0.015	0.022	0.004	−0.044	0.002	0.020	0.001	−0.014	−0.000	0.004	0.000	−0.011	0.000	0.002	0.000
175	−0.055	−0.016	0.025	0.004	−0.048	0.002	0.025	0.001	−0.016	−0.000	0.005	0.000	−0.013	0.000	0.002	0.000
200	−0.054	−0.017	0.027	0.004	−0.051	0.003	0.030	0.001	−0.018	−0.001	0.007	0.000	−0.015	0.000	0.003	0.000
225	−0.052	−0.017	0.028	0.004	−0.053	0.003	0.035	0.002	−0.019	−0.001	0.008	0.000	−0.017	0.000	0.004	0.000
250	−0.050	−0.017	0.027	0.004	−0.055	0.003	0.039	0.002	−0.021	−0.001	0.008	0.001	−0.019	0.000	0.005	0.000
275	−0.048	−0.016	0.026	0.003	−0.055	0.003	0.044	0.002	−0.022	−0.001	0.009	0.001	−0.021	0.000	0.006	0.000
300	−0.045	−0.016	0.025	0.003	−0.055	0.003	0.048	0.003	−0.023	−0.001	0.010	0.001	−0.023	0.001	0.007	0.000
325	−0.042	−0.015	0.022	0.002	−0.054	0.003	0.052	0.003	−0.024	−0.002	0.011	0.001	−0.025	0.001	0.008	0.000
350	−0.039	−0.014	0.018	0.002	−0.053	0.003	0.056	0.004	−0.025	0.002	0.011	0.001	−0.026	0.001	0.009	0.000
375	−0.036	−0.012	0.014	0.002	−0.051	0.003	0.060	0.004	−0.026	−0.002	0.012	0.001	−0.028	0.001	0.011	0.000
400	−0.033	−0.011	0.009	0.001	−0.049	0.003	0.064	0.005	−0.026	−0.002	0.012	0.001	−0.029	0.001	0.012	0.000
450	−0.027	−0.008	−0.003	0.002	−0.043	0.006	0.071	0.006	−0.027	−0.002	0.012	0.001	−0.032	0.001	0.014	0.000
500	−0.022	−0.005	−0.018	0.003	−0.034	0.014	0.077	0.007	−0.028	−0.003	0.012	0.001	−0.034	0.002	0.017	0.000
550	−0.017	0.001	−0.034	0.005	−0.021	0.031	0.083	0.008	−0.029	−0.003	0.012	0.001	−0.035	0.005	0.020	0.001
600	−0.014	0.007	−0.052	0.008	−0.009	0.061	0.088	0.009	−0.029	−0.003	0.011	0.001	−0.035	0.010	0.023	0.001
650	−0.012	0.015	−0.071	0.012	−0.005	0.102	0.093	0.010	−0.030	−0.003	0.011	0.001	−0.033	0.017	0.026	0.002
700	−0.011	0.022	−0.091	0.016	−0.020	0.146	0.097	0.012	−0.030	−0.003	0.009	0.001	−0.029	0.026	0.029	0.004
750	−0.010	0.028	−0.112	0.022	−0.049	0.180	0.099	0.014	−0.030	−0.003	0.008	0.001	−0.024	0.033	0.031	0.006
800	−0.010	0.033	−0.133	0.027	−0.083	0.200	0.101	0.016	−0.030	−0.003	0.007	0.001	−0.018	0.038	0.034	0.009
850	−0.010	0.037	−0.154	0.034	−0.114	0.210	0.101	0.019	−0.030	−0.003	0.005	0.001	−0.012	0.043	0.037	0.011
900	−0.009	0.041	−0.174	0.042	−0.140	0.214	0.100	0.021	−0.030	−0.003	0.004	0.001	−0.007	0.047	0.039	0.014
950	−0.008	0.045	−0.195	0.050	−0.161	0.215	0.098	0.024	−0.030	−0.003	0.002	0.001	−0.003	0.050	0.042	0.017
1000	−0.008	0.047	−0.215	0.059	−0.179	0.216	0.095	0.027	−0.029	−0.003	−0.000	0.001	0.001	0.052	0.044	0.020
1050	−0.007	0.050	−0.234	0.069	−0.195	0.217	0.091	0.031	−0.029	−0.003	−0.002	0.001	0.005	0.055	0.047	0.023

TABLE VII. *np* energy-dependent-analysis scattering amplitude. For each partial wave the left-hand column is ReT and the right-hand column is ImT. T_{lab} = laboratory kinetic energy in MeV.

