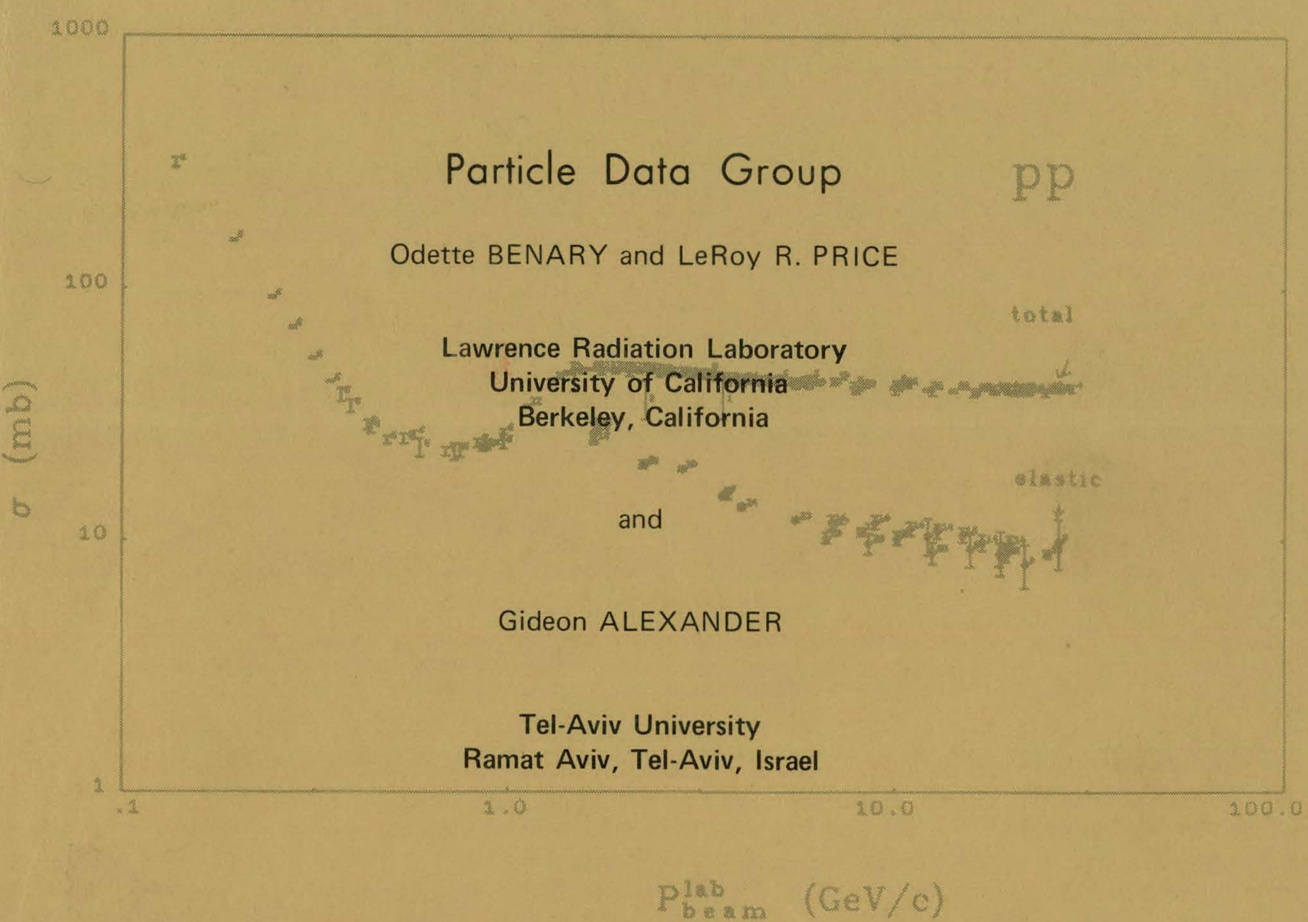
UCRL-20000 NN
August 1970

NN AND ND INTERACTIONS (ABOVE 0.5 GeV/c) – A COMPILATION



Particle Data Group

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DISCLAIMER

N N Kinematics

P_{lab} (MeV/c)	T_{lab} (MeV)	$E_{c.m.}$ (MeV)	$P_{c.m.}$ (MeV/c)	$4\pi \bar{\lambda}^2$ (mb)
0	0	1877	0	
20	0	1877	10	48908.14
40	1	1877	20	12231.20
60	2	1877	30	5439.17
80	3	1878	40	3061.96
100	5	1879	50	1961.64
120	8	1880	60	1363.94
140	10	1882	70	1003.54
160	14	1883	80	769.62
180	17	1885	90	609.24
200	21	1887	99	494.52
220	25	1889	109	409.63
240	30	1892	119	345.07
260	35	1894	129	294.82
280	41	1897	138	254.94
300	47	1900	148	222.76
320	53	1903	158	196.43
340	60	1906	167	174.60
360	67	1910	177	156.30
380	74	1913	186	140.81
400	82	1917	196	127.58
420	90	1921	205	116.19
440	98	1925	214	106.32
460	107	1929	224	97.70
480	116	1933	233	90.13
500	125	1938	242	83.45
520	134	1943	251	77.52
540	144	1947	260	72.24
560	154	1952	269	67.51
580	165	1957	278	63.25
600	175	1962	287	59.42
620	186	1967	296	55.94
640	197	1973	304	52.78
660	209	1978	313	49.90
680	221	1984	322	47.27
700	232	1989	330	44.86
720	244	1995	339	42.65
740	257	2001	347	40.61
760	269	2007	355	38.72
780	282	2013	364	36.98
800	295	2019	372	35.37
820	308	2025	380	33.86
840	321	2031	388	32.47
860	335	2037	396	31.16
880	348	2043	404	29.95
900	362	2049	412	28.81
920	376	2056	420	27.74
940	390	2062	428	26.74
960	404	2069	435	25.80
980	418	2075	443	24.91
1000	433	2082	451	24.07
1020	448	2088	458	23.29
1040	462	2095	466	22.54
1060	477	2102	473	21.84
1080	492	2108	481	21.17
1100	508	2115	488	20.54
1120	523	2122	495	19.94
1140	538	2129	502	19.37
1160	554	2135	510	18.83
1180	569	2142	517	18.31
1200	585	2149	524	17.82
1220	601	2156	531	17.35
1240	617	2163	538	16.90
1260	633	2170	545	16.48
1280	649	2177	552	16.07
1300	665	2184	559	15.68
1320	681	2191	565	15.30
1340	698	2198	572	14.94
1360	714	2205	579	14.60

P_{lab} (MeV/c)	T_{lab} (MeV)	$E_{c.m.}$ (MeV)	$P_{c.m.}$ (MeV/c)	$4\pi \bar{\lambda}^2$ (mb)
1380	730	2212	585	14.27
1400	747	2219	592	13.95
1420	764	2226	599	13.65
1440	780	2233	605	13.36
1460	797	2240	612	13.08
1480	814	2247	618	12.80
1500	831	2254	624	12.54
1520	848	2261	631	12.29
1540	865	2268	637	12.05
1560	882	2275	643	11.82
1580	899	2282	650	11.59
1600	917	2289	656	11.37
1620	934	2296	662	11.16
1640	951	2304	668	10.96
1660	969	2311	674	10.76
1680	986	2318	680	10.57
1700	1003	2325	686	10.39
1720	1021	2332	692	10.21
1740	1039	2339	698	10.04
1760	1056	2346	704	9.87
1780	1074	2353	710	9.71
1800	1092	2360	716	9.55
1820	1109	2367	721	9.40
1840	1127	2374	727	9.25
1860	1145	2381	733	9.10
1880	1163	2388	739	8.96
1900	1181	2395	744	8.83
1920	1199	2402	750	8.70
1940	1217	2409	756	8.57
1960	1235	2416	761	8.44
1980	1253	2423	767	8.32
2000	1271	2430	772	8.20
2020	1289	2437	778	8.09
2040	1307	2444	783	7.97
2060	1325	2451	789	7.87
2080	1344	2458	794	7.76
2100	1362	2465	799	7.65
2120	1380	2472	805	7.55
2140	1398	2479	810	7.45
2160	1417	2486	815	7.36
2180	1435	2493	821	7.26
2200	1453	2500	826	7.17
2220	1472	2507	831	7.08
2240	1490	2514	836	6.99
2260	1509	2520	841	6.91
2280	1527	2527	846	6.83
2300	1546	2534	852	6.74
2320	1564	2541	857	6.66
2340	1583	2548	862	6.59
2360	1601	2555	867	6.51
2380	1620	2561	872	6.43
2400	1639	2568	877	6.36
2420	1657	2575	882	6.29
2440	1676	2582	887	6.22
2460	1695	2589	892	6.15
2480	1713	2595	897	6.08
2500	1732	2602	901	6.02
2520	1751	2609	906	5.95
2540	1769	2616	911	5.89
2560	1788	2622	916	5.83
2580	1807	2629	921	5.77
2600	1826	2636	926	5.71
2620	1845	2643	930	5.65
2640	1864	2649	935	5.59
2660	1882	2656	940	5.54
2680	1901	2663	944	5.48
2700	1920	2669	949	5.43
2720	1939	2676	954	5.38
2740	1958	2682	958	5.32
2760	1977	2689	963	5.27
2780	1996	2696	968	5.22

P_{lab} (GeV/c)	T_{lab} (GeV)	$E_{c.m.}$ (GeV)	$P_{c.m.}$ (GeV/c)	$4\pi \bar{\lambda}^2$ (mb)
3.0	2.2	2.77	1.02	4.73
3.2	2.4	2.83	1.06	4.35
3.4	2.6	2.89	1.10	4.03
3.6	2.8	2.96	1.14	3.75
3.8	3.0	3.02	1.18	3.50
4.0	3.2	3.08	1.22	3.29
4.2	3.4	3.14	1.26	3.10
4.4	3.6	3.19	1.29	2.93
4.6	3.8	3.25	1.33	2.77
4.8	4.0	3.31	1.36	2.64
5.0	4.1	3.36	1.40	2.51
5.2	4.3	3.42	1.43	2.40
5.4	4.5	3.47	1.46	2.29
5.6	4.7	3.52	1.49	2.20
5.8	4.9	3.58	1.52	2.11
6.0	5.1	3.63	1.55	2.03
6.2	5.3	3.68	1.58	1.95
6.4	5.5	3.73	1.61	1.88
6.6	5.7	3.78	1.64	1.82
6.8	5.9	3.83	1.67	1.76
7.0	6.1	3.87	1.70	1.70
7.2	6.3	3.92	1.72	1.65
7.4	6.5	3.97	1.75	1.60
7.6	6.7	4.02	1.78	1.55
7.8	6.9	4.06	1.80	1.51
8.0	7.1	4.11	1.83	1.46
8.2	7.3	4.15	1.85	1.42
8.4	7.5	4.20	1.88	1.39
8.6	7.7	4.24	1.90	1.35
8.8	7.9	4.29	1.93	1.32
9.0	8.1	4.33	1.95	1.29
9.2	8.3	4.37	1.97	1.25
9.4	8.5	4.41	2.00	1.23
9.6	8.7	4.46	2.02	1.20
9.8	8.9	4.50	2.04	1.17
10.0	9.1	4.54	2.07	1.14
10.5	9.6	4.64	2.12	1.09
11.0	10.1	4.74	2.18	1.03
11.5	10.6	4.84	2.23	.98
12.0	11.1	4.93	2.28	.94
12.5	11.6	5.03	2.33	.90
13.0	12.1	5.12	2.38	.86
13.5	12.6	5.21	2.43	.83
14.0	13.1	5.30	2.48	.80
14.5	13.6	5.39	2.53	.77
15.0	14.1	5.47	2.57	.74
16.0	15.1	5.64	2.66	.69
17.0	16.1	5.81	2.75	.65
18.0	17.1	5.97	2.83	.61
19.0	18.1	6.12	2.91	.58
20.0	19.1	6.27	2.99	.55
22.0	21.1	6.56	3.14	.49
24.0	23.1	6.84	3.29	.45
26.0	25.1	7.11	3.43	.42
28.0	27.1	7.37	3.56	.38
30.0	29.1	7.62	3.69	.36
32.0	31.1	7.86	3.82	.34
34.0	33.1	8.10	3.94	.32
36.0	35.1	8.33	4.06	.30
38.0	37.1	8.55	4.17	.28
40.0	39.1	8.77	4.28	.27
42.0	41.1	8.98	4.39	.25
44.0	43.1	9.18	4.50	.24
46.0	45.1	9.39	4.60	.23
48.0	47.1	9.58	4.70	.22
50.0	49.1	9.78	4.80	.21
55.0	54.1	10.25	5.04	.19
60.0	59.1	10.69	5.26	.18
65.0	64.1	11.12	5.48	.16
70.0	69.1	11.54	5.69	.15

PREFACE TO THE SERIES

This is the third in a new series of reports produced by the Particle Data Group. In this series we will collect and display total and differential cross sections, polarizations, mass spectra, and other similar data. Each report will cover one input channel. This one is NN (the first one was on K^+N[‡] and the second on YN[§]). In the next few months we hope to bring out π^+N and $\bar{N}N$. Following later will be π^-N, K^-N, etc. All reports will be complete from January 1968, and will also contain selected results before that date. The reports will be updated periodically, as necessary.

At present there are many physicists in the Particle Data Group who are working on one or more phases of these reports. They are:

I. System Development (LRL)

- Art Rosenfeld
- LeRoy Price
- Odette Benary
- Naomi Schmidt[†]

II. Encoding and Verifying Data, Editing Reports, Fitting Data (LRL)

- Odette Benary
- LeRoy Price

III. Reading and Evaluating Articles, and Analyzing Compiled Data in:

K^+N Interactions

- Odette Benary (LRL)
- Roger Bland (Ecole Polytechnique)
- LeRoy Price (LRL)
- Naomi Schmidt (Brandeis)
- *Charles Wohl (Oxford)
- Victor Henri (CERN)

K^-N Interactions - below 2.0 GeV/c

- *Claude Bricman (CERN)

K^-N Interactions - above 2.0 GeV/c

- J. Badier (Ecole Polytechnique)
- *Enzo Flaminio (BNL)
- G. Kayas (Ecole Polytechnique)
- Brian Musgrave (ANL)

π^+N Interactions

- *Henry Lubatti (Univ. of Wash.)
- Fred Winkelmann (SLAC)
- James Wolfson (M. I. T.)

π^-N Interactions

- *Alan Thorndike (BNL)
- Frank Turkot (BNL)

YN and NN Interactions

- Gideon Alexander (Tel-Aviv)
- *Odette Benary (LRL)

$\bar{N}N$ Interactions

- Pierre Bastien (Univ. of Wash.)
- *Tom Ferbel (Rochester)
- David Miller (M. I. T.)
- Paul Slattery (Rochester)
- Yoshio Sumi (Osaka)
- Toshihiro Yoshida (Kyoto)

If you have any suggestions for improving these reports, please let us know. Our address is:

Particle Data Center
Lawrence Radiation Laboratory
Berkeley, California 94720

(415) 843-2740, Ext. 6301;
nights, weekends, and holidays
call 642-0466

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*"Chairman."

†Now at Brandeis Univ., Waltham, Massachusetts.

‡Particle Data Group (L. R. Price, N. Barash-Schmidt, O. Benary, R. W. Bland, A. H. Rosenfeld, C. G. Wohl), "A Compilation of K^+N Reactions," UCRL-20 000 K^+N (Sept. 1969). The supply of this first report has now been exhausted.

§Particle Data Group (O. Benary, N. Barash-Schmidt, L. R. Price, A. H. Rosenfeld, and G. Alexander, "A Compilation of YN Reactions," UCRL-20 000 YN (Jan. 1970). These are available from LRL-Berkeley and CERN.

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TABLE OF CONTENTS

NN AND ND INTERACTIONS (ABOVE 0.5 GeV/c)— A COMPILATION

Particle Data Group

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University of California
Berkeley, California 94720

and

Gideon Alexander

Tel-Aviv University
Ramat Aviv, Tel-Aviv, Israel

ABSTRACT—We compile 165 papers reporting pp, np, nn, pd, and nd interactions from 0.5 to 70 GeV/c. We display cross sections, angular distributions, and polarizations as well as our fits to some of the data. Included are indices to the papers, as well as a complete listing of the selected data. The cutoff date for this report was 1 July 1970.

*The Berkeley Particle Data Group is jointly supported by the U. S. Atomic Energy Commission, the National Science Foundation, and the office of Standard Reference Data of the National Bureau of Standards.

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Section I.

GENERAL PROCEDURES

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Introduction

It has been known for some time that a comprehensive, evaluated compilation of experimental high energy physics results is essential. In the past there have been numerous collections of data, generally covering rather narrow fields. But because they were not computerized, the authors became "exhausted" on the first edition, and updated versions were never published.

Encouraged by the success of the Particle Data Group's computerized "Particle Properties Tables,"* we have started also to compile cross-sectional data. Our system is completely computer based, so that we will be able to answer specific user requests, in addition to periodically publishing the collected data.

During the last three years, we have had two full-time physicists here at LRL developing and coding the system programs.

During the last year we have been feeding data into the system—and this report on NN is our third result. (We consider these first few reports to be more or less "debug" versions—we are still trying to figure out the best ways to organize the reports and present the data.)

We plan to continue our program development and would appreciate any comments you may have on the way the data are displayed, the types of data collected, etc. In the next few months we hope to go to a form of photocomposition. This means essentially that we will have an unlimited character set and can print Greek letters instead of having to spell them out, for example.

*Particle Data Group, Rev. Mod. Phys. 42, 87 (1970).

Scope of the Compilation

1. We will collect all experimental high energy physics results that can be represented by simple tables or graphs, i.e., σ, $d\sigma/d\omega$, polarizations, angular distributions, density matrices, etc.

We leave it to Data Summary Type Libraries to store Dalitz plots or other $\geq$ 2-dimensional displays (although the presence of such data is indicated in our KEY WORDS). In any case our printed compilations should serve as a necessary "table of contents" to a DST library.

2. The data come primarily from published journals, e.g., Physical Review, Physical Review Letters, Nuclear Physics, Physics Letters, Nuovo Cimento, etc.

We do also compile unpublished theses and conference reports—if the reports give enough information to permit a valid evaluation of the experiment and analysis.

We do not record data that appear in abstract form only, nor do we generally accept preprints unless the article has already been accepted for publication.

3. The compilation is to be complete from January 1968. Before that time we will enter data that are particularly important. But the bulk of the pre-1968 papers will not be put into our system.

4. To reduce the number of errors to the very minimum, all punched information is checked by the physicist who read the article and by another physicist as well.

Data Handling

In order to make this compilation as accurate and complete as possible, many physicists are involved. These physicists fall into two general categories:

a) Those who read and evaluate the data. These physicists (referred to as "readers") are generally experimentalists chosen for their "expertise" in a particular field. In general they are not from LRL. They are organized into small groups, each group being responsible for a different input channel.

b) Those physicsts who encode the data, run the programs, write system programs, etc. These are all at LRL.

The list below indicates the most important steps that every article must go through in order to have its information entered onto the DATA TAPE (the magnetic tape that contains all of our data). This list is summarized in the "Flow Diagram" in Fig. A.

a) The "reader" (physicist) finds a relevant article, reads it, marks it, fills out a form, and mails a copy of the article plus the form to us.

b) Our secretary assigns it a number and it is logged in.

c) The LRL physicist responsible for this initial state quickly scans it, writes out the standard KEY WORDS, etc., to help in the next step.

d) Our secretary transcribes bibliographic information, putting abstract, citations, comments, beam information, and KEY WORDS, onto coding sheets.

e) The LRL physicist transcribes the data that the reader has selected onto coding sheets (this is much more laborious than you might suspect).

f) Key-punch operators punch the data.

g) The LRL physicist puts the cards for a particular article into the correct order.

h) Cards are put onto the DATA TAPE with the DATAPE program.

i) If any cards are out of order, essential information missing, etc., the article is rejected by DATAPE. The physicist repairs the deck, and it is again put through DATAPE.

j) The output DATA TAPE is read by the SKELM program, which makes a listing of all the data stored for each article.

k) The SKELM is looked over by the LRL physicist for obvious errors.

l) SKELM output is mailed to the original physicist "reader," who checks all entries carefully and returns SKELM plus corrections (if any) to us.

m) If any errors are found, steps e) through l) are repeated as many times as necessary.

n) When the reader has no more corrections or changes to make, the LRL physicist gives the article its final verification (i.e., he rechecks all data with the original article). The name of this physicist is put on the tape, and the article is then ready to be used by any one of a number of programs.

Steps b) through n) take, on the average, about 1-3/4 hours per article (1-1/4 hour physicist + 1/2 hour secretary).

Even after being verified, an article can have its contents slightly increased, e.g., if renormalized data are added. In this case only steps e) through k) are repeated.

Again, all the above is just to get the data onto the DATA TAPE. When preparing a report such as this, many additional tasks are involved. A few typical ones are:

a) Collecting all the data on a particular set of reactions—plotting them, looking at systematic errors, removing obviously bad data from the graphs (but leaving it in the tables).

b) Ironing out normalization differences between experiments.

c) Worrying about the various ways in which different authors make resonance cuts and subtractions.

d) Deciding what types of curves (if any) should be fit to certain classes of data.

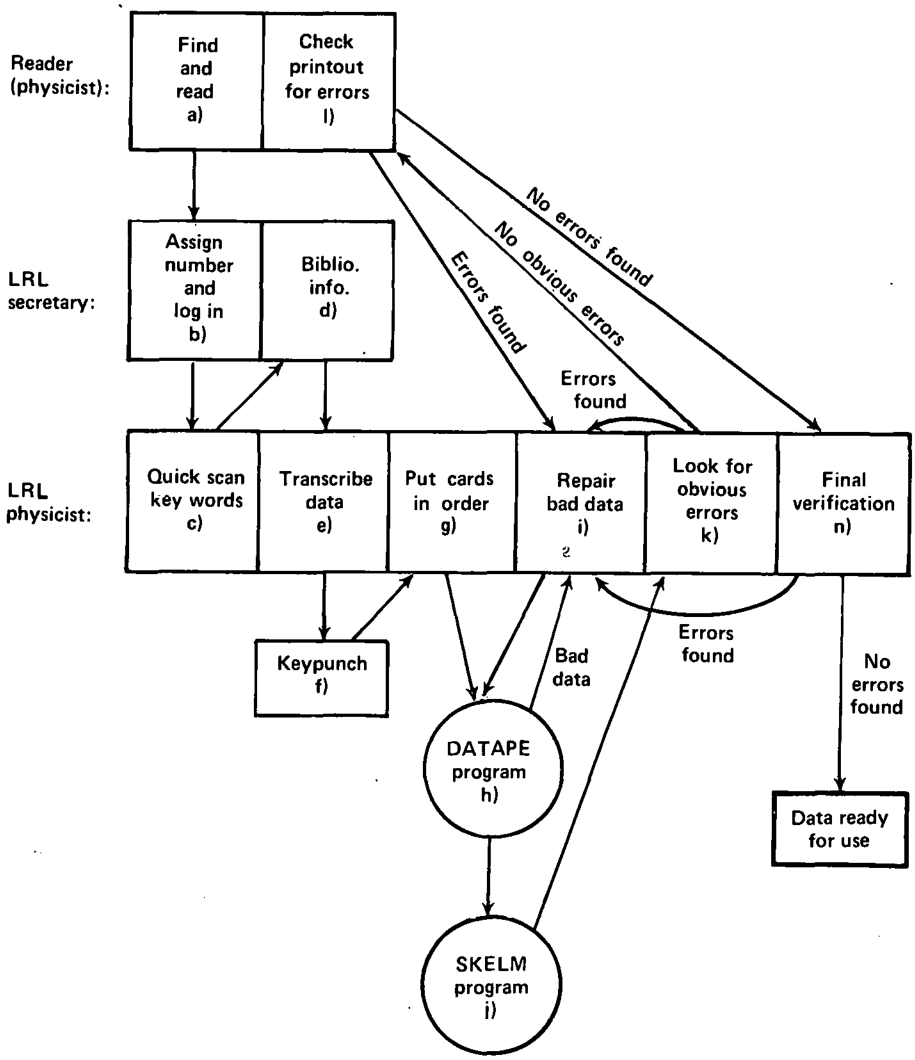

Fig. A.

XBL 701-132

Collaboration with Other Groups

Some physicists in Europe have formed a group called HERA (High Energy Reactions Analysis)* to also compile cross-section data. We are trying to keep in close contact with one another in order to minimize duplication of effort both in programming and data collection. Their first reports† were published last year and more reports are expected soon.

*See B. Sadoulet, "An Example of an Organization of Compilation of Data," Preprint CERN/D. Ph. II/PHYSICS 68-21.

†G. Giacomelli, P. Pini, and S. Stagni, "A Compilation of Pion-Nucleon Scattering Data," CERN-HERA 69-1 (1960). B. Sadoulet, "Data Compilation of Antiproton-Proton Reactions into Antihyperon-Hyperon," CERN-HERA 69-2 (1969).

We also cooperate with HERA on report distribution: LRL prints and distributes both HERA and our reports for the Western Hemisphere and Japan, and CERN does the same for the rest of the world.

We originally planned to collaborate closely with John Hornbostel of BNL. He had been compiling cross-section information for a number of years and was going to bring out a series of reports covering the data appearing before January 1968. Sadly, however, he died early last year, with the project incompleted. We wish to thank BNL for sending all of his files to us.

We also thank the Michigan Cross Section Group for sending us all of their files. Their report is referred to in the next section under Williams et al.

Other Cross-Section Compilations

We present below (in chronological order) all of the previous large cross-section compilations that we know of. In addition to just listing data, some of them have nice reviews, perform various fits to the data, etc.

- V. S. Barashenkov and V. M. Maltsev, Cross Sections for Elementary Particle Interactions, Fortsch. Physik 9, 549 (1961).
- V. S. Barashenkov and J. Patera, Cross Sections for Antinucleon Production, Fortsch. Physik 11, 469 (1963).
- V. S. Barashenkov and J. Patera, Strange Particle Production, Fortsch. Physik 11, 479 (1963).
- M. N. Focacci and G. Giacomelli, Pion-Proton Elastic Scattering, CERN 66-18 (1966)
- J. T. Beale, S. D. Ecklund, and R. L. Walker, Pion Photoproduction Data Below 1.5 GeV, CALT-68-108 (1966).
- H. Yukawa, ed., Experimental Data on Hadron Interactions in GeV Region, Supplement of the Progress of Theoretical Physics (Kyoto), Extra Number (1967).
- P. K. Williams, D. M. Levine, J. A. Koschik, References and Some Two-Body Data for High Energy Reactions, University of Michigan, 1967 (unpublished).
- G. Alexander, O. Benary, and U. Maor, Data Compilation of Proton-Proton Interactions Between 1 and 32 GeV/c, Nucl. Phys. B5, 1 (1968).
- G. Alexander, O. Benary, and U. Maor, Data Compilation of Baryon-Baryon Interactions. (II) Proton-Neutron Collisions Between 1 and 27 GeV/c, Nucl. Phys. B7, 281 (1968).
- G. Alexander, O. Benary, U. Karshon, and U. Maor, Data Compilation of Baryon-Baryon Interactions. (III) Hyperon-Proton Collisions, Nucl. Phys. B10, 554 (1969).
- B. Sadoulet, Data Compilation of Antiproton-Proton Reactions into Antihyperon-Hyperon, CERN-HERA 69-2 (1969).
- G. Giacomelli, P. Pini, and S. Stagni, A Compilation of Pion-Nucleon Scattering Data, CERN-HERA 69-1 (1969).
- Particle Data Group (L. R. Price, N. Barash-Schmidt, O. Benary, R. W. Bland, A. H. Rosenfeld, C. G. Wohl), A Compilation of K^+N Reactions, UCRL-20 000 K^+N (1969).
- Particle Data Group (D. J. Herndon, A. Barbaró-Galtieri, A. H. Rosenfeld), πN Partial Wave Amplitudes; A Compilation, UCRL-20030 πN(1970).
- Particle Data Group (O. Benary, N. Barash-Schmidt, L. R. Price, A. H. Rosenfeld, G. Alexander), A Compilation of YN Reactions, UCRL-20 000 YN (1970).

Acknowledgments

We thank Prof. Arthur Rosenfeld for his constant interest, support, and advice. We are also grateful for his many suggestions on ways to significantly improve these reports. We also wish to thank Dr. Naomi Barash-Schmidt for her significant contributions to our system development. We also thank Arlene Wells for her general help in handling the data and Marjorie Hutchinson for her assistance with some of the programming.

Section II.

NN AND ND INTERACTIONS (ABOVE 0.5 GeV/c)

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Scope of This Compilation

This compilation of NN interactions covers the range of beam momenta from 0.5 to 70 GeV/c. We do not include any cosmic ray data or data obtained from emulsions.

Our lower limit of 0.5 GeV/c was selected to coincide approximately with the uppermost energy at which reliable NN phase shift analyses have been performed. Data below 0.5 GeV/c will be the topic of a later report. For already available information on this low-energy range see:

1) V. S. Barashenkov and V. M. Maltsev, Cross Sections for Elementary Particle Interactions, Fortschr. Physik 9, 549 (1961);

2) M. H. McGregor, R. A. Arndt, and R. M. Wright, (p, p) and (n, p) Data Listing 0 → 750 MeV/c, UCRL-50426 (1968).

For continuity we have in a few places presented data below our cutoff of 0.5 GeV/c; in these cases we have taken the data from the compilation of Barashenkov and Maltsev (above).

In this report we have included all articles reporting NN data in our energy range published since 1 January 1968. In addition we have included many important works before that date. In particular we have included most of the papers used in two earlier compilations on high-energy NN interactions.* Our final cutoff date for inclusion in this report is 15 June 1970.

pp Interactions

It is not surprising that most of the data on NN interactions above 0.5 GeV/c are on the pp interaction. Not only is it easier to form well-defined proton beams than neutron beams, but one can also use a pure hydrogen target—thus eliminating the subtractions and corrections which must be applied in order to extract neutron data when using proton beams on complex targets. Also, the art of building high-energy proton beams is much older and more highly developed than it is for neutron beams.

Total pp Cross Section

Although there is a huge dip in the σ^T(pp) below 2 GeV/c (in the vicinity of the 1π and 2π thresholds), above 2 GeV/c there is no appreciable structure (see Figs. 1a, b, c). For most 1
purposes this cross section can be considered to be a constant 40 mb from 5 GeV/c up to the highest momentum yet reported (30 GeV/c).

Elastic pp Cross Section†

From Fig. 1 we see that below about 1 GeV/c, σ^{el}(pp) is equal to σ^T(pp). Above 2 GeV/c there is no appreciable structure in σ^{el}. From 7 to 30 GeV/c, $\sigma^{el}/\sigma^T \approx 1/4$.

Elastic pp Angular Distributions

In contrast to many other elastic processes (e.g., $\pi^{\pm}$N scattering), there are no known resonances in the pp system. Thus the angular distributions for pp elastic scattering are somewhat simpler than those of the other processes.

Empirically, however, the pp angular distributions do divide into two regions:

1) The forward region (where the shape is expressible as a diffraction peak), and

2) The large-angle region (i.e., outside the diffraction-peak region).

Let us first consider the forward region where the cross section decreases approximately exponentially in t. As the energy increases this region extends out to higher t values. Around P_{beam} = 1 GeV/c, the diffraction

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*G. Alexander, O. Benary, and U. Maor, Data Compilation of Proton-Proton Interactions Between 1 and 32 GeV/c, Nucl. Phys. B5, 1 (1968); G. Alexander, O. Benary, and U. Maor, Data Compilation of Baryon-Baryon Interactions. II Proton-Neutron Collisions Between 1 and 27 GeV/c, Nucl. Phys. B7, 281 (1968).

†For a good discussion of NN elastic scattering see: Yoshio Sumi and Toshihiro Yoshida, Suppl. Prog. Teor. Phys. (Kyoto) Extra Number, p. 53 (1967). This is a special edition devoted entirely to "Experimental Data on Hadron Interactions in GeV Region."

region extends out to about $|t| = 0.5$ $(\mathrm{GeV}/c)^2$ (i. e., to $\theta_{c.m.} = 90$ deg). At the highest energies it extends out to $|t| \approx 1$ $(\mathrm{GeV}/c)^2$ (e. g., $\theta_{c.m.} = 17$ deg at 26 GeV/c). In Fig.
2 2 we display the log of $d\sigma/dt$ vs. $|t|$. In this figure we have also plotted out best fits (solid lines) to the data of the formula

$$\frac{d\sigma}{dt} = \left.\frac{d\sigma}{dt}\right|_{t=0} e^{bt},$$

using only data in the interval $0.03 \leq |t| \leq 0.3$ $(\mathrm{GeV}/c^2$. This interval was arbitrarily selected to be a compromise that would permit us to use the same interval to fit all of the data. A word of caution: the results of fits of this nature are extremely cutoff dependent. We have plotted our best-fit parameters in Figs.
3 3a and 3b. In Table I we give the values of the parameters reported by the experimenters to their own data. Figure 3 is the same as 3b except that we have added the slope fits done by the Serpukov group. The vertical discontinunity between these fits and ours is not meaningful since they use a different fitting interval, etc.

It is easy to see from Fig. 3b that the diffraction peak for pp elastic scattering shrinks rapidly—particularly up to a P-beam of about 6 GeV/c.* From 6 to 22 GeV/c the slope appears to be roughly constant at about 9 $(\mathrm{GeV}/c)^{-2}$. The Serpukov data perhaps show a slow additional shrinkage from 30 to 70 GeV/c.

In Fig. 3a we see that our fitted values of the intercept $d\sigma/dt_{\,t=0}$ are generally larger than the optical lower limit (represented by the smooth curve in Fig. 3a), showing that the forward elastic amplitude is not purely imaginary.

We now turn to the "large angles" region,† i. e., the region outside of the diffraction peak and extending up to $\theta_{c.m.} = 90$ deg (there is always a symmetry about 90 deg for identical particles in the initial or final state). Here we find the two general features (Figs.
2, 4, and 5): 4

1) At fixed P_{beam}, $d\sigma/dt$ varies in general 5
rather slowly with t (in the large angle region), and

2) At fixed t, $d\sigma/dt$ decreases very rapidly with increasing P_{beam}. The larger the value of t, the faster the fall-off.

In 1964 Orear‡ fitted these features [of the Cornell-BNL wide angle data of Cocconi et al. Phys. Rev. 138, B165 (1965)] with the simple formula

$$S\left(\frac{d\sigma}{d\omega}\right)_{c.m.} = Ae^{-\frac{P_\perp}{b}},$$

where S is the c. m. energy squared, $P_\perp$ is the transverse momentum, and b is a "universal" constant.
However, as higher-energy data became available, it became clear that the value of b was in fact energy dependent. In addition various "breaks" and "wiggles" began to be discovered. In 1967 Krisch** proposed an empirical formula that has had outstanding quali-
tative success. In Fig. 6 we reproduce one 6
of Krisch's plots. It is easy to see that his formula of the type

$$\frac{d\sigma}{dt} = \sum_{i=1}^{3} c_i\, e^{-\frac{\beta^2 P_\perp^2}{a_i}},$$

where β is the c. m. velocity of the proton,

*Carrigan has recently proposed that there is a "break" in the diffraction peak at $|t| = 0.15$ $(\mathrm{GeV}/c)^2$ at energies around 20 GeV/c. See R. A. Carrigan, Jr., Phys. Rev. Letters 24, 168 (1969) for his full discussion.

†See Charles B. Chiu, Rev. Mod. Phys. 41, 640 (1969) for an excellent discussion of large-angle scattering including various models.

‡J. Orear, Phys. Letters 13, 190 (1964).

**For the exact form of his formula and details of the fitting, the reader is referred to A. D. Krisch, Phys. Rev. Letters 19, 1149 (1967).

does an admirable job of fitting the data over 12 orders of magnitude (both small angles and large angles).

Neither the significance of the dependence upon the variable $\beta^2 P_\perp^2$ nor the reason for the breaks in the curve in Fig. 6 is yet clear. It has been suggested that the breaks might be associated with the openings of various inelastic processes.

Although Krisch's fit explains the general features of the elastic pp data, there is some "fine structure" that it does not explain. This oscillatory structure is nicely
7 displayed in Fig. 7 [taken from J. V. Allaby et al., in Proceedings of Topical Conference on High Energy Collisions of Hadrons (CERN, Geneva, 1968), p. 580]. Allaby et al. point out that: "Such an oscillation is reminiscent of similar phenomena seen in πp, Kp and $\bar{p}p$ scattering. A simple-minded interpretation of such behaviour is in terms of diffraction scattering. There, as well as here, the first diffraction minimum reveals itself when the cross section has fallen below a level of about $10^{-28} cm^2/(GeV)^2$. Equating the dips of the oscillation to the zeros of the first order Bessel function, $J_1(R\sqrt{t})$ results in an obsorbing disc radius of R = 0.6 f, an anomalously small value. In any case, it seems premature to conlude that large angle proton-proton scattering is dynamically nothing else than the tail of diffraction scattering."

There are two experiments (Diddens et al., Ref. 53, and Cocconi et al., Ref. 161) that report results on pp elastic angular distributions at fixed angle rather than fixed energy. We have not reproduced their data in this section, but it is tabulated in Sec. III of this report.

Re/Im Ratio of the Forward pp Elastic Amplitude

The real part of the forward elastic amplitude is of great interest. Its magnitude can be estimated by extrapolating $d\sigma^{el}/dt$ to t = 0 and then using the optical theorem to evaluate the imaginary part from the total cross section.*

If one looks at $d\sigma/dt$ at extremely forward angles {in the Coulomb interference region [e.g., $|t| < 0.01\ (GeV/c)^2$]} one can presumable measure not only the magnitude but also the sign of the real part. As a matter of fact, this is exactly what is generally done
(see, e.g., Fig. 8). 8

In reality, of course the determination of Re(f)/Im(f) at zero degrees is considerably more complicated than suggested by the above simple prescription. For instance, Re(f) means only the total nuclear contribution; i.e., the Coulomb scattering contributions must be removed. This subtraction is somewhat model dependent.

In addition, if all of the forward amplitude cannot be explained by the imaginary spin-independent part, the discrepancy can be due to either:

1) A real part of the forward spin-independent amplitude, and/or

2) The existence of a spin-dependent part of the forward amplitude.

The separation of these effects is not easy, and it seems probable that other data, in addition to precise $d\sigma/dt$'s, are going to have to be employed to finally resolve the ambiguities.

In reporting their results, authors usually give the ratio of the Real part to the Imaginary part of the spin-independent for-
ward amplitude (defined as α_{pp}). In Fig. 9 9
we have plotted most of the measurements of α_{pp} done recently (i.e., since 1964). The agreement above 2 GeV/c with the curve calculated from forward dispersion relations by

*See the discussion by H. A. Bethe, Ann. Phys. (N.Y.) 3, 190 (1958).

Söding* is quite striking. However, below 2 GeV/c they appear to disagree completely. It is interesting to note that 2 GeV/c is also the place where the total cross section levels off and begins to assume a relatively constant value. A possible connection between these two effects is speculated upon by Bellettini et al.†

Actually, Söding's calculation is based upon the assumption that the spin-dependent part of the forward amplitude is zero (i. e., $\beta_{pp} = 0$). As Fig. 9 shows, the experimental points do agree with the calculation at high energies, suggesting that β_{pp} is indeed consistent with 0.

However, below ~2 GeV/c the experimental values for α_{pp} are much smaller than the calculated ones, suggesting that β_{pp} might become important at low energies. This is confirmed by the values of β_{pp} reported by Dutton et al. (Refs. 51 and 52).

P_{lab}	β_{pp}	
1.29	0.75 ± 0.27	
1.54	0.50 ± 0.10	two separate experiments
1.54	0.25 ± 0.36	
1.69	0.50 ± 0.13	

Thus it seems that the spin-dependent part of the elastic scattering amplitude decreases with increasing momentum.

Polarization in Elastic pp Scattering

Good polarization measurements on pp elastic scattering are vital to the pp phase
10 shift analyses. In Fig. 10 we plot the polarizations at various momenta. The distributions are presented for $0 \leq \cos\theta_{c.m.} \leq 1$ because the symmetry of the identical protons requires that the distributions be antisymmetric about $\cos\theta_{c.m.} = 0$.

In Fig. 11 we have plotted [after Grannis 11
et al., Phys. Rev. 148, 1297 (1966)] the maximum polarization vs. beam momentum. It is easy to see that there is a maximum at about 1.4 GeV/c.

Elastic pp Partial-Wave Analyses

A partial-wave analysis is the most complete description we have of an elementary particle reaction. All possible information is contained in it. However, such analyses are in practice feasible only for the low-energy regions where only a few partial waves need be considered, and only a very few inelastic channels are open. MacGregor et al. have managed to extend the pp elastic partial-wave analysis up to 1.4 GeV/c.* However, they point out that above 1 GeV/c these analyses are really only qualitative so far.

As a matter of fact, it is because the low-energy data is well described by partial-wave analyses and the high-energy (about ~ 1 GeV/c) data are not, that we decided to bring out our NN compilation in two parts: this first section covering 0.5 GeV/c and above, and a second section (some time in the future) below 0.5 GeV/c.

Although we are going to leave all the partial-wave results for our later report, in this section we would just like to indicate the general "state-of-the-art."

In March 1967 the University of Florida hosted the International Conference on the Nucleon-Nucleon Interaction. A rather complete report of this conference is the subject of the special issue of the July 1967 Reviews of Modern Physics. In their introductory paper to this issue Green, MacGregor, and Wilson make the following comments: "Our knowledge of the N-N interaction around 1960 might be

*P. Söding, Real Part of the Proton-Proton and Proton-Antiproton Forward Scattering Amplitude at High Energies, Phys. Letters 8, 285 (64).

† Bellettini et al., Phys. Letters 14, 164 (1965).

*MacGregor et al., Determination of the Nucleon-Nucleon Scattering Matrix. VIII. (p, p) Analysis from 350 to 750 MeV, Phys. Rev. 169, 1149 (1968).

summarized by the succinct statement of Professor M. L. Goldberger: ' There are few problems in modern theoretical physics which have attracted more attention than that of trying to determine the fundamental interaction between two nucleons. It is also true that scarcely ever has the world of physics owed so little to so many. In general, in surveying the field, one is oppressed by the unbelievable confusion and conflict that exists. It is hard to believe that many of the authors are talking about the same problem or, in fact, that they know what the problem is. ' After three days of presentations and discussions at the 1967 N-N Interaction Conference at the University of Florida in Gainesville, it would appear that our view has improved considerably from the bleak picture of 1960. Indeed several relatively simple and accurate descriptions of the nucleon-nucleon interaction based upon meson field theory have emerged. While the formalisms used differ greatly, it appears now that these theories have about the same physical substance and that the various authors are not only talking about the same problem but that correspondences between the various languages are being established. "

Inelastic pp Reactions*

The total pp inelastic cross section can be easily estimated by eye from Fig. 1b or 1c. It is virtually zero below 1 GeV/c; it quickly increases to about 30 mb by 2 GeV/c and remains relatively constant up to the highest energies yet reported (30 GeV/c). As we will see in the next section, the inelastic reactions are dominated by Δ and N^* productions.

12 In Fig. 12 we present the single-pion production cross sections (which include resonance contributions). Because of the importance of $\Delta(1236)$ production, the $pn\pi^+$ cross section is considerably larger than the $pp\pi^0$ cross section. We will shortly see that those single-pion production cross sections follow rather closely the shapes of the $pp \to N\Delta(1236)$ cross sections.

We next present a plot of the cross section for $pp \to d\pi^+$ (Figs. 13a and 13b). Note 13
that the steep decrease of σ with P_{beam} is reasonably well fit by the form $\sigma = KP_{beam}^{-n}$ (the dashed line in Fig. 13b). The significance of this fit and the fitted value of $n = 4.29 \pm 0.04$ will be discussed in a later section.

We present in Fig. 14 the differential 14
cross sections for the reaction $pp \to d\pi^+$. Since the initial-state particles are identical, these distributions are symmetric about $\cos\theta_{c.m.} = 0$. It is clear that the distributions are peaked in the forward (backward) direction, and this peaking increases as the energy increases from 1.7 to 3.6 GeV/c.

Next we turn to double-pion production and in particular to $pp \to pp\pi^+\pi^-$, as the other three possible double-pion processes

$$\begin{aligned} pp \to\ & pp\pi^0\pi^0 \\ & pn\pi^+\pi^0 \\ & nn\pi^+\pi^+ \end{aligned}$$

each involve two missing neutrals and are therefore considerably harder to detect (and are underconstrained in the bubble chamber).
In Fig. 15 we see that the double-pion cross 15
section displays the same general features as the single-pion production: a peak near threshold (neither as high nor as sharp as for the single-pion case, however), tapering off to a rather constant value at higher beam momenta. When we look at resonance production shortly we will see that most of this distribution is due to quasi-two-body reactions involving N^*'s and Δ's.

In Fig. 16 we see that the triple-pion 16
production cross sections have the same

*For further information on NN inelastic processes, see the excellent review talk by E. Lillenthun, Lund Conference, 1969. Also see Kimio Fujimura, Suppl. Prog. Theor. Phys. (Kyoto), Extra Number, (1967), p. 282.

general shape as the single- and double-pion productions. Again this plot contains a large smount of resonance contributions.

Finally in Table II we present the available data on 4- and 5-pion production, as well as deuteron+3π and deuteron+4π reactions. These data are not plotted because there are too few points available.

N^* and Δ Resonances

The most thoroughly investigated phenomena in the pp inelastic final states are the nucleon resonances—and for good reason. They make up generally from 50 to 80% of the inelastic cross section.

Before proceeding to look at the data, it is essential to understand a couple of basic facts about how these experiments are performed. Briefly, there are two basic methods of gathering data on resonance production in inelastic reactions, and each type has its advantages and disadvantages that must be understood before the data can be properly interpreted:

1) The "missing mass" experiments. In these one usually measures only the mass recoiling against the detected particle (neutral or charged). Thus these experiments are able to measure the total production cross sections for all decay modes of the produced resonance. However, they generally must measure

$$\frac{d\sigma}{dt}\,(pp \rightarrow pN^*)$$

over some limited t range, and then assume a dependence like

$$\frac{d\sigma}{dt} = A\, e^{Bt}$$

in order to evaluate the integrated cross section.

2) The "bubble chamber-like" experiments. These have the advantage of being able to detect all angular regions equally. However, only part of the decay modes are generally detected.

This latter point brings us to the question of how to correct for unmeasured decay modes. Where possible we have used isospin relations. For resonances that have both Nπ and Nππ decay modes and only the Nπ mode has been reported, we have used the factor

$$x \equiv \frac{\Gamma(N^* \rightarrow N\pi)}{\Gamma(N^* \rightarrow \text{all})}$$

as given by the most recent "Reviews of Particle Properties."* The error in x has been included in our quoted cross-sectional errors.

Another problem that affects any type of detector is the separation of "signal" from "background." Frequently these resonances sit on top of large backgrounds so the subtractions become complicated. See for example the mass plots in Fujimura's review article.†

With these preliminaries understood, we now turn to the data, taking the baryon resonances in roughly increasing mass order.

Δ(1236)

The cross sections for the reactions $pp \rightarrow n\Delta^{++}$ and $pp \rightarrow p\Delta^{+}$ and plotted in Fig. 17. **17**
From isospin the ratio of $\sigma(n\Delta^{++})/(p\Delta^{+})$ should be 3, and the data is consistent with this. The dashed line in Fig. 17b represents our best fit of $\sigma(n\Delta^{++})$, above 10 GeV/c, to the formula

$$\sigma = KP_{\text{beam}}^{-n}$$

(with best-fit value of n = 2.20 ± 0.16). The significance of this parameterization will be explained in a later section. We did not fit $\sigma(p\Delta^{+})$ because as yet there are too few data above 10 GeV/c.

In Fig. 18 we present the differential **18**
cross sections for (a) $pp \rightarrow n\Delta(1236)^{++}$ and (b) $pp \rightarrow p\Delta(1236)^{+}$. In Figs. 18a and 18b we have also displayed the results of our fits to the data of the form $d\sigma/dt = Ae^{bt}$. In Fig. 18c

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*Particle Data Group, Review of Particle Properties, Rev. Mod. Phys. 42, 87 (1970).
†K. Fujimura, op. cit.

we have plotted our best-fit values of b. We see that the diffraction peak is shrinking for the $p\Delta^+$ processses, but it is not clear whether the $pp \rightarrow n\Delta^{++}$ peak is shrinking or not. One should not put too much faith into the actual numbers plotted in Fig. 18c. As we have said before, the data (Figs. 18a and 18b) are sensitive to background subtractions, etc.

$N^*(1470, 1/2^+)$, $N^*(1520, 3/2^-)$, $N^*(2190, 7/2^-)$

Next we look at the "elastic-like" pp
19 interactions, i.e., $pp \rightarrow p N^*_{1/2}$. In Fig. 19a is $\sigma[pN^*(1470)^+]$; Fig. 19b, $\sigma[pN^*(1520)^+]$ and Fig. 19c shows $\sigma[pN^*(2190)^+]$ in addition to the previous two. We see that although the productions of $N^*(1470)^+$ and $N^*(1520)^+$ are essentially of the same magnitude around 4 GeV/c, by 10 GeV/c the $N^*(1520)^+$ has dropped by a factor of 3, whereas the $N^*(1470)$ has remained relatively constant (and does so all the way up to 30 GeV/c).

The energy dependence of these "elastic-like" reactions is in marked contrast to the $\Delta(1236)$ production, which continues to decrease as a function of energy (see Fig. 17b). They are, however, quite similar to the pp elastic scattering, which also is about constant above 10 GeV/c.

The $\Delta(1236)$ cross section falls so fast that although at ~ 4 GeV/c the $p\Delta(1236)$ production is considerably greater than $pN^*(1470$ or $1520)$, by 10 GeV/c it is less than that for $N^*(1470)$ and by 15 GeV/c it is less than for
20 $N^*(1520)$.

21 Figures 20 and 21 show the differential cross sections for the processes $pp \rightarrow pN^*(1470)^+$ and $pp \rightarrow pN^*(1520)^+$ respectively. From the data we have displayed it is not easy to tell whether these diffraction peaks are shrinking or not. In Table III we have plotted the parameters that various experimenters have obtained in fitting to their own data. Although the fits were not done in a completely consistent manner from one experiment to another (i.e., various $|t|$ cuts, different background subtractions), it does appear that neither the $N^*(1470)$, the $N^*(1520)$, nor the $N^*(2190)$ peaks are in fact shrinking. Notice also that the $N^*(1470)$ peak is considerably sharper than that of the $N^*(1520)$ and $N^*(2190)$. Also, notice by comparing Table III with Fig. 3 (the coefficients for the pp elastic scattering) that the $N^*(1470)$ [as well as the $\Delta(1236)$] are about twice as steep as the elastic, where the $N^*(1520)$ and $N^*(2190)$ [as well as the composite "$N^*(1688)$"] are only about half as steep.

In the "large angle" $[|t| > 1 \ (GeV/c)^2]$ region we have no data on $pp \rightarrow pN^*(1470)^+$. However, for the $pN^*(1520)^+$ final state (Fig. 21) we do have some information for large $|t|$. The data below 19 GeV/c show a very flat dependence on t. We can also see that the $d\sigma/dt$ values in this region decrease as P_{beam} increases. These two characteristics are also found in the elastic pp scattering, and thus the reaction $pp \rightarrow pN^*(1520)^+$ is sometimes said to exhibit "elastic-like behavior in the region $|t| > 1$." If we look at the data at 19.2 GeV/c, however, we see that the cross section in this region is still rather t dependent. More data above 8 GeV/c would be most helpful in understanding this reaction.

"$N^*(1688)$" Bump

Next we look at the "$N^*(1688)$". Actually πN phase shift analyses have shown that this region contains a number of resonances with differing J^P and I-spin [e.g., $N(1670, 5/2^-)$, $N(1688, 5/2^+)$, $N''(1700, 1/2^-)$, $\Delta(1650, 1/2^-)$, $\Delta(1670, 3/2^-)$]. Thus it is impossible at present to correct for unseen decay modes. There-
fore, in Fig. 22 we have plotted only those ex- 22
periments (mostly counters) that reported all decay modes. In this figure we see that the composite "$N^*(1688)^+$" production cross section is roughly constant from 4 to 30 GeV/c.

In Fig. 23 we plot the available differenti- 23
al cross sections for $pp \rightarrow p$"$N^*(1688)^+$."

Again in Table III we present the fitted parameters for this distribution. They show that the "$N^*(1688)$," like the other N^*'s(1470, 1520, and 2190), does not have a shrinking diffraction peak.

In the large-angle region $[|t| > 1\ (GeV/c)^2]$ we find a behavior quite analogous to that found in the reaction $pp \to pN(1520)^+$; i. e., below 19 GeV/c the $d\sigma/dt$ is quite constant in $|t|$ but falls with increasing beam momentum ("elastic-like"). Again, however, the data at 19.2 GeV/c does not show this behavior, but rather continues to decrease as $|t|$ increases.

A Parameterization of the dσ/dt's

Ankenbrandt et al. [Phys. Rev. 170, 1223 (1968)] have introduced an interesting parameterization of the inelastic channels we have been considering. Probably stimulated by the success that plotting the elastic $d\sigma/dt$ vs. $P_\perp^2$ has shown, they introduce the kinematic variable

$$v \equiv -[tu/(t+u)] ,$$

where t and u are the familiar Mandelstam variables:

$$t = (P_1 - P_3)^2 ;$$

$$u = (P_1 - P_4)^2 .$$

As they point out, v has some of the desirable properties that $P_\perp^2$ manifests for elastic scattering (v is identically $P_\perp^2$ for elastic scattering). It is symmetric under interchange of the initial state protons; it takes the same value for the inverse process; and it reduces to (-t) for small $|v|$.

24 In Fig. 24 we display the results of our fits of the form

$$\frac{d\sigma}{dt} = be^{-v/v_0}$$

to the $pp \to p\Delta^+$, $pN^*(1520)^+$, $p"N^*(1688)^+"$, and pp elastic scattering data. The results of such fits are of course dependent somewhat upon the range of v values chosen. Following Ankenbrandt et al. we fitted the reactions to the above formula for v values just outside of the diffraction peak. Thus, this figure is essentially identical to that presented by Ankenbrandt et al., except that we have extended the plot above their 7 GeV/c upper limit.

As already noted by Ankenbrandt et al., the most striking feature of Fig. 24 is the tendency of all the slopes toward the same value ($1/v_0 \approx 2.5$) around 7 GeV/c. We see that above 7 GeV/c, the elastic points are slowly falling. The points at 19 GeV/c are interesting but may not be very significant since the experiment covers a somewhat different t range than do the lower-momentum experiments. Additional experiments above 7 GeV/c would be most useful.

Baryon Resonances in Other Final States

So far we have been considering the production of baryon resonances in the simplest manner, i. e., in quasi-two-body final states, where one particle is a nucleon. However, there are a few bubble chamber experiments which also look at baryon production in more
complicated situations. In Fig. 25 we see 25
single-resonance production: (a) $pp \to p\pi^-\Delta^{++}$
and (b) $pp \to p\pi^+\Delta^0$. In Fig. 26 is displayed 26
the double-resonance production:
(a) $pp \to \Delta^{++}\Delta^0$ and (b) $pp \to \Delta^{++}N^*(1520)^0$.

In addition there have been numerous results published on various other final states containing N^*'s and Δ's. Such data may be found in the following articles (in Sec. III).

First author	Reference no.
Alexander	57
Almeida	153
Bodini	139
Boggild	96
Boggild	159
Caso	120
Connolly	93
Connolly	97
Ginestet	131
Kayas	82
Kinsey	126
Klein	122
Yekutieli	83

Boson Resonances

In contrast to πN and KN interactions, the NN initial state has no bosons. Thus the lack of boson resonances in NN final states is not too surprising. In general, boson resonance production seems to be only about 1% as probable as nucleon resonance production in pp reactions.

27 In Fig. 27 we present the cross sections for (a) $pp \rightarrow pp\omega$ and (b) $pp \rightarrow pp\eta$.

In Table II we give the only cross section measurement (at 21.1 GeV/c) for the
28 process $pp \rightarrow d\rho^+$. In Fig. 28 is shown the $d\rho^+$ production angular distribution corresponding to this point.

Strange-Particle Production in pp Interactions

The production of strange-particle final states accounts for only about 1% of the total inelastic cross section in the energy range measured so far (up to ~ 10 GeV/c). Many of these reactions are dominated by strong N^*, Y^*, Σ^*, or K^* production.

29 The three-body final states are dis-
30 played in Fig. 29 ($pp \rightarrow p\Lambda K$), Fig. 30a ($pp \rightarrow p\Sigma^+K^0$), and Fig. 30b ($pp \rightarrow p\,\Sigma^0K^+$). (The only other possible strange three-body final state is $nK^+\Sigma^+$ and no data has yet been reported for this reaction.) We see from Figs. 30a and 30b that the cross sections for $p\Sigma^0K^+$ and $p\,\Sigma^+K^0$ are about equal. We also note that the $p\Lambda K^+$ cross section is about 2 1/2 times as great as either of the Σ cross sections.

Next we display the four-body final
31 states. In Fig. 31 are all possible reactions of the type $pp \rightarrow N\Lambda K\pi$. We see that in tho energy interval measured (~ 5 to 10 GeV/c) all three reactions have about equal cross sections.

32 In Fig. 32 are plotted all possible reactions of the type $N\Sigma K^0\pi$.

3 Figure 33 shows the reactions (a) pp $K^0\overline{K}^0$ and (b) $pnK^+\overline{K}^0$. These have about the same cross sections as the other strange four-body processes in Figs. 31 and 32.

In Table IV are listed various strange-particle production cross sections from 4-, 5-, and 6-body final states. These data are not plotted because they are too sparse.

For cross sections involving Y^* productions see Klein et al. (Ref. 122).

$pp \rightarrow$ n-prongs

Table V displays the cross sections for the reactions $pp \rightarrow$ n-prongs.

nn Interactions

By isospin invariance the nn interactions should be identical to the pp interactions reported in the previous section (as long as one stays out of the Coulomb-force region).

In Fig. 34 we have plotted the values of 34
σ^T(nn) along with a smooth curve for σ^T(pp) taken from Fig. 1. Considering the difficulties associated with nn experiments (with we shall enumerate in the next section on np and pn interactions) the agreement seems quite good.

In Fig. 35 is displayed the most recent 35
(1956!) differential cross-section measurement for elastic nn scattering. It appears to be quite consistent with pp elastic scattering at the same energy.

np and pn Interactions

By "np" interactions we mean those interactions where the n is the beam particle and the p is the target; "pn" obviously then means the reverse situation. We know that as far as the basic interactions are concerned the np and pn interactions must be identical. However, due to the differences in experimental techniques and setup, it is worthwhile keeping the np and pn reactions somewhat separate. The major experimental differences (and problems) are:

1) np. Although deuteron beams are occasionally used, one ordinarily uses free neutrons on a hydrogen target. This is a most

desirable situation except that, at present, high-energy monoenergetic neutral beams are hard to construct. Thus the data are sometimes "smeared out" over a large region of center-of-mass energy. Also the calculation of the absolute beam normalization is frequently rather difficult.

2) pn. Here one usually uses a conventional proton beam, but the target is deuterium (or something even more complex). This then calls for various "deuteron corrections" to be applied, including those for screening, spectator momentum, Fermi motion, and rescattering. These various corrections are not too well known and thus introduce uncertainties.

Because of the difficulties involved, the np and pn interactions have not been measured as well as the pp interactions, as will be obvious from the data we have reproduced in this section.

pn and np Total Cross Sections

36 In Fig. 36 we have plotted the np and pn total cross sections (a) on a log-log plot and (b) on a linear scale. The data below 0.5 GeV/c are from the compilation of Barashenkov et al. We have plotted only those pn data that have had Glauber-type corrections applied. The solid curve is a smooth curve drawn through the pp total cross section of Fig. 1.

The following observations may be made:

1) The pn data seem to fall consistently higher than the np data;

2) Although σ^T(np) is considerably less than σ^T(pp) below about 4 GeV/c, they cross at about 4.5 GeV/c and then again at about 10 GeV/c. Above about 10 GeV/c they are very close together and for most practical purposes may be considered to be identical.

np and pn Elastic Scattering (Including Charge Exchange)

The σ^{el}(np) and σ^{el} (pn) data are dis-
37 played in Fig. 37a. The solid curve is the σ^{el} (pp), taken from the data of Fig. 1. Although there are only very few data, we see that the np and pn data appear to agree with one another, and that above 1 GeV/c they are very close to the σ^{el}(pp).

In Fig. 37b we present the np "charge exchange" cross sections. These are just those elastic events in which the beam particle is scattered backwards in the center of mass, thus the data in Fig. 37a includes these data. Even though there are only three data points, we fitted them to the equation

$$\sigma = KP_{beam}^{-n}$$

The solid line shows our best-fit curve (n = 3.0 ± 0.6). The possible significance of this parameterization is explained in a later section.

np and pn Elastic Angular Distributions (Including Charge Exchange)

The elastic np (or pn) differential cross section may be divided into three regions:

1) In the forward direction (Fig. 38) 38
there is a diffraction peak similar to that found in pp elastic scattering. The straight lines are our fits of the forward peaks to the formula

$$d\sigma/dt = \left.\frac{d\sigma}{dt}\right|_{t=0} e^{bt} .$$

In Fig. 39 we display our fitted slopes.* We 39
see that the peak shrinks as P_{beam} increases from threshold up to ~ 10 GeV/c. For comparison we have also plotted the results of our fits (from Fig. 36) for pp elastic scattering. We see that the np and pp slopes are about equal up to 6 GeV/c. Above 6 GeV/c there seems to be a difference between the np and pp data [the pp has a constant slope of ~ 9 $(GeV/c)^{-2}$; np of ~ 7 $(GeV/c)^{-2}$]. However,

*All experiments represented in Fig. 39, except Dzhelepov (Ref.137) have normalized their data, using the optical theorem and taking various amounts of real parts. Thus a plot of the intercept $d\sigma/dt\,|_{t=0}$ is in this case relatively meaningless and we do not give it.

this difference is due only to the fact that the pp data were fit over a smaller t range than were the np. As a matter of fact, if one uses the same t range for pp that is used for np, the two sets of slopes are perfectly consistent.

The results of various author's fits to their own data are given in Table VI.

So far we have been considering only the np elastic scattering. We also have one experiment on pn elastic scattering, and pre-
40 sent it in Fig. 40. The only reason for separating this one pn experiment from the numerous np experiments is that (as discussed earlier) the experimental techniques (and biases) are quite different in the two processes.

Just as is done for the elastic pp scattering, one can deduce the Re/Im part of the forward np (or pn) amplitude from the elastic scattering (plus total cross section) data. This difficult task has been done at only four momenta so far, and the results are displayed
41 in Fig. 41.

42 2) In the large-angle region (see Fig. 42) the np differential cross section is fairly flat and decreases rapidly with beam energy—in strong analogy to pp elastic scattering (the elastic pp drops slightly faster). There is also generally a minimum near $\theta_{c.m.} = 90$ deg.

43 3) In the backwards direction (Fig. 43) there exists a "charge exchange" peak. Unlike the forward np scattering, in backward np scattering experimenters have been able to measure much closer to the kinematical limit (u = 0), because it is easier to detect a forward-going particle if it is of a type different from the beam particle. Experimenters have succeeded in measuring very close to the 180 deg (u = 0) point, and they have uncovered a very interesting effect: below ~ 1 GeV/c a very sharp peak appears for $|u| < 0.01$ $(GeV/c)^2$. We have fitted these $d\sigma/du$'s to the form $\frac{d\sigma}{du} = \frac{d\sigma}{du}\Big|_{u=0} e^{bu}$ ($|u| \leq 0.01$). Our fitted parameters appear in Fig. 44.* We can 44
see the precipitous decrease in intercept as the beam momentum increases from 0.6 to 1.0 GeV/c in Fig. 44a. The dotted line represents our best fit to the form

$$\frac{d\sigma}{du}\Big|_{u=0} = KP_{beam}^{-n}$$

with a best fit of $n = 2.02 \pm 0.02$.

In Fig. 44b we see that the slope appears to go through some sort of maximum around 0.8 GeV/c and then begins to decrease (i.e., the peak shrinks as the beam momentum is increased to ~ 0.8 GeV/c, and then it beings to expand).

A recent article by Mishke et al.† points out that this maximum in the slope is near the one-pion threshold. Possible explanations of this structure suggested by those authors are: (a) threshold effects, (b) a possible two-baryon particle or resonant state, and (c) the influence of t-channel resonances on the back scattering cross section. It is not yet clear what mechanism is involved in the np charge exchange process. For a review of many of the various proposed mechanisms and their criticisms, see for example Shepard et al. (Ref. 94).

Polarization in Elastic np and pn Scattering

In Fig. 45 we present data from a recent 45
experiment on (backwards) np elastic scattering.
In Fig. 46 are displayed data on polarization in 46
pn elastic scattering. In contrast to the pp elastic data (where the polarization must be antisymmetric about $\cos\theta_{c.m.} = 0$) the np data is displayed in $\cos\theta$ from -1 to +1. It is interesting that over the entire energy range covered from $P_{beam} = 0.8$ to 1.3 GeV/c, there is a pronounced dip at $\cos\theta \approx -0.2$ and the

*The only authors who give fits to these distributions are Shepard et al. (Ref. 94 in Sec. III). Thus we have not separately tabulated them here.

†R. E. Mishke, P. F. Shepard, and T. Y. Devlin, Structure in np Charge Exchange, Phys. Rev. Letters 23, 542 (1969).

polarization reaches its maximum values at $\cos\theta \approx +0.8$. ($|\cos\theta| \approx 0.8$ is also where the pp elastic polarization reaches its maximum.)

Inelastic np and pn Reactions

Data on np and pn inelastic reactions are very sparse. In Table VII we list all of the data on these reactions picked up in our compilation.

NN Reactions in the I = 0 State

Since the pp (and nn) are in pure I = 1, we need not make special mention of the I = 1 reactions. The I = 0 part of the NN interactions must, however, be determined by subtraction.

From isospin we have

$$\sigma_{I=0} = 2\sigma_{np} - \sigma_{pp}.$$

So far np data has been so sparse that this formula can be applied meaningfully only
47 to the total cross section. In Fig. 47 we see the NN(I=0) total cross section, along with a curve of the NN(I=1) total cross section [i. e., σ^T(pp), taken from Fig. 1]. From this figure we see that although the I=1 interaction dominates from 1.25 to 4 GeV/c, the I=0 part becomes the larger around 4 GeV/c and remains so at least up to 10 GeV/c. This tendency for the lower I-spin to predominate seems to be a general property of high-energy cross sections.

Interactions with Deuterons: pd, nd, and dp

In order to get information on pn, nn, or np reactions, one frequently uses deuterium as the neutron source and then "corrects" the deuterium data appropriately to extract the neutron data.

In this section we present some of these deuterium data, which are interesting in their own right.

48 Figure 48 shows pd and nd total cross sections. Since the deuteron has I=0, isospin invariance requires that both of these processes be identical. Although the nd data are scanty they do in fact agree.

In Table IX we list the only available data on σ^{el}(pd).

Figure 49 displays a very forward region in 49
pd elastic scattering (in the Coulomb interference region). The purpose of this experiment was to measure α_{np} (i. e., the ratio of the Re/Im parts of the np forward elastis scattering amplitude).

Finally in Fig. 50 we present various 50
pd elastic differential cross sections.

A Parameterization of the Integrated Cross Sections

For two-body and quasi-two-body final states, Morrison* has proposed a parameterization of the high-energy cross sections as a function of the incident momentum:

$$\sigma = \text{const} \cdot P_{beam}^{-n}, \qquad (1)$$

suggesting that the value of the exponent n might indicate what mechanism is involved in a particular reaction. He proposes the following:

n ≈	Suggested exchange mechanism
0	"Elastic-like"
1.5	Non-strange meson exchange
2.0	Strange meson exchange
4	Baryon exchange

*D. R. O. Morrison, Interpretation of the Variation of Cross Section with Incident Momentum for Inelastic Two Body Reactions, Phys. Letters 22, 528 (1966).

We have fitted to formula (1) the following reactions:

Reaction	Energy interval	Restrictions on experiments	Fitted value of n	n. Morrison
$pp \to d\pi^+$	All data	None	4.29 ± 0.04	4
$\to n\Delta^{++}$	Above 10 GeV/c	None	2.2 ± 0.16	1.5
$\to pN^*(1470)^+$ ("Roper")	Above 10 GeV/c	Only experiments reporting production cross section for all decay modes of N^*	-0.09 ± 0.27	0
$\to pN^*(1520)^+$	Above 10 GeV/c	"	0.10 ± 0.33	0
Elastic	Above 10 GeV/c	None	-0.22 ± 0.06	0
$np \to pn$ (charge exchange)	All data	None	3.0 ± 0.6	1.5 or 4

Except for the last entry, agreements between Morrison's predictions and what one might reasonably expect in each of these reactions is really quite good.

$2q^2$ Table

P_{lab} (MeV/c)	$2\,P^2_{c.m.}$ (MeV/c)^2	P_{lab} (MeV/c)	$2\,P^2_{c.m.}$ (MeV/c)^2	P_{lab} (GeV/c)	$2\,P^2_{c.m.}$ (GeV/c)^2
0	0	1380	685389	3.0	2.07
20	199	1400	700943	3.2	2.25
40	799	1420	716565	3.4	2.43
60	1798	1440	732254	3.6	2.61
80	3194	1460	748009	3.8	2.79
100	4985	1480	763826	4.0	2.97
120	7170	1500	779705	4.2	3.16
140	9746	1520	795644	4.4	3.34
160	12708	1540	811641	4.6	3.52
180	16053	1560	827694	4.8	3.71
200	19777	1580	843802	5.0	3.89
220	23876	1600	859963	5.2	4.08
240	28343	1620	876176	5.4	4.26
260	33174	1640	892439	5.6	4.45
280	38364	1660	908751	5.8	4.63
300	43905	1680	925111	6.0	4.82
320	49791	1700	941517	6.2	5.00
340	56017	1720	957969	6.4	5.19
360	62575	1740	974464	6.6	5.37
380	69459	1760	991002	6.8	5.56
400	76661	1780	1007582	7.0	5.75
420	84175	1800	1024202	7.2	5.93
440	91993	1820	1040862	7.4	6.12
460	100108	1840	1057560	7.6	6.30
480	108512	1860	1074296	7.8	6.49
500	117198	1880	1091068	8.0	6.68
520	126159	1900	1107876	8.2	6.86
540	135388	1920	1124718	8.4	7.05
560	144878	1940	1141595	8.6	7.24
580	154621	1960	1158504	8.8	7.42
600	164609	1980	1175446	9.0	7.61
620	174838	2000	1192419	9.2	7.80
640	185298	2020	1209423	9.4	7.98
660	195984	2040	1226457	9.6	8.17
680	206889	2060	1243520	9.8	8.36
700	218006	2080	1260611	10.0	8.54
720	229329	2100	1277730	10.5	9.01
740	240852	2120	1294876	11.0	9.48
760	252568	2140	1312049	11.5	9.95
780	264472	2160	1329248	12.0	10.41
800	276558	2180	1346472	12.5	10.88
820	288821	2200	1363721	13.0	11.35
840	301254	2220	1380994	13.5	11.82
860	313852	2240	1398290	14.0	12.28
880	326611	2260	1415610	14.5	12.75
900	339525	2280	1432952	15.0	13.22
920	352589	2300	1450316	16.0	14.16
940	365799	2320	1467702	17.0	15.09
960	379150	2340	1485108	18.0	16.03
980	392638	2360	1502536	19.0	16.97
1000	406258	2380	1519983	20.0	17.91
1020	420006	2400	1537451	22.0	19.78
1040	433878	2420	1554937	24.0	21.66
1060	447871	2440	1572443	26.0	23.53
1080	461980	2460	1589967	28.0	25.41
1100	476201	2480	1607509	30.0	27.28
1120	490532	2500	1625069	32.0	29.16
1140	504970	2520	1642646	34.0	31.03
1160	519509	2540	1660240	36.0	32.91
1180	534148	2560	1677851	38.0	34.78
1200	548884	2580	1695478	40.0	36.66
1220	563713	2600	1713121	42.0	38.54
1240	578633	2620	1730780	44.0	40.41
1260	593641	2640	1748454	46.0	42.29
1280	608733	2660	1766143	48.0	44.16
1300	623909	2680	1783847	50.0	46.04
1320	639165	2700	1801565	55.0	50.73
1340	654498	2720	1819298	60.0	55.42
1360	669907	2740	1837044	65.0	60.11
		2760	1854804	70.0	64.80
		2780	1872577		

pp Total and Elastic Cross Sections

For elastic scattering the expression for t in the c.m. is $t = -2q^2 (1 - \cos\theta_{c.m.})$.
We give in the tables for elastic differential cross section $2q^2$ in $(GeV/c)^2$ and call it 2Q SQUARE.

On the facing page we have tabulated $2q^2$ vs incident nucleon momentum.

$$pp \rightarrow \begin{cases} \text{total} \\ \text{elastic} \end{cases}$$

P_{beam} (GeV/c)	σ_{total} (mb)	$\sigma_{elastic}$ (mb)	References
.14	314.00 ± 13.00		BARASHENKO 61 X
.19	155.00 2.00		BARASHENKO 61 X
.24	92.00 1.00		BARASHENKO 61 X
.28	70.00 1.00		BARASHENKO 61 X
.31	52.80 .60		BARASHENKO 61 X
.35	42.50 .40		BARASHENKO 61 X
.37	37.40 2.30		BARASHENKO 61 X
.39	33.90 2.00		BARASHENKO 61 X
.43	28.50 1.30		BARASHENKO 61 X
.44	27.70 1.30		BARASHENKO 61 X
.49	24.80 .80		BARASHENKO 61 X
.54	25.20 1.20		BARASHENKO 61 X
.57	26.10 1.00		BARASHENKO 61 X
.59	23.20 1.90		BARASHENKO 61 X
.69	22.40 .90		BARASHENKO 61 X
.72	22.40 1.80		BARASHENKO 61 X
.75	22.60 1.30		BARASHENKO 61 X
.83	24.30 1.00		BARASHENKO 61 X
.85	23.40 .90		BARASHENKO 61 X
.88	23.20 .30		BARASHENKO 61 X
.93	24.40 .40		BARASHENKO 61 X
.97	24.00 1.00		BARASHENKO 61 X
.97	2[illegible].99 .78		BARASHENKO 61 X
1.11	34.03 .17		BUGG 66
1.29	43.23 .11		BUGG 66
1.41	46.49 .05		BUGG 66
1.42	46.20 + .50 - .45		LONGO 62
1.48	45.00 6.00		MORRIS 56
1.60	47.50 +1.02 - .61		LONGO 62
1.61	47.48 .06		BUGG 66
1.66	47.55 .06		BUGG 66
1.66		24.80 ± .90	BUGG 64
1.66		26.80 2.30	MCFARLANE 63
1.69		28.20 2.10	MURRAY 67
1.73	46.20 + .82 - .46		LONGO 62
1.78	47.49 .05		BUGG 66
1.86	47.45 .04		BUGG 66
1.89	46.80 +1.51 .60		LONGO 62
1.94	47.36 .05		BUGG 66
1.95	47.41 .04		BUGG 66
2.05	45.30 +1.12 - .47		LONGO 62
2.08	47.22 .04		BUGG 66
2.21	46.98 .05		BUGG 66
2.23		19.86 + .73 - .64	EISNER 65
2.25	35.00 +8.00 -5.00	20.00	FOWLER 56
2.28	46.67 .04		BUGG 66
2.42	46.13 .04		BUGG 66
2.45	45.83 .04		BUGG 66
2.47	45.10 + .83 - .45		LONGO 62
2.59	45.53 .04		BUGG 66
2.68	45.33 .04		BUGG 66
2.70	45.17 .04		BUGG 66
2.81		19.21 .48	FICKINGER 62
2.82	45.01 .04		BUGG 66
2.86	44.93 .04		BUGG 66
2.96	44.65 .04		BUGG 66
2.97	44.50 + .46 - .42		LONGO 62
2.99	44.47 .04		BUGG 66
3.00	44.33 .32		ABRAMS 69
3.05	44.40 .04		BUGG 66
3.11	44.19 .04		BUGG 66
3.13	44.16 .04		BUGG 66
3.14	44.11 .04		BUGG 66
3.27	47.10 .90		DIDDENS 62
3.28	43.61 .04		BUGG 66
3.30	43.67 .04		BUGG 66
3.44	43.14 .04		BUGG 66
3.55	42.90 .04		BUGG 66
3.57	35.00 +8.00 -5.00	15.00	BLOCK 56
3.58	43.20 .43		LONGO 62
3.67		15.32 .76	SMITH 61
3.67	42.10 ± 1.20		HART 62
3.73	42.68 .04		BUGG 66
3.91	42.32 .04		BUGG 66
4.00	41.60 .62		LONGO 62
4.00	43.00 1.50	13.50 ± .30	COLETTI 67
4.04	42.14 .04		BUGG 66
4.26	41.76 .04		BUGG 66
4.51	42.10 .70		DIDDENS 62
4.55	41.46 .04		BUGG 66
4.78	41.38 .04		BUGG 66
4.97	41.16 .04		BUGG 66
5.00	44.00 1.00		VON DARDEL 60 *
5.22	41.17 .03		BUGG 66
5.52	41.60 1.40	11.99 .25	ALEXANDER 67
5.53	40.88 .04		BUGG 66
5.82	40.85 .04		BUGG 66
5.83	41.60 .60		DIDDENS 62
6.00	44.00 1.00		VON DARDEL 60 *
6.00	40.60 .60		GALBRAITH 65
6.60		10.20 .50	COLTON 68
6.80		11.79 .74	FOLEY 63
6.92	42.60 1.30	11.40 .50	ALEXANDER 68
7.00	43.00 1.00		VON DARDEL 60 *
7.75	41.60 1.10		DIDDENS 62
7.82	40.34 .12		FOLEY 67
7.83	40.07 .05		BUGG 66
7.85	40.00 .60		TAYLOR 65
7.87	39.00 1.50		FIREBAUGH 68
8.00	40.00 .60		GALBRAITH 65
8.10	40.10 .20	10.80 .40	GINESTET 69
8.50		9.68 .92	HARTING 65
8.80		11.71 .74	FOLEY 63
9.80	39.84 .12		FOLEY 67
9.90	39.40 1.50		ASHMORE 60
10.00	42.00 .50		VON DARDEL 60 *
10.00	39.90 .60		GALBRAITH 65
10.01	41.10 1.70	10.20 .60	ALMEIDA 68
10.11	40.00 .30		BELLETTINI 65
10.70	41.00 .50		VON DARDEL 60 *
10.80		11.04 .70	FOLEY 63
11.90	39.62 .12		FOLEY 67
12.00	39.40 .60		GALBRAITH 65
12.10		10.40 1.70	DIDDENS 62
12.40	39.00 1.50		ASHMORE 60
12.40		8.90 .87	HARTING 65
12.80		10.89 .72	FOLEY 63
14.00	39.10 .60		GALBRAITH 65
14.01	39.42 .12		FOLEY 67
14.80		10.48 .71	FOLEY 63
15.50		9.20 1.40	DIDDENS 62
15.80	38.70 1.50		ASHMORE 60
16.00	38.70 .60		GALBRAITH 65
16.03	39.23 .12		FOLEY 67
16.70		9.74 .69	FOLEY 63
17.70	39.70 1.50		ASHMORE 60
17.91	39.18 .12		FOLEY 67
18.00	38.70 .60		GALBRAITH 65
18.40		8.80 .95	HARTING 65
18.60		9.00 1.80	DIDDENS 62
19.00		8.70 .50	BOGGILD 69
19.33	38.90 .30		BELLETTINI 65
19.40	39.70 1.50		ASHMORE 60
19.60		9.64 .73	FOLEY 63
20.00	38.40 .60		GALBRAITH 65
20.22	39.05 .12		FOLEY 67
20.46	39.09 .12		FOLEY 67
21.40	39.40 1.50		ASHMORE 60
21.40		8.00 1.60	DIDDENS 62
22.00	38.88 .12		FOLEY 67
22.00	38.30 .60		GALBRAITH 65
24.00	38.89 .12		FOLEY 67
24.20	38.70 1.50		ASHMORE 60
24.50	39.30 .80	8.80 .30	BREITENLOH 63
26.00	38.90 .12		FOLEY 67
26.20		9.80 2.20	DIDDENS 62
26.42	38.80 .30		BELLETTINI 65
28.40	39.90 1.50		ASHMORE 60

* DATA WAS READ FROM A GRAPH
X DATA TAKEN FROM A REVUE ARTICLE

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11	HART	62.....PR	126 747	HBC
12	LONGO	62.....PR	125 701	CNTR
13	BREITENLOH	63.....PL	7 73	HBC
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15	MCFARLANE	63.....NC	28 943	CNTR
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17	BELLETTINI	65.....PL	14 164	SPRK
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29	COLTON	68.....UCLA	1025	HBC
30	FIREBAUGH	68.....PR	172 1354	HBC
31	ABRAMS	69.....BNL	14125	CNTR
32	BOGGILD	69.....PL	30B 369	HBC
33	GINESTET	69.....NP	B13 283	HBC

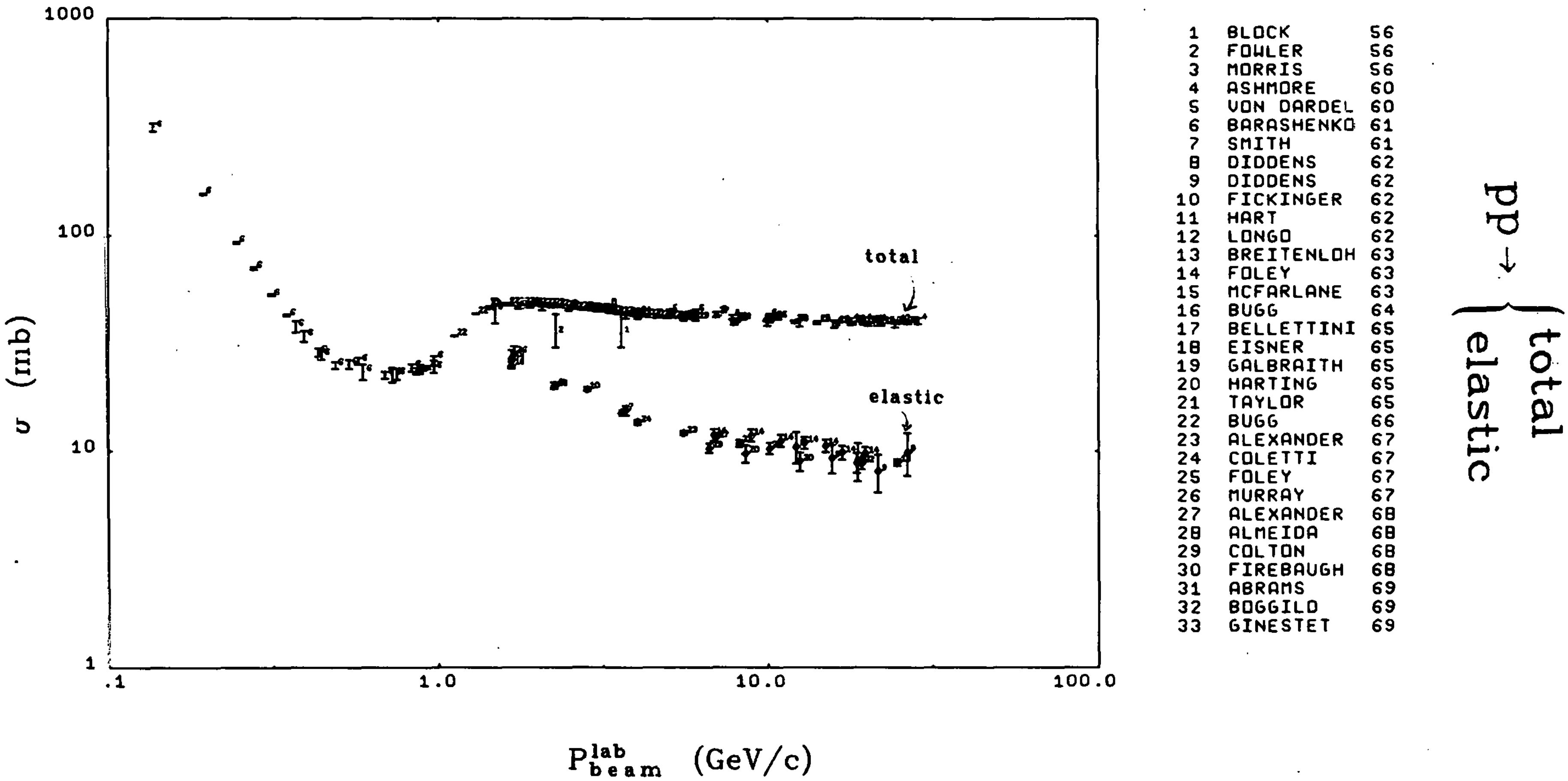


Fig. 1a. pp total and elastic cross sections from 0.1 GeV/c up to the highest reported momentum. Data below our cutoff of 0.5 GeV/c are from the review article of Barashenkov (Ref. 56). For a linear representation of this same data see Figs. 1b and 1c.