T_{lab}	$^1S_0$		$^1D_2$		$^1G_4$		$^1I_6$		$^3P_0$		$^3P_1$		$^3P_2$	
1	0.415	0.779	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.000	−0.002	0.000	0.000	0.000
5	0.402	0.797	0.001	0.000	0.000	0.000	0.000	0.000	0.034	0.001	−0.019	0.000	0.005	0.000
10	0.439	0.740	0.003	0.000	0.000	0.000	0.000	0.000	0.075	0.006	−0.041	0.002	0.013	0.000
15	0.464	0.685	0.006	0.000	0.000	0.000	0.000	0.000	0.111	0.013	−0.061	0.004	0.024	0.001
20	0.481	0.636	0.010	0.000	0.000	0.000	0.000	0.000	0.141	0.020	−0.078	0.006	0.035	0.001
25	0.491	0.592	0.013	0.000	0.001	0.000	0.000	0.000	0.165	0.028	−0.093	0.009	0.046	0.002
50	0.494	0.420	0.031	0.001	0.003	0.000	0.000	0.000	0.224	0.053	−0.152	0.024	0.102	0.012
75	0.456	0.295	0.049	0.002	0.005	0.000	0.001	0.000	0.229	0.055	−0.196	0.040	0.149	0.025
100	0.398	0.198	0.067	0.004	0.008	0.000	0.002	0.000	0.208	0.045	−0.234	0.058	0.186	0.039
125	0.329	0.123	0.083	0.007	0.010	0.000	0.003	0.000	0.172	0.031	−0.267	0.077	0.215	0.052
150	0.254	0.069	0.098	0.010	0.013	0.000	0.003	0.000	0.128	0.017	−0.297	0.098	0.238	0.064
175	0.178	0.033	0.112	0.013	0.015	0.000	0.004	0.000	0.079	0.006	−0.324	0.119	0.255	0.074
200	0.104	0.011	0.125	0.016	0.018	0.000	0.005	0.000	0.027	0.001	−0.349	0.142	0.269	0.083
225	0.035	0.001	0.136	0.019	0.020	0.000	0.006	0.000	−0.025	0.001	−0.370	0.164	0.279	0.089
250	−0.028	0.001	0.147	0.022	0.023	0.001	0.007	0.000	−0.075	0.006	−0.390	0.187	0.287	0.095
275	−0.085	0.007	0.157	0.025	0.025	0.001	0.008	0.000	−0.123	0.015	−0.407	0.209	0.294	0.099
300	−0.135	0.019	0.165	0.028	0.028	0.001	0.009	0.000	−0.168	0.029	−0.421	0.231	0.299	0.102
325	−0.178	0.033	0.173	0.033	0.030	0.001	0.010	0.000	−0.209	0.046	−0.434	0.253	0.302	0.104
350	−0.216	0.050	0.180	0.038	0.033	0.001	0.011	0.000	−0.245	0.064	−0.445	0.274	0.304	0.106
375	−0.249	0.068	0.186	0.046	0.036	0.001	0.012	0.000	−0.278	0.085	−0.454	0.294	0.306	0.107
400	−0.276	0.090	0.191	0.055	0.038	0.001	0.013	0.000	−0.307	0.106	−0.460	0.315	0.307	0.107
450	−0.325	0.144	0.196	0.081	0.044	0.002	0.015	0.000	−0.353	0.155	−0.464	0.358	0.306	0.106
500	−0.371	0.203	0.189	0.114	0.049	0.003	0.017	0.000	−0.384	0.221	−0.460	0.406	0.303	0.106
550	−0.409	0.261	0.167	0.144	0.054	0.003	0.019	0.000	−0.408	0.306	−0.454	0.456	0.295	0.108
600	−0.438	0.320	0.136	0.164	0.059	0.005	0.021	0.000	−0.423	0.400	−0.449	0.504	0.281	0.114
650	−0.456	0.380	0.104	0.173	0.064	0.007	0.023	0.001	−0.423	0.492	−0.443	0.545	0.258	0.124
700	−0.466	0.439	0.076	0.177	0.068	0.010	0.025	0.001	−0.409	0.576	−0.435	0.580	0.230	0.136
750	−0.467	0.497	0.051	0.178	0.072	0.015	0.027	0.001	−0.385	0.650	−0.426	0.611	0.197	0.150
800	−0.462	0.552	0.029	0.179	0.076	0.020	0.029	0.001	−0.355	0.711	−0.415	0.638	0.162	0.163
850	−0.451	0.603	0.009	0.180	0.079	0.025	0.031	0.001	−0.323	0.761	−0.403	0.662	0.126	0.178
900	−0.436	0.650	−0.011	0.183	0.081	0.032	0.033	0.001	−0.291	0.801	−0.390	0.684	0.090	0.193
950	−0.418	0.692	−0.029	0.186	0.084	0.039	0.035	0.001	−0.261	0.832	−0.378	0.702	0.056	0.209
1000	−0.398	0.730	−0.048	0.190	0.086	0.047	0.036	0.001	−0.234	0.857	−0.365	0.719	0.023	0.226
1050	−0.377	0.762	−0.065	0.194	0.087	0.056	0.038	0.002	−0.210	0.877	−0.353	0.735	−0.009	0.244

TABLE VII. (*Continued.*)

T_{lab}	E_2		$^3F_2$		$^3F_3$		$^3F_4$		E_4		$^3H_4$		$^3H_5$		$^3H_6$	
1	−0.000	−0.000	0.000	0.000	−0.000	0.000	0.000	0.000	−0.000	−0.000	0.000	0.000	−0.000	0.000	0.000	0.000
5	−0.001	−0.000	0.000	0.000	−0.000	0.000	0.000	0.000	−0.000	−0.000	0.000	0.000	−0.000	0.000	0.000	0.000
10	−0.004	−0.000	0.000	0.000	−0.001	0.000	0.000	0.000	−0.000	−0.000	0.000	0.000	−0.000	0.000	0.000	0.000
15	−0.008	−0.000	0.001	0.000	−0.002	0.000	0.000	0.000	−0.000	−0.000	0.000	0.000	−0.000	0.000	0.000	0.000
20	−0.012	−0.000	0.001	0.000	−0.003	0.000	0.000	0.000	−0.001	−0.000	0.000	0.000	−0.000	0.000	0.000	0.000
25	−0.016	−0.001	0.002	0.000	−0.005	0.000	0.001	0.000	−0.001	−0.000	0.000	0.000	−0.000	0.000	0.000	0.000
50	−0.033	−0.004	0.006	0.001	−0.014	0.000	0.003	0.000	−0.004	−0.000	0.001	0.000	−0.002	0.000	0.000	0.000
75	−0.045	−0.007	0.011	0.002	−0.024	0.001	0.006	0.000	−0.007	−0.000	0.001	0.000	−0.004	0.000	0.000	0.000
100	−0.052	−0.011	0.015	0.003	−0.032	0.001	0.011	0.000	−0.010	−0.000	0.002	0.000	−0.006	0.000	0.001	0.000
125	−0.056	−0.014	0.019	0.004	−0.039	0.002	0.016	0.000	−0.012	−0.000	0.003	0.000	−0.008	0.000	0.001	0.000
150	−0.058	−0.016	0.023	0.004	−0.045	0.002	0.021	0.001	−0.015	−0.000	0.004	0.000	−0.011	0.000	0.002	0.000
175	−0.058	−0.018	0.026	0.004	−0.050	0.002	0.026	0.001	−0.017	−0.001	0.006	0.000	−0.013	0.000	0.002	0.000
200	−0.057	−0.018	0.028	0.004	−0.053	0.003	0.031	0.001	−0.019	−0.001	0.007	0.000	−0.015	0.000	0.003	0.000
225	−0.055	−0.019	0.029	0.004	−0.056	0.003	0.035	0.002	−0.020	−0.001	0.008	0.000	−0.018	0.000	0.004	0.000
250	−0.053	−0.018	0.029	0.004	−0.057	0.003	0.040	0.002	−0.022	−0.001	0.009	0.001	−0.020	0.000	0.005	0.000
275	−0.050	−0.018	0.028	0.004	−0.058	0.003	0.045	0.003	−0.023	−0.001	0.010	0.001	−0.022	0.000	0.006	0.000
300	−0.047	−0.017	0.026	0.003	−0.058	0.003	0.049	0.003	−0.024	−0.001	0.010	0.001	−0.024	0.001	0.007	0.000