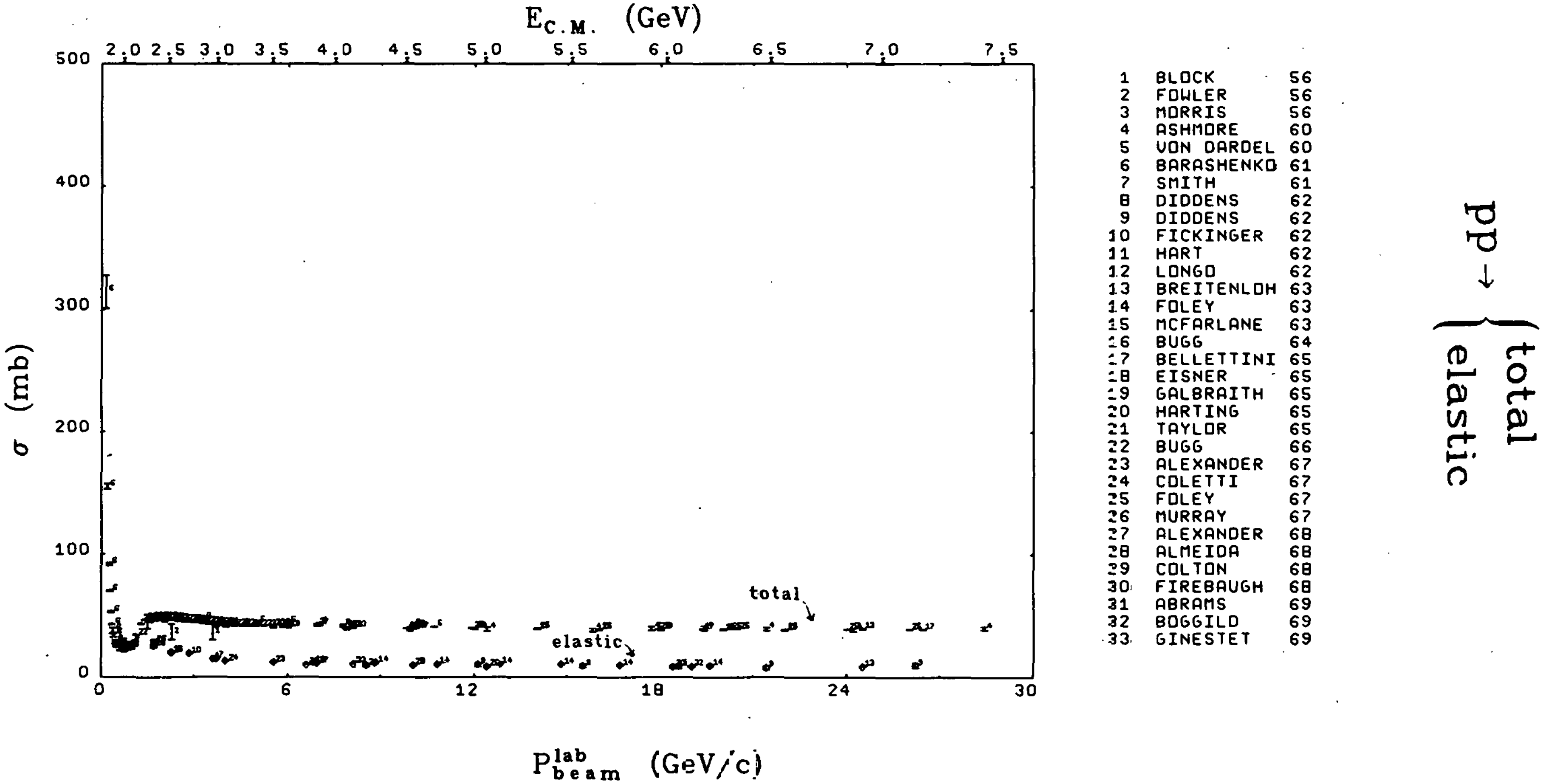


Fig. 1b. Same as Fig. 1a but now on linear scales.

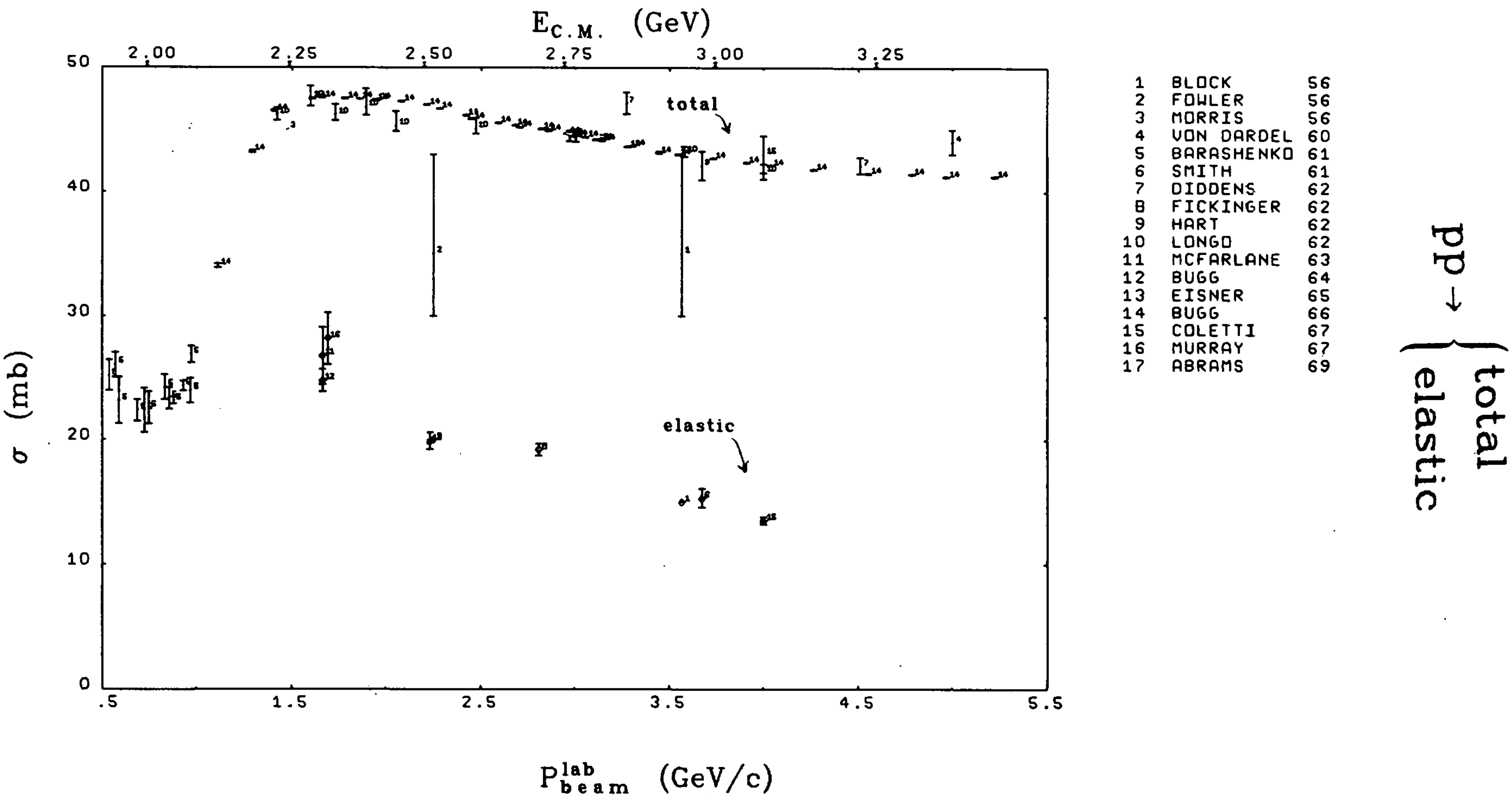


Fig. 1c. Same as Fig. 1b but only for P_{beam} from 0.5 to 5.5 GeV/c.

pp elastic dσ/dt

MOMENTUM TRANSFER BETWEEN BEAM AND SCATT BEAM
(GEV/C)**2

BEAM MOMENTUM(CENTRAL VALUE)= .849 GEV/C

BEAM MOMENTUM RANGES FROM .800 TO .899 GEV/C

MOM TR MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.050	.099	89.500	4.000
.100	.149	80.700	4.500
.150	.199	76.600	3.200
.200	.249	84.300	3.700
.250	.299	81.800	4.900

2Q SQUARE= .307

RYAN PPPA PPAR-11 (1969) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= .949 GEV/C

BEAM MOMENTUM RANGES FROM .900 TO .999 GEV/C

MOM TR MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.050	.099	76.100	3.800
.100	.149	67.800	5.300
.150	.199	71.200	4.200
.200	.249	63.900	3.900
.250	.299	66.600	2.800
.300	.349	66.300	3.200

2Q SQUARE= .372
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 1PER CENT

RYAN PPPA PPAR-11 (1969) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= 1.049 GEV/C

BEAM MOMENTUM RANGES FROM 1.000 TO 1.099 GEV/C

MOM TR MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.050	.099	58.100	2.900
.100	.149	63.600	3.300
.150	.199	56.500	3.500
.200	.249	58.600	3.700
.250	.299	54.400	2.400
.300	.349	46.900	2.300
.350	.399	49.500	2.600
.400	.449	50.900	3.000

2Q SQUARE= .441
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 2PER CENT

RYAN PPPA PPAR-11 (1969) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= 1.149 GEV/C

BEAM MOMENTUM RANGES FROM 1.100 TO 1.199 GEV/C

MOM TR MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.050	.099	53.300	2.800
.100	.149	52.700	2.800
.150	.199	43.700	2.800
.200	.249	45.100	3.600
.250	.299	48.100	2.500
.300	.349	41.400	2.100
.350	.399	36.300	2.000
.400	.449	33.600	2.000
.450	.499	40.400	2.400
.500	.549	38.900	2.900

2Q SQUARE= .512
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 2PER CENT

RYAN PPPA PPAR-11 (1969) SPRK

BEAM MOMENTUM= 1.168 GEV/C

****THIS DATA WAS READ FROM A GRAPH****

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.126	53.812	3.587
.179	48.431	4.185
.231	47.833	4.185
.284	50.225	4.783
.336	46.637	4.783
.389	41.854	4.185
.441	41.854	4.185
.494	37.071	3.587

2Q SQUARE= .525

BALDONI NC 26 1376(1962) HBC

BEAM MOMENTUM(CENTRAL VALUE)= 1.249 GEV/C

BEAM MOMENTUM RANGES FROM 1.200 TO 1.299 GEV/C

MOM TR MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.050	.099	62.200	3.700
.100	.149	54.100	3.300
.150	.199	47.200	3.200
.200	.249	39.700	3.100
.250	.299	33.900	3.400
.300	.349	36.000	4.200
.350	.399	26.400	4.600
.400	.449	25.500	1.700
.450	.499	22.400	1.700
.500	.549	25.200	1.800
.550	.599	24.000	1.900
.600	.649	24.100	1.400

2Q SQUARE= .586
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 2PER CENT

RYAN PPPA PPAR-11 (1969) SPRK

pp elastic dσ/dt

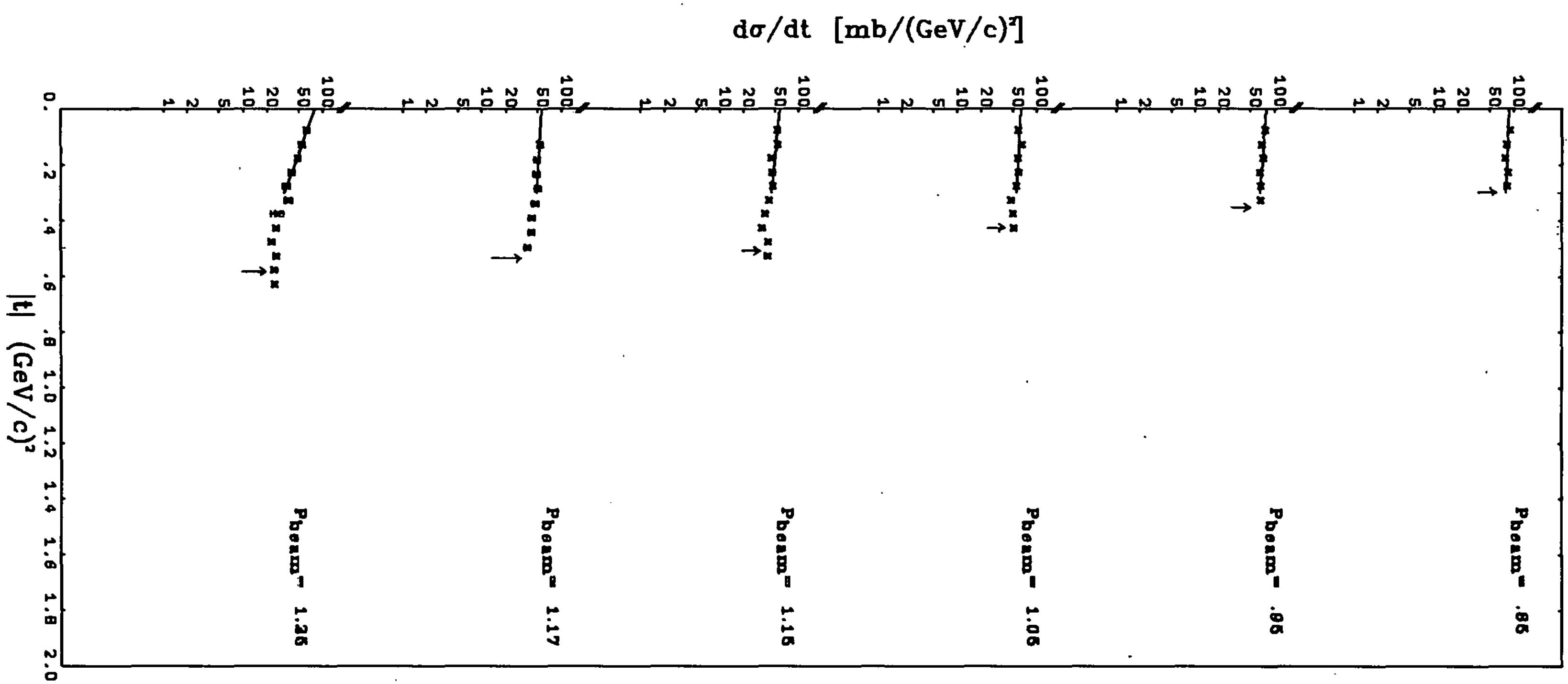


Fig. 2. pp elastic differential cross sections. For experiments measuring especially small angles or very large angles, see the following figures. Since the two particles are identical the angular distributions are symmetric about 90 deg. So as not to mask possible structures, systematic errors have not been included, even though they may have been given by the authors. Some distributions given originally as $d\sigma/d\omega$ vs. $\theta_{c.m.}$ have been transformed to $d\sigma/dt$ vs. t. We have not included Connolly et al. (Ref. 93), which reports numbers of events, rather than $d\sigma/dt$ (and does not give a factor that would enable us to convert to σ). The solid lines are the results of our least-squares fit to $d\sigma/dt = \frac{d\sigma}{dt}\Big|_{t=0} \cdot e^{bt}$, using data in the interval $0.03 \leq |t| \leq 0.3\ (GeV/c)^2$. This interval was arbitrarily selected to be a compromise that would allow us to use the same interval to fit all the data. Author's extrapolated values for $d\sigma/dt$ at t = 0 were not used in our fits. WARNING—the fit is very cutoff dependent. The fitted parameters are plotted in Fig. 3. The vertical arrows represent the values of t at $\theta_{c.m.}$ = 90 deg. In those cases where the beam has a very wide momentum spread (see facing table), we have placed the arrow at the position corresponding to the middle of the momentum range (i. e., at the value appearing on the figure).

pp elastic dσ/dt

MOMENTUM TRANSFER BETWEEN BEAM AND SCATT BEAM
(GEV/C)**2

BEAM MOMENTUM(CENTRAL VALUE)= 1.349 GEV/C

BEAM MOMENTUM RANGES FROM 1.300 TO 1.399 GEV/C

MOM TR

MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.050	.099	80.600	3.900
.100	.149	63.800	3.700
.150	.199	46.600	3.200
.200	.249	38.600	3.200
.250	.299	40.800	3.700
.300	.349	28.000	4.100
.350	.399	23.000	1.700
.400	.449	18.800	1.500
.450	.499	15.300	1.400
.500	.549	15.100	1.400
.550	.599	13.500	1.400
.600	.649	14.000	1.500
.650	.699	11.800	1.400

2Q SQUARE= .662
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3PER CENT

RYAN PPPA PPAR-11 (1969) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= 1.450 GEV/C

BEAM MOMENTUM RANGES FROM 1.400 TO 1.499 GEV/C

MOM TR

MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.050	.099	89.100	5.000
.100	.149	68.500	4.300
.150	.199	54.600	4.000
.200	.249	42.700	3.600
.250	.299	32.100	3.600
.300	.349	22.600	3.300
.350	.399	19.800	4.500
.400	.449	19.300	1.700
.450	.499	16.400	1.500
.500	.549	12.700	1.400
.550	.599	10.500	1.300
.600	.649	8.500	1.200
.650	.699	10.400	1.400
.700	.749	5.500	1.100

2Q SQUARE= .740
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 2PER CENT

RYAN PPPA PPAR-11 (1969) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= 1.549 GEV/C

BEAM MOMENTUM RANGES FROM 1.500 TO 1.599 GEV/C

MOM TR

MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.050	.099	93.500	5.500
.100	.199	55.300	4.900
.200	.299	31.600	3.100
.300	.399	19.300	2.900
.400	.499	14.000	1.300
.500	.599	8.800	1.100
.600	.699	7.000	1.100
.700	.799	6.800	1.100
.800	.899	7.100	.900
.900	.999	6.600	1.100

2Q SQUARE= .819
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 1PER CENT

RYAN PPPA PPAR 11 (1969) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= 1.649 GEV/C

BEAM MOMENTUM RANGES FROM 1.600 TO 1.699 GEV/C

MOM TR

MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.050	.099	93.000	6.200
.100	.199	58.500	6.100
.200	.299	28.800	4.700
.300	.399	19.700	3.500
.500	.599	8.300	1.200
.600	.699	5.600	1.300
.700	.799	4.600	1.000
.800	.899	4.600	.900
.900	.999	5.600	1.100

2Q SQUARE= .900
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 1PER CENT

RYAN PPPA PPAR-11 (1969) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= 1.749 GEV/C

BEAM MOMENTUM RANGES FROM 1.700 TO 1.799 GEV/C

MOM TR

MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.050	.099	98.500	9.100
.100	.199	46.000	8.900
.200	.299	27.200	8.700
.300	.399	16.900	7.700
.500	.599	6.800	1.300
.600	.699	4.200	1.200
.700	.799	6.500	1.300
.800	.899	4.800	1.500
.900	.999	5.000	1.600

2Q SQUARE= .982
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 1PER CENT

RYAN PPPA PPAR-11 (1969) SPRK

BEAM MOMENTUM= 2.230 GEV/C

****THIS DATA WAS READ FROM A GRAPH****

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.010	8.139	4.069
.020	47.475	9.947
.032	76.865	9.043
.048	92.690	13.564
.068	85.907	13.564
.090	72.343	9.043
.116	49.736	4.521
.144	38.437	4.521
.176	36.172	4.521
.212	29.389	4.521
.250	21.251	4.521
.290	21.251	4.521
.340	14.016	3.617
.390	15.825	2.261
.440	12.208	2.261
.490	7.686	1.356
.550	4.521	1.356
.640	5.878	.904
.710	4.069	.904

2Q SQUARE= 1.390

EISNER PR 138 B670(1965) HBC

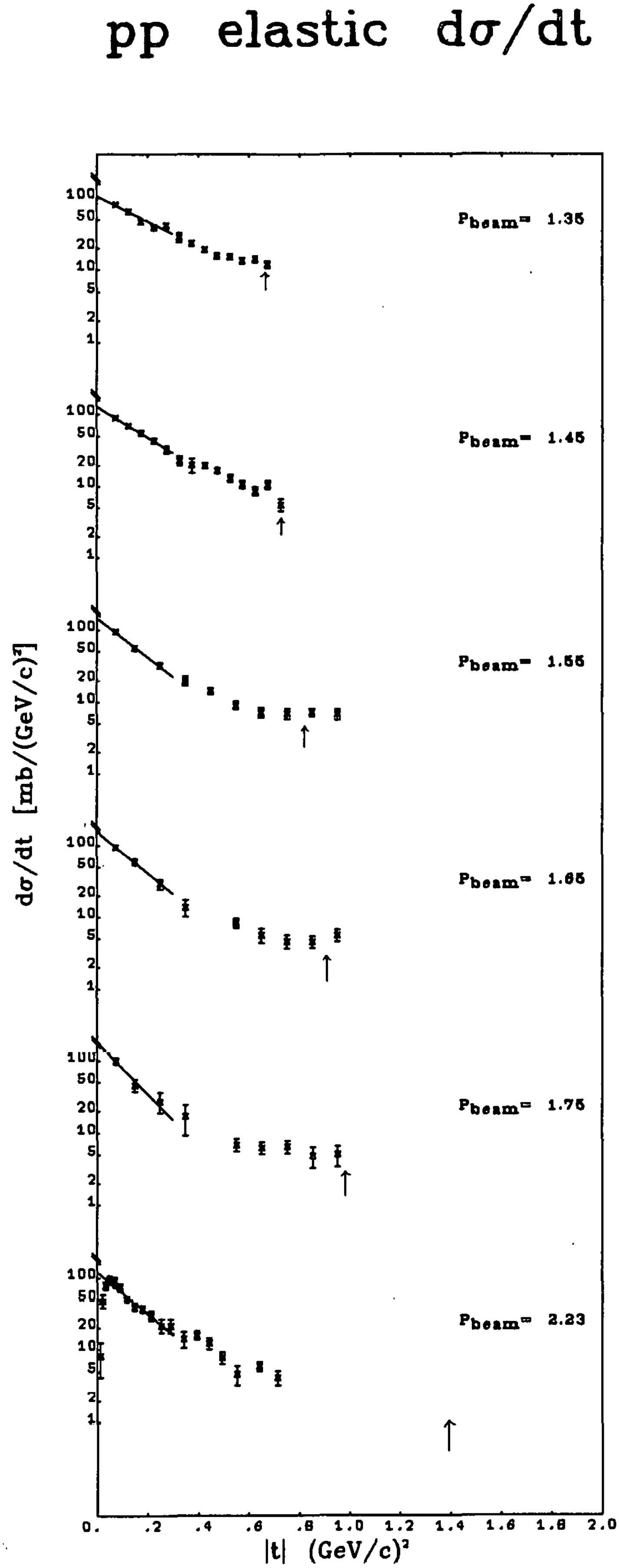


Fig. 2 (continued)

pp elastic dσ/dt

MOMENTUM TRANSFER BETWEEN BEAM AND SCATT BEAM
(GEV/C)**2

BEAM MOMENTUM= 2.980 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.270	16.000	4.000
.390	8.900	.700
.580	3.200	.200
.680	2.100	.200
.790	1.480	.090
.940	1.060	.050
.940	1.050	.050
1.340	.630	.030
1.750	.470	.030
1.980	.930	.020

2Q SQUARE= 2.051
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7PER CENT

ANKENBRAND PR 170 1223(1968) CNTR

BEAM MOMENTUM= 5.520 GEV/C

****THIS DATA WAS READ FROM A GRAPH****

MOM TR MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.010	.020	25.920	3.527
.020	.030	57.840	5.269
.030	.040	61.920	5.452
.040	.050	54.000	5.091
.050	.060	62.880	5.494
.060	.070	60.000	5.367
.070	.080	43.920	4.591
.080	.090	44.800	4.641
.090	.100	30.000	4.320
.100	.110	36.000	4.157
.110	.120	29.040	3.734
.120	.130	32.880	3.973
.130	.140	26.880	3.592
.140	.150	27.840	3.656
.150	.160	24.960	3.461
.160	.170	14.880	2.673
.170	.180	18.960	3.017
.180	.190	18.000	2.939
.190	.200	18.960	3.017
.200	.210	18.480	2.978
.210	.220	18.720	2.998
.220	.230	10.560	2.251
.230	.240	11.040	2.302
.240	.250	14.880	2.673
.250	.260	10.560	2.251
.260	.270	10.080	2.200
.270	.280	14.880	2.673
.280	.290	6.960	1.828
.290	.300	6.480	1.764
.300	.310	12.000	2.400
.310	.320	7.920	1.950
.320	.330	9.120	2.092
.330	.340	9.600	2.147
.340	.350	7.920	1.950
.350	.360	5.520	1.628
.360	.370	5.520	1.628
.370	.380	7.920	1.950
.380	.390	4.080	1.399
.390	.400	5.280	1.592
.400	.410	4.080	1.399
.410	.420	4.080	1.399
.420	.430	5.040	1.555
.430	.440	6.000	1.687
.440	.450	1.920	.960
.450	.460	4.080	1.399
.460	.470	1.440	.831
.470	.480	2.880	1.176
.480	.490	1.920	.960
.490	.500	1.920	.960
.500	.510	2.880	1.176
.510	.520	2.880	1.176
.520	.530	2.880	1.176
.530	.540	1.440	.831
.540	.550	2.880	1.176
.550	.560	.960	.679
.560	.570	0.	+ .480 - 0.
.570	.580	1.920	.960
.580	.590	2.400	1.073
.590	.600	2.400	1.073
.600	.610	.960	.679
.610	.620	1.440	.831
.620	.630	.960	.679
.630	.640	.960	.679
.640	.650	.960	.679
.650	.660	0.	+ .480 - 0.
.660	.670	0.	+ .480 - 0.
.670	.680	0.	+ .480 - 0.
.680	.690	0.	+ .480 - 0.
.690	.700	1.920	.960
.700	.710	.960	.679
.710	.720	0.	+ .480 - 0.
.720	.730	0.	+ .480 - 0.
.730	.740	.960	.679
.740	.750	1.920	.960

2Q SQUARE= 4.373

ALEXANDER PR 154 1284(1967) HBC

BEAM MOMENTUM= 6.800 GEV/C

MOM TR MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
(0.	)EXTRAPOLATED POINT	(105.900+-2.400)	
.021	.025	86.800	3.400
.031	.037	76.700	3.000
.042	.050	69.300	2.500
.058	.068	57.100	2.100
.075	.089	46.800	1.800
.093	.109	41.600	1.800
.228	.268	10.880	.440
.292	.342	6.650	.310
.363	.427	3.830	.210
.438	.514	2.230	.140
.519	.609	1.222	.092
.605	.711	.717	.066
.697	.819	.418	.047
.794	.932	.234	.033

2Q SQUARE= 5.560
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 6PER CENT

FOLEY PRL 11 425(1963) CNTR

BEAM MOMENTUM= 4.000 GEV/C

****THIS DATA WAS READ FROM A GRAPH****

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.025	80.000	8.000
.040	70.000	8.000
.050	67.000	8.000
.075	50.000	7.000
.100	40.000	8.000
.130	32.000	6.000
.150	28.000	5.000
.210	25.000	5.000
.230	20.000	3.000
.270	15.000	3.000
.380	8.000	1.000
.650	1.300	.400
1.100	.360	.100
1.300	.020	.050
1.600	.080	.003
2.400	.011	.002

2Q SQUARE= 2.975

COLETTI NC 49A 479(1967) HBC

BEAM MOMENTUM= 6.600 GEV/C

****THIS DATA WAS READ FROM A GRAPH****

MOM TR MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
0.	.020	16.500	2.031
.020	.040	62.000	3.937
.040	.060	60.500	3.889
.060	.080	53.000	3.640
.080	.100	40.000	3.162
.100	.120	38.000	3.082
.120	.140	38.000	3.082
.140	.160	30.000	2.739
.160	.180	24.000	2.449
.180	.200	21.000	2.291
.200	.220	17.000	2.062
.220	.240	14.000	1.871
.240	.260	14.000	1.871
.260	.280	11.000	1.658
.280	.300	9.000	1.500
.300	.320	6.000	1.225
.320	.340	5.500	1.173
.340	.360	6.500	1.275
.360	.380	4.500	1.061
.380	.400	3.000	.866
.400	.420	2.500	.791
.420	.440	3.750	.968
.440	.460	3.500	.935
.460	.480	2.000	.707
.480	.500	2.750	.829
.500	.520	2.750	.829
.520	.540	1.500	.612
.540	.560	1.500	.612

2Q SQUARE= 5.374

COLTON UCLA 1025 (1968) HBC

BEAM MOMENTUM= 8.920 GEV/C

****THIS DATA WAS READ FROM A GRAPH****

MOM TR MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.010	.020	14.000	2.646
.020	.030	40.000	4.472
.030	.040	50.000	5.000
.040	.050	68.000	5.831
.050	.060	50.000	5.000
.060	.070	54.000	5.196
.070	.080	48.000	4.899
.080	.090	43.000	4.637
.090	.100	50.000	5.000
.100	.110	40.000	4.472
.110	.120	31.000	3.937
.120	.130	24.000	3.464
.130	.140	29.000	3.808
.140	.150	22.000	3.317
.150	.160	18.000	3.000
.160	.170	28.000	3.742
.170	.180	27.000	3.674
.180	.190	20.000	3.162
.190	.200	12.000	2.449
.200	.210	15.000	2.739
.210	.220	13.000	2.550
.220	.230	14.000	2.646
.230	.240	13.000	2.550
.240	.250	6.000	1.732
.250	.260	13.500	2.598
.260	.270	11.000	2.345
.270	.280	12.000	2.449
.280	.290	10.500	2.291
.290	.300	17.000	2.915
.300	.310	13.500	2.598
.310	.320	14.000	2.646
.320	.330	10.000	2.236
.330	.340	8.000	2.000
.340	.350	5.000	1.581
.350	.360	4.000	1.414
.360	.370	6.000	1.732
.370	.380	5.000	1.581
.380	.390	2.700	1.162
.390	.400	2.000	1.000
.400	.410	3.000	1.225
.410	.420	6.000	1.732
.420	.430	2.000	1.000
.430	.440	4.500	1.500
.440	.450	5.000	1.581
.450	.460	4.500	1.500
.460	.470	4.500	1.500
.470	.480	1.000	.707
.490	.500	1.000	.707
.500	.510	1.000	.707
.510	.520	.500	.500
.520	.530	1.500	.866
.530	.540	.500	.500
.540	.550	1.000	.707
.550	.560	1.500	.866
.560	.570	1.000	.707
.570	.580	.500	.500
.580	.590	1.500	.866
.590	.600	.500	.500
.600	.610	1.500	.866
.610	.620	1.500	.866

2Q SQUARE= 5.672

ALEXANDER PR 173 1322(1968) HBC

pp elastic dσ/dt

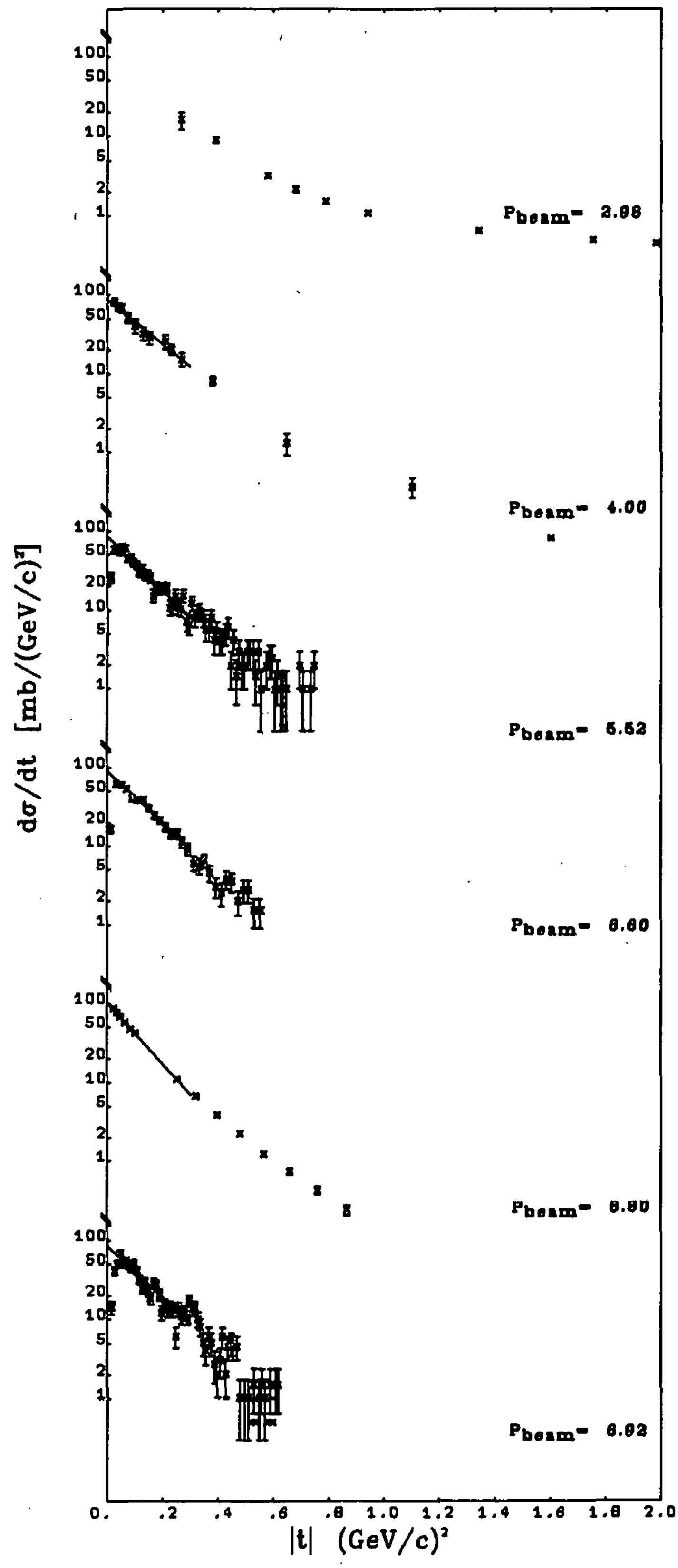


Fig. 2 (continued)

pp elastic dσ/dt

MOMENTUM TRANSFER BETWEEN BEAM AND SCATT BEAM
(GEV/C)**2

BEAM MOMENTUM= 8.100 GEV/C

MOM TR MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
(0.	)EXTRAPOLATED POINT	(79.650+-3.279)	
.060	.080	44.955	2.464
.080	.100	37.260	2.243
.100	.120	34.560	2.160
.120	.140	29.835	2.007
.140	.160	27.675	1.933
.160	.180	23.220	1.711
.180	.200	17.550	1.539
.200	.220	16.875	1.509
.220	.240	13.500	1.350
.240	.260	10.125	1.169
.260	.300	11.340	1.237
.280	.300	9.180	1.113
.300	.320	7.560	1.010
.320	.340	6.075	.906
.340	.360	5.940	.895
.360	.380	5.400	.854
.380	.400	3.645	.701
.400	.420	3.375	.675
.420	.440	4.455	.776

2Q SQUARE= 6.770

GINESTET NP B13 283(1969) HBC

BEAM MOMENTUM= 8.500 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.130	24.500	.660
.150	20.650	.610
.170	17.780	.570
.190	14.990	.520
.220	11.800	.330
.260	8.740	.280
.300	7.210	.250
.340	4.770	.200
.380	3.590	.170
.420	2.490	.150
.460	1.790	.120
.500	1.370	.110
.540	1.139	.098
.580	.800	.085
.650	.485	.041
.750	.278	.032
.850	.123	.021
.950	.059	.016
1.050	.058	.016

2Q SQUARE= 7.143
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7PER CENT

HARTING NC 38 60(1965) SPRK

BEAM MOMENTUM= 8.800 GEV/C

MOM TR MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
(0.	)EXTRAPOLATED POINT	(106.400+-2.700)	
.036	.042	74.700	2.500
.052	.062	60.300	2.100
.072	.084	49.900	1.700
.097	.113	38.900	1.200
.126	.148	32.200	1.200
.155	.181	22.510	.920
.242	.284	9.500	.380
.310	.364	5.320	.250
.385	.453	2.840	.160
.464	.544	1.554	.102
.549	.645	.805	.063
.641	.753	.402	.040
.739	.867	.192	.026
.843	.989	.112	.020

2Q SQUARE= 7.423
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 6PER CENT

FOLEY PRL 11 425(1963) CNTR

BEAM MOMENTUM=10.800 GEV/C

MOM TR MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
(0.	)EXTRAPOLATED POINT	(102.800+-3.100)	
.053	.063	59.400	1.700
.077	.091	44.000	1.400
.107	.125	32.700	1.100
.144	.170	23.730	.760
.188	.220	16.560	.610
.230	.270	10.260	.450
.247	.289	8.100	.320
.316	.370	4.530	.210
.393	.461	2.380	.130
.474	.556	1.148	.075
.563	.661	.548	.044
.656	.770	.295	.029
.758	.890	.138	.018

2Q SQUARE= 9.291
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 6PER CENT

FOLEY PRL 11 425(1963) CNTR

BEAM MOMENTUM=10.940 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.200	13.190	.320
.263	8.100	.230
.333	4.660	.160
.411	2.570	.110
.493	1.411	.076
.582	.641	.048
.679	.393	.039
.782	.178	.026
.891	.094	.018

2Q SQUARE= 9.677

FOLEY PRL 15 45(1965) CNTR

BEAM MOMENTUM=12.800 GEV/C

MOM TR MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
(0.	)EXTRAPOLATED POINT	(104.000+-4.300)	
.045	.053	66.200	4.600
.067	.079	46.700	1.700
.110	.130	33.900	1.400
.153	.179	22.900	1.100
.206	.242	13.930	.780
.256	.300	6.880	.280
.260	.306	7.840	.540
.329	.386	[illegible]	.170
.408	.478	1.920	.110
.491	.577	[illegible]	.062
.583	.685	.420	.036
.682	.000	.229	.025
.788	.924	.091	.015

2Q SQUARE= 11.162
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 6PER CENT

FOLEY PRL 11 425(1963) CNTR

BEAM MOMENTUM=12.400 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.130	23.430	.770
.150	18.400	.650
.170	16.220	.610
.190	12.440	.490
.220	10.430	.320
.260	7.150	.260
.300	5.360	.220
.340	3.600	.190
.380	2.960	.160
.420	2.100	.140
.460	1.430	.110
.500	1.280	.110
.540	.815	.091
.580	.506	.069
.650	.370	.038
.750	.178	.026
.850	.087	.020
.950	.034	.011
1.100	.020	.006
1.300	.012	.005
1.500	.012	.005
2.000	.004	.002

2Q SQUARE= 10.787
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7PER CENT

HARTING NC 38 60(1965) SPRK

pp elastic dσ/dt

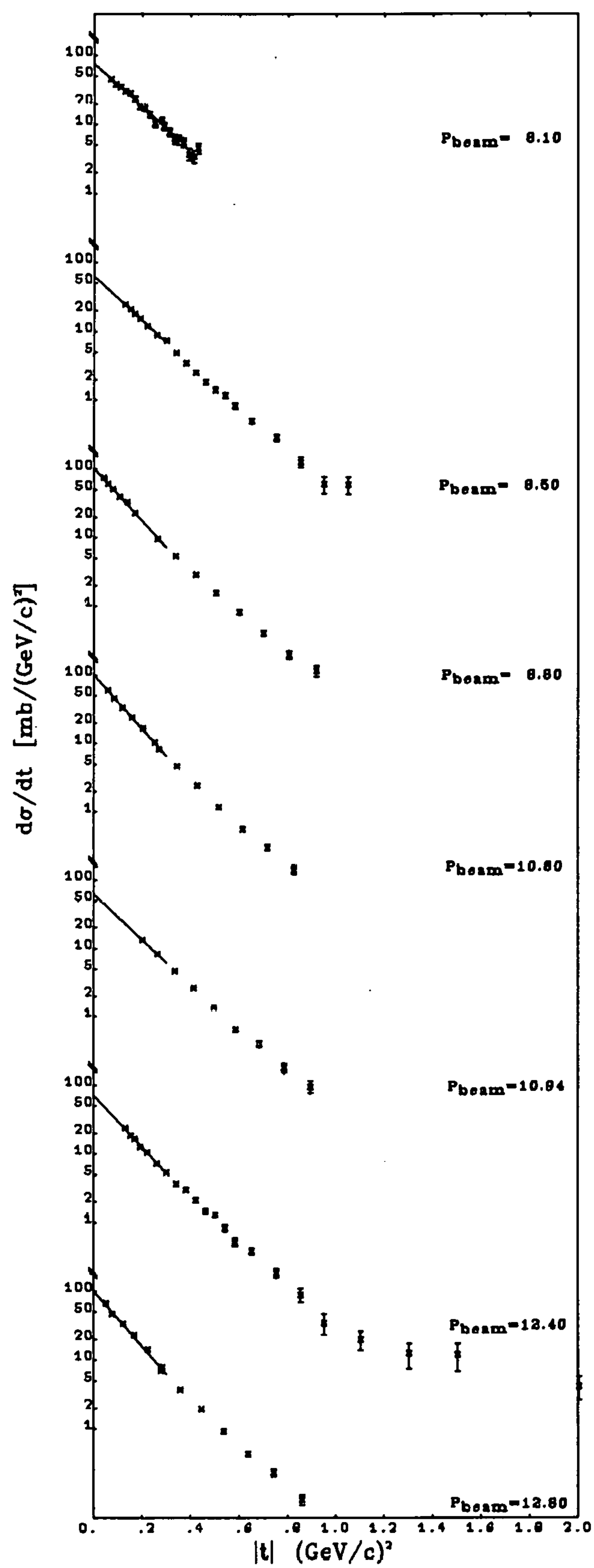


Fig. 2 (continued)

pp elastic dσ/dt

MOMENTUM TRANSFER BETWEEN BEAM AND SCATT BEAM
(GEV/C)**2

BEAM MOMENTUM=14.800 GEV/C

MOM TR

MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
(0.	)EXTRAPOLATED POINT	(103.200+-4.800)	
.061	.071	49.400	1.900
.110	.130	34.200	1.300
.147	.173	20.820	.960
.203	.239	10.980	.880
.270	.318	5.780	.250
.274	.322	5.830	.470
.346	.406	2.930	.150
.355	.417	2.400	.280
.431	.505	1.489	.089
.519	.609	.663	.050
.615	.721	.317	.030
.719	.843	.128	.017