325	−0.044	−0.016	0.024	0.003	−0.057	0.003	0.053	0.003	−0.025	−0.002	0.011	0.001	−0.025	0.001	0.008	0.000
350	−0.041	−0.015	0.020	0.002	−0.056	0.003	0.057	0.004	−0.026	−0.002	0.011	0.001	−0.027	0.001	0.009	0.000
375	−0.038	−0.014	0.016	0.002	−0.054	0.003	0.061	0.004	−0.027	−0.002	0.012	0.001	−0.029	0.001	0.011	0.000
400	−0.035	−0.012	0.011	0.002	−0.052	0.003	0.065	0.005	−0.027	−0.002	0.012	0.001	−0.030	0.001	0.012	0.000
450	−0.029	−0.010	−0.001	0.002	−0.046	0.006	0.072	0.006	−0.028	−0.002	0.013	0.001	−0.032	0.001	0.014	0.000
500	−0.024	−0.006	−0.015	0.003	−0.037	0.014	0.079	0.007	−0.029	−0.003	0.013	0.001	−0.035	0.002	0.0017	0.000
550	−0.019	−0.000	−0.031	0.005	−0.024	0.032	0.085	0.008	−0.030	−0.003	0.013	0.001	−0.036	0.005	0.020	0.001
600	−0.016	0.007	−0.049	0.008	−0.011	0.062	0.090	0.009	−0.030	−0.003	0.012	0.001	−0.036	0.010	0.023	0.001
650	−0.014	0.014	−0.068	0.011	−0.007	0.104	0.095	0.011	−0.031	−0.003	0.011	0.001	−0.035	0.018	0.026	0.002
700	−0.013	0.022	−0.088	0.016	−0.022	0.149	0.099	0.013	−0.031	−0.003	0.010	0.001	−0.030	0.026	0.029	0.004
750	−0.012	0.028	−0.109	0.021	−0.051	0.183	0.101	0.015	−0.031	−0.003	0.009	0.001	−0.025	0.033	0.032	0.006
800	−0.012	0.033	−0.130	0.027	−0.085	0.204	0.103	0.017	−0.031	−0.003	0.008	0.001	−0.019	0.039	0.034	0.009
850	−0.011	0.038	−0.151	0.033	−0.117	0.214	0.103	0.019	−0.031	−0.003	0.006	0.001	−0.013	0.043	0.037	0.011
900	−0.011	0.042	−0.172	0.041	−0.143	0.218	0.102	0.022	−0.031	−0.003	0.004	0.001	−0.008	0.047	0.040	0.014
950	−0.010	0.045	−0.192	0.049	−0.165	0.220	0.100	0.025	−0.031	−0.003	0.003	0.001	−0.003	0.050	0.042	0.018
1000	−0.009	0.048	−0.213	0.058	−0.183	0.221	0.097	0.028	−0.030	−0.003	0.001	0.001	0.001	0.053	0.045	0.021
1050	−0.008	0.051	−0.232	0.068	−0.199	0.222	0.093	0.031	−0.030	−0.003	−0.001	0.001	0.004	0.055	0.047	0.024

TABLE VII. (*Continued.*)

T_{lab}	$^1P_1$		$^1F_3$		$^1H_5$		$^3S_1$		E_1		$^3D_1$		$^3D_2$	
1	−0.003	0.000	−0.000	0.000	−0.000	0.000	−0.452	0.285	−0.002	0.001	−0.000	0.000	0.000	0.000
5	−0.019	0.000	−0.000	0.000	−0.000	0.000	−0.415	0.778	−0.008	0.014	−0.003	0.000	0.004	0.000
10	−0.036	0.001	−0.001	0.000	−0.000	0.000	−0.215	0.951	−0.005	0.022	−0.009	0.001	0.016	0.000
15	−0.047	0.002	−0.003	0.000	−0.000	0.000	−0.062	0.996	−0.001	0.021	−0.019	0.001	0.031	0.001
20	−0.056	0.003	−0.006	0.000	−0.000	0.000	0.054	0.997	0.002	0.019	−0.029	0.001	0.049	0.002
25	−0.064	0.004	−0.008	0.000	−0.001	0.000	0.143	0.979	0.003	0.016	−0.041	0.002	0.066	0.004
50	−0.103	0.011	−0.023	0.001	−0.003	0.000	0.391	0.811	0.008	0.013	−0.098	0.010	0.150	0.023
75	−0.153	0.024	−0.036	0.001	−0.006	0.000	0.482	0.632	0.015	0.015	−0.150	0.024	0.215	0.049
100	−0.207	0.045	−0.046	0.002	−0.008	0.000	0.499	0.478	0.026	0.016	−0.194	0.040	0.262	0.074
125	−0.258	0.072	−0.055	0.003	−0.010	0.000	0.476	0.354	0.038	0.016	−0.231	0.059	0.295	0.096
150	−0.303	0.102	−0.063	0.004	−0.012	0.000	0.434	0.258	0.050	0.013	−0.262	0.077	0.318	0.114
175	−0.340	0.134	−0.069	0.005	−0.013	0.000	0.383	0.185	0.060	0.008	−0.288	0.096	0.334	0.128
200	−0.371	0.165	−0.074	0.006	−0.014	0.000	0.329	0.130	0.069	0.002	−0.310	0.114	0.345	0.139
225	−0.395	0.194	−0.078	0.006	−0.016	0.000	0.275	0.089	0.076	−0.005	−0.329	0.131	0.353	0.146
250	−0.415	0.220	−0.082	0.007	−0.017	0.000	0.222	0.059	0.081	−0.013	−0.345	0.147	0.357	0.150
275	−0.430	0.245	−0.085	0.007	−0.019	0.000	0.171	0.038	0.085	−0.020	−0.358	0.162	0.359	0.152
300	−0.442	0.266	−0.088	0.008	−0.021	0.000	0.123	0.024	0.087	−0.027	−0.371	0.177	0.360	0.153
325	−0.451	0.285	−0.090	0.008	−0.023	0.001	0.078	0.015	0.088	−0.033	−0.381	0.190	0.359	0.152
350	−0.459	0.302	−0.091	0.008	−0.026	0.001	0.036	0.011	0.087	−0.039	−0.391	0.203	0.357	0.150
375	−0.465	0.316	−0.092	0.009	−0.029	0.001	−0.003	0.010	0.086	−0.045	−0.399	0.215	0.353	0.146
400	−0.469	0.329	−0.093	0.009	−0.033	0.001	−0.040	0.011	0.085	−0.050	−0.407	0.226	0.349	0.142
450	−0.474	0.350	−0.094	0.009	−0.041	0.002	−0.106	0.022	0.080	−0.058	−0.420	0.247	0.339	0.133
500	−0.476	0.365	−0.095	0.009	−0.050	0.003	−0.164	0.038	0.074	−0.063	−0.431	0.267	0.325	0.122
550	−0.476	0.376	−0.094	0.009	−0.061	0.004	−0.213	0.059	0.068	−0.067	−0.441	0.285	0.308	0.113
600	−0.474	0.384	−0.093	0.009	−0.073	0.005	−0.255	0.081	0.061	−0.069	−0.449	0.301	0.290	0.104
650	−0.472	0.388	−0.092	0.009	−0.086	0.007	−0.291	0.105	0.055	−0.070	−0.457	0.317	0.270	0.097
700	−0.471	0.390	−0.090	0.008	−0.099	0.010	−0.322	0.129	0.048	−0.070	−0.463	0.332	0.250	0.090
750	−0.469	0.390	−0.088	0.008	−0.114	0.013	−0.349	0.153	0.043	−0.069	−0.469	0.346	0.230	0.084
800	−0.468	0.388	−0.085	0.007	−0.129	0.017	−0.372	0.176	0.037	−0.067	−0.473	0.359	0.210	0.078
850	−0.466	0.386	−0.083	0.007	−0.144	0.021	−0.391	0.199	0.032	−0.064	−0.478	0.372	0.190	0.072
900	−0.465	0.382	−0.080	0.007	−0.160	0.026	−0.407	0.221	0.028	−0.062	−0.481	0.384	0.171	0.067
950	−0.463	0.377	−0.077	0.006	−0.175	0.032	−0.421	0.241	0.024	−0.059	−0.485	0.395	0.152	0.063
1000	−0.462	0.371	−0.074	0.006	−0.191	0.038	−0.434	0.261	0.021	−0.055	−0.487	0.406	0.134	0.059
1050	−0.460	0.365	−0.071	0.005	−0.207	0.045	−0.444	0.279	0.017	−0.052	−0.490	0.417	0.116	0.056