2Q SQUARE= 13.034
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 6PER CENT

FOLEY PRL 11 425(1963) CNTR

BEAM MOMENTUM=14.930 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.216	11.480	.230
.284	6.670	.160
.360	3.480	.100
.444	1.752	.064
.534	.886	.039
.631	.402	.024
.736	.189	.016

2Q SQUARE= 13.155

FOLEY PRL 15 45(1965) CNTR

BEAM MOMENTUM=15.500 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.019	75.733	13.632
.085	34.893	5.232
.196	12.393	1.859
.364	2.938	.470
.564	.505	.106

2Q SQUARE= 15.689

DIDDENS PRL 9 108(1962) CNTR

BEAM MOMENTUM=16.700 GEV/C

MOM TR

MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
(0.	)EXTRAPOLATED POINT	(92.200+-5.500)	
.039	.045	56.000	4.300
.077	.091	42.400	2.900
.130	.152	24.420	.980
.186	.220	15.240	.600
.259	.303	7.030	.430
.283	.333	5.060	.220
.350	.410	2.810	.260
.362	.424	2.430	.130
.449	.527	1.114	.072
.452	.530	1.090	.170
.542	.636	.471	.038
.642	.754	.214	.023

2Q SQUARE= 14.813
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 6PER CENT

FOLEY PRL 11 425(1963) CNTR

BEAM MOMENTUM=18.400 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.190	12.510	.860
.220	10.260	.600
.260	7.350	.470
.300	4.800	.260
.340	3.570	.220
.380	2.360	.170
.420	1.710	.120
.460	1.288	.100
.500	1.064	.095
.540	.603	.071
.580	.387	.057
.650	.277	.030
.750	.092	.018
.850	.041	.011
.950	.050	.014
1.100	.013	.005
1.300	.005	.003
1.500	.002	.002
2.000	.000	.000
3.600	.000	.000

2Q SQUARE= 16.406
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7PER CENT

HARTING NC 38 60(1965) SPRK

BEAM MOMENTUM=18.600 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.037	79.159	17.411
.134	24.991	4.998
.289	4.771	.954
.521	.606	.145
.794	.095	.026

2Q SQUARE= 16.593

DIDDENS PRL 9 108(1962) CNTR

BEAM MOMENTUM=19.200 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MICROBARNS/(GEV/C)**2)	
.058	48500.000	2910.000
.147	21400.000	1284.000
.229	10300.000	618.000
.329	4170.000	250.200
.446	1600.000	96.000
.511	965.000	57.900
.581	546.000	32.760
.654	295.000	17.700
.732	149.000	8.940
.813	76.000	4.560
.899	37.000	2.220
.989	18.200	1.092
1.082	10.300	.618
1.180	6.160	.370
1.281	4.320	.259
1.385	3.850	.231
1.494	3.400	.204
1.606	3.060	.184
1.721	2.330	.140
1.840	2.270	.136
1.962	1.940	.116
2.088	1.600	.096
2.216	1.250	.075
2.348	.947	.057
2.483	.685	.041
2.620	.604	.036
2.761	.517	.031
3.050	.257	.015
3.349	.159	.010
3.658	.085	.005
3.976	.054	.003
4.302	.032	.002
4.636	.016	.001
4.976	.011	.001
5.323	.008	.000
5.676	.005	.000
6.033	.004	.000

2Q SQUARE= 17.156
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 8PER CENT

ALLABY PL 28B 67(1968) CNTR

pp elastic dσ/dt

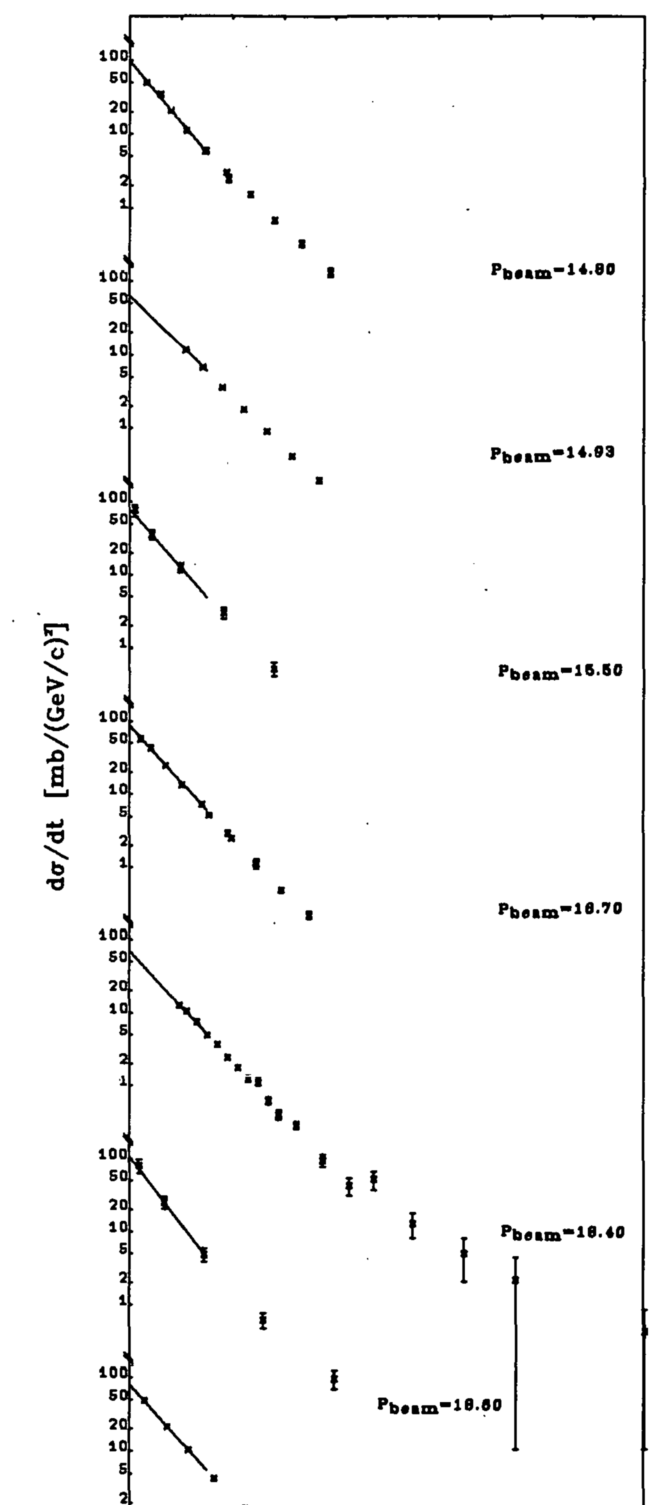


Fig. 2 (continued)

pp elastic dσ/dt

MOMENTUM TRANSFER BETWEEN BEAM AND SCATT BEAM
(GEV/C)**2

BEAM MOMENTUM=19.600 GEV/C

MOM TR MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
(0.	)EXTRAPOLATED POINT	(96.500+-7.000)	
.106	.124	29.400	1.200
.177	.207	14.080	.410
.256	.300	6.390	.260
.278	.326	5.010	.240
.353	.415	2.260	.130
.357	.419	2.400	.130
.444	.522	1.089	.076
.476	.558	.710	.073
.536	.630	.465	.043
.637	.747	.156	.023
.746	.876	.113	.018

2Q SQUARE= 17.531
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 6PER CENT

FOLEY PRL 11 425(1963) CNTR

BEAM MOMENTUM=19.840 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.230	9.290	.280
.302	5.140	.190
.383	2.640	.120
.474	1.269	.070
.569	.552	.042
.674	.291	.030
.787	.100	.018

2Q SQUARE= 17.755

FOLEY PRL 15 45(1965)

BEAM MOMENTUM=21.120 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MICROBARNS/(GEV/C)**2)	
.070	39300.000	1572.000
.178	14400.000	576.000
.277	6000.000	240.000
.398	2150.000	86.000
.539	690.000	27.600
.701	212.000	8.480
.790	88.600	3.544
.883	40.100	1.604
.982	18.200	.728
1.085	10.100	.404
1.193	5.230	.209
1.305	4.040	.162
1.423	3.120	.125
1.544	2.740	.110
1.670	2.510	.100
1.800	2.110	.084
1.934	1.760	.070

2Q SQUARE= 18.955
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 8PER CENT

ALLABY PL 28B 67(1968) CNTR

BEAM MOMENTUM=21.400 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.032	59.505	12.496
.156	14.059	2.531
.365	2.092	.398
.681	.170	.034
1.047	.015	.005

2Q SQUARE= 19.218

DIDDENS PRL 9 108(1962) CNTR

BEAM MOMENTUM=21.880 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.235	8.980	.280
.309	4.820	.180
.392	2.250	.100
.485	1.100	.063
.583	.494	.038
.691	.209	.024
.807	.096	.016

2Q SQUARE= 19.668

FOLEY PRL 15 45(1965) CNTR

BEAM MOMENTUM=24.630 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.254	7.560	.340
.334	3.740	.210
.424	1.712	.122
.525	.824	.074
.632	.203	.036
.748	.110	.028

2Q SQUARE= 22.246

FOLEY PRL 15 45(1965) CNTR

BEAM MOMENTUM=26.200 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.064	50.069	11.015
.267	5.934	1.246
.597	.328	.072
1.040	.020	.006

2Q SQUARE= 23.718

DIDDENS PRL 9 108(1962) CNTR

pp elastic dσ/dt

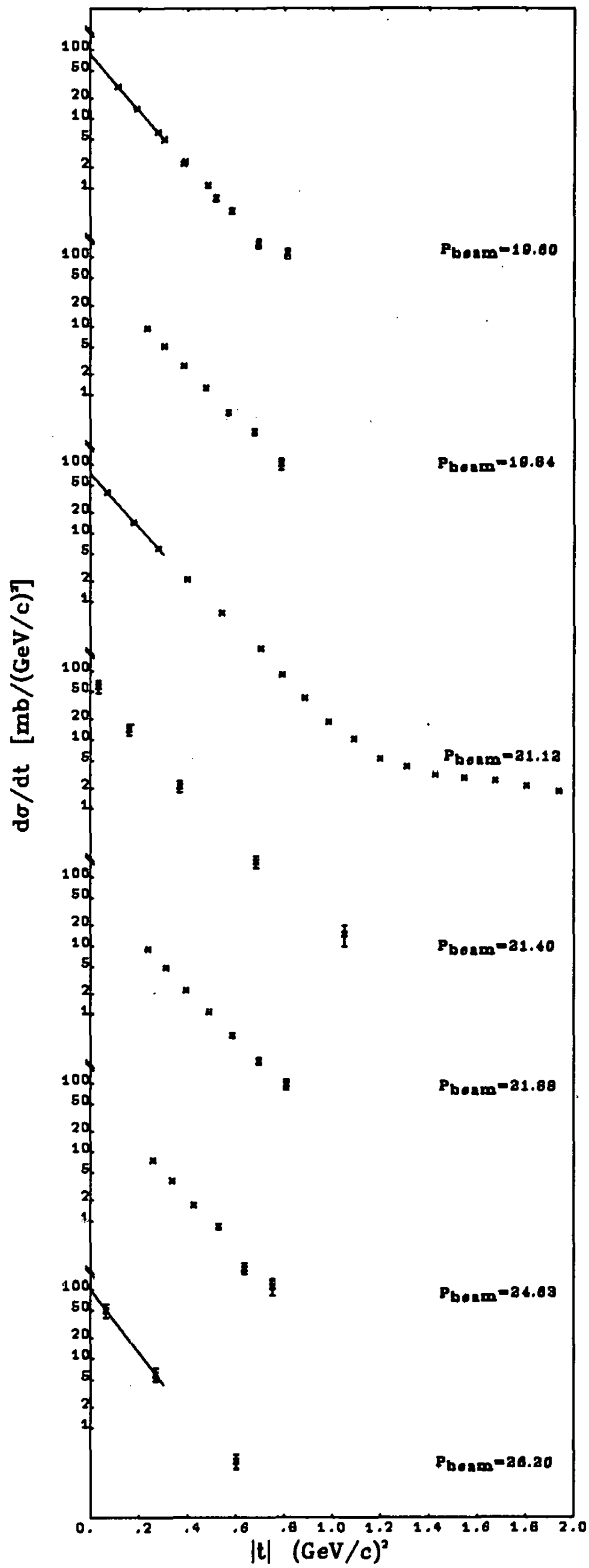


Fig. 2 (continued)

Fits to the pp elastic scattering data.

P_{beam} (GeV/c)	$d\sigma/dt$ [t = 0] mb/(GeV/c)^2		SLOPE (GeV/c)$^{-2}$		χ^2/N
.849	87.47 ±	5.07	.35 ±	.32	1.90
.949	78.27	4.98	.66	.31	.64
1.049	62.87	3.93	.46	.31	1.06
1.149	56.38	3.77	.87	.35	1.26
1.249	78.43	6.40	3.01	.48	.03
1.349	105.92	7.88	4.10	.43	2.50
1.450	128.86	10.44	4.98	.50	.04
1.549	147.51	13.84	6.27	.64	.34
4.000	86.94	8.07	6.59	.67	.40
5.520	86.53	4.90	8.05	.39	1.22
6.600	89.52	5.06	7.68	.39	.60
6.800	102.07	6.87	9.05	.24	.62
6.920	83.94	4.72	7.58	.38	2.21
8.100	74.90	4.14	7.20	.34	.84
8.500	62.88	5.16	7.45	.21	1.60
8.800	101.10	6.88	8.91	.23	1.27
10.800	98.50	6.55	9.11	.18	1.89
[illegible]	[illegible]	6.00	8.65	.25	1.42
12.800	98.52	7.05	9.22	.21	3.74
14.800	98.73	7.20	9.62	.22	2.52
16.700	85.54	7.29	8.96	.34	.54
19.600	85.56	8.00	9.36	.35	.14
21.120	73.30	7.03	9.07	.27	.26

Table I. Fits reported by authors to their own pp elastic scattering data. For our fits to these data see Fig. 3.

P_{beam} (GeV/c)	$\|t\|_{min}$	$\|t\|_{max}$	FORMULA	PARAMETERS									References	
.80			Y=A*EXP[-BT+CT**2]	A	87.10 ±	5.10	B	-.96 ±	.55	C	2.91 ±	1.81	RYAN	69
.90			Y=A*EXP[-BT+CT**2]	A	78.80	4.70	B	-1.17	.57	C	1.89	1.69	RYAN	69
1.00			Y=A*EXP[-BT+CT**2]	A	64.70	3.60	B	-1.00	.52	C	.72	1.31	RYAN	69
1.10			Y=A*EXP[-BT+CT**2]	A	60.40	3.40	B	-2.01	.47	C	2.10	.99	RYAN	69
1.20			Y=A*EXP[-BT+CT**2]	A	79.60	4.70	B	-4.38	.44	C	3.96	.72	RYAN	69
1.30			Y=A*EXP[-BT+CT**2]	A	107.40	5.00	B	-5.76	.41	C	4.60	.69	RYAN	69
1.40			Y=A*EXP[-BT+CT**2]	A	116.10	7.10	B	-5.45	.46	C	2.04	.79	RYAN	69
1.50			Y=A*EXP[-BT+CT**2]	A	126.20	9.60	B	-6.51	.34	C	3.56	.39	RYAN	69
1.60			Y=A*EXP[-BT+CT**2]	A	137.00	11.70	B	-7.20	.49	C	3.80	.57	RYAN	69
1.70			Y=A*EXP[-BT+CT**2]	A	140.90	15.70	B	-7.66	.59	C	4.39	.72	RYAN	69
4.00	.02	.40	X=A*EXP(B[T])	A	91.00	5.00	B	6.70	.50				COLETTI	67
5.52	.03	.75	X=EXP(A+B[T])	A	4.39	.04	B	7.17	.18				ALEXANDER	67
5.52	.03	.75	X=EXP(A+B[T]+C[T**2])	A	4.45	.05	B	7.96	.41	C	1.50	.75	ALEXANDER	67
6.60	.06	.60	Y =EXP[A+B*T]	A	4.49	.09	B	-7.71	.24				COLTON	68
6.60	.06	.60	Y =EXP[A+BT+CT**2]	A	4.54	.11	B	-8.25	.92	C	1.05	1.72	COLTON	68
6.92	.04	.50	X=A*EXP(B[T]+C[T**2])	A	94.00	2.50	B	9.03	.15	C	3.68	.80	ALEXANDER	68
6.92	.04	.12	X=A*EXP(B[T])	A	90.70	6.70	B	7.70	.50				ALEXANDER	68
8.10	.06	.50	Y =A*EXP[LAMBDA*T]	A	80.00	3.00	LAMBD	7.50	.20				GINESTET	69
8.50	.13	.50	X=EXP[A+BT]	A	4.20	.03	B	7.75	.11				HARTING	65
8.50	.13	.95	X=EXP[A+BT+CT**2]	A	4.24	.04	B	8.16	.28	C	.84	.36	HARTING	65
8.50	.13	1.05	X=EXP[A+BT+CT**2]	A	4.27	.04	B	8.35	.25	C	1.14	.31	HARTING	65
10.94			X = EXP(A + B[T] + C[T**2])	A	4.25	.09	B	8.64	.47	C	1.70	.56	FOLEY	65
12.40	.13	.95	X=EXP[A+BT+CT**2]	A	4.26	.05	B	9.05	.34	C	1.41	.44	HARTING	65
12.40	.13	.50	X=EXP(A+BT)	A	4.15	.03	B	8.19	.13				HARTING	65
12.40	.13	2.00	X=EXP[A+BT+CT**2]	A	4.35	.03	B	9.71	.16	C	2.33	.14	HARTING	65
13.00	.01	.12	Y=EXP[-B*ABS(T)]	B	9.81	.35							BEZNOGIKH	69
14.93			X = EXP(A + B[T] + C[T**2])	A	4.32	.10	B	8.89	.52	C	.98	.62	FOLEY	65
15.71	.01	.12	Y=EXP[-B*ABS(T)]	B	9.98	.12							BEZNOGIKH	69
18.40	.19	3.60	X=EXP[A+BT+CT**2]	A	4.42	.07	B	9.96	.21	C	1.70	.10	HARTING	65
18.40	.19	.50	X=EXP[A+BT]	A	4.18	.08	B	8.50	.24				HARTING	65
18.40	.19	.95	X=EXP[A+BT+CT**2]	A	4.39	.13	B	9.79	.63	C	1.53	.69	HARTING	65
18.81	.01	.12	Y=EXP[-B*ABS(T)]	B	10.46	.12							BEZNOGIKH	69
19.84			X = EXP(A + B[T] + C[T**2])	A	4.19	.15	B	8.68	.79	C	.70	.92	FOLEY	65
21.82	.01	.12	Y=EXP[-B*ABS(T)]	B	10.58	.12							BEZNOGIKH	69
21.88			X = EXP(A + B[T] + C[T**2])	A	4.38	.16	B	9.63	.78	C	1.56	.89	FOLEY	65
25.50			Y=A*EXP[B*T]	B	9.00	.30							BREITENLOH	63
24.63			X = EXP(A + B[T] + C[T**2])	A	4.09	.30	B	7.97	1.56	C	.82	1.83	FOLEY	65
24.72	.01	.12	Y=EXP[-B*ABS(T)]	B	10.59	.11							BEZNOGIKH	69
27.62	.01	.12	Y=EXP[-B*ABS(T)]	B	10.77	.11							BEZNOGIKH	69
28.50			Y =EXP[A-B*T+C*T**2]	A	7.34	.11	B	-10.91	1.05	C	4.18	2.11	CONNOLLY	67
30.62	.01	.12	Y=EXP[-B*ABS(T)]	B	10.68	.11							BEZNOGIKH	69
33.53	.01	.12	Y=EXP[-B*ABS(T)]	B	10.66	.11							BEZNOGIKH	69
36.43	.01	.12	Y=EXP[-B*ABS(T)]	B	10.77	.11							BEZNOGIKH	69
39.53	.01	.12	Y=EXP[-B*ABS(T)]	B	10.89	.10							BEZNOGIKH	69
41.63	.01	.12	Y=EXP[-B*ABS(T)]	B	10.87	.14							BEZNOGIKH	69
45.13	.01	.12	Y=EXP[-B*ABS(T)]	B	10.95	.10							BEZNOGIKH	69
48.93	.01	.12	Y=EXP[-B*ABS(T)]	B	11.19	.11							BEZNOGIKH	69
52.13	.01	.12	Y=EXP[-B*ABS(T)]	B	11.31	.11							BEZNOGIKH	69
54.33	.01	.12	Y=EXP[-B*ABS(T)]	B	11.24	.12							BEZNOGIKH	69
57.03	.01	.12	Y=EXP[-B*ABS(T)]	B	11.16	.10							BEZNOGIKH	69
60.23	.01	.12	Y=EXP[-B*ABS(T)]	B	11.40	.09							BEZNOGIKH	69
63.53	.01	.12	Y=EXP[-B*ABS(T)]	B	11.76	.12							BEZNOGIKH	69
66.13	.01	.12	Y=EXP[-B*ABS(T)]	B	11.52	.12							BEZNOGIKH	69
69.93	.01	.12	Y=EXP[-B*ABS(T)]	B	11.38	.11							BEZNOGIKH	69

Fits to the pp elastic scattering data.

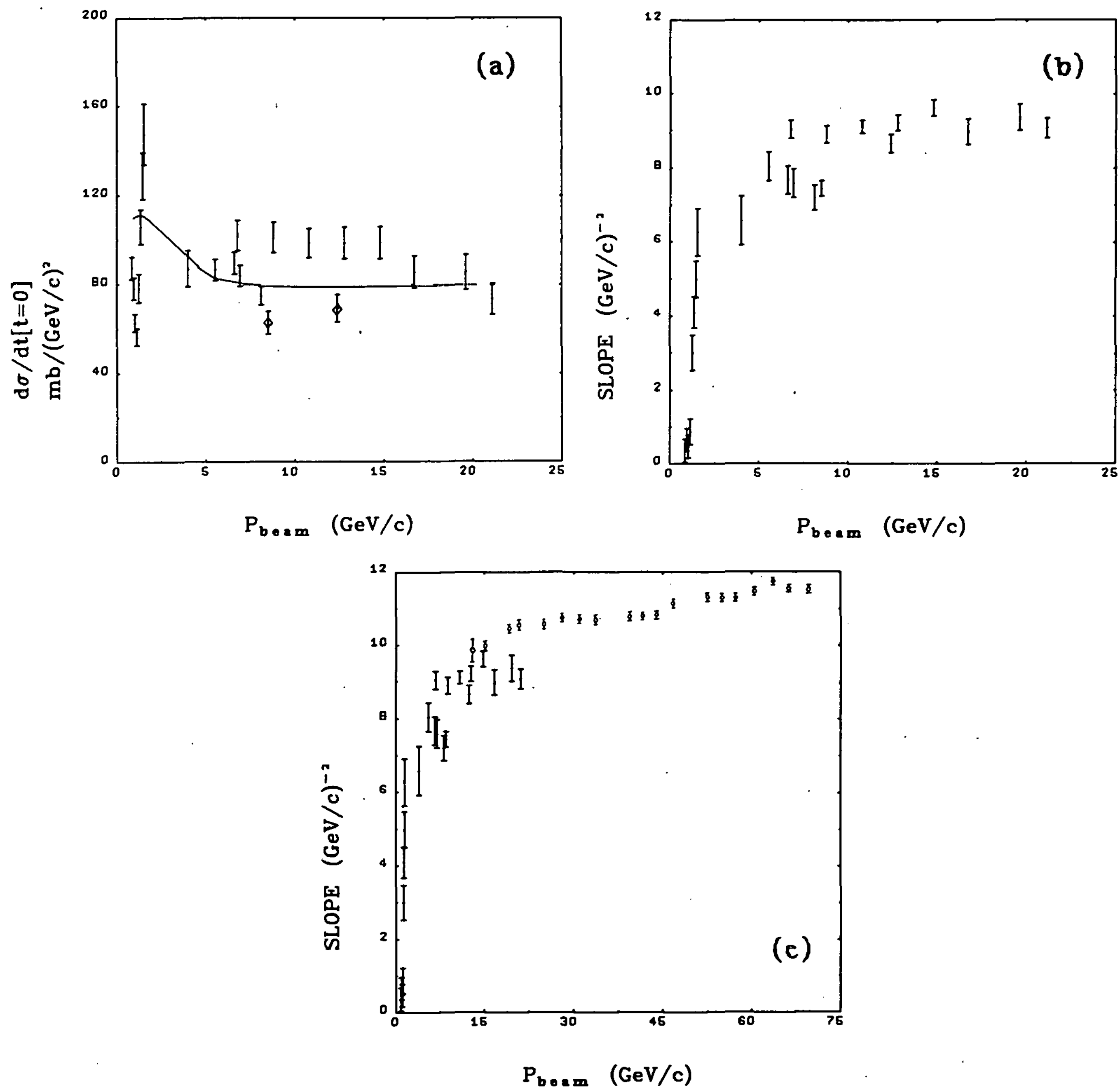


Fig. 3. Coefficients from our least-squares fit of the pp elastic scattering $d\sigma/dt$ to the form $d\sigma/dt = \frac{d\sigma}{dt}\Big|_{t=0} \cdot e^{bt}$ over the interval $0.03 \leq |t| \leq 0.3$ $(GeV/c)^2$. Systematic scaling errors in the data have been folded into the errors of $\frac{d\sigma}{dt}\Big|_{t=0}$. In the table χ^2/N is the chi-square of the fit divided by the number of degrees of freedom. We have tabulated and plotted values only from those distributions giving $\chi^2/N \leq 5$ and a relative error in $\frac{d\sigma}{dt}\Big|_{t=0} \leq 10\%$. The solid line in (a) is the optical lower limit calculated from $\sigma_{total}(pp)$, Fig. 1. The two points falling below this line (represented by ◇) are from an experiment that starts at a relatively high $|t|$ value of ~ 0.15 $(GeV/c)^2$. The fitted values of these parameters whenever given by the authors are shown in Table I. For convenience we have plotted the Serpukov results in Fig. 3c together with ours. The vertical discontinuity between these fits and ours is not meaningful since they use a different cutoff, etc.

pp elastic dσ/dt

(large |t|)

MOMENTUM TRANSFER BETWEEN BEAM AND SCATT BEAM (GEV/C)**2

BEAM MOMENTUM= 4.000 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.480	4.900	.300
.490	4.500	.300
.540	3.200	.200
.690	1.600	.100
1.180	.320	.100
1.610	.188	.007
2.230	.087	.004
2.850	.059	.002

2Q SQUARE= 2.975
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7PER CENT

ANKENBRAND PR 170 1223(1968) CNTR

BEAM MOMENTUM= 5.020 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.730	.950	.060
.750	1.050	.080
.750	1.070	.080
.830	.630	.040
.840	.710	.050
1.030	.320	.030
1.040	.330	.020
1.520	.100	.010
1.760	.064	.005
1.800	.060	.003
2.800	.021	.001
3.000	.020	.001
3.230	.017	.000
3.590	.015	.001
3.640	.016	.000
3.640	.015	.001
3.800	.019	.002

2Q SQUARE= 3.911
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7PER CENT

ANKENBRAND PR 170 1223(1968) CNTR

BEAM MOMENTUM= 6.070 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
1.090	.200	.020
1.230	.123	.009
1.510	.057	.003
1.830	.029	.002
2.180	.017	.001
2.180	.017	.002
2.180	.017	.002
2.510	.012	.001
2.850	.009	.001
3.320	.006	.000
3.900	.005	.000
4.550	.003	.000
4.660	.003	.000
4.660	.003	.000
4.670	.003	.000

2Q SQUARE= 4.883
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7PER CENT

ANKENBRAND PR 170 1223(1968) CNTR

BEAM MOMENTUM= 7.100 GEV/C

MOM TR MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MICROBARNS/(GEV/C)**2)	
2.902	2.937	4.401	.176
3.080	3.116	3.766	.151
3.353	3.390	2.733	.109
3.633	3.671	2.152	.086
3.919	3.957	1.666	.067
4.308	4.348	1.263	.051
4.805	4.845	.894	.036
5.819	5.860	.673	.027

2Q SQUARE= 5.839
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7PER CENT

ALLABY CERN 68-7 580(1968) CNTR

BEAM MOMENTUM= 7.120 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
1.420	.053	.006
1.580	.034	.004
1.810	.021	.002
2.370	.008	.001
2.710	.006	.001
3.160	.004	.001
4.360	.002	.000
4.460	.001	.000
4.630	.001	.000
5.670	.001	.000

2Q SQUARE= 5.858
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7PER CENT

ANKENBRAND PR 170 1223(1968) CNTR

BEAM MOMENTUM= 8.100 GEV/C

MOM TR MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MICROBARNS/(GEV/C)**2)	
1.569	1.599	16.724	.669
1.803	1.835	11.239	.450
2.050	2.084	8.399	.336
2.311	2.346	5.912	.236
2.584	2.621	4.464	.179
2.868	2.906	3.081	.123
3.163	3.203	2.199	.088
3.365	3.406	1.852	.074
3.571	3.613	1.470	.059
3.888	3.931	1.012	.040
4.212	4.256	.721	.029
4.544	4.589	.544	.022
4.995	5.041	.349	.014
5.571	5.618	.276	.011
6.747	6.794	.184	.007

2Q SQUARE= 6.770
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7PER CENT

ALLABY CERN 68-7 580(1968) CNTR

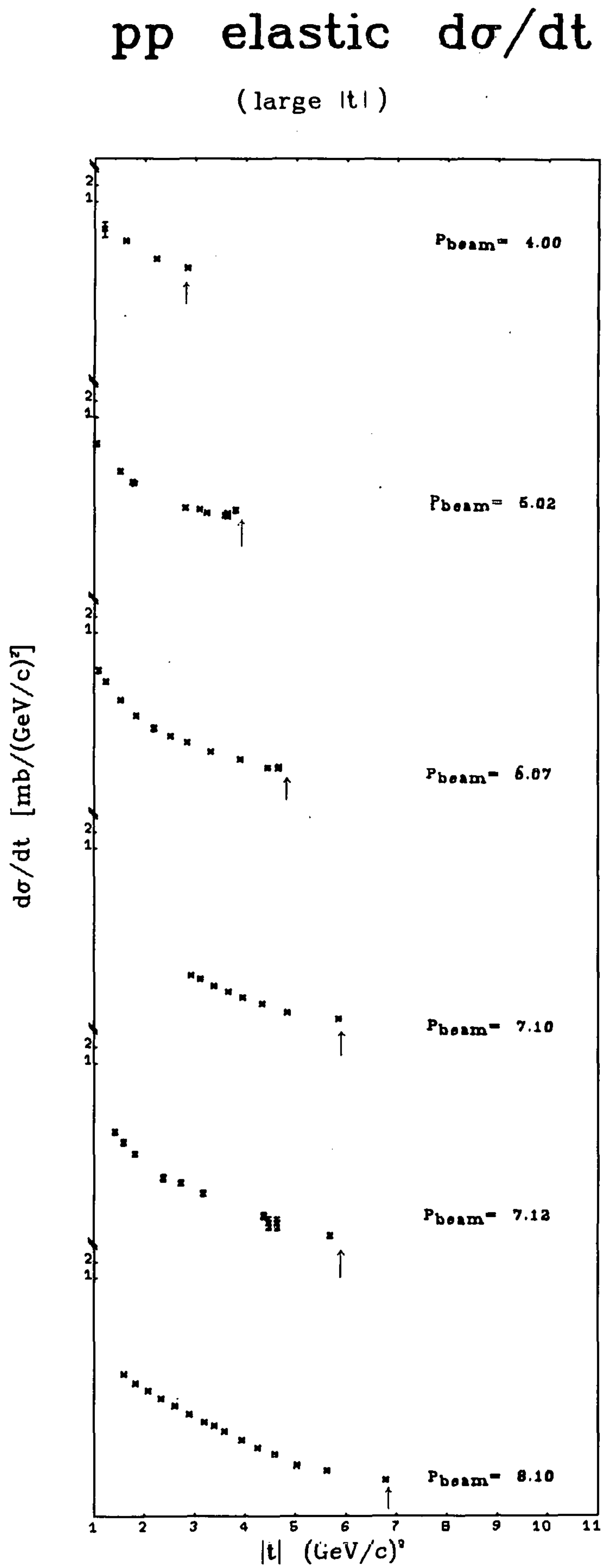


Fig. 4. pp elastic differential cross sections from experiments measuring at large |t|. Some distributions given originally as $d\sigma/d\omega$ vs. $\theta_{c.m.}$ were transformed to $d\sigma/dt$ vs. t. The vertical arrows represent t for $\theta_{c.m.}$ = 90 deg.

pp elastic $d\sigma/dt$
(large |t|)

MOMENTUM TRANSFER BETWEEN BEAM AND SCATT BEAM
(GEV/C)**2

BEAM MOMENTUM= 9.200 GEV/C

MOM TR MINIMUM	MOM TR MAXIMUM	SIGMA +- DSIGMA (MICROBARNS/(GEV/C)**2)	
1.807	1.842	7.084	.283
2.076	2.113	5.392	.216
2.361	2.400	4.142	.166
2.661	2.702	3.135	.125
2.975	3.018	1.950	.078
3.302	3.347	1.365	.055
3.642	3.688	.923	.037
3.875	3.922	.681	.027
4.112	4.160	.496	.020
4.477	4.526	.315	.013
4.851	4.901	.213	.009
5.232	5.284	.161	.006
5.752	5.805	.117	.005
6.416	6.469	.090	.004
7.769	7.824	.085	.003

2Q SQUARE= 7.796
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7PER CENT

ALLABY CERN 68-7 580(1968) CNTR

BEAM MOMENTUM=10.100 GEV/C

MOM TR MINIMUM	MOM TR MAXIMUM	SIGMA +- DSIGMA (MICROBARNS/(GEV/C)**2)	
2.001	2.040	4.343	.174
2.198	2.239	4.059	.162
2.403	2.445	3.266	.131
2.616	2.659	2.481	.099
2.835	2.880	1.826	.073
3.062	3.108	1.357	.054
3.296	3.343	.958	.038
3.536	3.585	.719	.029
3.782	3.832	.468	.019
4.034	4.086	.350	.014
4.292	4.345	.251	.010
4.555	4.609	.186	.007
4.959	5.014	.123	.005
5.373	5.429	.093	.004
5.796	5.853	.068	.003
6.372	6.431	.053	.002
7.107	7.167	.044	.002
8.607	8.667	.038	.002

2Q SQUARE= 8.637
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7PER CENT

ALLABY CERN 68-7 580(1968) CNTR

BEAM MOMENTUM=11.100 GEV/C

MOM TR MINIMUM	MOM TR MAXIMUM	SIGMA +- DSIGMA (MICROBARNS/(GEV/C)**2)	
2.218	2.261	3.368	.135
2.549	2.604	2.170	.087
2.899	2.947	1.319	.053
3.267	3.317	.783	.031
3.652	3.706	.437	.017
4.054	4.109	.236	.009
4.471	4.528	.146	.006
4.757	4.815	.103	.004
5.048	5.107	.072	.003
5.496	5.557	.051	.002
5.955	6.017	.038	.002
6.424	6.487	.031	.001
7.062	7.126	.025	.001
7.876	7.942	.022	.001
9.538	9.605	.020	.001

2Q SQUARE= 9.571
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7PER CENT

ALLABY CERN 68-7 580(1968) CNTR

BEAM MOMENTUM=12.100 GEV/C

MOM TR MINIMUM	MOM TR MAXIMUM	SIGMA +- DSIGMA (MICROBARNS/(GEV/C)**2)	
2.435	2.482	2.105	.084
2.798	2.868	1.166	.047
3.182	3.235	.624	.025
3.586	3.641	.331	.013
4.009	4.067	.177	.007
4.450	4.510	.096	.004
4.908	4.970	.055	.002
5.222	5.285	.043	.002
5.542	5.606	.034	.001
6.033	6.100	.021	.001
6.537	6.605	.018	.001
7.051	7.121	.015	.001
7.752	7.823	.011	.001
8.646	8.718	.010	.001
10.470	10.543	.010	.001

2Q SQUARE= 10.507
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7PER CENT

ALLABY CERN 68-7 580(1968) CNTR

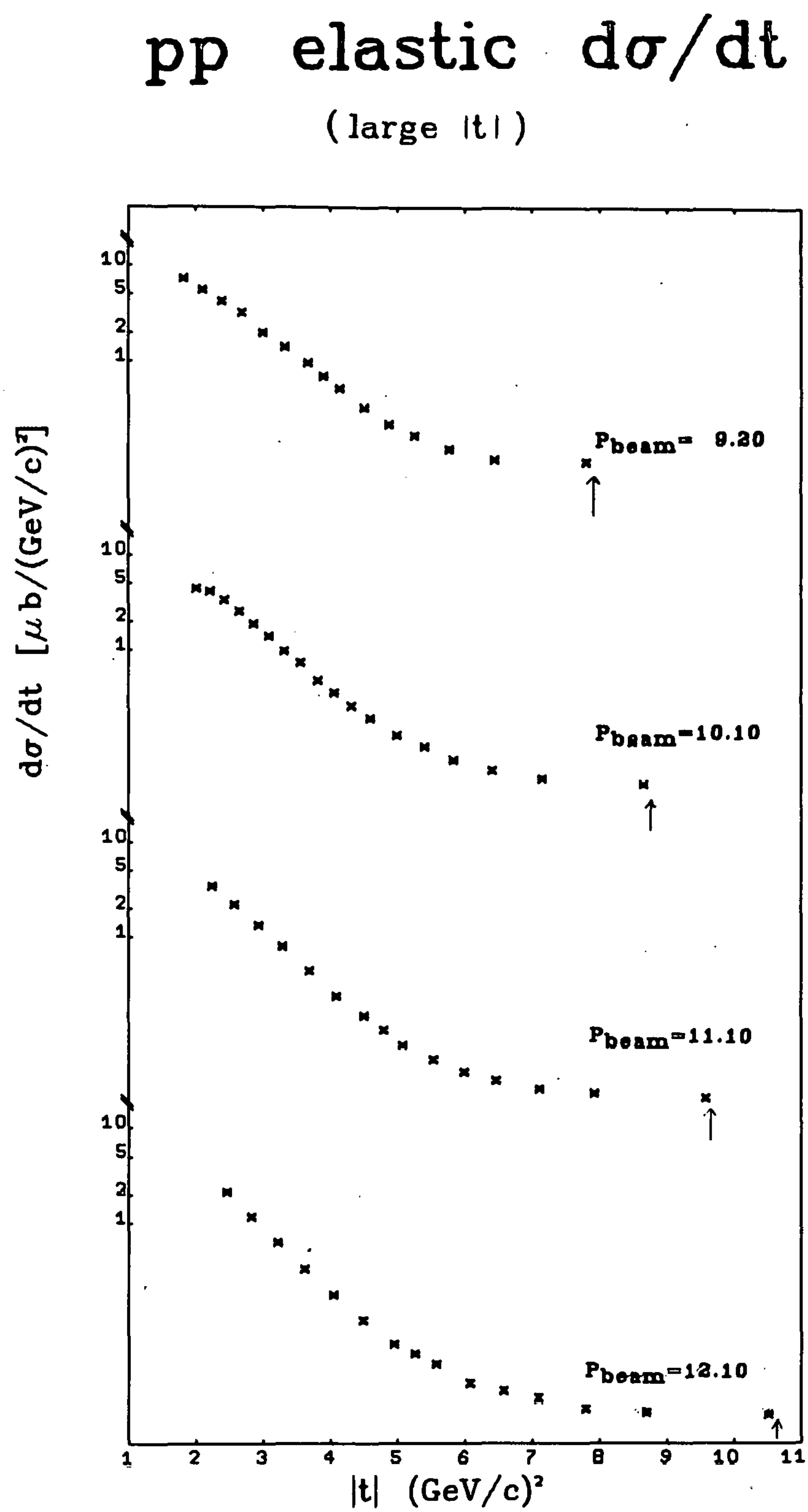


Fig. 4 (continued)

pp elastic dσ/dt

(large |t|)

MOMENTUM TRANSFER BETWEEN BEAM AND SCATT BEAM
(GEV/C)**2

BEAM MOMENTUM=14.250 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (NANOBARNS/(GEV/C)**2)	
7.627	4.070	.125
8.443	3.147	.100
9.703	2.344	.075
12.519	1.777	.050

2Q SQUARE= 12.519
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7PER CENT

ALLABY PL 25B 156(1967) CNTR

BEAM MOMENTUM=16.900 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (NANOBARNS/(GEV/C)**2)	
9.139	.901	.017
9.870	.708	.025
10.365	.641	.021
11.118	.540	.017
11.626	.461	.013
12.396	.410	.017
12.913	.385	.013
13.693	.364	.017
15.001	.335	.021

2Q SQUARE= 15.001
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7PER CENT

ALLABY PL 25B 156(1967) CNTR

BEAM MOMENTUM=19.300 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (NANOBARNS/(GEV/C)**2)	
9.688	.263	.011
11.068	.153	.010
12.785	.106	.008
17.249	.072	.007

2Q SQUARE= 17.249
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7PER CENT

ALLABY PL 25B 156(1967) CNTR

BEAM MOMENTUM=21.300 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (NANOBARNS/(GEV/C)**2)	
11.345	.076	.006
12.583	.047	.004
14.174	.035	.003
18.123	.021	.003

2Q SQUARE= 19.124
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7PER CENT

ALLABY PL 25B 156(1967) CNTR

pp elastic $d\sigma/dt$

(large |t|)