TABLE VII. (*Continued.*)

T_{lab}	$^3D_3$		E_3		$^3G_3$		$^3G_4$		$^3G_5$		E_5		$^3I_5$		$^3I_6$	
1	0.000	0.000	0.000	0.000	−0.000	0.000	0.000	0.000	−0.000	0.000	0.000	−0.000	−0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	−0.000	0.000	0.000	0.000	−0.000	0.000	0.000	−0.000	−0.000	0.000	0.000	0.000
10	0.001	0.000	0.002	0.000	−0.000	0.000	0.000	0.000	−0.000	0.000	0.000	−0.000	−0.000	0.000	0.000	0.000
15	0.001	0.000	0.004	0.000	−0.000	0.000	0.001	0.000	−0.000	0.000	0.000	−0.000	−0.000	0.000	0.000	0.000
20	0.002	0.000	0.007	0.000	−0.001	0.000	0.002	0.000	−0.000	0.000	0.000	−0.000	−0.000	0.000	0.000	0.000
25	0.003	0.000	0.010	0.000	−0.001	0.000	0.003	0.000	−0.000	0.000	0.001	−0.000	−0.000	0.000	0.000	0.000
50	0.012	0.001	0.030	0.000	−0.005	0.001	0.014	0.000	−0.001	0.000	0.004	−0.000	−0.000	0.000	0.002	0.000
75	0.023	0.003	0.048	0.001	−0.010	0.002	0.027	0.001	−0.002	0.000	0.008	−0.000	−0.001	0.000	0.005	0.000
100	0.034	0.005	0.063	0.001	−0.016	0.004	0.041	0.002	−0.003	0.000	0.013	−0.000	−0.002	0.000	0.008	0.000
125	0.044	0.008	0.076	0.002	−0.022	0.006	0.054	0.003	−0.005	0.000	0.018	−0.000	−0.004	0.000	0.012	0.000
150	0.052	0.010	0.087	0.002	−0.028	0.008	0.067	0.005	−0.006	0.001	0.022	−0.000	−0.005	0.001	0.016	0.000
175	0.058	0.013	0.096	0.002	−0.035	0.011	0.080	0.006	−0.007	0.001	0.027	−0.000	−0.007	0.001	0.021	0.000
200	0.063	0.015	0.104	0.002	−0.040	0.013	0.091	0.008	−0.007	0.001	0.030	−0.000	−0.008	0.001	0.025	0.001
225	0.067	0.017	0.111	0.002	−0.046	0.015	0.101	0.010	−0.008	0.001	0.034	−0.001	−0.010	0.001	0.030	0.001
250	0.070	0.019	0.117	0.002	−0.052	0.017	0.110	0.012	−0.008	0.001	0.037	−0.001	−0.011	0.002	0.034	0.001
275	0.072	0.020	0.122	0.002	−0.057	0.018	0.119	0.014	−0.008	0.002	0.040	−0.001	−0.013	0.002	0.039	0.001
300	0.073	0.022	0.126	0.001	−0.062	0.020	0.126	0.016	−0.008	0.002	0.043	−0.001	−0.015	0.002	0.043	0.002
325	0.073	0.023	0.130	0.001	−0.067	0.022	0.133	0.018	−0.008	0.002	0.045	−0.001	−0.016	0.002	0.047	0.002
350	0.072	0.024	0.134	0.000	−0.071	0.024	0.138	0.020	−0.007	0.002	0.048	−0.001	−0.018	0.003	0.052	0.003
375	0.071	0.024	0.137	−0.001	−0.076	0.025	0.143	0.021	−0.007	0.003	0.050	−0.001	−0.020	0.003	0.056	0.003
400	0.069	0.025	0.140	−0.002	−0.080	0.027	0.147	0.022	−0.006	0.003	0.052	−0.001	−0.021	0.003	0.060	0.004
450	0.064	0.026	0.145	−0.004	−0.088	0.030	0.154	0.024	−0.005	0.003	0.055	−0.002	−0.024	0.004	0.068	0.005
500	0.058	0.026	0.148	−0.006	−0.096	0.032	0.158	0.026	−0.004	0.003	0.058	−0.002	−0.027	0.004	0.075	0.006
550	0.051	0.026	0.152	−0.008	−0.103	0.035	0.160	0.026	−0.002	0.004	0.061	−0.002	−0.030	0.005	0.082	0.007
600	0.043	0.026	0.154	−0.011	−0.110	0.037	0.161	0.026	−0.000	0.004	0.063	−0.002	−0.032	0.005	0.089	0.008
650	0.034	0.026	0.156	−0.014	−0.116	0.040	0.159	0.026	0.001	0.004	0.065	−0.002	−0.035	0.006	0.096	0.009
700	0.025	0.027	0.158	−0.016	−0.122	0.042	0.157	0.025	0.003	0.005	0.067	−0.002	−0.037	0.006	0.102	0.011
750	0.016	0.027	0.159	−0.019	−0.127	0.044	0.153	0.024	0.005	0.005	0.069	−0.002	−0.040	0.006	0.109	0.012
800	0.007	0.027	0.160	−0.022	−0.132	0.046	0.148	0.022	0.007	0.005	0.070	−0.002	−0.042	0.007	0.114	0.013
850	−0.003	0.027	0.161	−0.024	−0.137	0.048	0.142	0.021	0.009	0.005	0.072	−0.003	−0.044	0.007	0.120	0.015
900	−0.012	0.028	0.162	−0.027	−0.142	0.049	0.135	0.019	0.011	0.006	0.073	−0.003	−0.046	0.008	0.125	0.016
950	−0.022	0.029	0.162	−0.030	−0.146	0.051	0.128	0.017	0.013	0.006	0.075	−0.003	−0.048	0.008	0.131	0.017
1000	−0.031	0.029	0.163	−0.032	−0.150	0.053	0.120	0.015	0.015	0.006	0.076	−0.003	−0.050	0.008	0.136	0.019
1050	−0.041	0.030	0.163	−0.035	−0.154	0.054	0.111	0.013	0.017	0.006	0.077	−0.003	−0.052	0.009	0.140	0.020