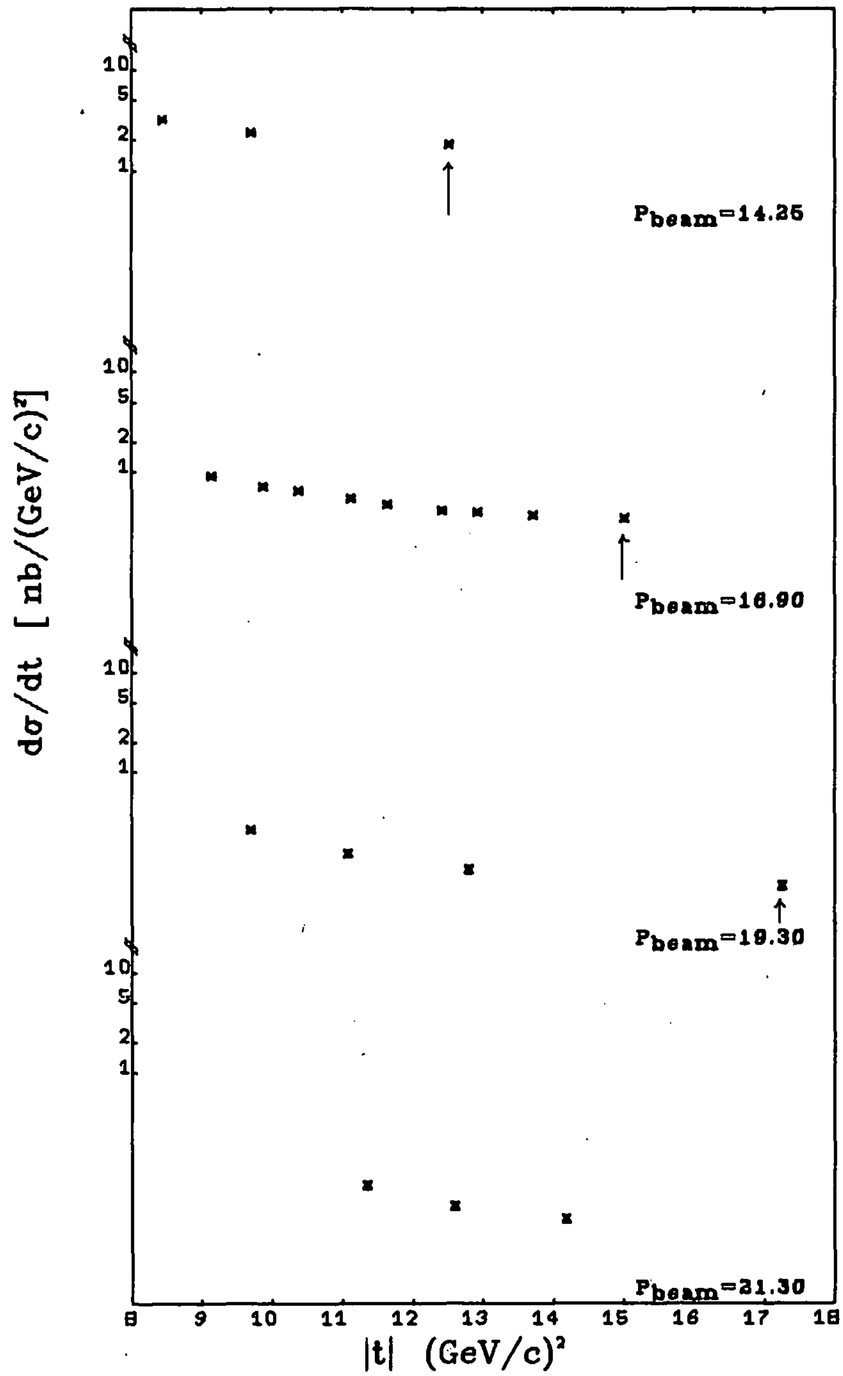


Fig. 4 (continued)

pp elastic $d\sigma/d\omega$ at $\theta_{c.m.} = 90^\circ$

BEAM MOMENTUM MINIMUM (GEV/C)	MAXIMUM	SIGMA +- DSIGMA (MICROBARNS/STERADIAN)	
4.975	5.025	8.51000	.24679
5.095	5.105	7.90000	.26070
5.195	5.205	7.09000	.21979
5.295	5.305	6.49000	.23364
5.395	5.405	5.53000	.17143
5.495	5.505	4.90000	.16660
5.595	5.605	4.47000	.13857
5.695	5.705	3.72000	.12276
5.795	5.805	3.37000	.11121
5.895	5.905	2.74000	.09590
5.995	6.005	2.44000	.07564
6.095	6.105	2.19000	.08103
6.195	6.205	1.83000	.06771
6.395	6.405	1.50000	.05550
6.595	6.605	1.07000	.05029
6.795	6.805	.79600	.03741
6.995	7.005	.64500	.03644
7.195	7.205	.51500	.02060
7.395	7.405	.38600	.01853
7.595	7.605	.30500	.01647
7.795	7.805	.25300	.01138
7.995	8.005	.21700	.00976
8.095	8.105	.16900	.00659
8.195	8.205	.17200	.00757
8.295	8.305	.15400	.00585
8.395	8.405	.15300	.00704
8.595	8.605	.12700	.00584
8.795	8.805	.10300	.00494
8.995	9.005	.08090	.00372
9.195	9.205	.07800	.00335
9.395	9.405	.06760	.00358
9.595	9.605	.05890	.00289
9.795	9.805	.05360	.00252
9.995	10.005	.04680	.00229
10.195	10.205	.04400	.00211
10.395	10.405	.03860	.00181
10.595	10.605	.03560	.00171
10.795	10.805	.03030	.00148
10.995	11.005	.02840	.00156
11.195	11.205	.02550	.00130
11.395	11.405	.02020	.00109
11.595	11.605	.01900	.00099
11.795	11.805	.01530	.00083
11.995	12.005	.01430	.00077
12.195	12.205	.01180	.00063
12.395	12.405	.01160	.00063
12.595	12.605	.00953	.00060
12.795	12.805	.00867	.00049
12.995	13.005	.00739	.00044
13.195	13.205	.00722	.00051
13.395	13.405	.00525	.00030

2Q SQUARE= 83.567
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 2PER CENT

AKERLOF PR 159 1138(1967) CNTR

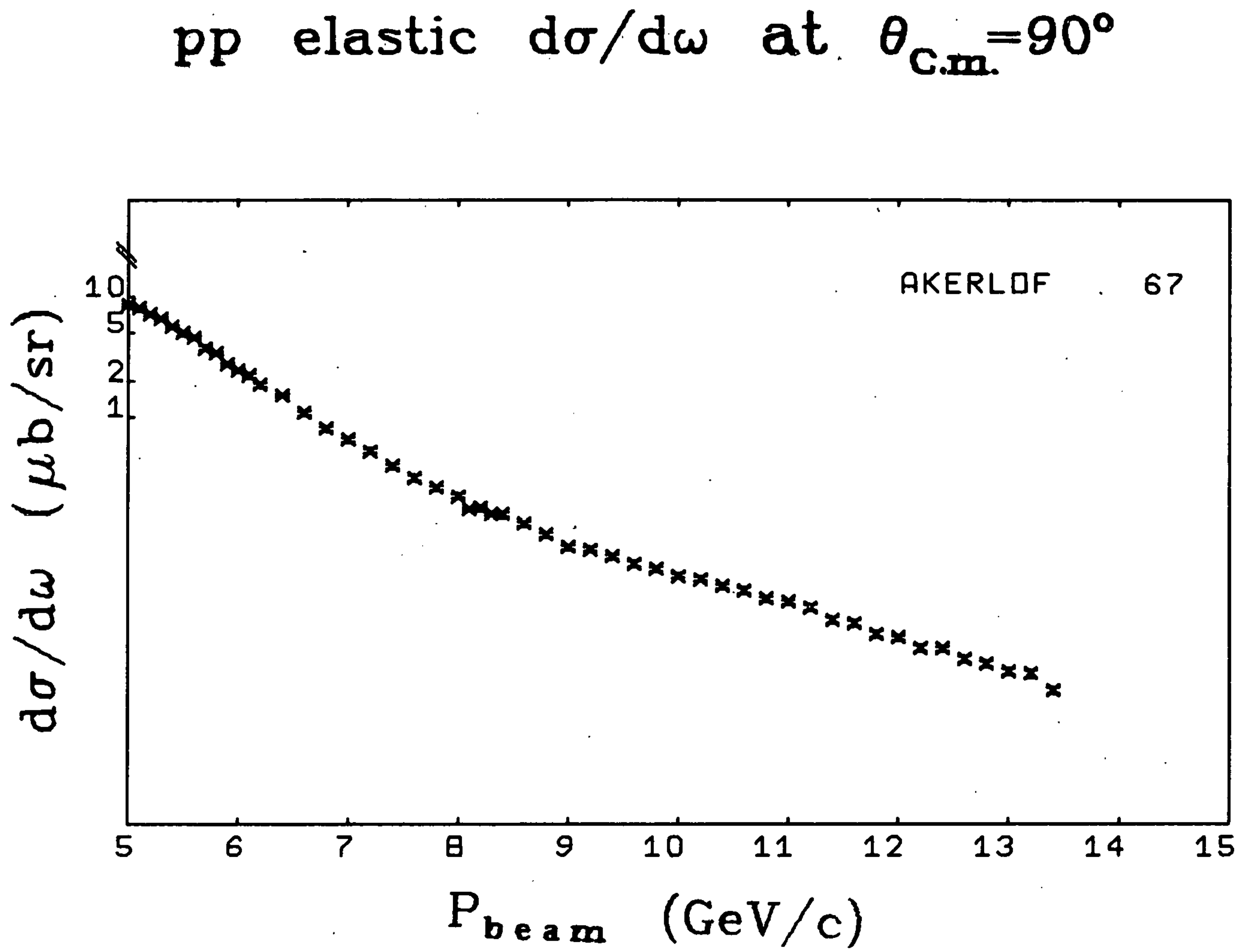


Fig. 5. pp elastic $d\sigma/d\omega$ at $\theta_{c.m.}$ = 90 deg from P_{beam} = 5 to 14 GeV/c.

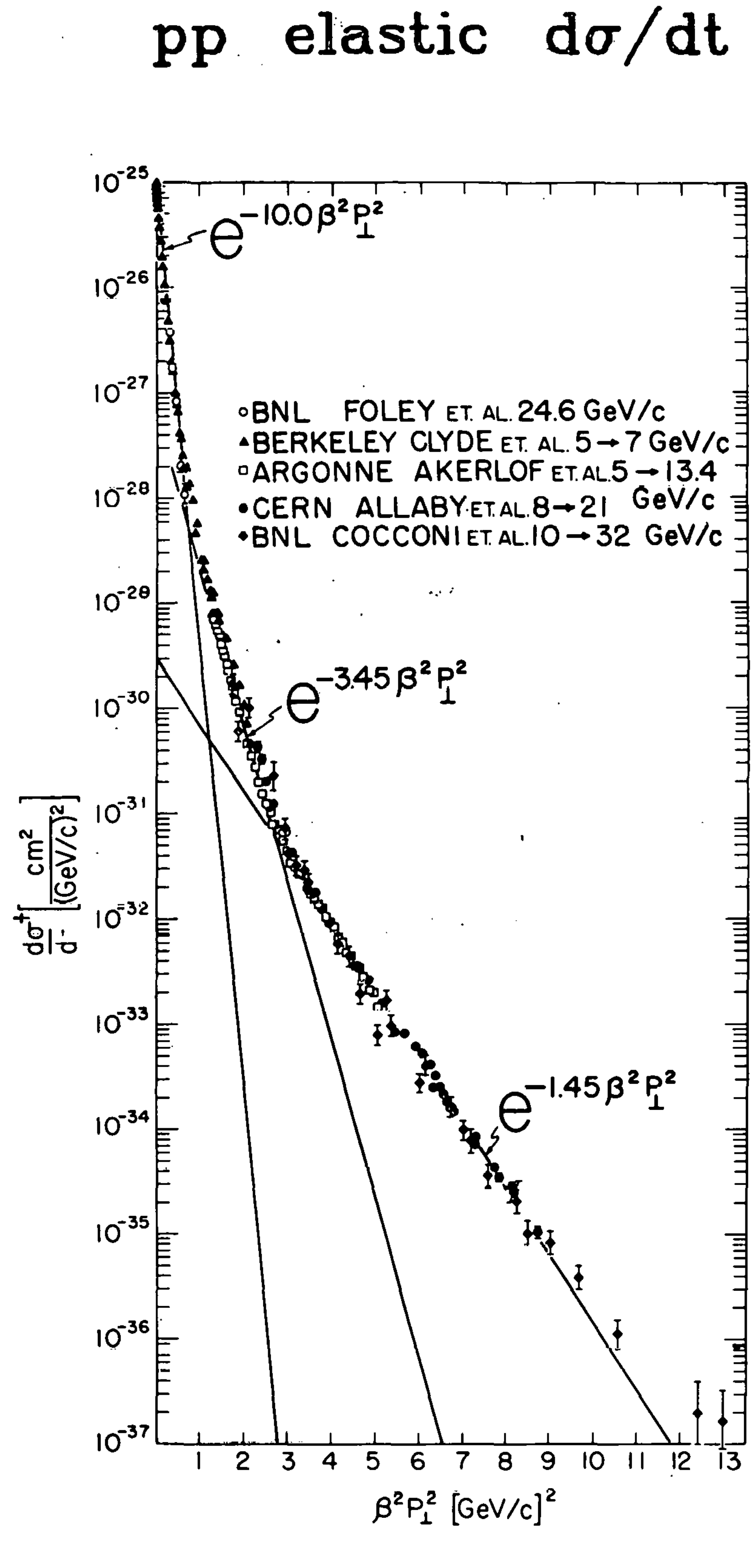


Fig. 6. The pp differential cross section plotted versus $\beta^2 P_\perp^2$ [taken from A. D. Krisch, Phys. Rev. Letters 19, 1149 (1967)]. The lines indicate the three characteristic slopes in the differential cross section data. We refer the reader to Krisch's article for the details of the fit. The $d\sigma^+/dt$ is not actually the differential cross section, but rather the differential cross section multiplied by a monotonically decreasing factor, which equals 1 at $\theta = 0$ deg and 0.5 at 90 deg.

pp elastic $d\sigma/dt$

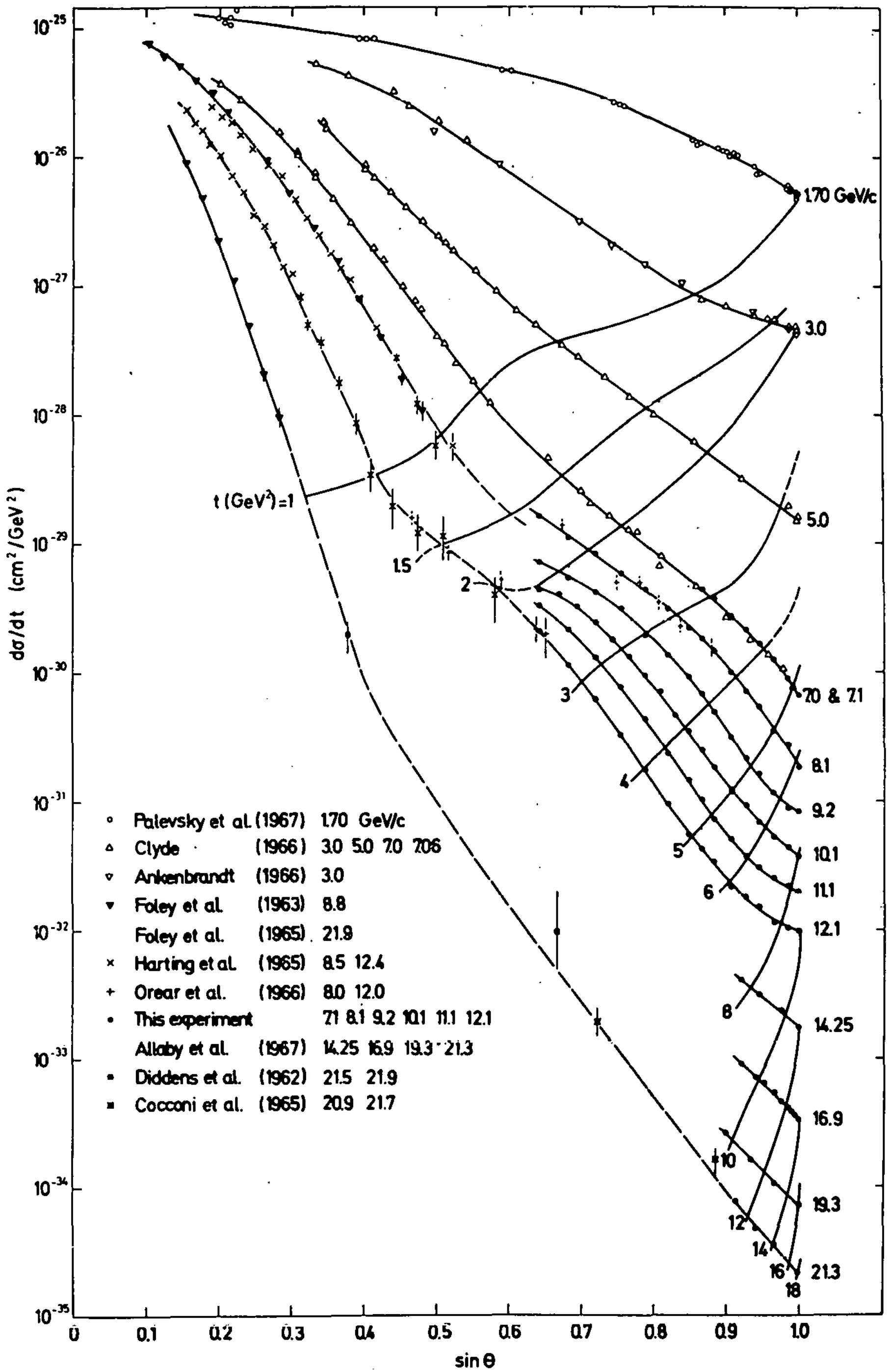


Fig. 7. The pp differential cross section in $d\sigma/dt$ versus $\sin\theta$. Note the fine oscillatory pattern. The lines of fixed t are also indicated (from Allaby et al., 1968, Ref. 143).

pp elastic dσ/dω (very forward angles)

DISTRIBUTION IN THE ANGLE OF THE SCATT BEAM WITH RESPECT TO THE BEAM DIRECTION IN THE LAB SYSTEM

BEAM MOMENTUM= 1.290 GEV/C

THETA(DEG)	SIGMA +- DSIGMA (MILLIBARNS/STERADIAN)	
1.175	892.000	100.000
1.289	697.000	85.000
1.404	608.000	73.000
1.518	306.000	60.000
1.633	292.000	33.000
1.748	263.000	30.000
1.862	244.000	27.000
1.977	214.000	24.000
2.091	162.000	22.000
2.206	164.000	20.000
2.320	167.000	19.000
2.435	154.000	18.000
2.550	142.000	17.000
2.664	163.000	17.000
2.779	136.000	16.000
2.893	132.000	16.000
3.008	137.000	15.000
3.237	132.000	20.000
3.352	97.000	20.000
3.466	101.000	20.000
3.581	94.000	20.000
3.696	81.000	19.000
3.810	69.000	18.000
3.925	78.000	16.000
4.039	71.000	16.000
4.154	59.000	14.000

2Q SQUARE= .616

DUTTON PL 26B 679(1968) SPRK

BEAM MOMENTUM= 1.390 GEV/C

THETA(DEG)	SIGMA +- DSIGMA (MILLIBARNS/STERADIAN)	
1.003	1039.000	135.000
1.117	535.000	73.000
1.232	524.000	40.000
1.346	430.000	31.000
1.461	384.000	28.000
1.576	324.000	24.000
1.690	207.000	22.000
1.805	212.000	20.000
1.919	175.000	19.000
2.034	130.000	17.000
2.149	146.000	16.000
2.263	129.000	14.000
2.378	75.000	13.000
2.492	106.000	13.000
2.607	99.000	13.000
2.722	121.000	13.000
2.836	94.000	12.000
2.951	95.000	12.000
3.065	99.000	12.000
3.180	94.000	11.000
3.295	97.000	11.000
3.409	71.000	11.000
3.524	81.000	11.000
3.638	96.000	11.000
3.753	80.000	10.000
3.867	73.000	9.000
3.982	62.000	9.000
4.097	56.000	7.000

2Q SQUARE= .693

DUTTON PL 26B 679(1968) SPRK

BEAM MOMENTUM= 1.540 GEV/C

THETA(DEG)	SIGMA +- DSIGMA (MILLIBARNS/STERADIAN)	
.945	1014.000	243.000
1.060	590.000	76.000
1.175	532.000	58.000
1.289	337.000	36.000
1.404	326.000	31.000
1.518	278.000	27.000
1.633	228.000	24.000
1.748	220.000	22.000
1.862	147.000	19.000
1.977	183.000	22.000
2.091	146.000	21.000
2.206	192.000	20.000
2.320	136.000	18.000
2.435	135.000	18.000
2.550	116.000	17.000
2.664	135.000	16.000
2.779	144.000	16.000
2.893	144.000	15.000
3.008	101.000	14.000
3.123	128.000	15.000
3.237	91.000	14.000
3.352	126.000	14.000
3.466	95.000	13.000
3.581	123.000	13.000
3.696	106.000	13.000
3.810	102.000	12.000
3.925	105.000	12.000
4.039	96.000	11.000
4.154	86.000	10.000

2Q SQUARE= .812

DUTTON PL 26B 679(1968) SPRK

BEAM MOMENTUM= 1.540 GEV/C

THETA(DEG) MINIMUM	THETA(DEG) MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/STERADIAN)	
1.003	1.117	533.000	53.000
1.117	1.232	472.000	47.000
1.232	1.346	431.000	41.000
1.346	1.461	321.000	34.000
1.461	1.576	259.000	30.000
1.576	1.690	219.000	27.000
1.690	1.805	176.000	25.000
1.805	1.919	144.000	22.000
1.919	2.034	176.000	22.000
2.034	2.149	100.000	20.000
2.149	2.263	122.000	19.000
2.263	2.378	114.000	19.000
2.378	2.492	127.000	19.000
2.492	2.607	114.000	16.000
2.607	2.722	129.000	17.000
2.722	2.836	111.000	17.000

2Q SQUARE= .812

DUTTON PL 25B 245(1967) SPRK

BEAM MOMENTUM= 1.690 GEV/C

THETA(DEG) MINIMUM	THETA(DEG) MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/STERADIAN)	
1.060	1.175	372.000	50.000
1.289	1.404	253.000	39.000
1.518	1.633	194.000	32.000
1.748	1.862	142.000	26.000
1.977	2.091	137.000	23.000
2.206	2.320	121.000	20.000
2.435	2.550	142.000	19.000
2.664	2.779	154.000	19.000
2.893	3.008	133.000	17.000

2Q SQUARE= .933

DUTTON PL 25B 245(1967) SPRK

pp elastic dσ/dω (very forward angles)

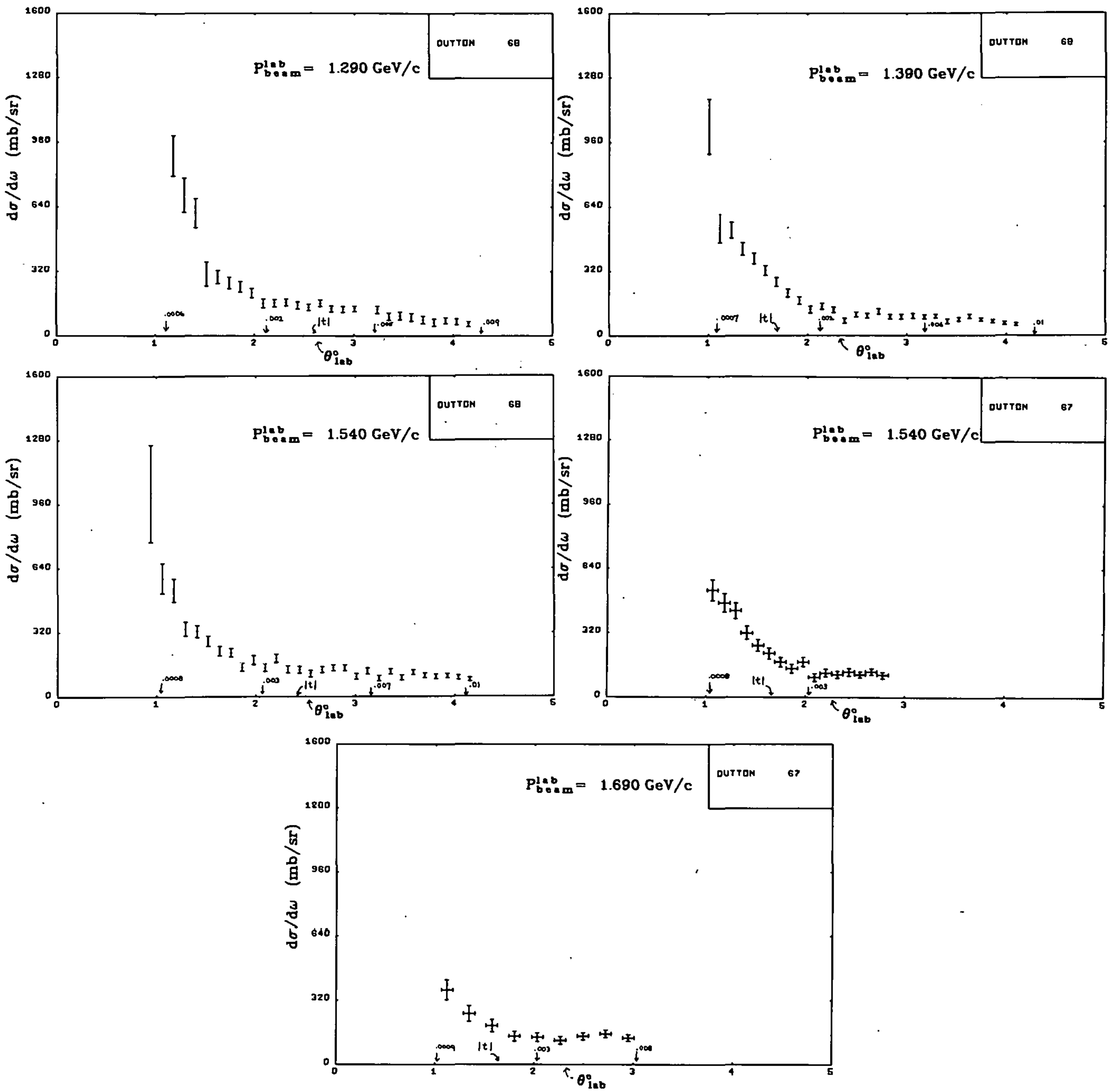


Fig. 8. pp elastic differential cross sections at very forward angles. The main purpose of such experiments (in the Coulomb-nuclear interference region) is to accurately measure parameters related to the forward nuclear elastic amplitudes.

pp Re $f^{el}(0)/\mathrm{Im}\ f^{el}(0)$

P_{beam} (GeV/c)	$E_{c.m.}$ (GeV)	$\alpha \pm \delta\alpha$		References	
1.29	2.18	-.76	.13	DUTTON	68
1.39	2.22	-.58	.06	DUTTON	68
1.54	2.27	-.30	.09	DUTTON	67
1.54	2.27	-.32	.07	DUTTON	68
1.69	2.32	-.50	.15	DUTTON	67
1.69	2.32	.10	.16	DUTTON	67
1.70	2.32	-.007	.07	DOWELL	64
2.78	2.70	-.17	.08	KIRILLOVA	64
7.85 ± .02	4.07	-.29	.03	TAYLOR	65
10.11	4.56	-.43	.04	BELLETTINI	65
10.90	4.72	-.25	.07	KIRILLOVA	64
19.33	6.17	-.33	.03	BELLETTINI	65
24.00	6.84	-.19	.09	LOHRMANN	64
26.42	7.17	-.32	.03	BELLETTINI	65

REFERENCES

1	DOWELL	64.....PL	12	252	CNTR
2	KIRILLOVA	64.....PL	13	93	CNTR
3	LOHRMANN	64.....PL	13	78	EMUL
4	BELLETTINI	65.....PL	14	164	SPRK
5	TAYLOR	65.....PL	14	54	SPRK
6	DUTTON	67.....PL	25B	245	SPRK
7	DUTTON	68.....PL	26B	679	SPRK

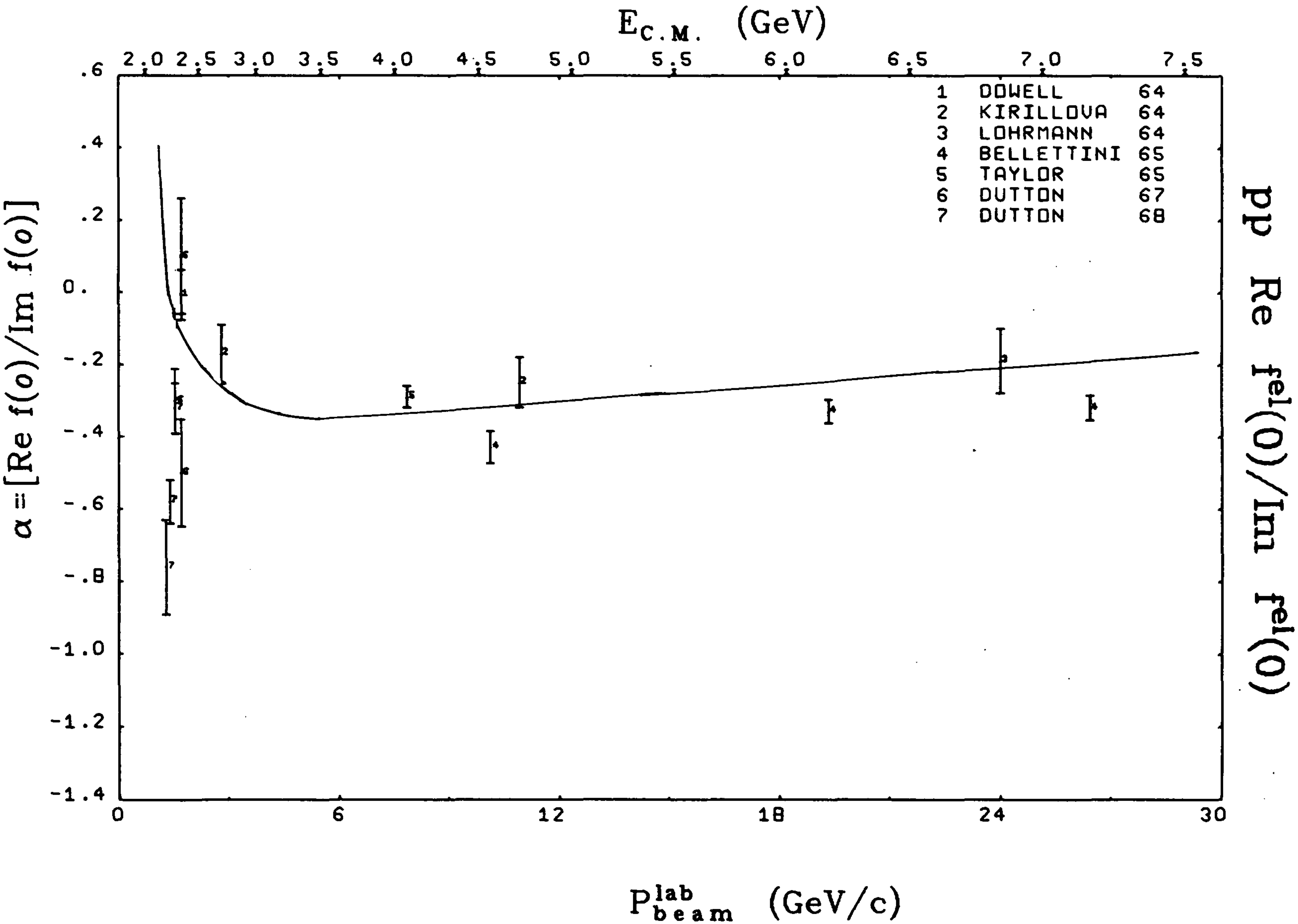


Fig. 9. Ratio of real to imaginary parts of the pp forward nuclear elastic scattering amplitude. The smooth curve is the dispersion relation calculation by Söding (see text).

Polarization in pp elastic scattering

DISTRIBUTION IN COS(THETA) OF THE SCATT BEAM WITH RESPECT TO THE BEAM DIRECTION IN THE C.M. SYSTEM

BEAM MOMENTUM= .823 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
.047	.172	.035	.008
.124	.244	.117	.007
.342	.460	.217	.008
.413	.512	.276	.007
.605	.677	.362	.011
.641	.713	.374	.007
.809	.855	.402	.025

2Q SQUARE= .291
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3PER CENT

CHENG PR 163 1470(1967) CNTR

BEAM MOMENTUM= .850 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
-.201	-.167	-.094	.027
-.131	-.096	-.054	.024
-.063	-.028	-.008	.025
.002	.037	.016	.027
.065	.099	.163	.035
.247	.281	.187	.023
.302	.335	.165	.023
.357	.389	.191	.024
.410	.442	.256	.027
.460	.491	.255	.020
.509	.539	.317	.022
.555	.584	.324	.025
.599	.627	.349	.031
.641	.668	.389	.045

2Q SQUARE= .308
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 6PER CENT

BETZ PR 148 1289(1966) CNTR

BEAM MOMENTUM= .954 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
.066	.194	.084	.009
.103	.223	.105	.008
.360	.477	.272	.010
.394	.497	.275	.008
.621	.714	.419	.011
.631	.711	.419	.008
.000	.053	.442	.014

2Q SQUARE= .375
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3PER CENT

CHENG PR 163 1470(1967) CNTR

BEAM MOMENTUM= 1.090 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
.082	.203	.113	.016
.089	.213	.107	.015
.376	.480	.313	.025
.379	.492	.270	.010
.618	.700	.452	.014
.636	.728	.461	.018
.790	.811	.510	.059
.809	.854	.490	.011

2Q SQUARE= .469
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3PER CENT

CHENG PR 163 1470(1967) CNTR

BEAM MOMENTUM= 1.090 GEV/C

COS(THETA)	POLARIZ+-DPOL	
-.063	-.070	.005
-.007	-.031	.013
.049	.015	.016
.110	.060	.018
.163	.094	.005
.177	.095	.009
.225	.087	.019
.242	.125	.013
.286	.141	.017
.302	.190	.020
.365	.230	.020
.426	.260	.020
.442	.295	.020
.485	.300	.020
.500	.330	.020
.542	.340	.032
.559	.345	.022
.610	.435	.040
.620	.375	.022
.667	.454	.030
.674	.420	.032
.722	.490	.034
.729	.430	.022
.771	.440	.054
.823	.490	.035

2Q SQUARE= .469

COZZIKA PR 164 1672(1967) CNTR

BEAM MOMENTUM= 1.213 GEV/C

COS(THETA)	POLARIZ+-DPOL	
-.240	-.235	.014
-.105	-.084	.011
-.021	-.018	.010
.037	.040	.011
.106	.106	.011
.179	.160	.013
.249	.231	.013
.391	.297	.015
.456	.380	.020
.585	.425	.022
.645	.459	.020
.702	.488	.025
.755	.488	.026
.804	.526	.027
.848	.473	.117
.921	.445	.074

2Q SQUARE= .558

COIGNET NC 43A 708(1966) CNTR

Polarization in pp elastic scattering

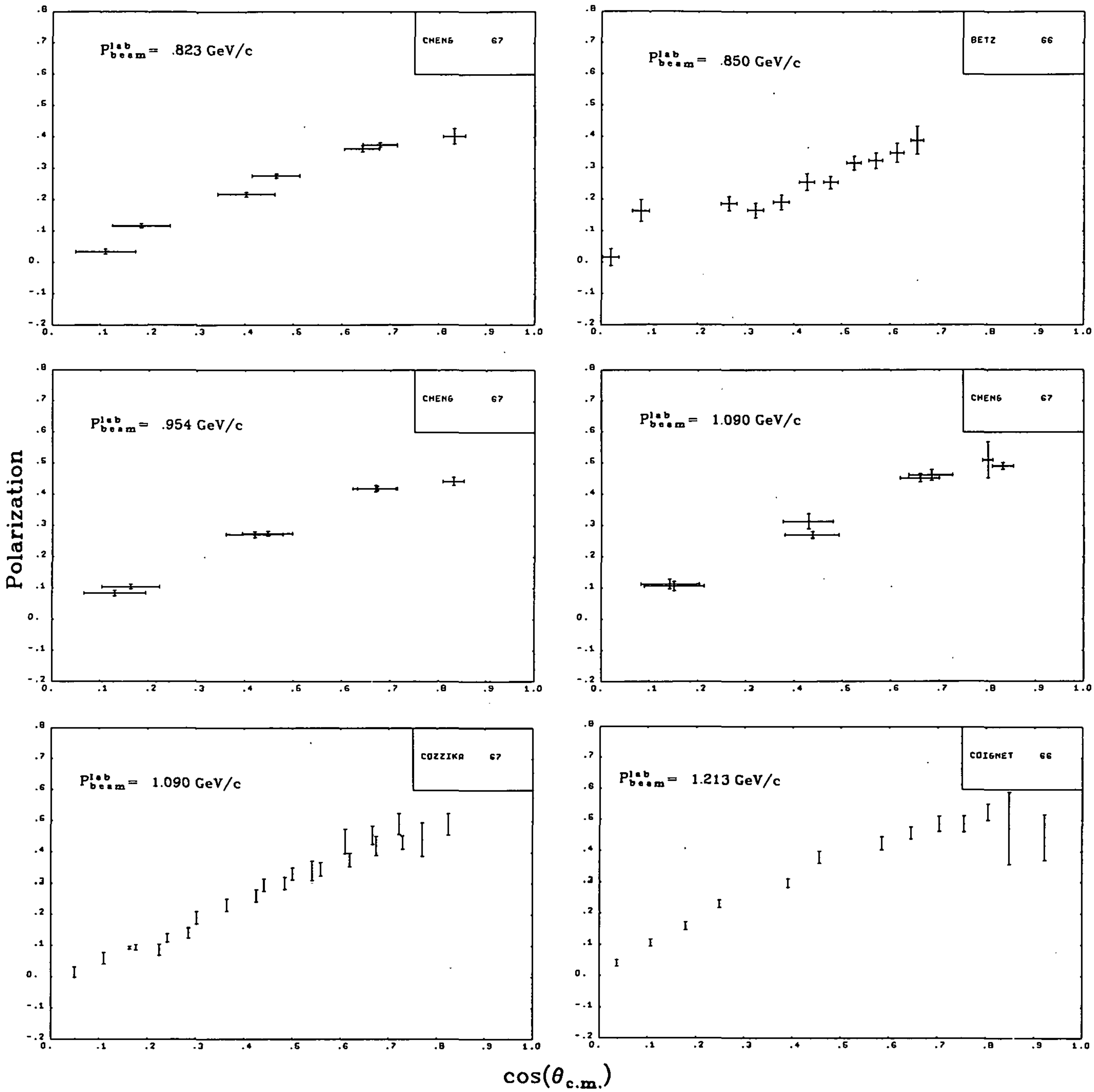


Fig. 10. Polarization in pp elastic scattering. Whenever a distribution was given in $\theta_{c.m.}$ or t, we transfored it to cos($\theta_{c.m.}$). Due to the indistinguishability of the protons, the polarization is antisymmetric about $\theta_{c.m.}$ = 90 deg.

Polarization in pp elastic scattering

DISTRIBUTION IN COS(THETA) OF THE SCATT BEAM WITH RESPECT TO THE BEAM DIRECTION IN THE C.M. SYSTEM

BEAM MOMENTUM= 1.219 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
.063	.184	.114	.025
.108	.232	.168	.010
.358	.466	.361	.038
.396	.508	.399	.019
.606	.691	.484	.010
.647	.737	.516	.010
.809	.839	.595	.035
.808	.856	.513	.010

2Q SQUARE= .563
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3PER CENT

CHENG PR 163 1470(1967) CNTR

BEAM MOMENTUM= 1.230 GEV/C

COS(THETA)	POLARIZ+-DPOL	
.007	-.006	.020
.068	.029	.015
.129	.122	.010
.193	.180	.015
.257	.210	.020
.276	.290	.070
.319	.265	.020
.337	.320	.019
.384	.345	.020
.400	.380	.018
.466	.400	.036
.524	.465	.025
.540	.410	.025
.585	.500	.024
.600	.455	.024
.628	.410	.045
.643	.500	.023
.660	.450	.019
.682	.476	.029
.718	.450	.026
.736	.480	.027
.768	.415	.029
.790	.440	.026
.817	.415	.043
.859	.260	.091
.863	.440	.080

2Q SQUARE= .571

COZZIKA PR 164 1672(1967) CNTR

BEAM MOMENTUM= 1.237 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
.078	.148	.091	.015
.181	.249	.238	.016
.271	.337	.357	.019
.277	.344	.325	.018
.369	.415	.463	.019
.371	.435	.413	.020
.426	.488	.492	.019
.500	.559	.505	.019

2Q SQUARE= .576
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 19PER CENT

BETZ PR 148 1289(1966) CNTR

BEAM MOMENTUM= 1.263 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
-.017	.027	.012	.009
.154	.197	.181	.016
.292	.333	.296	.014
.433	.472	.405	.021
.469	.507	.395	.014
.499	.537	.455	.016
.532	.569	.419	.014
.563	.598	.445	.014
.594	.629	.482	.014
.609	.643	.497	.014
.625	.698	.492	.014
.639	.672	.482	.016
.655	.688	.485	.009
.670	.702	.501	.014
.684	.715	.508	.014
.698	.728	.513	.016
.711	.741	.511	.014
.738	.767	.518	.014
.764	.792	.522	.019
.789	.815	.522	.019
.813	.837	.450	.025
.839	.858	.499	.021
.876	.896	.475	.024

2Q SQUARE= .596

KAZARINOV RMP 39 509(1967) CNTR

BEAM MOMENTUM= 1.303 GEV/C

COS(THETA)	POLARIZ+-DPOL	
.667	.580	.046
.884	.506	.016
.932	.448	.028
.960	.357	.019
.978	.272	.017
.984	.242	.026
.992	.140	.029
.996	.051	.024
.997	.012	.028

2Q SQUARE= .626

AZHGIREI SJNP 2 636(1966) CNTR

BEAM MOMENTUM= 1.317 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
.111	.146	.073	.044
.163	.198	.151	.036
.213	.247	.247	.031
.264	.297	.274	.027
.312	.345	.293	.030
.379	.412	.363	.019
.427	.459	.399	.018
.477	.508	.430	.017
.524	.553	.484	.018
.569	.598	.529	.013
.613	.640	.570	.013
.655	.681	.596	.017
.695	.719	.583	.017
.733	.756	.578	.019
.768	.790	.578	.028

2Q SQUARE= .637
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 6PER CENT

BETZ PR 148 1289(1966) CNTR

Polarization in pp elastic scattering

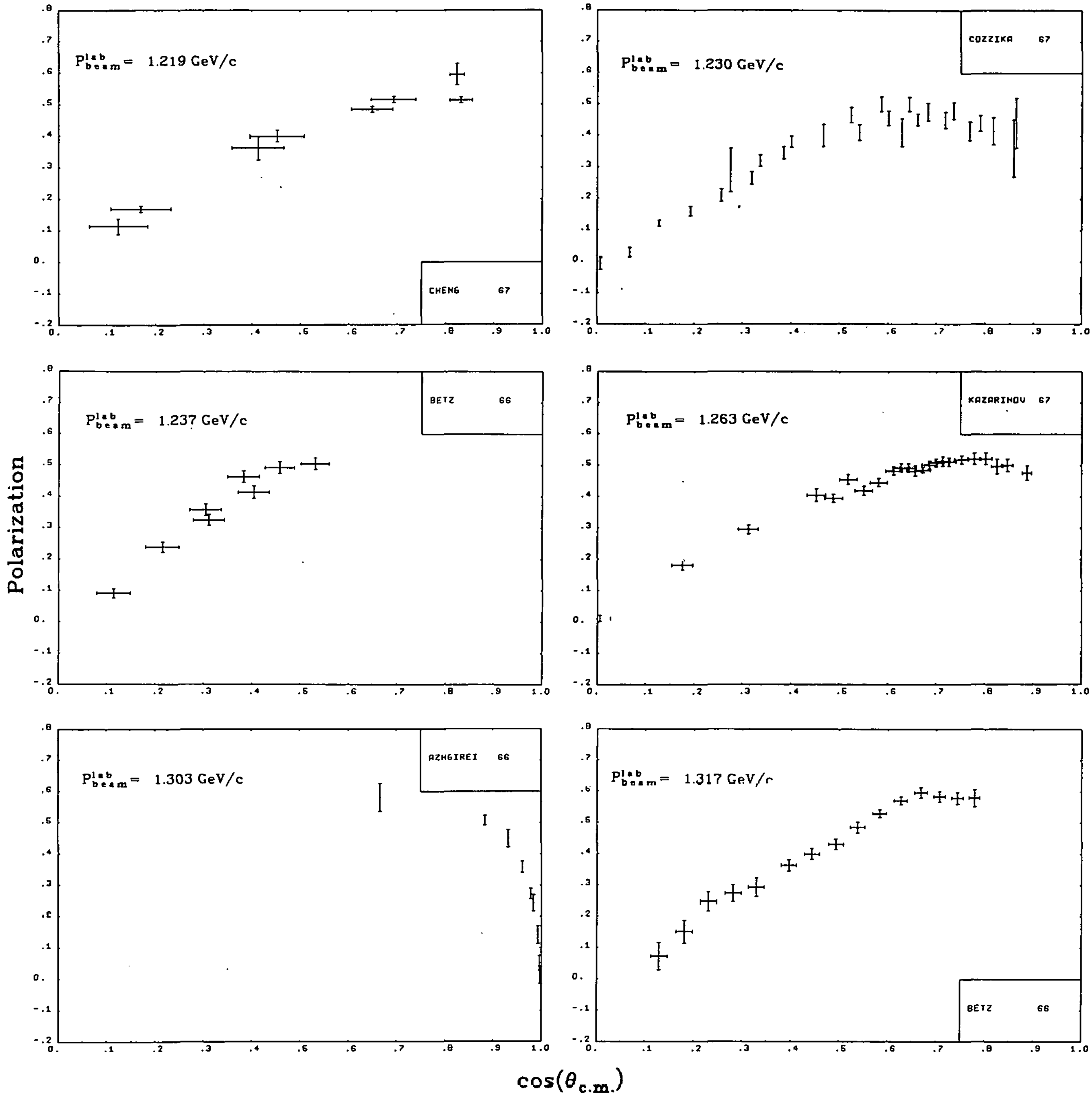


Fig. 10 (continued)

Polarization in pp elastic scattering

DISTRIBUTION IN COS(THETA) OF THE SCATT BEAM WITH RESPECT TO THE BEAM DIRECTION IN THE C.M. SYSTEM

BEAM MOMENTUM= 1.343 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
.007	.129	.109	.038
.163	.286	.255	.015
.309	.410	.355	.032
.443	.552	.474	.011
.566	.652	.529	.022
.686	.769	.558	.016
.794	.829	.522	.012
.843	.874	.555	.019

2Q SQUARE= .657
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3PER CENT

CHENG PR 163 1470(1967) CNTR

BEAM MOMENTUM= 1.385 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
.269	.269	.268	.015
.335	.335	.296	.050
.406	.404	.364	.030
.463	.463	.404	.030
.527	.527	.460	.020
.585	.585	.486	.030
.669	.669	.500	.030
.724	.724	.550	.030
.777	.777	.570	.030
.827	.827	.530	.040
.868	.868	.520	.040
.903	.903	.490	.030
.938	.960	.367	.032
.988	.997	.118	.160

2Q SQUARE= .690

COZZIKA PR 164 1672(1967) CNTR

BEAM MOMENTUM= 1.387 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
.101	.136	.144	.023
.153	.187	.180	.018
.204	.239	.231	.018
.254	.287	.304	.018
.302	.335	.342	.018
.352	.384	.365	.017
.399	.431	.419	.018
.471	.502	.473	.014
.520	.549	.498	.013
.565	.593	.497	.013
.610	.637	.520	.011
.652	.678	.528	.011
.693	.718	.559	.015
.731	.755	.560	.014
.768	.790	.553	.017
.803	.823	.579	.028
.834	.853	.579	.049

2Q SQUARE= .691
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 6PER CENT

BETZ PR 148 1289(1966) CNTR

BEAM MOMENTUM= 1.404 GEV/C

COS(THETA)	POLARIZ+-DPOL	
.065	.097	.078
.439	.470	.067
.598	.530	.029
.680	.513	.044
.721	.541	.075

2Q SQUARE= .704
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5PER CENT

NEAL PR 161 1374(1967) CNTR+SPRK

BEAM MOMENTUM= 1.487 GEV/C

COS(THETA)	POLARIZ+-DPOL	
.059	.056	.085
.124	.100	.036
.187	.155	.016
.252	.225	.017
.322	.300	.011
.335	.315	.035
.384	.335	.025
.400	.355	.017
.445	.330	.017
.463	.392	.012
.524	.410	.017
.593	.445	.016
.605	.465	.016
.652	.455	.015
.667	.435	.022
.691	.410	.040
.710	.450	.017
.722	.475	.016
.743	.476	.030
.773	.455	.012
.797	.484	.025
.823	.443	.016
.842	.470	.025
.866	.443	.029
.883	.465	.035
.919	.435	.035

2Q SQUARE= .769

COZZIKA PR 164 1672(1967) CNTR

BEAM MOMENTUM= 1.609 GEV/C

COS(THETA)	POLARIZ+-DPOL	
.624	.370	.018
.682	.385	.024
.738	.385	.024
.794	.445	.024
.841	.435	.021
.883	.400	.017
.918	.340	.018

2Q SQUARE= .867

COZZIKA PR 164 1672(1967) CNTR

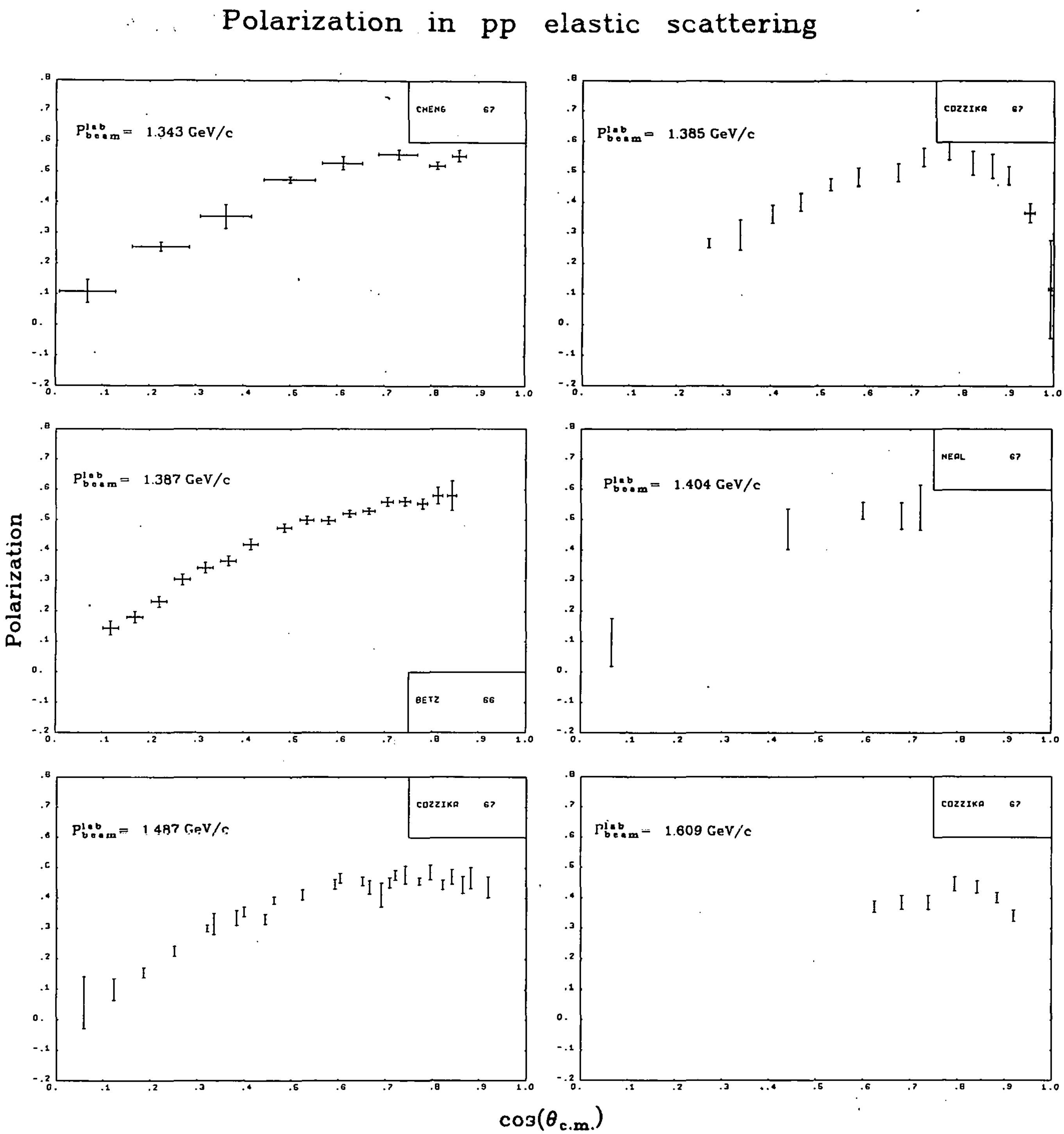


Fig. 10 (continued)

Polarization in pp elastic scattering

DISTRIBUTION IN COS(THETA) OF THE SCATT BEAM WITH RESPECT TO THE BEAM DIRECTION IN THE C.M. SYSTEM

BEAM MOMENTUM= 1.729 GEV/C

COS(THETA)	POLARIZ	+-DPOL
.052	-.017	.046
.118	.090	.020
.184	.092	.013
.249	.080	.035
.316	.210	.020
.363	.210	.060
.388	.287	.050
.429	.265	.030
.500	.285	.020
.568	.330	.020
.627	.330	.020
.643	.345	.021
.687	.360	.025
.702	.370	.020
.743	.405	.027
.759	.385	.030
.813	.370	.030
.858	.355	.020
.900	.345	.040

2Q SQUARE= .965

COZZIKA PR 164 1672(1967) CNTR

BEAM MOMENTUM= 1.730 GEV/C

COS(THETA)	POLARIZ	+-DPOL
.031	-.021	.034
.221	.095	.029
.319	.265	.037
.366	.245	.033
.418	.258	.073
.475	.325	.033
.533	.417	.038
.593	.481	.023
.738	.464	.040
.767	.419	.031

2Q SQUARE= .966
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5PER CENT

NEAL PR 161 1374(1967) CNTR+SPRK

BEAM MOMENTUM= 1.915 GEV/C

COS(THETA) MINIMUM	COS(THETA) MAXIMUM	POLARIZ	+-DPOL
.080	.080	-.016	.070
.146	.146	-.083	.025
.211	.211	.035	.017
.281	.281	.020	.035
.349	.349	.080	.028
.367	.367	.085	.030
.418	.418	.085	.024
.432	.432	.105	.019
.503	.503	.190	.020
.571	.571	.275	.024
.588	.588	.245	.020
.591	.591	.320	.025
.635	.635	.305	.024
.656	.656	.330	.019
.656	.656	.337	.040
.698	.698	.310	.036
.717	.717	.369	.017
.721	.721	.385	.037
.775	.775	.375	.015
.777	.777	.392	.060
.827	.827	.405	.016
.829	.829	.370	.044
.875	.875	.390	.025
.876	.876	.355	.034
.914	.914	.350	.090
.916	.941	.224	.030
.962	.979	.124	.033

2Q SQUARE= 1.120

COZZIKA PR 164 1672(1967) CNTR

BEAM MOMENTUM= 2.054 GEV/C

COS(THETA)	POLARIZ	+-DPOL
.031	.034	.029
.142	.059	.034
.263	.062	.032
.370	.034	.030
.482	.190	.025
.600	.266	.020
.646	.339	.022
.687	.407	.025
.776	.343	.045
.821	.403	.030
.845	.361	.036

2Q SQUARE= 1.238
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5PER CENT

NEAL PR 161 1374(1967) CNTR+SPRK

BEAM MOMENTUM= 2.391 GEV/C

COS(THETA)	POLARIZ	+-DPOL
.164	0.	.031
.277	.025	.030
.390	.025	.028
.471	.141	.035
.559	.151	.053
.647	.177	.040
.718	.369	.020
.782	.335	.025
.841	.352	.032
.876	.228	.029

2Q SQUARE= 1.529
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5PER CENT

NEAL PR 161 1374(1967) CNTR+SPRK

BEAM MOMENTUM= 2.466 GEV/C

COS(THETA) MINIMUM	COS(THETA) MAXIMUM	POLARIZ	+-DPOL
.791	.812	.362	.020
.818	.838	.396	.017
.844	.863	.404	.016
.869	.885	.423	.015
.891	.906	.389	.014
.911	.925	.431	.021

2Q SQUARE= 1.595
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12PER CENT

GRANNIS PR 148 1297(1966) CNTR

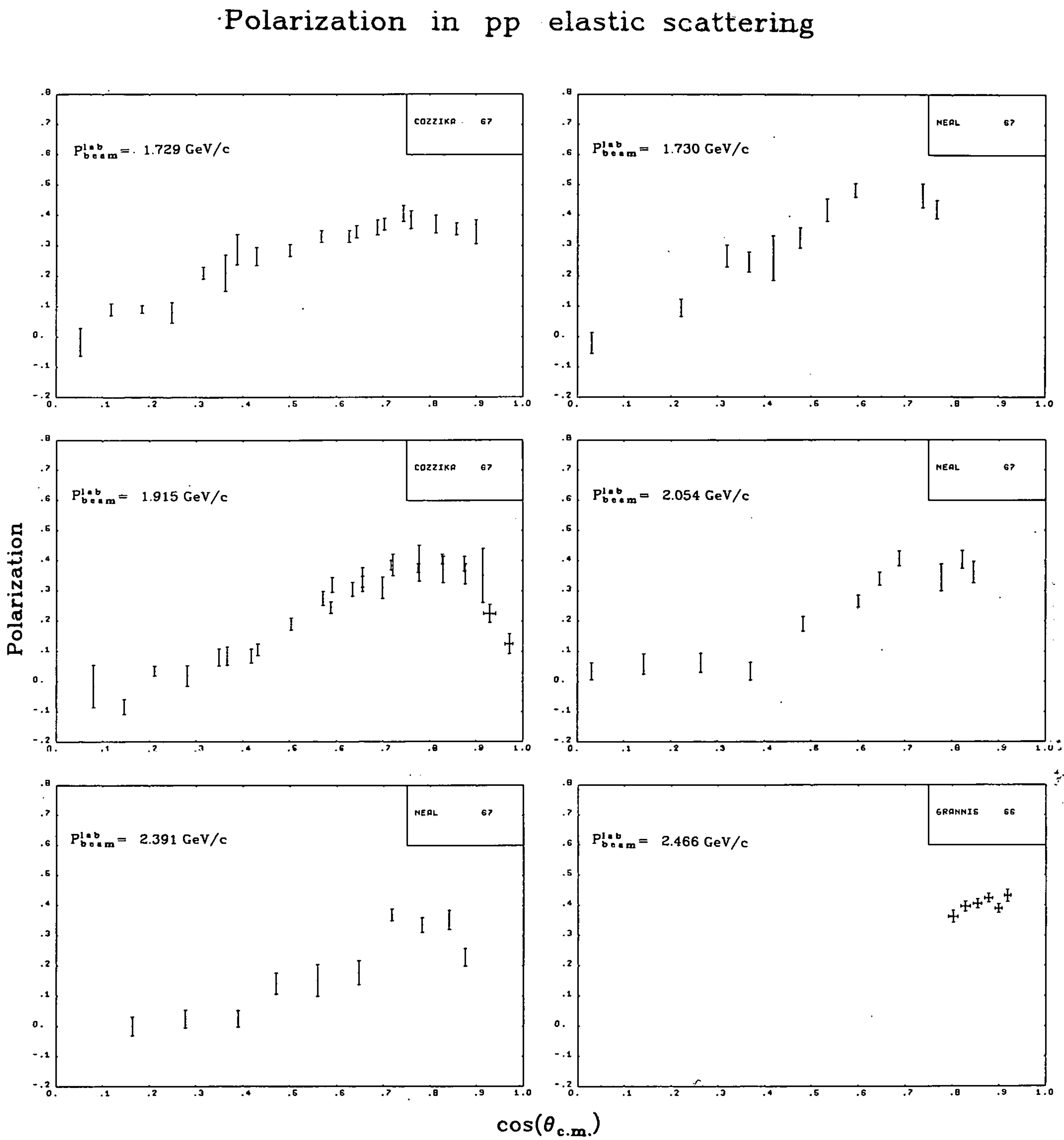


Fig. 10 (continued)

Polarization in pp elastic scattering

DISTRIBUTION IN COS(THETA) OF THE SCATT BEAM WITH RESPECT TO THE BEAM DIRECTION IN THE C.M. SYSTEM

BEAM MOMENTUM= 3.037 GEV/C

COS(THETA)	POLARIZ+-DPOL	
.083	.006	.061
.353	.093	.050
.466	.020	.041
.544	.048	.075
.588	.147	.032
.612	.134	.036
.634	.163	.037
.680	.182	.033
.726	.178	.027
.761	.205	.025
.780	.229	.052
.808	.292	.030
.862	.252	.026
.890	.315	.026
.90[illegible]	.277	.031

2Q SQUARE= 2.102
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5PER CENT

NEAL PR 161 1374(1967) CNTR+SPRK

BEAM MOMENTUM= 3.660 GEV/C

COS(THETA)	POLARIZ+-DPOL	
.297	.043	.059
.499	.115	.055
.680	.142	.071
.750	.175	.037
.810	.199	.057
.851	.237	.039
.915	.188	.054
.926	.193	.026

2Q SQUARE= 2.665
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5PER CENT

NEAL PR 161 1374(1967) CNTR+SPRK

BEAM MOMENTUM= 3.670 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
.605	.632	.104	.092
.633	.660	.171	.055
.669	.695	.130	.042
.690	.714	.156	.040
.717	.741	.218	.036
.743	.766	.142	.031
.768	.790	.196	.027
.793	.814	.225	.023
.815	.835	.242	.022
.826	.845	.283	.028
.839	.857	.270	.019
.848	.866	.221	.022
.869	.886	.260	.020
.889	.905	.255	.017
.907	.921	.245	.015
.924	.937	.237	.015
.940	.951	.188	.020
.953	.963	.151	.085

2Q SQUARE= 2.674
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12PER CENT

GRANNIS PR 148 1297(1966) CNTR

BEAM MOMENTUM= 4.338 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
.774	.795	.127	.063
.794	.815	.083	.054
.814	.834	.123	.044
.833	.852	.131	.046
.851	.869	.224	.035
.868	.885	.207	.030
.885	.900	.218	.028
.900	.915	.203	.024
.915	.928	.203	.021
.928	.941	.171	.019

2Q SQUARE= 3.284
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12PER CENT

GRANNIS PR 148 1297(1966) CNTR

BEAM MOMENTUM= 4.848 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
.878	.894	.194	.026
.894	.909	.181	.022
.909	.923	.217	.020
.923	.935	.193	.017
.935	.947	.211	.015
.948	.958	.191	.016
.958	.968	.144	.025

2Q SQUARE= 3.753
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12PER CENT

GRANNIS PR 140 1297(1966) CNTR

BEAM MOMENTUM= 5.150 GEV/C

****THIS DATA WAS READ FROM A GRAPH****

COS(THETA)	POLARIZ+-DPOL	
.566	.320	.130
.611	.180	.130
.635	.250	.100
.663	.150	.100
.695	.260	.080
.722	.240	.070
.747	.200	.050
.772	.140	.050
.794	.130	.030
.814	.150	.030
.834	.120	.020
.861	.120	.020
.881	.170	.010
.901	.180	.010
.916	.190	.010
.931	.210	.010
.945	.220	.010

2Q SQUARE= 4.031
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10PER CENT

BOOTH PRL 21 651(1968) CNTR

Polarization in pp elastic scattering

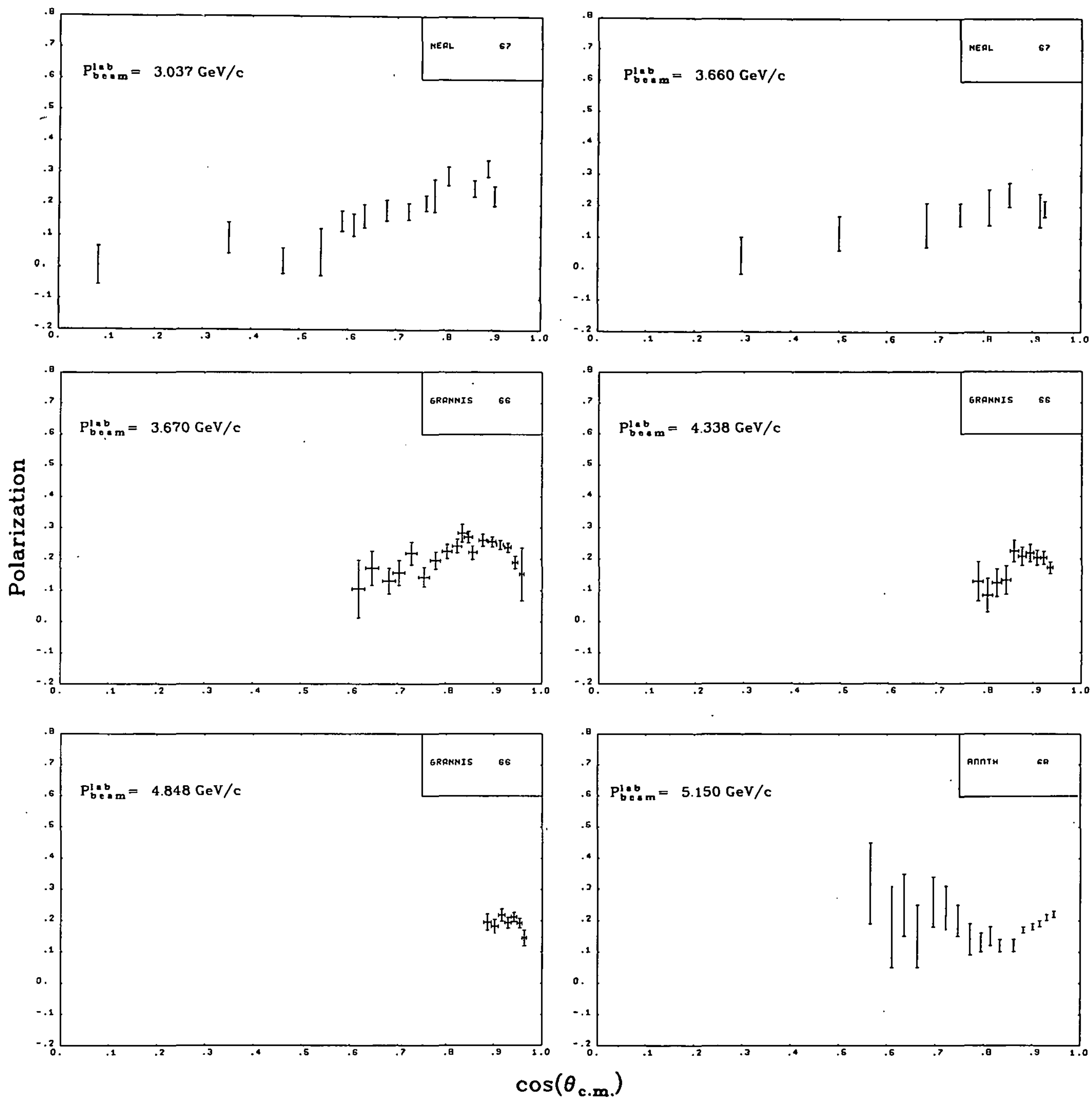


Fig. 10 (continued)

Polarization in pp elastic scattering

DISTRIBUTION IN COS(THETA) OF THE SCATT BEAM WITH RESPECT TO THE BEAM DIRECTION IN THE C.M. SYSTEM

BEAM MOMENTUM= 5.914 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
.797	.817	.041	.138
.818	.838	.100	.121
.835	.854	.206	.100
.851	.869	.231	.087
.867	.884	.008	.062
.881	.897	.145	.055
.896	.911	.201	.059
.899	.914	.138	.034
.909	.923	.226	.054
.911	.925	.136	.030
.924	.937	.185	.027
.935	.947	.178	.022
.946	.956	.153	.019
.956	.965	.166	.019
.965	.973	.152	.024
.972	.980	.089	.100

2Q SQUARE= 4.738
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12PER CENT

GRANNIS PR 148 1297(1966) CNTR

BEAM MOMENTUM= 6.000 GEV/C

COS(THETA)	POLARIZ+-DPOL	
.850	.092	.104
.862	.062	.080
.874	.135	.041
.886	.063	.029
.896	.108	.023
.907	.083	.019
.917	.117	.018
.926	.141	.017
.935	.095	.015
.944	.117	.014
.952	.101	.014
.959	.138	.016
.966	.122	.025
.972	.041	.034
.977	.124	.069

2Q SQUARE= 4.818
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5PER CENT

BORGHINI PL 24B 77(1967) CNTR

BEAM MOMENTUM= 6.000 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
.481	.564	.060	.092
.564	.606	.086	.102
.606	.647	.120	.127
.647	.689	.074	.086
.689	.730	.154	.069
.730	.751	.244	.083
.751	.772	.217	.073
.772	.792	.131	.062
.792	.803	.100	.068
.803	.813	.034	.056
.813	.824	.039	.045
.824	.834	.064	.042
.834	.844	.107	.037
.844	.855	.097	.030
.855	.865	.107	.029
.865	.875	.112	.029
.875	.886	.052	.019
.886	.896	.090	.017
.896	.907	.099	.015
.907	.917	.113	.013
.917	.927	.124	.011
.927	.938	.112	.009
.938	.948	.142	.009
.948	.958	.131	.007
.958	.969	.137	.007
.969	.979	.129	.008
.979	.990	.108	.032

2Q SQUARE= 4.818
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5PER CENT

BORGHINI PL 31B 405(1970) CNTR

BEAM MOMENTUM= 7.026 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
.860	.877	.002	.074
.874	.890	.142	.053
.888	.903	.085	.042
.897	.912	.077	.064
.901	.916	.117	.032
.910	.924	.157	.053
.913	.927	.169	.027
.922	.935	.160	.092
.933	.945	.262	.037
.943	.954	.177	.031
.953	.963	.196	.028
.961	.970	.177	.031
.969	.977	.112	.049

2Q SQUARE= 5.770
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12PER CENT

GRANNIS PR 148 1297(1966) CNTR

BEAM MOMENTUM=10.000 GEV/C

COS(THETA)	POLARIZ+-DPOL	
.913	.080	.045
.920	.117	.046
.927	.077	.037
.934	.067	.028
.941	.024	.023
.947	.067	.019
.953	.081	.018
.959	.093	.017
.964	.082	.014
.969	.071	.013
.973	.093	.013
.978	.097	.015
.981	.058	.023
.985	.059	.030
.988	.074	.072

2Q SQUARE= 8.543
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5PER CENT

BORGHINI PL 24B 77(1967) CNTR

BEAM MOMENTUM=12.000 GEV/C

COS(THETA)	POLARIZ+-DPOL	
.927	.002	.056
.940	.066	.026
.948	.073	.023
.954	.046	.020
.959	.031	.019
.964	.055	.017
.969	.081	.014
.973	.064	.013
.977	.066	.012
.981	.042	.013
.984	.036	.018
.987	.032	.023
.990	.034	.055

2Q SQUARE= 10.413
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5PER CENT

BORGHINI PL 24B 77(1967) CNTR

Polarization in pp elastic scattering

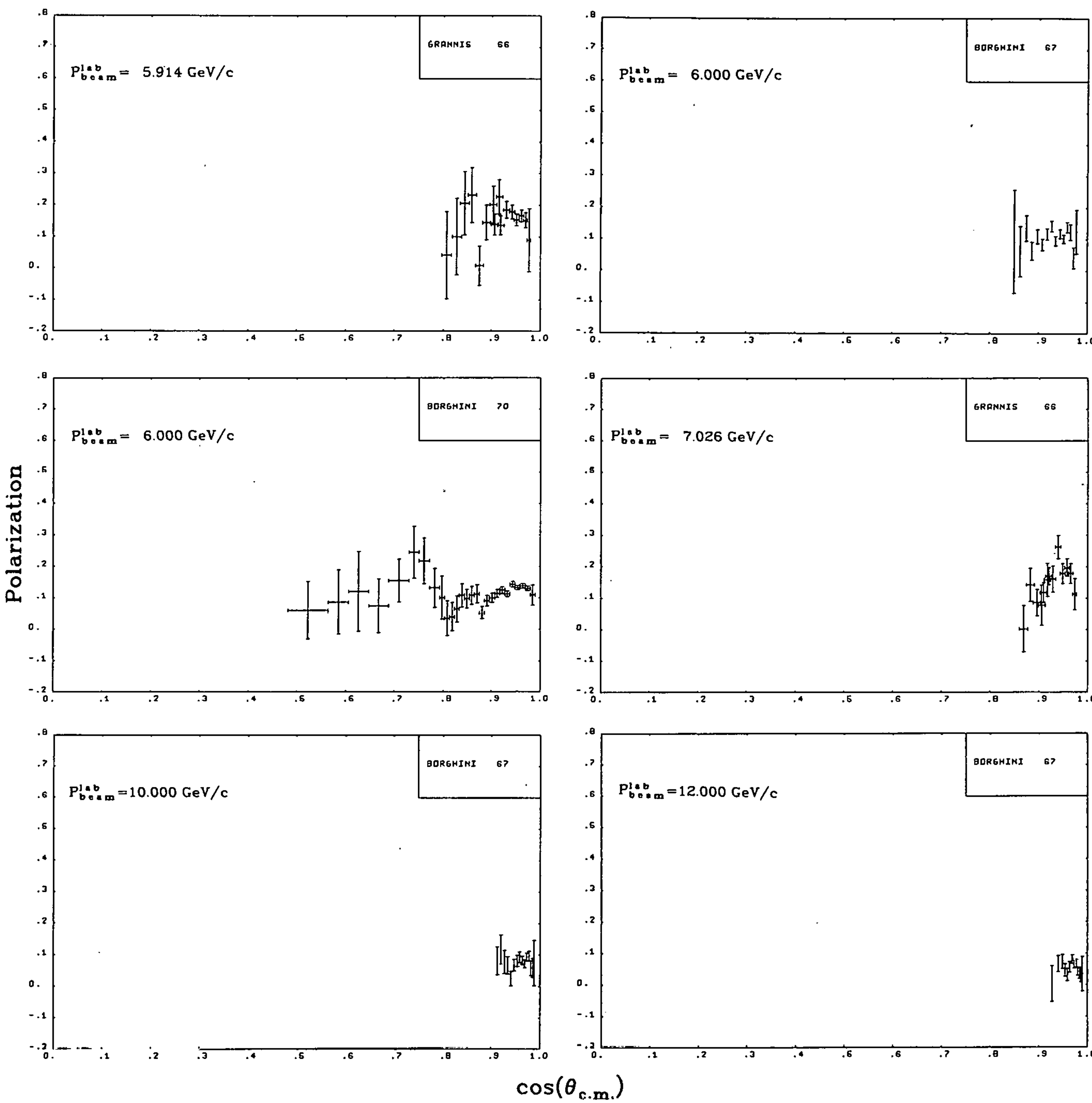
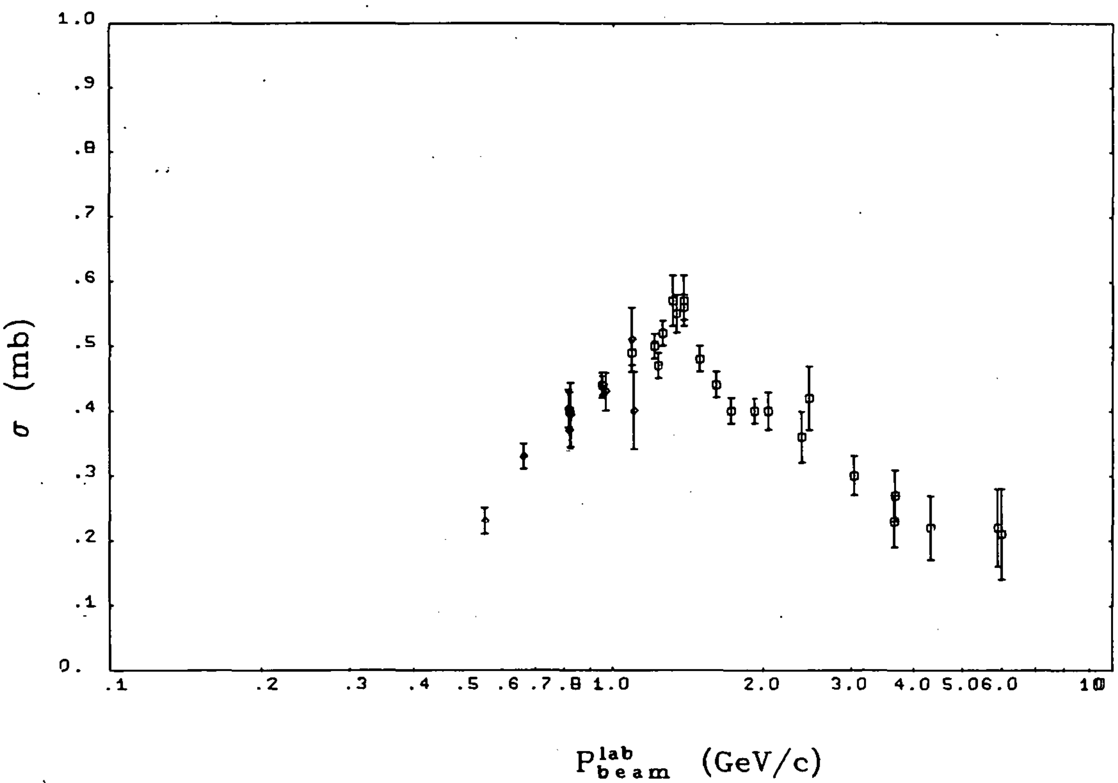


Fig. 10 (continued)

Maximum polarization in pp elastic scattering.



P_{beam} (GeV/c)	$E_{c.m.}$ (GeV)	Polarization		References	
.55	1.95	.23	± .02	GRANNIS	66 X
.66	1.98	.33	.02	GRANNIS	66 X
.82	2.02	.40	.03	GRANNIS	66 X
.92	2.03	.37	.03	GRANNIS	66 X
.82	2.02	.40	.03	CHENG	67
.82	2.03	.39	.05	GRANNIS	66 X
.95	2.07	.44	.02	CHENG	67
.95	2.07	.44	.01	GRANNIS	66 X
.97	2.07	.43	.03	GRANNIS	66 X
1.09	2.11	.49	.02	CHENG	67
1.09	2.11	.51	.05	GRANNIS	66 X
1.10	2.12	.40	.06	GRANNIS	66 X
1.21	2.15	.50	.02	COIGNET	66
1.23	2.16	.47	.02	COZZIKA	67
1.26	2.17	.52	.02	KAZARINOV	67
1.32	2.19	.57	.04	BETZ	66
1.34	2.20	.55	.03	CHENG	67
1.39	2.22	.56	.02	COZZIKA	67
1.39	2.22	.57	.04	BETZ	66
1.49	2.25	.48	.02	COZZIKA	67
1.61	2.29	.44	.02	COZZIKA	67
1.73	2.34	.40	.02	COZZIKA	67
1.92	2.40	.40	.02	COZZIKA	67
2.05	2.45	.40	.03	NEAL	67
2.39	2.56	.36	.04	NEAL	67
2.47	2.59	.42	.05	GRANNIS	66
3.04	2.78	.30	.03	NEAL	67
3.66	2.98	.23	.04	NEAL	67
3.67	2.98	.27	.04	GRANNIS	66
4.34	3.18	.22	.05	GRANNIS	66
5.90	3.60	.22	.06	GRANNIS	66
6.00	3.63	.21	.07	BORGHINI	70

X DATA TAKEN FROM A REVUE ARTICLE

Fig. 11. The maximum polarization in pp elastic scattering as a function of beam momentum [after Grannis et al., Phys. Rev. 148, 1297 (1966)]. The points represented by diamonds are from the compilation by Grannis et al. The squares are our estimates from the distributions in Fig. 10.

pp Inelastic Interactions—Non-Strange Particle Production

$pp \rightarrow \begin{cases} pn\pi^+ \\ pp\pi^0 \end{cases}$

P_{beam} (GeV/c)	$\sigma_{pp\pi^0}$ (mb)		$\sigma_{pn\pi^+}$ (mb)		References	
1.17	.91	± .15	5.21	± .44	BALDONI	62
1.39	3.46	.25			CENCE	63
1.66	3.70	.30	18.30	.70	BUGG	64
2.23	3.98	+ .27 - .26	17.22	+ .66 - .57	EISNER	65
2.81	3.85	.22	16.06	.44	FICKINGER	62
3.67	2.90	.31	11.44	.65	SMITH	61
4.00	2.60	.30	9.70	.40	COLETTI	67
5.52	2.77	.11	8.03	.19	ALEXANDER	67
6.07	2.80	.30	6.70	.50	TAN	68
6.60			5.73	.35	MA	69
6.60	2.06	.19	4.89	.28	COLTON	68
6.92	2.00	.20	5.20	.40	ALEXANDER	68
8.10	1.75	.20	4.50	.40	GINESTET	69
10.01	1.40	.30	4.10	.40	ALMEIDA	68
19.00	1.10	.20	1.90	.20	BOGGILD	69
28.50			1.50	.10	CONNOLLY	67

REFERENCES

1	SMITH	61.....PR	123 2160	HBC
2	BALDONI	62.....NC	26 1376	HBC
3	FICKINGER	62.....PR	125 2082	HBC
4	CENCE	63.....PR	131 2713	CNTR
5	BUGG	64.....PR	133B1017	HBC
6	EISNER	65.....PR	138 B670	HBC
7	ALEXANDER	67.....PR	154 1284	HBC
8	COLETTI	67.....NC	49A 479	HBC
9	CONNOLLY	67.....BNL	11980	HBC
10	ALEXANDER	68.....PR	173 1322	HBC
11	ALMEIDA	68.....PR	174 1638	HBC
12	COLTON	68.....UCLA	1025	HBC
13	TAN	68.....PL	28B 195	HBC
14	BOGGILD	69.....PL	30B 369	HBC
15	GINESTET	69.....NP	B13 283	HBC
16	MA	69.....PRL	23 342	HBC

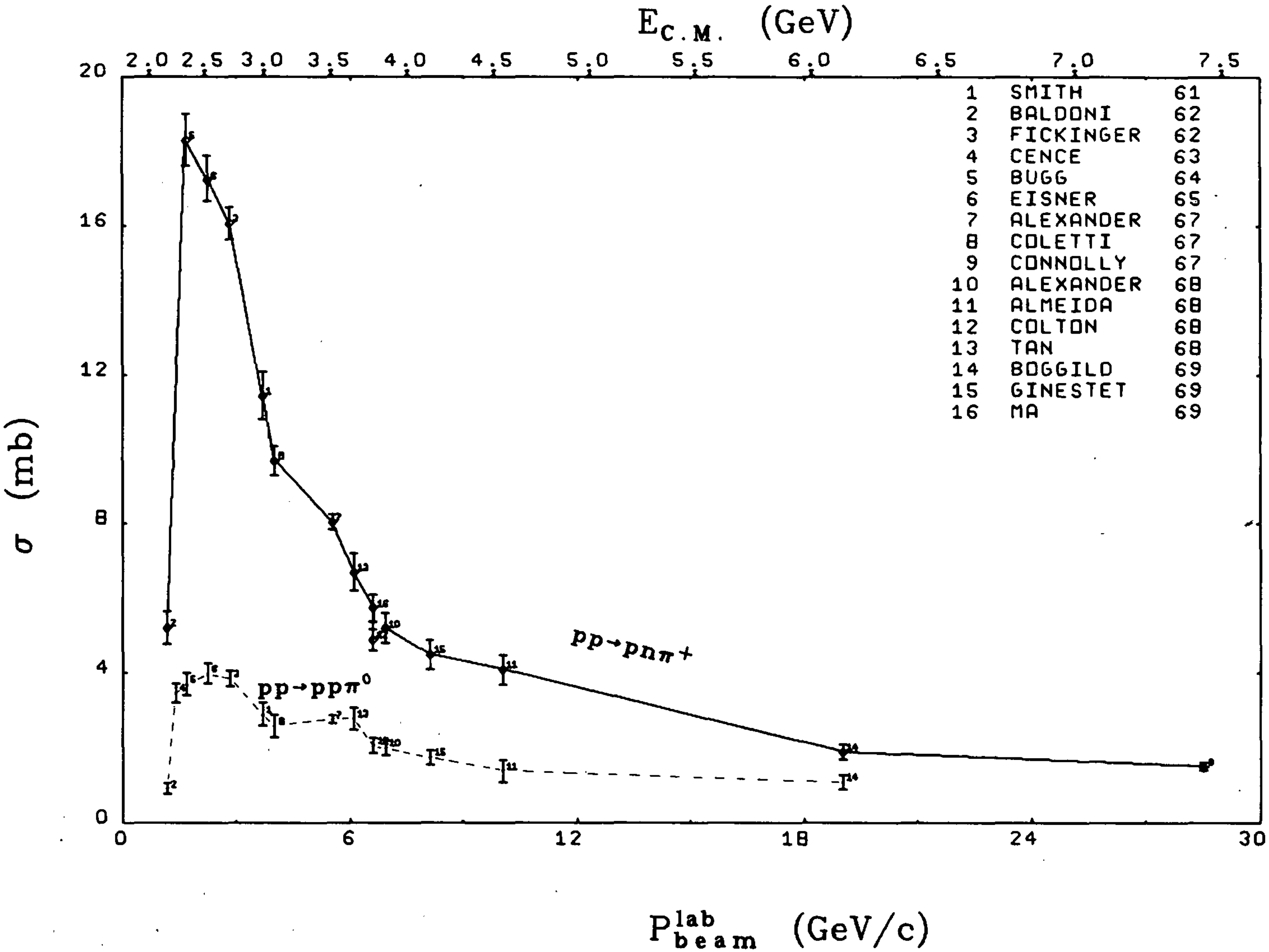


Fig. 12. Single-pion production in pp collisions including contributions from resonances.