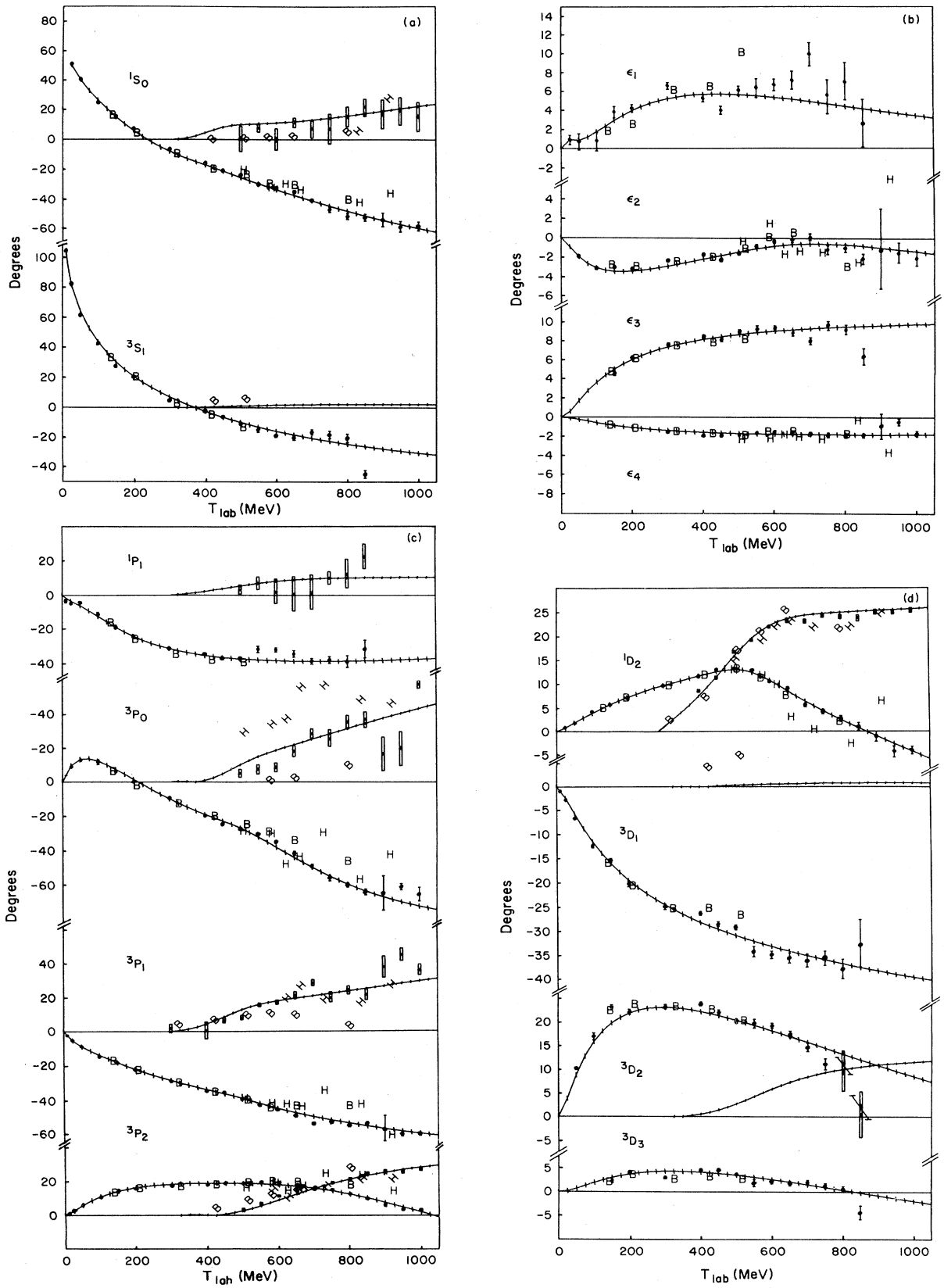

FIG. 3. Partial-wave parameters δ, ϵ (single-energy values for both =●), and ρ (single-energy values =□). See Eq. (4). The curves are our energy-dependent solution (SP82). The Dubois *et al.* (B) and Hashimoto *et al.* (H) solutions are as plotted.