$pp \to \begin{cases} pn\pi^+ \\ pp\pi^0 \end{cases}$

Cross section for $pp \to d\pi^+$

P_{beam} (GeV/c)		$E_{c.m.}$ (GeV)	$\sigma_{d\pi^+}$ (mb)		References	
1.17	± .10	2.14	2.75	± .29	BALDONI	62
1.66	.17	2.31	.48	.08	BUGG	64
1.68		2.32	.55	.03	CHAPMAN	64
1.70		2.32	.45	.05	HEINZ	68
2.03		2.44	.22	.02	HEINZ	68
2.23	.06	2.51	.13	.05	EISNER	65
2.25		2.52	.12	.01	HEINZ	68
2.47		2.59	.08	.01	HEINZ	68
2.78		2.70	.05	.01	HEINZ	68
3.31		2.87	.03	.003	HEINZ	68
3.62		2.96	.03	.003	HEINZ	68
3.67	.11	2.98	.11	.06	SMITH	61
4.00	.04	3.08	.03	.01	COLETTI	67
6.60	.01	3.78	.01		COLTON	68
21.10	.42	6.43	$(15.1 \pm 1.5) \times 10^{-6}$		ALLABY	69

REFERENCES

1	SMITH	61.....PR	123 2160	HBC
2	BALDONI	62.....NC	26 1376	HBC
3	BUGG	64.....PR	133B1017	HBC
4	CHAPMAN	64.....PL	11 253	CNTR
5	EISNER	65.....PR	138 B670	HBC
6	COLETTI	67.....NC	49A 479	HBC
7	COLTON	68.....UCLA	1025	HBC
8	HEINZ	68.....PR	167 1232	CNTR
9	ALLABY	69.....PL	29B 198	CNTR

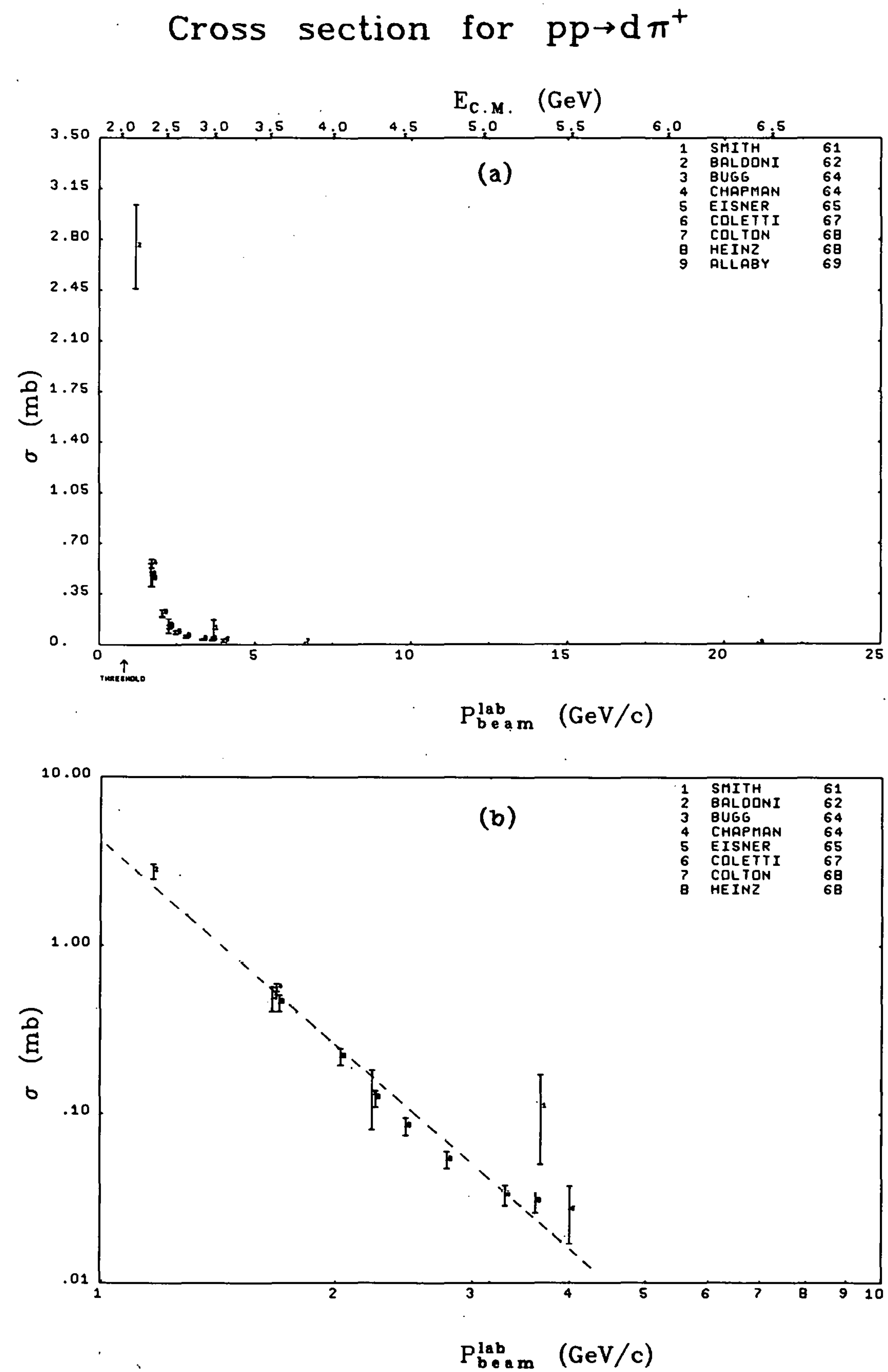


Fig. 13. Cross section for pp → $d\pi^+$. (a) Linear representation; (b) log-log display. The dashed line represents our best fit to these data, using $\sigma = Kp_{\text{beam}}^{-n}$, $n = 4.29 \pm 0.04$ (see text).

Differential Cross section for $pp \rightarrow d\pi^+$

DISTRIBUTION IN COS(THETA) OF THE DEUTERON WITH RESPECT TO THE BEAM DIRECTION IN THE C.M. SYSTEM

BEAM MOMENTUM= 1.168 GEV/C

****THIS DATA WAS READ FROM A GRAPH****

COS(THETA) MINIMUM	COS(THETA) MAXIMUM	SIGMA +- DSIGMA (NUMBER OF EVENTS)	
-.800	-.700	8.000	2.828
-.700	-.600	5.000	2.236
-.600	-.500	4.000	2.000
-.500	-.400	6.000	2.449
-.400	-.300	5.000	2.236
-.300	-.200	2.000	1.414
-.200	-.100	1.000	1.000
-.100	0.	5.000	2.236
0.	.100	5.000	2.236
.100	.200	5.000	2.236
.200	.300	9.000	3.000
.300	.400	4.000	2.000
.400	.500	3.000	1.732
.500	.600	4.000	2.000
.600	.700	5.000	2.236
.700	.800	12.000	3.464

2Q SQUARE= .525

BALDONI NC 26 1376(1962) HBC

BEAM MOMENTUM= 1.696 GEV/C

COS(THETA)	SIGMA +- DSIGMA (MICROBARNS/STERADIAN)	
-.960	50.100	2.500
-.930	49.900	2.700
-.900	52.100	2.000
-.800	51.200	2.400
-.700	45.900	2.200
-.600	42.100	1.500
-.500	33.400	1.700
-.400	31.900	1.600
-.300	24.400	1.200
-.200	23.500	1.100
-.100	21.000	.900
0.	20.300	.900

2Q SQUARE= .938
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10PER CENT

HEINZ PR 167 1232(1968) CNTR

BEAM MOMENTUM= 2.032 GEV/C

COS(THETA)	SIGMA +- DSIGMA (MICROBARNS/STERADIAN)	
-.950	17.500	1.300
-.925	22.700	1.600
-.900	21.000	.800
-.850	24.200	1.100
-.800	25.000	.900
-.700	23.800	.800
-.600	20.100	.700
-.500	17.000	.900
-.400	14.500	.700
-.300	13.600	.700
-.200	12.400	.600
-.100	13.000	.700
0.	12.200	.600

2Q SQUARE= 1.220
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10PER CENT

HEINZ PR 167 1232(1968) CNTR

BEAM MOMENTUM= 2.251 GEV/C

COS(THETA)	SIGMA +- DSIGMA (MICROBARNS/STERADIAN)	
-.965	9.900	.800
-.950	12.100	.700
-.925	14.600	1.000
-.900	15.900	.600
-.850	16.400	.600
-.800	13.300	.800
-.700	13.100	.700
-.600	10.200	.500
-.500	9.700	.500
-.400	7.600	.300
-.300	8.600	.500
-.200	6.900	.500
-.100	6.200	.400
0.	6.300	.400

2Q SQUARE= 1.407
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10PER CENT

HEINZ PR 167 1232(1968) CNTR

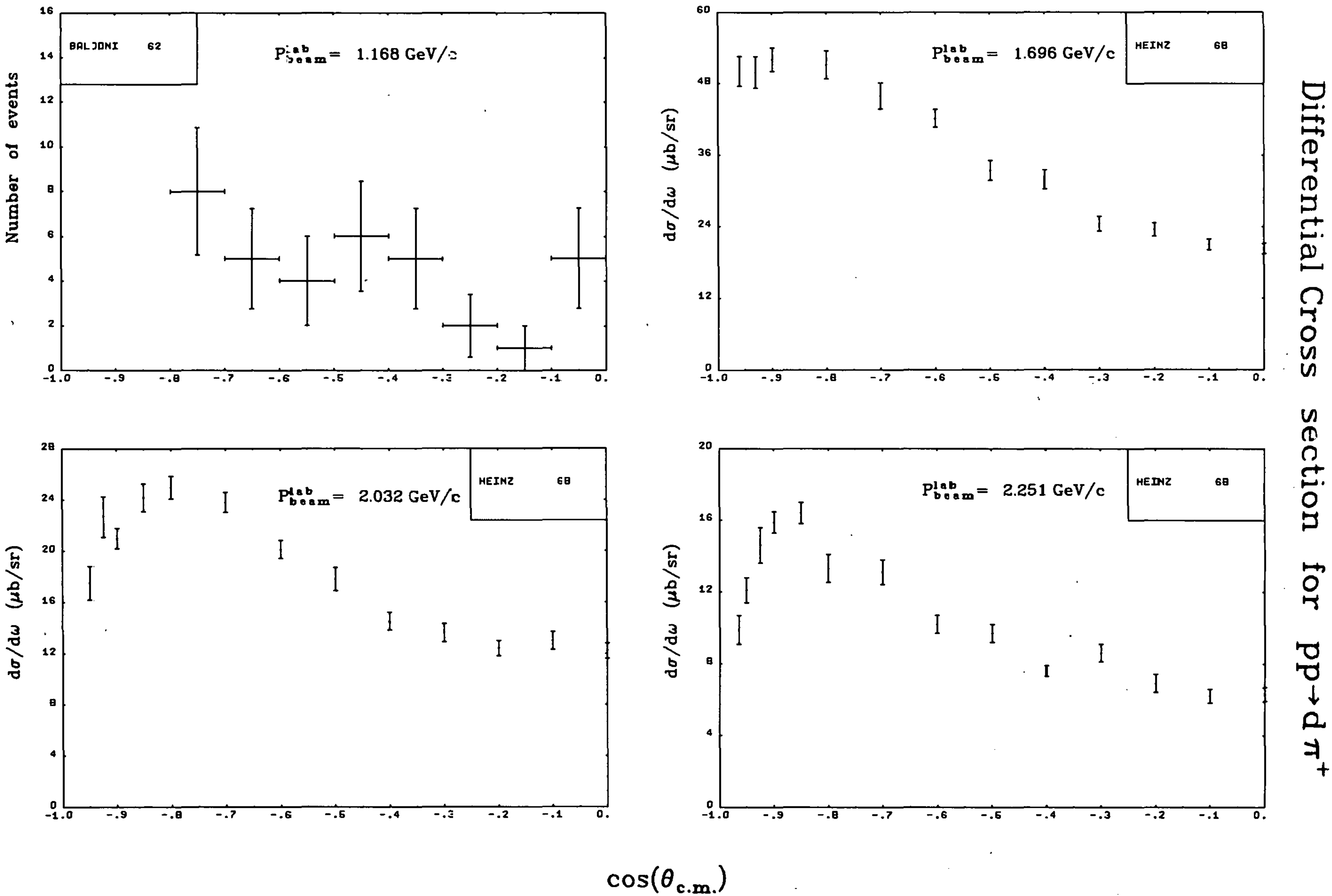


Fig. 14. Differential cross sections for $pp \rightarrow d\pi^+$. Because of the identity of the particles in the initial state, these distributions are symmetric about $\theta_{c.m.}$ = 90 deg.

Differential Cross section for $pp \to d\pi^+$

DISTRIBUTION IN COS(THETA) OF THE DEUTERON WITH RESPECT TO THE BEAM DIRECTION IN THE C.M. SYSTEM

BEAM MOMENTUM= 2.466 GEV/C

COS(THETA)	SIGMA +- DSIGMA (MICROBARNS/STERADIAN)	
-.965	10.600	.900
-.950	12.500	.900
-.925	14.600	.700
-.900	16.100	.800
-.850	12.900	.900
-.800	11.900	.800
-.700	9.400	.500
-.600	6.000	.400
-.500	5.000	.300
-.400	4.400	.200
-.300	3.000	.200
-.200	3.100	.200
-.100	3.000	.200
0.	2.900	.200

2Q SQUARE= 1.595
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10PER CENT

HEINZ PR 167 1232(1968) CNTR

BEAM MOMENTUM= 2.784 GEV/C

COS(THETA)	SIGMA +- DSIGMA (MICROBARNS/STERADIAN)	
-.965	9.500	.700
-.940	8.300	.600
-.920	10.200	.700
-.900	10.000	.500
-.850	8.400	.500
-.800	7.300	.400
-.700	6.200	.300
-.600	4.700	.300
-.500	2.900	.200
-.400	2.400	.100
.200	1.300	.100
-.100	1.200	.100
0.	1.100	.100

2Q SQUARE= 1.877
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10PER CENT

HEINZ PR 167 1232(1968) CNTR

BEAM MOMENTUM= 3.308 GEV/C

COS(THETA)	SIGMA +- DSIGMA (MICROBARNS/STERADIAN)	
-.970	12.300	1.200
-.950	10.600	.800
-.925	6.400	1.000
-.900	5.700	.400
-.800	3.500	.200
-.700	2.700	.300
-.600	1.900	.200
-.500	1.400	.100
-.300	.700	.100
-.100	.000	.100

2Q SQUARE= 2.346
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10PER CENT

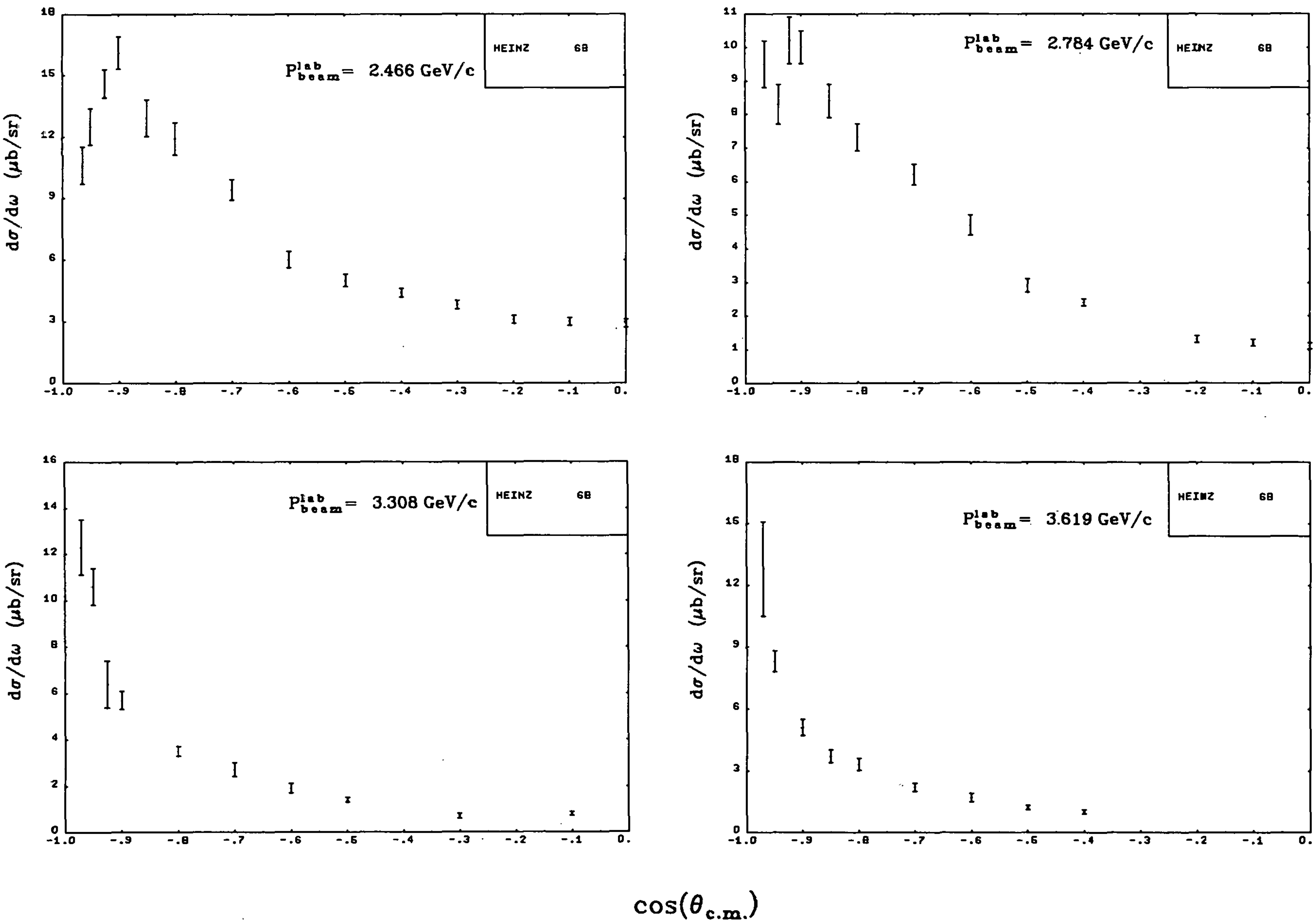
HEINZ PR 167 1232(1968) CNTR

BEAM MOMENTUM= 3.619 GEV/C

COS(THETA)	SIGMA +- DSIGMA (MICROBARNS/STERADIAN)	
-.970	12.800	2.300
-.950	8.300	.500
-.900	5.100	.400
-.850	3.700	.300
-.800	3.300	.300
-.700	2.200	.200
-.600	1.700	.200
-.500	1.200	.100
-.400	1.000	.100

2Q SQUARE= 2.627
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10PER CENT

HEINZ PR 167 1232(1968) CNTR



Differential Cross section for $pp \rightarrow d\pi^+$

Fig. 14 (continued)

$pp \rightarrow pp\pi^+\pi^-$

P_{beam} (GeV/c)		$E_{c.m.}$ (GeV)	$\sigma_{pp\pi^+\pi^-}$ (mb)		References	
2.23	± .06	2.51	1.22	± .14	EISNER	65
2.81		2.70	2.51	.14	PICKUP	62
3.67	.06	2.98	2.67	.13	HART	62
4.00		3.08	2.95	.15	BODINI	68
4.95	.03	3.35	2.96	.12	COLLERAINE	67
5.52	.01	3.50	2.84	.08	ALEXANDER	67
5.97	.05	3.62	2.80	.10	CASO	68
6.04	.03	3.64	3.20	.30	CHINOWSKY	68
6.60	.01	3.78	2.70	.16	COLTON	68
6.90		3.85	3.00	.30	YEKUTIELI	69
7.87	.04	4.08	2.54	.13	GRETHER	68
8.11	.08	4.13	2.46	.10	KAYAS	68
10.01	.01	4.54	2.40	.20	ALMEIDA	68
16.00		5.64	1.66	+ .13 − .06	RUSHBROOKE	69
19.00		6.12	1.50	.20	BOGGILD	68
21.80		6.54	1.36	.16	JESPERSEN	68
24.80		6.95	1.50	.20	EHRLICH	68
28.50		7.43	1.10	.20	CONNOLLY	67

REFERENCES

1	HART	62.....PR	126	747	HBC
2	PICKUP	62.....PR	125	2091	HBC
3	EISNER	65.....PR	138	B670	HBC
4	ALEXANDER	67.....PR	154	1284	HBC
5	COLLERAINE	67.....PR	161	1387	HBC
6	CONNOLLY	67.....BNL	11980		HBC
7	ALMEIDA	68.....PR	174	1638	HBC
8	BODINI	68.....NC	58A	175	HBC
9	BOGGILD	68.....SUB VNA			HBC
10	CASO	68.....NC	55A	66	HBC
11	CHINOWSKY	68.....PR	171	1421	HBC
12	COLTON	68.....UCLA	1025		HBC
13	EHRLICH	68.....PRL	21	1839	HBC
14	GRETHER	68.....ILL	C001195125		HBC
15	JESPERSEN	68.....PRL	21	1368	HBC
16	KAYAS	68.....NP	B5	169	HBC
17	RUSHBROOKE	69.....PRL	22	248	HBC
18	YEKUTIELI	69.....REHO			HBC

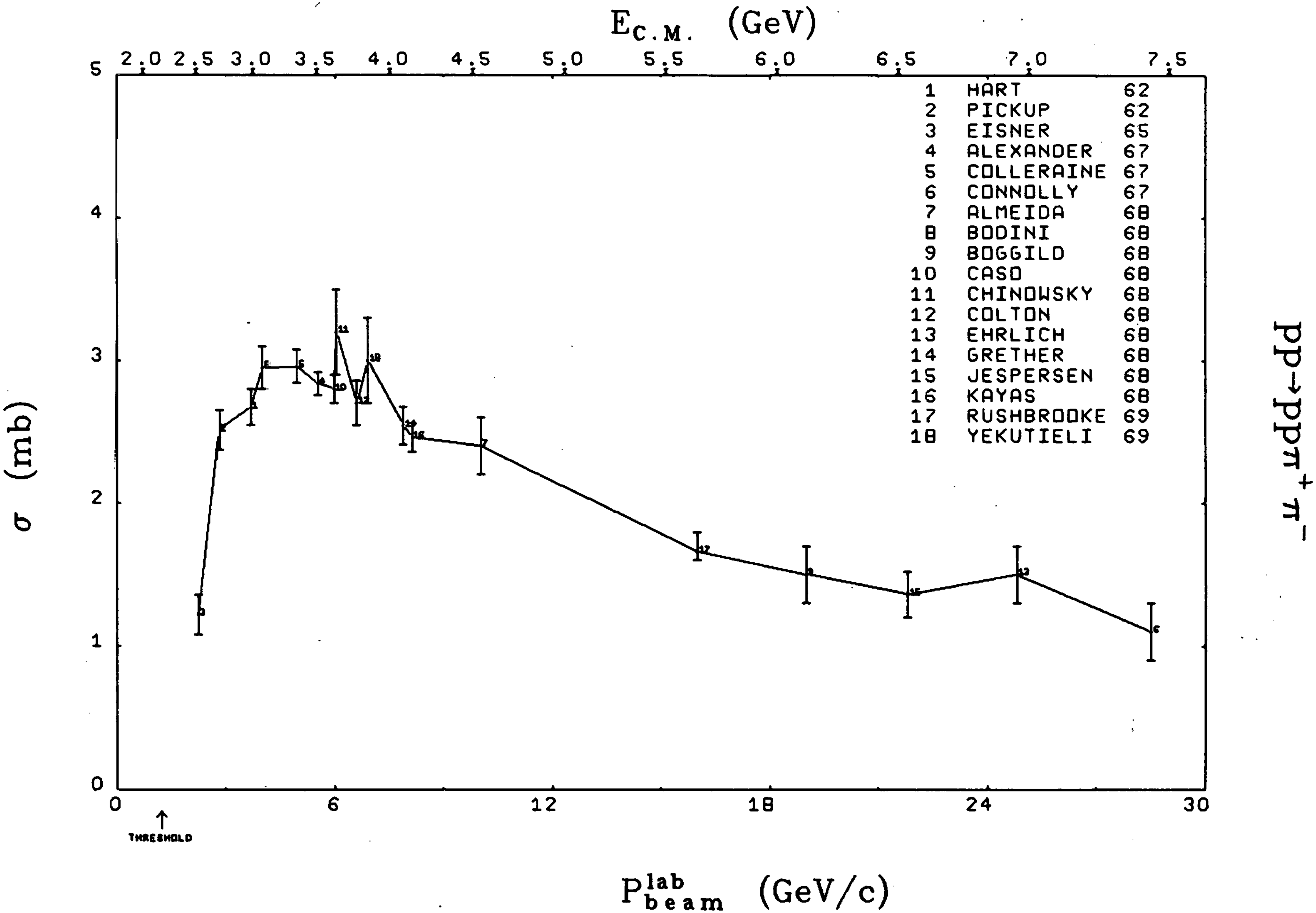


Fig. 15. Cross sections for $pp \rightarrow pp\pi^+\pi^-$ including any contributions from resonances.

$$pp \rightarrow \begin{cases} pn\pi^+\pi^+\pi^- \\ pp\pi^+\pi^-\pi^0 \end{cases}$$

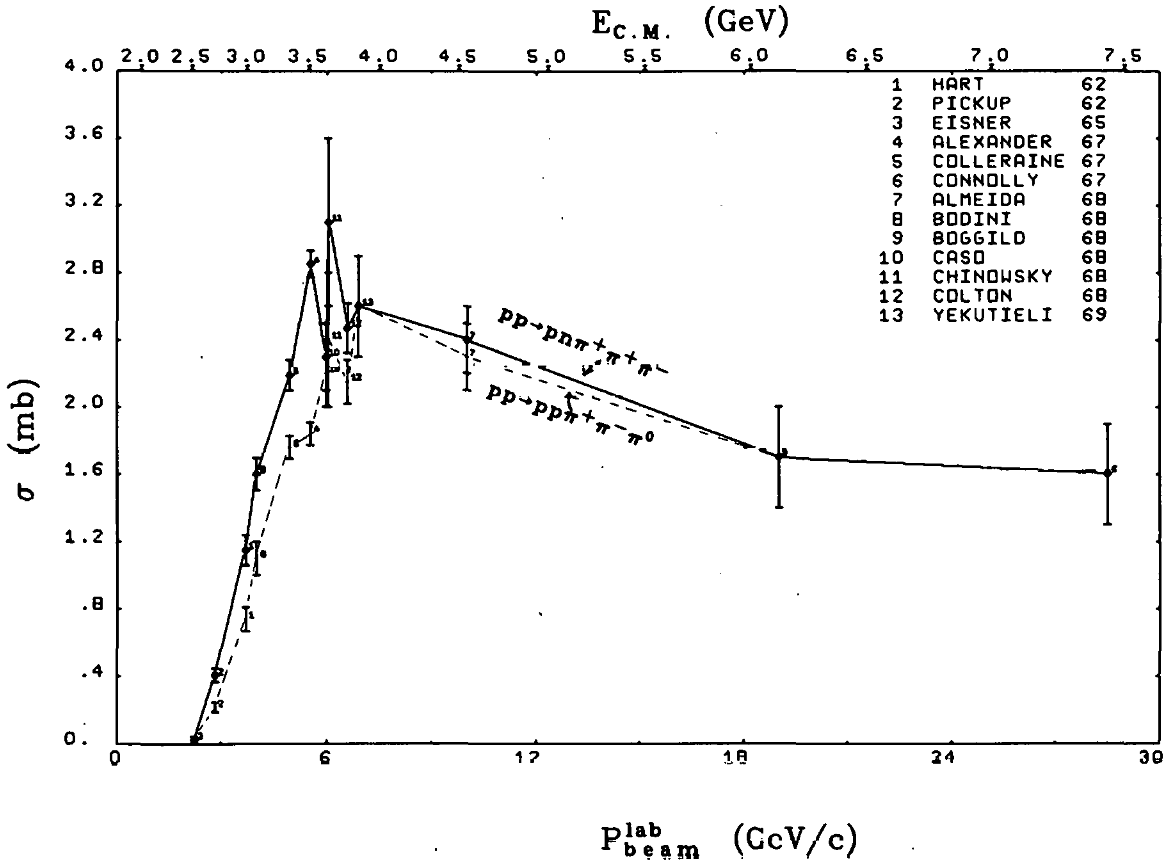


Fig. 16. Cross section for $pp \rightarrow pn\,\pi^+\pi^+\pi^-$ and $pp \rightarrow pp\,\pi^+\pi^-\pi^0$, including contributions from resonances.

P_{beam} (GeV/c)	$\sigma_{pp\pi^+\pi^-\pi^0}$ (mb)		$\sigma_{pn\pi^+\pi^+\pi^-}$ (mb)		References	
2.23	.02	± .02	.02	± .02	EISNER	65
2.81	.22	.03	.40	.04	PICKUP	62
3.67	.74	.07	1.15	.09	HART	62
4.00	1.10	.10	1.60	.10	BODINI	68
4.95	1.76	.07	2.19	.09	COLLERAINE	67
5.52	1.84	.07	2.85	.08	ALEXANDER	67
5.97	2.20	.20	2.30	.20	CASO	68
6.04	2.40	.40	3.10	.50	CHINOWSKY	68
6.60	2.15	.13	2.47	.15	COLTON	68
6.90	2.60	.30	2.60	.30	YEKUTIELI	69
10.01	2.30	.20	2.40	.20	ALMEIDA	68
19.00	1.70	.30	1.70	.30	BOGGILD	68
28.50			1.60	.30	CONNOLLY	67

REFERENCES

1	HART	62.....PR	126 747	HBC
2	PICKUP	62.....PR	125 2091	HBC
3	EISNER	65.....PR	138 B670	HBC
4	ALEXANDER	67.....PR	154 1284	HBC
5	COLLERAINE	67.....PR	161 1387	HBC
6	CONNOLLY	67.....BNL	11980	HBC
7	ALMEIDA	68.....PR	174 1638	HBC
8	BODINI	68.....NC	58A 175	HBC
9	BOGGILD	68.....SUB VNA		HBC
10	CASO	68.....NC	55A 66	HBC
11	CHINOWSKY	68.....PR	171 1421	HBC
12	COLTON	68.....UCLA	1025	HBC
13	YEKUTIELI	69.....REHO		HBC

Table II. Some nonstrange inelastic reactions in pp scattering.

P_{beam} (GeV/c)	$\sigma_{pn\pi^+\pi^0}$ (mb)	$\sigma_{nn\pi^+\pi^+}$ (mb)	$\sigma_{pp\pi^0\pi^0}$ (mb)	$\sigma_{pn\pi^+\pi^0\pi^0}$ (mb)	References
2.23	2.37 ± .20	.25 ± .06	.41 ± .08		EISNER 65
4.00	3.80 .30			1.80 ± .20	BODINI 68

REFERENCES

1	EISNER	65.....PR	138 B670	HBC
2	BODINI	68.....NC	58A 175	HBC

P_{beam} (GeV/c)	$\sigma_{pp\pi^+\pi^+\pi^-\pi^-}$ (mb)	$\sigma_{pp\pi^+\pi^+\pi^-\pi^-\pi^0}$ (mb)	$\sigma_{pn\pi^+\pi^+\pi^+\pi^-\pi^-}$ (mb)	References
5.52	.23 ± .02	.09 ± .01	.10 ± .01	ALEXANDER 67
10.00	.46 .04	.69 .05	.54 .04	HOLMGREN 68
28.50	.38			CONNOLLY 69

REFERENCES

1	ALEXANDER	67.....PR	154 1284	HBC
2	HOLMGREN	68.....NC	57A 20	HBC
3	CONNOLLY	69.....BNL	13694	HBC

P_{beam} (GeV/c)	$\sigma_{d\pi^+\pi^+\pi^-}$ (mb)	$\sigma_{d\pi^+\pi^+\pi^-\pi^0}$ (mb)	References
3.67	.06 ± .02		HART 62
4.00	.04 .01		COLETTI 67
4.95	.02 .01	.08 + .01 − .03	COLLERAINE 67
6.00	.04 .01	.16 ± .03	KINSEY 68

REFERENCES

1	HART	62.....PR	126 747	HBC
2	COLETTI	67.....NC	49A 479	HBC
3	COLLERAINE	67.....PR	161 1387	HBC
4	KINSEY	68.....UCRL	17707	HBC

P_{beam} (GeV/c)	$E_{c.m.}$ (GeV)	$\sigma_{d\rho^+}$ (mb)	References
21.10 .42	6.43	$(15.9 \pm 2.4) \times 10^{-6}$	ALLABY 69

REFERENCES

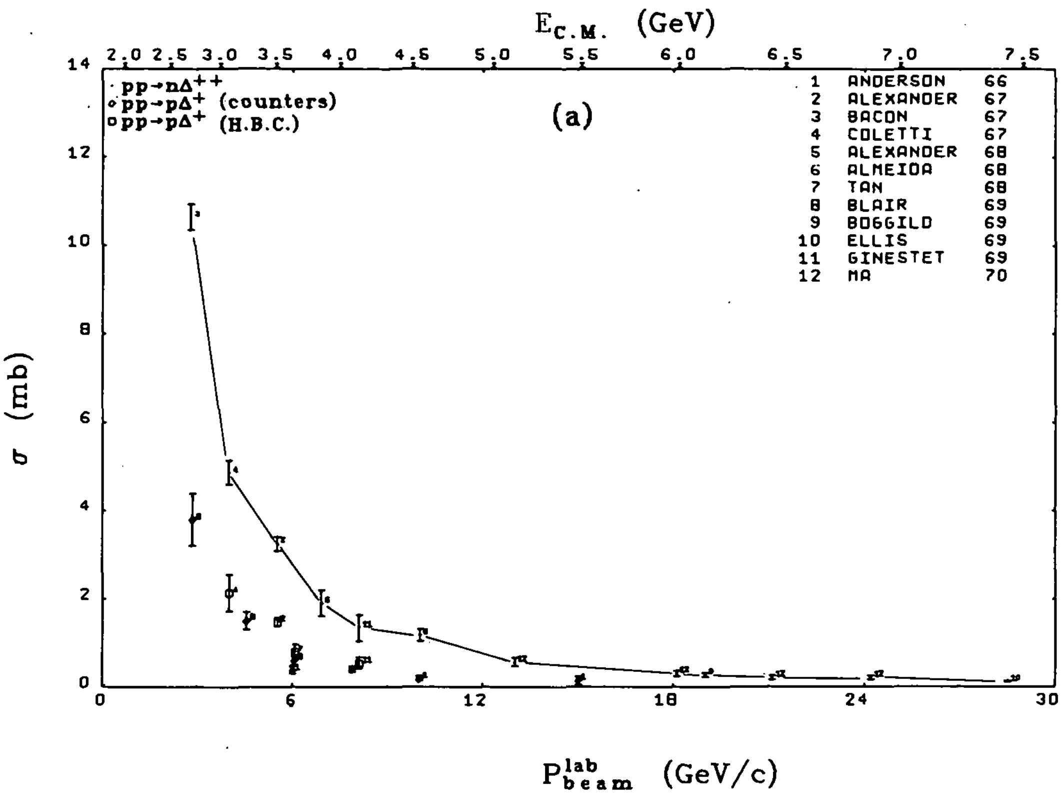
1	ALLABY	69.....PL	29B 198	CNTR

P_{beam} (GeV/c)	$\sigma_{p\Delta^+}$ (mb) $\Delta^+ \to p\pi^0$		$\sigma_{p\Delta^+}$ (mb) $\Delta^+ \to n\pi^+$		$\sigma_{p\Delta^+}$ (mb) $\Delta^+ \to$ all modes		$\sigma_{n\Delta^{++}}$ (mb)		References	
2.800							10.630 ±	.290	BACON	67
2.850					3.800 ±	.600			BLAIR	69
4.000	1.170 ±	.293	.970 ±	.294	2.140	.415	4.350	.279	COLETTI	67
4.550					1.500	.200			BLAIR	69
5.520	.720	.050	.750	.080	1.470	.094	3.250	.160	ALEXANDER	67
6.000					.376	.076			ANDERSON	66
6.060					.600	.100			BLAIR	69
6.070	.520	.130	.280	.080	.800	.153			TAN	68
6.920							1.900	.300	ALEXANDER	68
7.880					.410	.060			BLAIR	69
8.100	.150	.070	.400	.100	.530	.122	1.350	.300	GINESTET	69
10.000					.184	.050			ANDERSON	66
10.010							1.180	.140	ALMEIDA	68
13.000							.550	.099	MA	70
15.000					.142	.100			ANDERSON	66
18.100							.301	.052	MA	70
19.000							.270	.050	BOGGILD	69
21.100							.217	.053	MA	70
24.200							.205	.047	MA	70
28.500							.115	.015	ELLIS	69

REFERENCES

1	ANDERSON	66.....PRL	16	855	SPRK
2	ALEXANDER	67.....PR	154	1284	HBC
3	BACON	67.....PR	162	1320	HBC
4	COLETTI	67.....NC	49A	479	HBC
5	ALEXANDER	68.....PR	173	1322	HBC
6	ALMEIDA	68.....PR	174	1638	HBC
7	TAN	68.....PL	28B	195	HBC
8	BLAIR	69.....NC	63A	529	CNTR
9	BOGGILD	69.....PL	30B	369	HBC
10	ELLIS	69.....BNL	13671		HBC
11	GINESTET	69.....NP	B13	283	HBC
12	MA	70.....PRL	24	1031	HBC

$pp \to N\Delta(1236)$



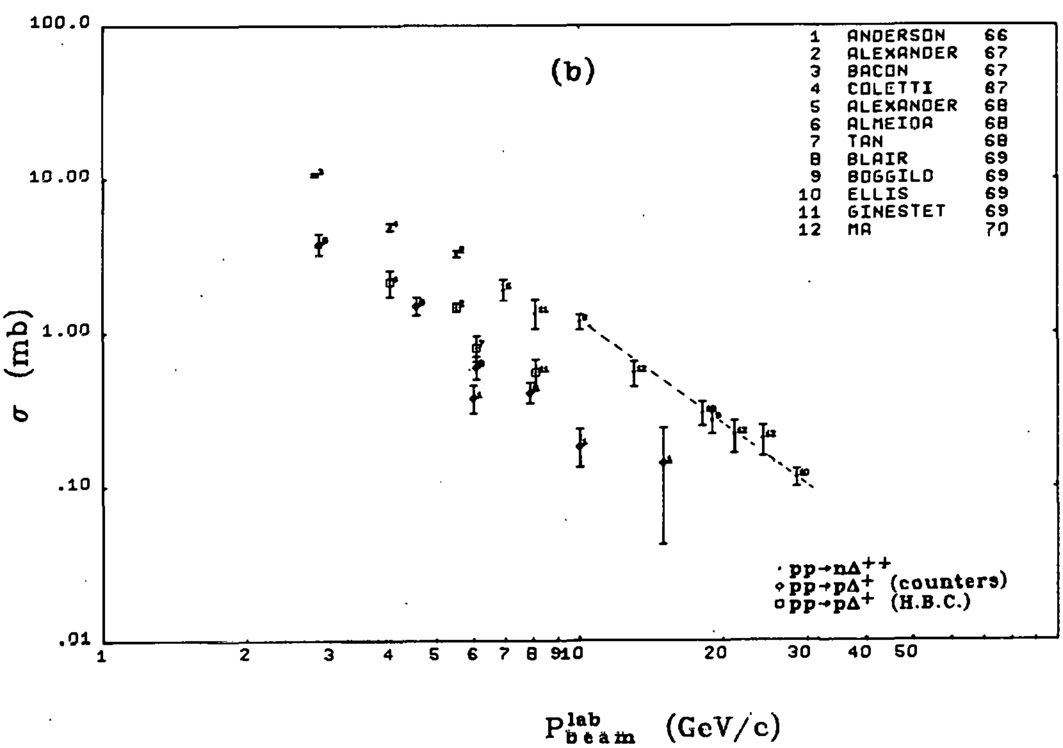


Fig. 17. Cross sections for $pp \to N\Delta(1236)$. (a) Linear display; (b) log-log display. From isospin, the ratio of $\sigma(n\Delta^{++})/\sigma(p\Delta^{+})$ should be 3, and the data are consistent with this. The dashed line in (b) represents our best fit of the $n\Delta^{++}$ cross section (above 10 GeV/c) to the formula $\sigma = Kp_{beam}^{-n}$, $n = 2.20 \pm 0.16$ (see text). We did not fit the $p\Delta^{+}$ because there are too few data above 10 GeV/c. See discussion in text concerning background subtractions and differences in data from various detectors.

dσ/dt for pp→nΔ(1236)$^{++}$

MOMENTUM TRANSFER BETWEEN BEAM AND DELTA++
(GEV/C)**2

BEAM MOMENTUM= 2.800 GEV/C

****THIS DATA WAS READ FROM A GRAPH****

MOM TR MINIMUM	MOM TR MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.048	.017	68.63866	5.78042
.079	.048	54.52149	5.15180
.110	.079	36.26652	4.20173
.141	.110	32.12873	3.95477
.171	.141	18.25496	2.98102
.202	.171	16.06437	2.79645
.233	.202	10.22278	2.23079
.264	.233	10.22278	2.23079
.295	.264	7.30198	1.88536
.326	.295	6.32839	1.75518
.357	.326	6.32839	1.75518
.388	.357	5.59819	1.65082
.419	.388	8.03218	1.97739
.450	.419	4.86799	1.53939
.481	.450	7.30198	1.88536
.512	.481	3.16419	1.24110
.543	.512	3.89439	1.37688
.574	.543	4.86799	1.53939
.605	.574	5.59819	1.65082
.636	.605	3.16419	1.24110
.667	.636	3.89439	1.37688
.698	.667	1.94720	.97360
.729	.698	1.94720	.97360
.760	.729	3.89439	1.37688
.791	.760	4.86799	1.53939

2Q SQUARE= 1.890

BACON PR 162 1320(1967) HBC

BEAM MOMENTUM= 5.520 GEV/C

****THIS DATA WAS READ FROM A GRAPH****

MOM TR MINIMUM	MOM TR MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)
.044	.004	10.87499
.085	.044	6.83571
.125	.085	4.35000
.166	.125	2.95178
.206	.166	1.55357
.247	.206	1.24286
.287	.247	1.08750
.327	.287	1.55357
.368	.327	1.08750
.408	.368	.77679
.449	.408	.77679
.489	.449	.62143
.530	.489	.46607
.570	.530	.46607
.611	.570	.46607
.651	.611	.31071

2Q SQUARE= 4.373

ALEXANDER PR 154 1284(1967) HBC

BEAM MOMENTUM= 6.600 GEV/C

MOM TR MINIMUM	MOM TR MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.002	.010	11.80000	1.12000
.010	.020	15.00000	1.13000
.020	.030	12.40000	1.03000
.030	.040	12.25000	1.02000
.040	.060	11.10000	.69000
.060	.080	7.44000	.57000
.080	.100	6.80000	.54000
.100	.120	4.45880	.44000
.120	.140	3.64000	.40000
.140	.160	3.04000	.61000
.160	.180	2.22000	.31000
.180	.200	2.27000	.31000
.200	.220	2.27000	.31000
.220	.240	1.67000	.27000
.240	.260	1.75000	.28000
.260	.280	1.41000	.25000
.280	.300	1.37000	.24000

2Q SQUARE= 5.374

MA PRL 23 342(1969) HBC

BEAM MOMENTUM= 6.920 GEV/C

****THIS DATA WAS READ FROM A GRAPH****

MOM TR MINIMUM	MOM TR MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)
0.	.025	11.00000
.025	.050	13.00000
.050	.075	13.50000
.075	.100	7.00000
.100	.125	3.70000
.125	.150	4.70000
.150	.175	1.70000
.175	.200	4.00000
.200	.225	5.00000
.225	.250	1.40000
.250	.275	2.00000
.275	.300	1.60000
.300	.325	2.40000
.325	.350	0.
.350	.375	1.00000
.375	.400	.40000
.400	.425	0.
.425	.450	1.00000
.450	.475	.50000
.475	.500	.30000
.500	.525	.60000
.525	.550	.40000
.550	.575	.60000
.575	.600	.40000

2Q SQUARE= 5.672

ALEXANDER PR 173 1322(1968) HBC

BEAM MOMENTUM= 8.100 GEV/C

MOM TR MINIMUM	MOM TR MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
0.	.020	6.48000	.93531
.020	.040	3.64500	.70148
.040	.060	3.64500	.70148
.060	.080	2.56500	.58045
.080	.100	2.02500	.52285
.100	.120	2.16000	.54000
.120	.140	1.62000	.46765
.140	.160	.81000	.33068
.160	.180	1.21500	.40500
.180	.200	.67500	.30187
.200	.220	.81000	.33068
.220	.240	1.21500	.40500
.240	.260	.27000	.19092
.260	.280	.27000	.19092
.280	.300	.27000	.19092
.300	.320	0.	+ .135 - 0.
.320	.340	.13500	.13500
.340	.360	.13500	.13500
.360	.380	0.	+ .135 - 0.
.380	.400	.27000	.19092
.400	.420	0.	+ .135 - 0.