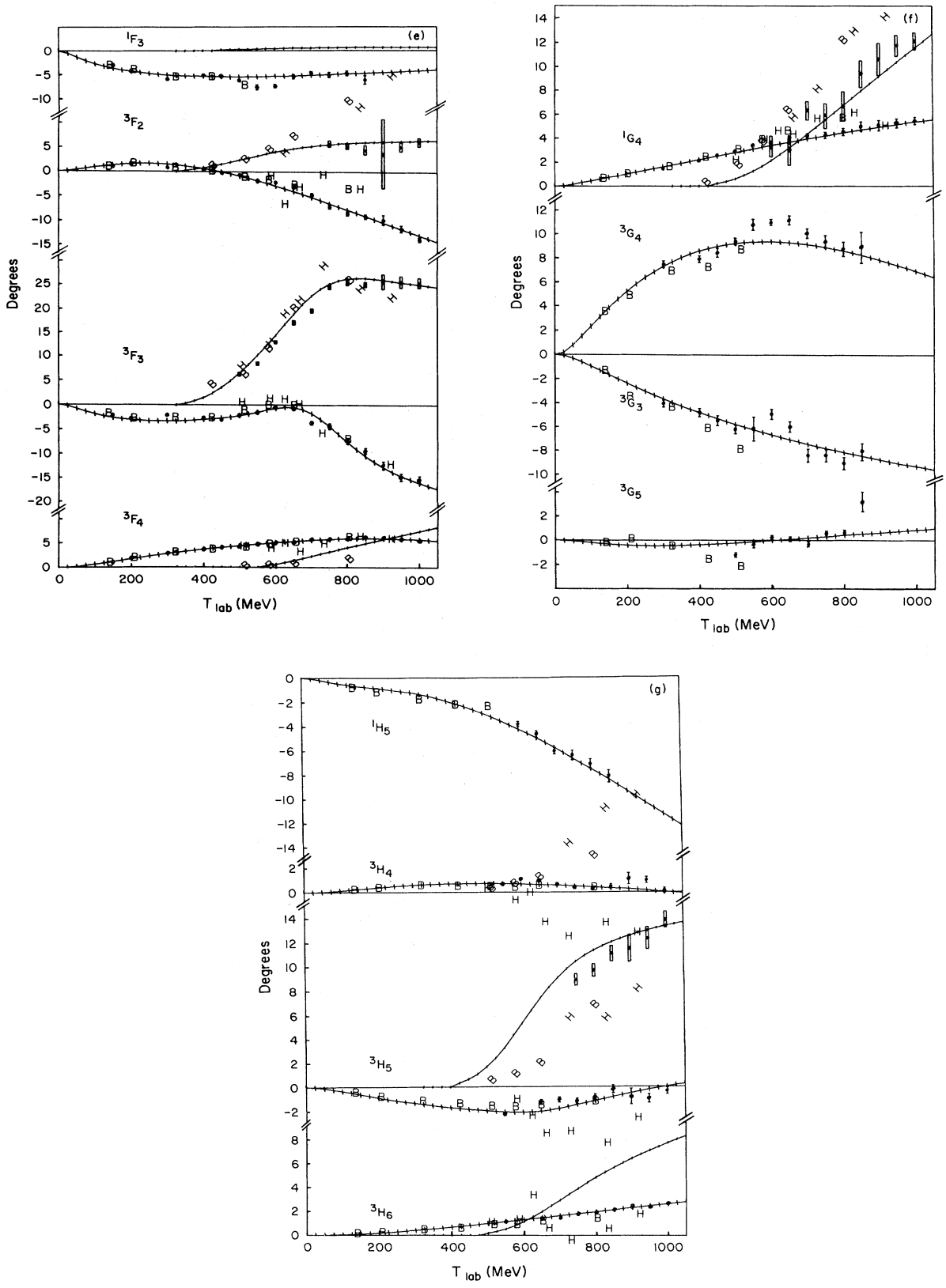

FIG. 3. (*Continued.*)

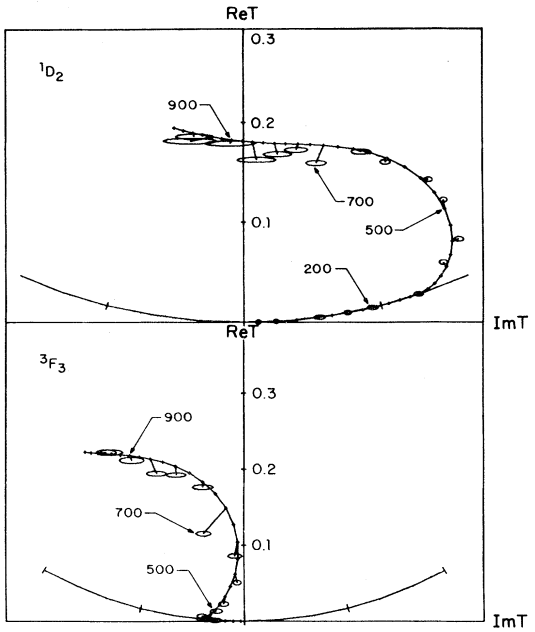

FIG. 4. Argand diagrams for the $^1D_2$ and $^3F_3$ states. The curve is our SP82 energy-dependent solution and the ellipses are our single-energy solutions (see Table III) with their attendant errors; the short lines connect the single-energy solutions to the appropriate energy for the energy-dependent solution. Four of the single-energy solutions are labeled by the energy in MeV.

VI. CONCLUSION

We have presented energy-dependent and single-energy analyses of nucleon-nucleon scattering below 1 GeV laboratory kinetic energy. Isovector (*pp*) amplitudes seem well constrained by existing data up to 800 MeV except for some "noise" between 650 and 800 MeV where, we believe, a few more spin parameters would enhance the *pp* data base. Isocalar amplitudes are not well determined above 600 MeV, but measurements now under way, or being planned, should clarify the *np* situation within the next few years. In both cases (*pp* and *np*), extrapolations above 700 MeV are based upon a very meager data base and are intended only as a reasonable indication where the phases are headed as energy increases.

Predictions of all these analyses are available through an interactive dial-in computing system (SAID) at VPI&SU, and through copies of SAID which exist at several laboratories and universities throughout the world. SAID can also be used to modify solutions and plan new experiments.

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