2Q SQUARE= 6.770

GINESTET NP B13 283(1969) HBC

BEAM MOMENTUM=10.010 GEV/C

****THIS DATA WAS READ FROM A GRAPH****

MOM TR MINIMUM	MOM TR MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
0.	.020	6.70000	1.70000
.020	.040	5.00000	1.60000
.040	.060	3.30000	1.10000
.060	.080	2.50000	1.00000
.080	.100	2.50000	1.00000
.100	.120	1.70000	.85000
.120	.140	.80000	.55000
.140	.160	1.70000	.85000
.160	.180	2.30000	.70000
.200	.220	.85000	.60000
.220	.240	.42000	.42000
.240	.260	.42000	.42000
.260	.280	.85000	.60000
.280	.300	.42000	.42000

2Q SQUARE= 8.553

DEHNE NC 53A 232(1968) HBC

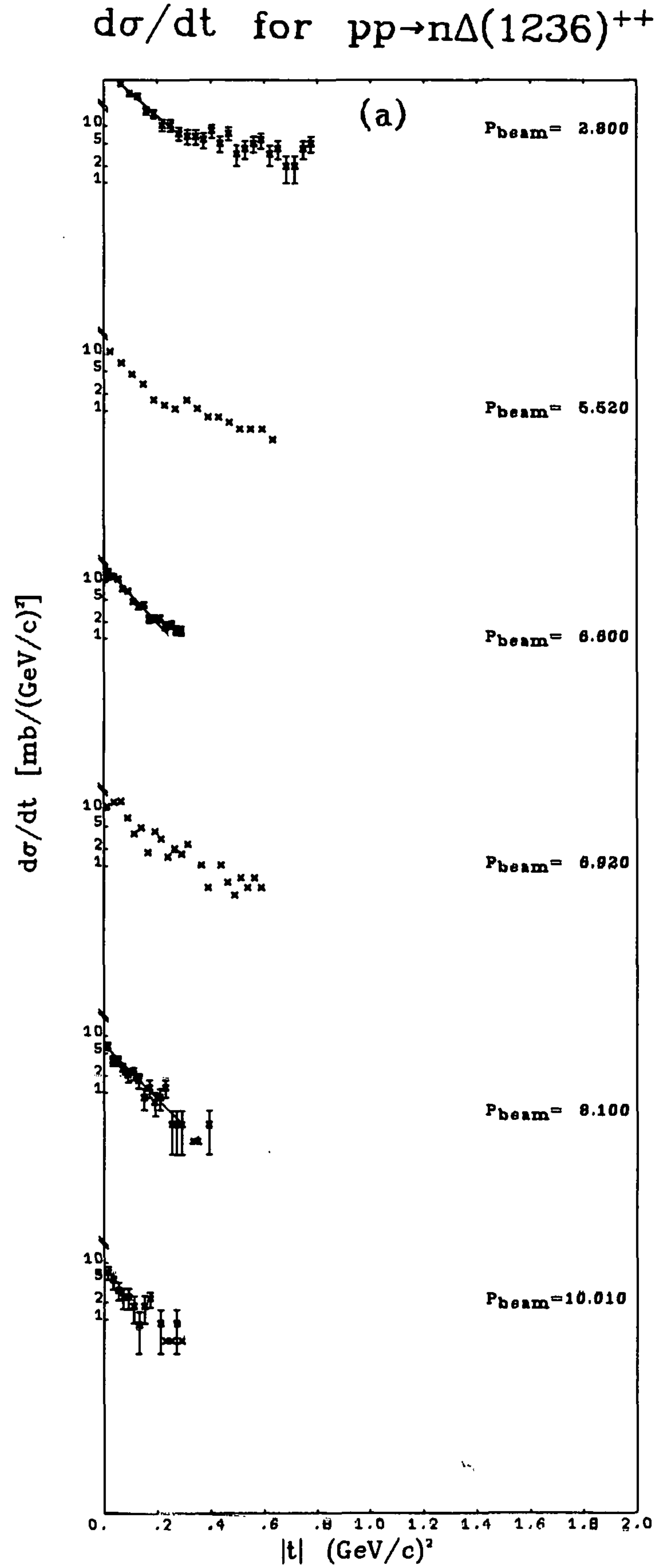


Fig. 18. Differential cross sections for pp → NΔ(1236). (a) pp → nΔ(1236)$^{++}$. (b) pp → pΔ(1236)$^{+}$ from counter experiments (i. e., all decay modes included). The distributions given originally as dσ/dω vs. cos $\theta_{c.m.}$ were transformed to dσ/dt vs. t [taking m(Δ) = 1.236 GeV]. In (c) we display our best-fit values of b (the slope) obtained by fitting the data in (a) and (b) to $d\sigma/dt = Ae^{bt}$ in the range $0.03 \le |t| \le 0.3$ (GeV/c)^2.

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$d\sigma/dt$ for $p\Delta(1236)^+$

MOMENTUM TRANSFER BETWEEN BEAM AND PROTON
(GEV/C)**2

BEAM MOMENTUM= 2.850 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.031	13.10000	.39300
.034	12.80000	.38400
.039	16.70000	.50100
.048	9.05000	.27150
.049	9.60000	.28800
.052	7.40000	.22200
.058	8.30000	.24900
.065	11.30000	.33900
.072	7.50000	.22500
.078	10.90000	.32700
.085	10.90000	.32700
.092	7.30000	.21900
.102	7.60000	.22800
.110	6.60000	.19800
.119	6.80000	.20400
.128	5.60000	.16800
.138	5.60000	.16800
.148	5.45000	.16350
.160	5.48000	.16440

2Q SQUARE= 1.935
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10PER CENT

BLAIR NC 63A 529(1969) CNTR

BEAM MOMENTUM= 2.980 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.260	1.50000	.20000
.290	.90000	.10000
.370	.90000	.10000
.640	.39000	.04000
.740	.39000	.04000
.880	.31000	.03000
1.260	.10000	.02000
1.630	.15000	.02000

2Q SQUARE= 2.051
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12PER CENT

ANKENBRAND PR 170 1223(1968) CNTR

BEAM MOMENTUM= 4.000 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.450	.41000	.04000
.510	.25000	.02000
.640	.18000	.02000
1.120	.04400	.00900
1.520	.02400	.00300
2.120	.02100	.00200
2.650	.02100	.00200

2Q SQUARE= 2.975
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12PER CENT

ANKENBRAND PR 170 1223(1968) CNTR

BEAM MOMENTUM= 4.550 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.034	4.65000	.13950
.035	5.30000	.15900
.042	5.60000	.16800
.043	4.70000	.14100
.053	5.05000	.15150
.053	3.80000	.11400
.064	4.10000	.12300
.075	3.40000	.10200
.089	2.85000	.08550
.096	3.25000	.09750
.109	2.40000	.07200
.140	1.81000	.05430
.160	1.80000	.05400
.161	1.57000	.04710
.180	1.81000	.05430
.181	1.17000	.03510
.220	.90000	.02700
.240	.94000	.02820
.270	.60000	.01800

2Q SQUARE= 3.479
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10PER CENT

BLAIR NC 63A 529(1969) CNTR

BEAM MOMENTUM= 5.020 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.700	.07600	.00800
.800	.04300	.00600
.990	.02400	.00300
1.460	.01200	.00300
1.720	.00500	.00100
1.910	.00900	.00100
2.670	.00350	.00050
3.080	.00200	.00100

2Q SQUARE= 3.911
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12PER CENT

ANKENBRAND PR 170 1223(1968) CNTR

BEAM MOMENTUM= 6.060 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.056	1.74000	.05220
.070	1.94000	.05820
.107	1.06000	.03180
.128	.67000	.02010
.154	.59000	.01770
.260	.27000	.00810

2Q SQUARE= 4.873
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10PER CENT

BLAIR NC 63A 529(1969) CNTR

BEAM MOMENTUM= 6.070 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
1.030	.01100	.00300
1.160	.01100	.00300
1.440	.00900	.00300
1.750	.00660	.00090
2.080	.00500	.00100
2.400	.00300	.00060
2.730	.00210	.00040
3.180	.00090	.00010
3.750	.00050	.00010
4.250	.00040	.00020

2Q SQUARE= 4.883
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12PER CENT

ANKENBRAND PR 170 1223(1968) CNTR

BEAM MOMENTUM= 7.120 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
1.330	.00800	.00300
1.500	.00500	.00100
1.720	.00420	.00080
2.270	.00260	.00090
2.600	.00110	.00050
3.050	.00100	.00060
4.220	.00025	.00009

2Q SQUARE= 5.858
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12PER CENT

ANKENBRAND PR 170 1223(1968) CNTR

BEAM MOMENTUM= 7.880 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.046	1.75000	.05250
.089	.72000	.02160
.093	1.00000	.03000
.114	.58000	.01740
.117	.63000	.01890
.146	.41000	.01230
.181	.35000	.01050
.217	.17000	.00510
.250	.17000	.00510
.260	.19000	.00570
.295	.16000	.00480
.340	.06000	.00180
.390	.12000	.00360
.440	.04600	.00138
.500	.07400	.00222
.526	.02900	.00087

2Q SQUARE= 6.565
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10PER CENT

BLAIR NC 63A 529(1969) CNTR

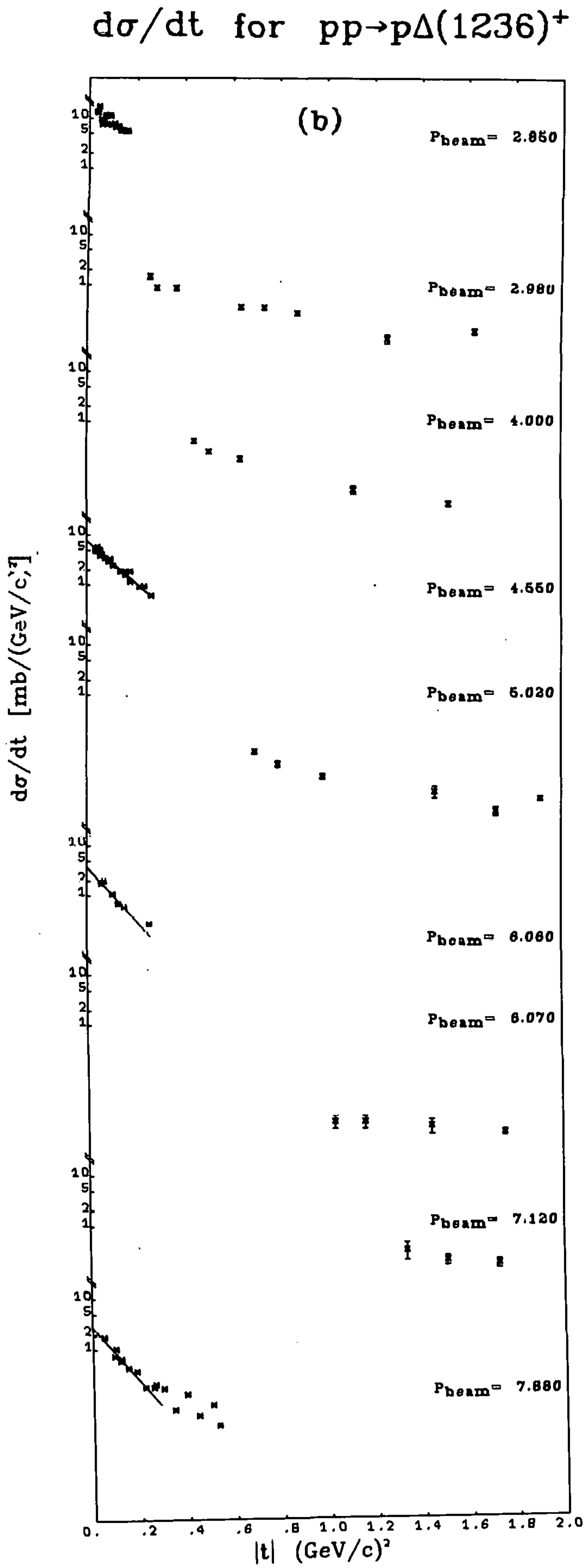


Fig. 18 (continued)

Fit to $d\sigma/dt$ for $pp \rightarrow N\ \Delta(1236)$

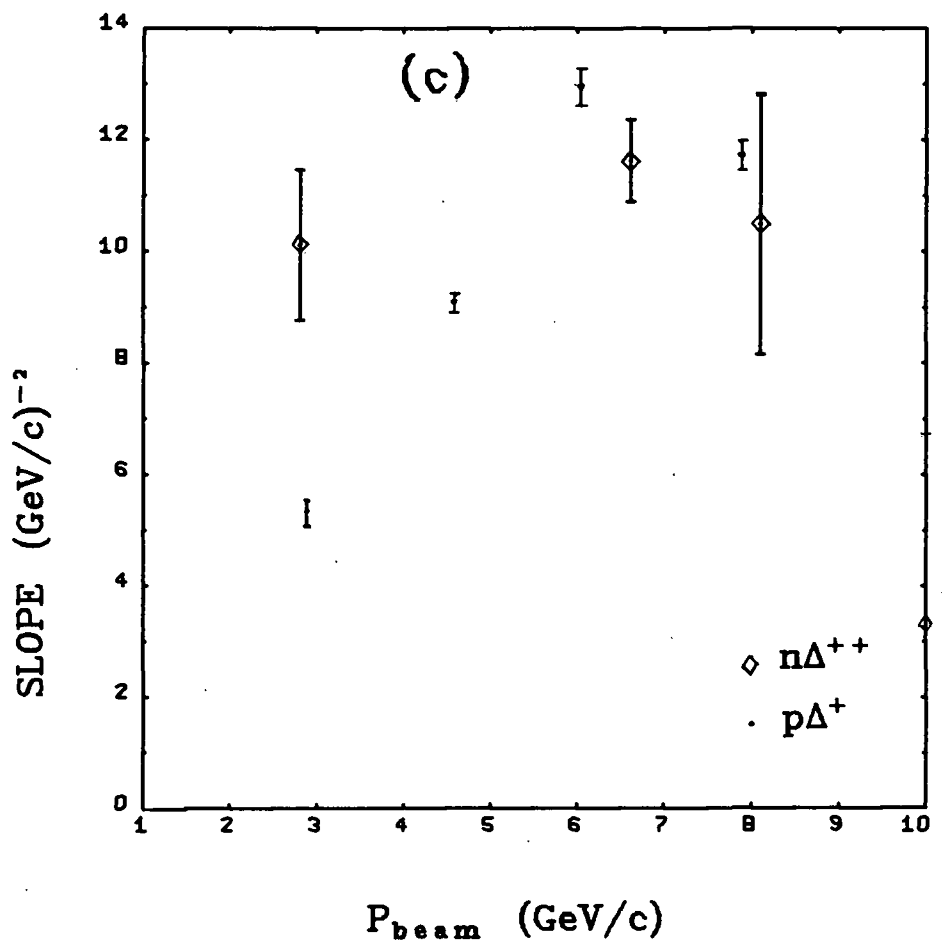


Fig. 18 (continued)

P_{beam} (GeV/c)	$d\sigma/dt$ [t = 0] mb/(GeV/c)^2			SLOPE (GeV/c)$^{-2}$			χ^2/N	
2.800	101.44	±	15.67	10.11	±	1.36	.70	$n\Delta^{++}$
6.600	18.52		1.46	11.62		.75	1.95	
8.100	5.86		1.45	10.48		2.33	.37	
10.010	3.34		1.36	3.33		3.46	.48	
2.850	12.65	±	1.29	5.41	±	.21	28.45	$p\Delta^{+}$
4.550	7.12		.72	9.09		.16	19.32	
6.060	4.06		.44	12.93		.37	25.90	
7.880	2.46		.26	11.71		.29	27.02	

$pp \to pN^*_{1/2}$

P_{beam} (GeV/c)	$\sigma_{pN^*(1470)^+}$ (mb) $N^* \to n\pi^+$	$N^* \to p\pi^0$	$N^* \to$ all modes	References
4.550			.640 ± .080	BLAIR 69
5.520	.800 ± .160	.360 ± .060	[1.900 .40]	ALEXANDER 67
6.060			.650 .180	BLAIR 69
6.070	.270 .130	.110 .090	[.620 .270]	TAN 68
7.880			.450 .090	BLAIR 69
8.100	.500 .150	.250 .150	[1.230 .380]	GINESTET 69
10.000			.544 .090	ANDERSON 66
10.010	.200 .130		[.490 .320]	ALMEIDA 68
15.000			.620 .106	ANDERSON 66
20.000			.660 .150	ANDERSON 66
28.500			.500 +.200 -.100	CONNOLLY 67
30.000			.744 .350	ANDERSON 66

REFERENCES				
1	ANDERSON	66.....PRL	16 855	SPRK
2	ALEXANDER	67.....PR	154 1284	HBC
3	CONNOLLY	67.....BNL	11980	HBC
4	ALMEIDA	68.....PR	174 1638	HBC
5	TAN	68.....PL	288 195	HBC
6	BLAIR	69.....NC	63A 529	CNTR
7	GINESTET	69.....NP	B13 283	HBC

P_{beam} (GeV/c)	$\sigma_{pN^*(1520)^+}$ (mb) $N^* \to n\pi^+$	$N^* \to p\pi^0$	$N^* \to$ all modes	References
4.000	.388 ± .291	.130 ± .015	[.980 ± .550]	COLETTI 67
4.550			.680 .000	BLAIR 69
5.520	.440 .200	0. .040	[.830 .390]	ALEXANDER 67
6.060			.450 .090	BLAIR 69
6.070	.150 .090	.080 .050	[.430 .190]	TAN 68
7.880			.310 .050	BLAIR 69
10.000			.196 .056	ANDERSON 66
15.000			.160 .032	ANDERSON 66
20.000			.170 .030	ANDERSON 66
30.000			.166 .042	ANDERSON 66

REFERENCES				
1	ANDERSON	66.....PRL	16 855	SPRK
2	ALEXANDER	67.....PR	154 1284	HBC
3	COLETTI	67.....NC	49A 479	HBC
4	TAN	68.....PL	288 195	HBC
5	BLAIR	69.....NC	63A 529	CNTR

P_{beam} (GeV/c)	$E_{c.m.}$ (GeV)	$\sigma_{pN^*(2190)^+}$ (mb) $N^* \to$ all modes	References
20.000	6.272	.128 ± .024	ANDERSON 66
30.000	7.621	.108 .036	ANDERSON 66

REFERENCES				
1	ANDERSON	66.....PRL	16 855	SPRK

P_{beam} (GeV/c)	$E_{c.m.}$ (GeV)	$\sigma_{pN^*(1470)^+}$ (mb) $N^* \to p\pi^+\pi$	References
6.000 ± .020	3.627	.680 ± .090	KINSEY 68
10.010 .010	4.542	.180 .040	ALMEIDA 68
19.000	6.120	.080 .020	BOGGILD 68
21.800	6.535	.155 .030	JESPERSEN 68

REFERENCES				
1	ALMEIDA	68.....PR	174 1638	HBC
2	BOGGILD	68.....SUB VNA		HBC
3	JESPERSEN	68.....PRL	21 1368	HBC
4	KINSEY	68.....UCRL	17707	HBC

P_{beam} (GeV/c)	$E_{c.m.}$ (GeV)	$\sigma_{pN^*(1520)^+}$ (mb) $N^* \to p\pi^+\pi^-$	References
5.520 ± .010	3.503	.570 ± .050	ALEXANDER 67
10.010 .010	4.542	.150 .040	ALMEIDA 68

REFERENCES				
1	ALEXANDER	67.....PR	154 1284	HBC
2	ALMEIDA	68.....PR	174 1638	HBC

not plotted

DATA IN SQUARE BRACKETS HAVE BEEN CALCULATED BY US

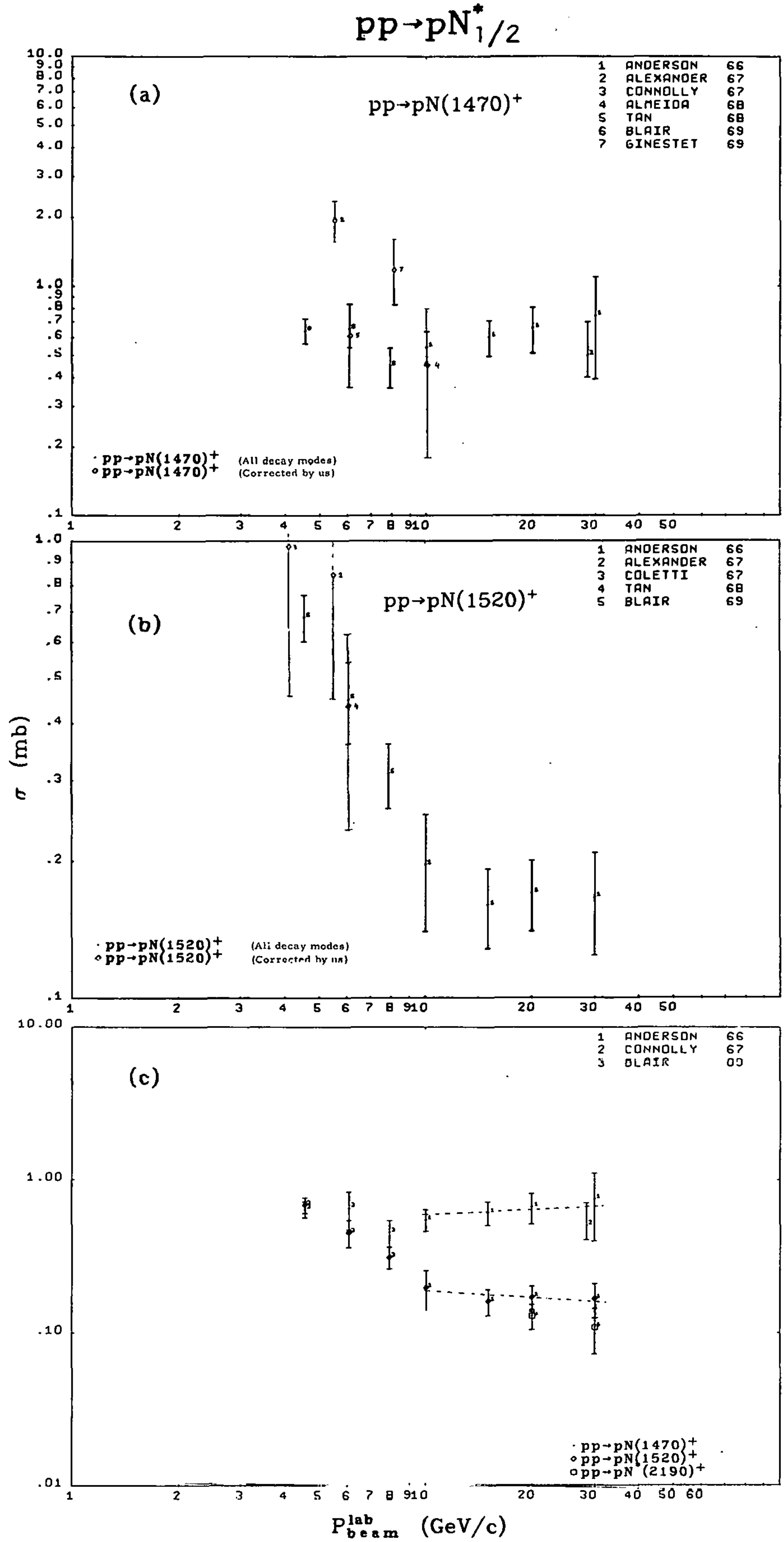


Fig. 19. Cross sections for "elastic-like" pp interactions ($pp \rightarrow pN^{*+}_{1/2}$). (a) $N^*(1470)$-"Roper", (b) $N^*(1520)$, (c) the first two plus $N^*(2190)$. In (a) and (b) we show those experiments that reported only one or two $N\pi$ decay modes, as well as those which have reported all decay modes. The former have been converted by us to the total rates by using isospin and taking the ratios of $\Gamma(N^* \rightarrow N\pi)/\Gamma(N^* \rightarrow \text{all})$ of 0.61 ± 0.09 for $N^*(1470)$ and 0.53 ± 0.04 for $N^*(1520)$. These ratios were taken from the most recent "Review of Particle Properties." Experiments reporting only $N^* \rightarrow p\pi^+\pi^-$ are not plotted, but are tabulated on the facing page. In (c) only those experiments reporting all decay modes (i.e., mainly counter experiments) have been included. The data above 10 GeV/c have been fitted to the formula $\sigma = Kp_{beam}^{-n}$. The dashed lines are our best fits. $n_{N(1470)} = -0.09 \pm 0.27$, and $n_{N(1520)} = 0.10 \pm 0.33$. See discussion in text concerning background subtractions and differences in data from various detectors.

dσ/dt for pp→pN(1470)$^+$

MOMENTUM TRANSFER BETWEEN BEAM AND PROTON
(GEV/C)**2

BEAM MOMENTUM= 4.550 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.044	2.72000	.08160
.045	3.05000	.09150
.052	3.02000	.09060
.053	2.61000	.07830
.062	2.20000	.06600
.063	2.30000	.06900
.073	2.13000	.06390
.084	1.53000	.04590
.098	1.31000	.03930
.117	1.08000	.03240
.140	.67000	.02010
.166	.55000	.01650
.220	.26000	.00780

2Q SQUARE= 3.479
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10PER CENT

BLAIR NC 63A 529(1969) CNTR

BEAM MOMENTUM= 6.060 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.061	2.50000	.07500
.074	2.50000	.07500
.110	.70000	.02100
.130	.38000	.01140
.154	.45000	.01350
.260	.13000	.00390

2Q SQUARE= 4.873
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10PER CENT

BLAIR NC 63A 529(1969) CNTR

BEAM MOMENTUM= 7.880 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.048	2.20000	.06600
.090	.69000	.02070
.094	.79000	.02370
.115	.35000	.01050
.117	.54000	.01620
.145	.26000	.00780
.180	.25000	.00750
.214	.15000	.00450
.250	.16000	.00480
.290	.07000	.00210

2Q SQUARE= 6.565
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10PER CENT

BLAIR NC 63A 529(1969) CNTR

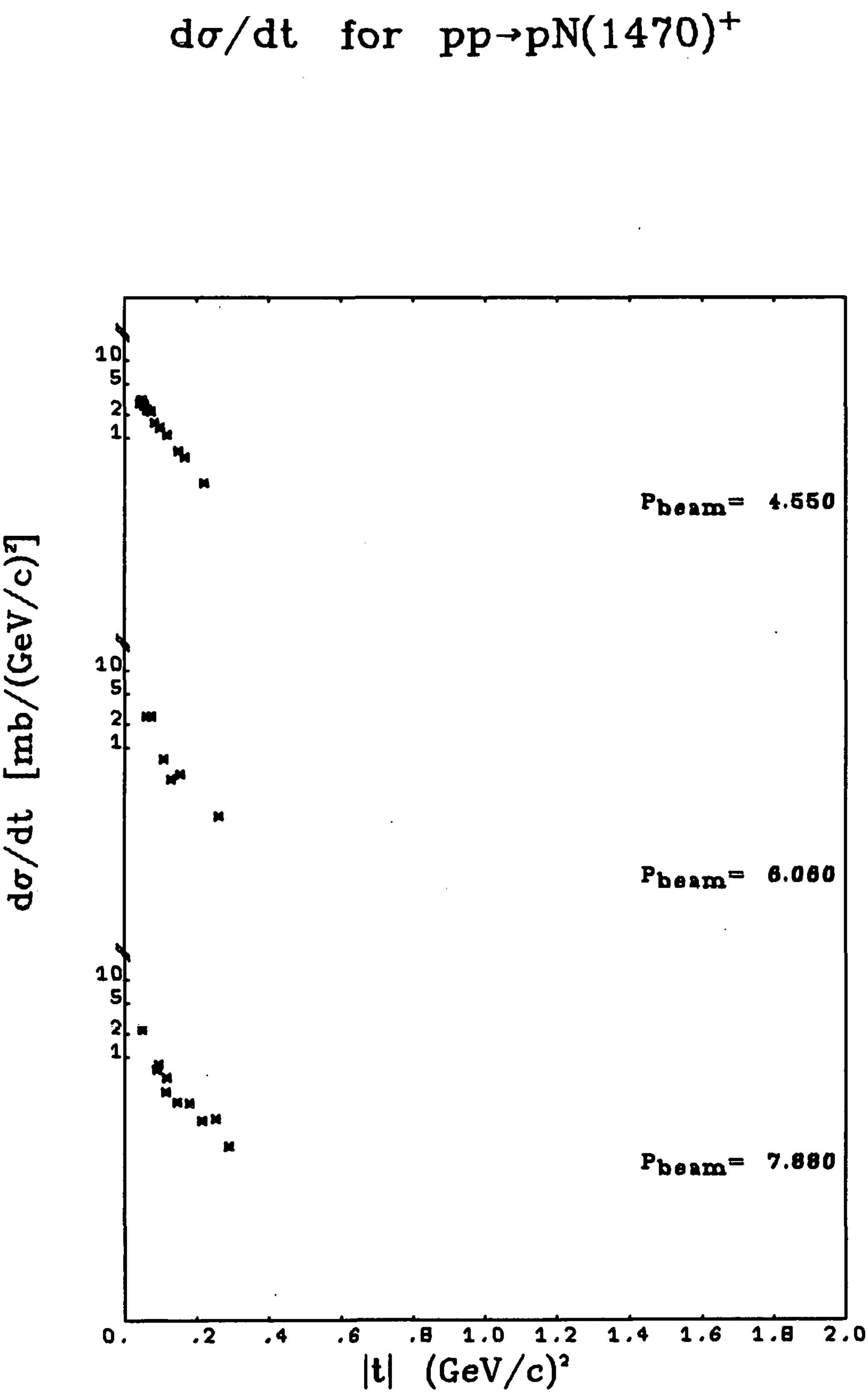


Fig. 20. Differential cross sections for $pp \rightarrow p\,N^*(1470)^+$.

$d\sigma/dt$ for $pp \to pN(1520)^+$

MOMENTUM TRANSFER BETWEEN BEAM AND PROTON
(GEV/C)**2

BEAM MOMENTUM= 4.000 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.440	.25000	.04000
.500	.20000	.02000
.620	.15000	.02000
1.060	.15000	.02000
1.430	.12000	.00900
1.990	.09200	.00600
2.050	.12200	.00900

2Q SQUARE= 2.975
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12PER CENT

ANKENBRAND PR 170 1223(1968) CNTR

BEAM MOMENTUM= 4.550 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.057	1.30000	.03900
.058	1.27000	.03810
.064	2.05000	.06150
.065	1.92000	.05760
.074	1.28000	.03840
.075	1.35000	.04050
.085	1.52000	.04560
.095	1.28000	.03840
.107	1.29000	.03870
.126	1.43000	.04290
.157	1.26000	.03780
.173	.99000	.02970
.175	.67000	.02010
.191	.64000	.01920
.191	.67000	.02010
.230	.49000	.01470
.250	.64000	.01920
.270	.62000	.01860

2Q SQUARE= 3.479
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10PER CENT

BLAIR NC 63A 529(1969) CNTR

BEAM MOMENTUM= 5.020 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.670	.10000	.10000
.760	.10500	.00900
.940	.08800	.00600
1.380	.07000	.01000
1.610	.05200	.00600
1.790	.05700	.00500
2.490	.03700	.00300
2.830	.03000	.01000
2.860	.03100	.00500
3.140	.02500	.00500

2Q SQUARE= 3.911
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12PER CENT

ANKENBRAND PR 170 1223(1968) CNTR

BEAM MOMENTUM= 6.060 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.065	1.15000	.03450
.079	.99000	.02970
.114	.95000	.02850
.134	.79000	.02370
.157	.55000	.01650
.260	.32000	.00960

2Q SQUARE= 4.873
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10PER CENT

BLAIR NC 63A 529(1969) CNTR

BEAM MOMENTUM= 6.070 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.980	.06600	.00800
1.100	.06300	.00600
1.360	.05900	.00800
1.650	.03200	.00300
1.970	.02800	.00400
2.270	.01900	.00200
2.580	.01400	.00100
3.000	.01070	.00070
3.520	.00820	.00060
3.890	.00700	.00100
4.020	.00640	.00080

2Q SQUARE= 4.683
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12PER CENT

ANKENBRAND PR 170 1223(1968) CNTR

BEAM MOMENTUM= 7.120 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
1.270	.03500	.00500
1.490	.02900	.00400
1.640	.02000	.00300
2.160	.00700	.00100
2.470	.00700	.00100
2.890	.00320	.00080
4.010	.00230	.00040
5.010	.00130	.00030

2Q SQUARE= 5.858
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12PER CENT

ANKENBRAND PR 170 1223(1968) CNTR

BEAM MOMENTUM= 7.880 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.051	1.12000	.03360
.092	.57000	.01710
.096	.48000	.01440
.116	.44000	.01320
.119	.45000	.01350
.146	.40000	.01200
.180	.32000	.00960
.214	.26000	.00780
.250	.24000	.00720
.255	.27000	.00810
.288	.19000	.00570
.340	.23000	.00690
.380	.12000	.00360
.414	.08200	.00246
.460	.06000	.00180
.484	.06800	.00204
.509	.10000	.00300
.626	.02800	.00084
.670	.05100	.00153
.750	.06500	.00195

2Q SQUARE= 6.565
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10PER CENT

BLAIR NC 63A 529(1969) CNTR

BEAM MOMENTUM=19.200 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MICROBARNS/(GEV/C)**2)	
.560	57.00000	11.40000
.870	21.00000	4.20000
1.230	3.60000	.72000
1.660	.39000	.07800
2.140	.16000	.03200
2.660	.32000	.06400
3.230	.02000	.00400
3.830	.01300	.00260
5.010	.00057	.00028

2Q SQUARE= 17.156

ALLABY PL 28B 229(1968) CNTR

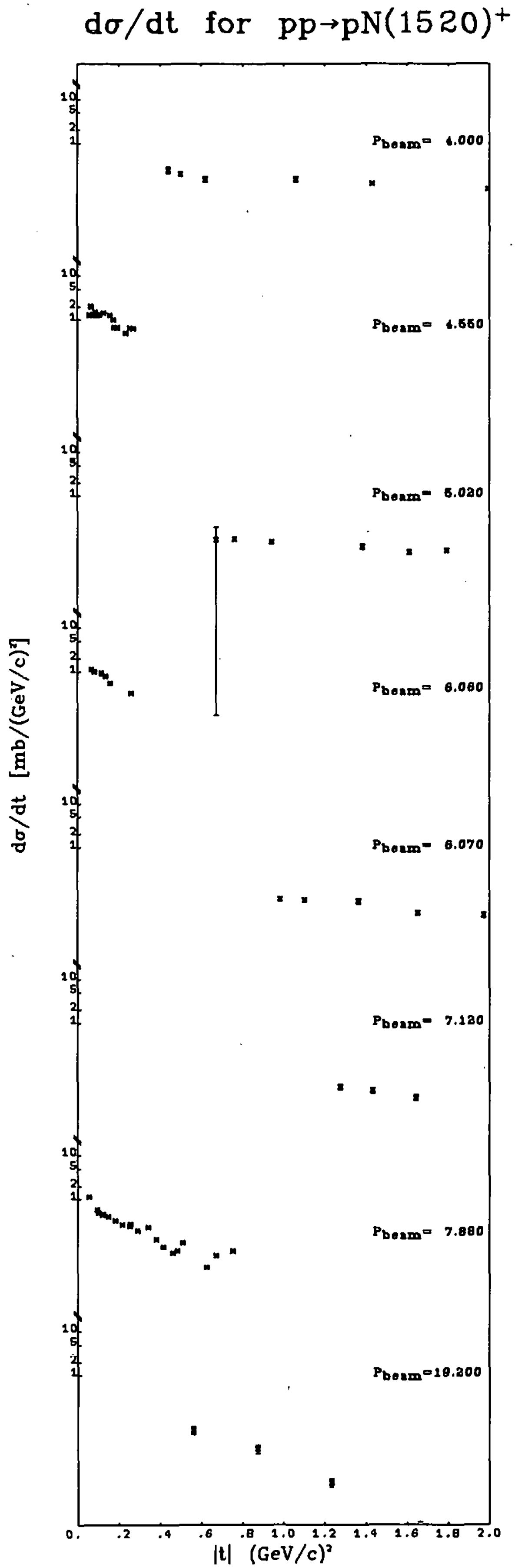


Fig. 21. Differential cross sections for $pp \rightarrow p N^{*}(1520)^{+}$.

pp → p "N*(1688)⁺" Bump

P_{beam} (GeV/c)	$E_{c.m.}$ (GeV)	$\sigma_{pN^*(1688)^+}$ (mb) $N^* \to$ all modes	References
4.550	3.237	.700 ± .100	BLAIR 69
6.060	3.642	.500 .100	BLAIR 69
7.880	4.081	.460 .090	BLAIR 69
10.000	4.540	.562 .058	ANDERSON 66
15.000	5.474	.638 .068	ANDERSON 66
20.000	6.272	.560 .070	ANDERSON 66
28.500	7.434	.320 + .130 − .070	CONNOLLY 67
30.000	7.621	.576 .084	ANDERSON 66

REFERENCES

1 ANDERSON 66.....PRL 16 855 SPRK

2 CONNOLLY 67.....BNL 11980 HBC

3 BLAIR 69.....NC 63A 529 CNTR

P_{beam} (GeV/c)	$\sigma_{pN^*(1688)^+}$ (mb) $N^* \to n\pi^+$	$\sigma_{pN^*(1688)^+}$ (mb) $N^* \to p\pi^0$	References
5.520	.320 ± .160	.220 ± .060	ALEXANDER 67
6.070	.190 .090	.100 .050	TAN 68
8.100	.100 .050	.100 .050	GINESTET 69

REFERENCES

1 ALEXANDER 67.....PR 154 1284 HBC

2 TAN 68.....PL 28B 195 HBC

3 GINESTET 69.....NP B13 283 HBC

P_{beam} (GeV/c)	$E_{c.m.}$ (GeV)	$\sigma_{pN^*(1688)^+}$ (mb) $N^* \to p\pi^+\pi^-$	References
5.520 ± .010	3.503	.480 ± .040	ALEXANDER 67
10.010 .010	4.542	.220 .070	ALMEIDA 68
19.000	6.120	.110 .030	BOGGILD 68

REFERENCES

1 ALEXANDER 67.....PR 154 1284 HBC

2 ALMEIDA 68.....PR 174 1638 HBC

3 BOGGILD 68.....SUB VNA HBC

not plotted

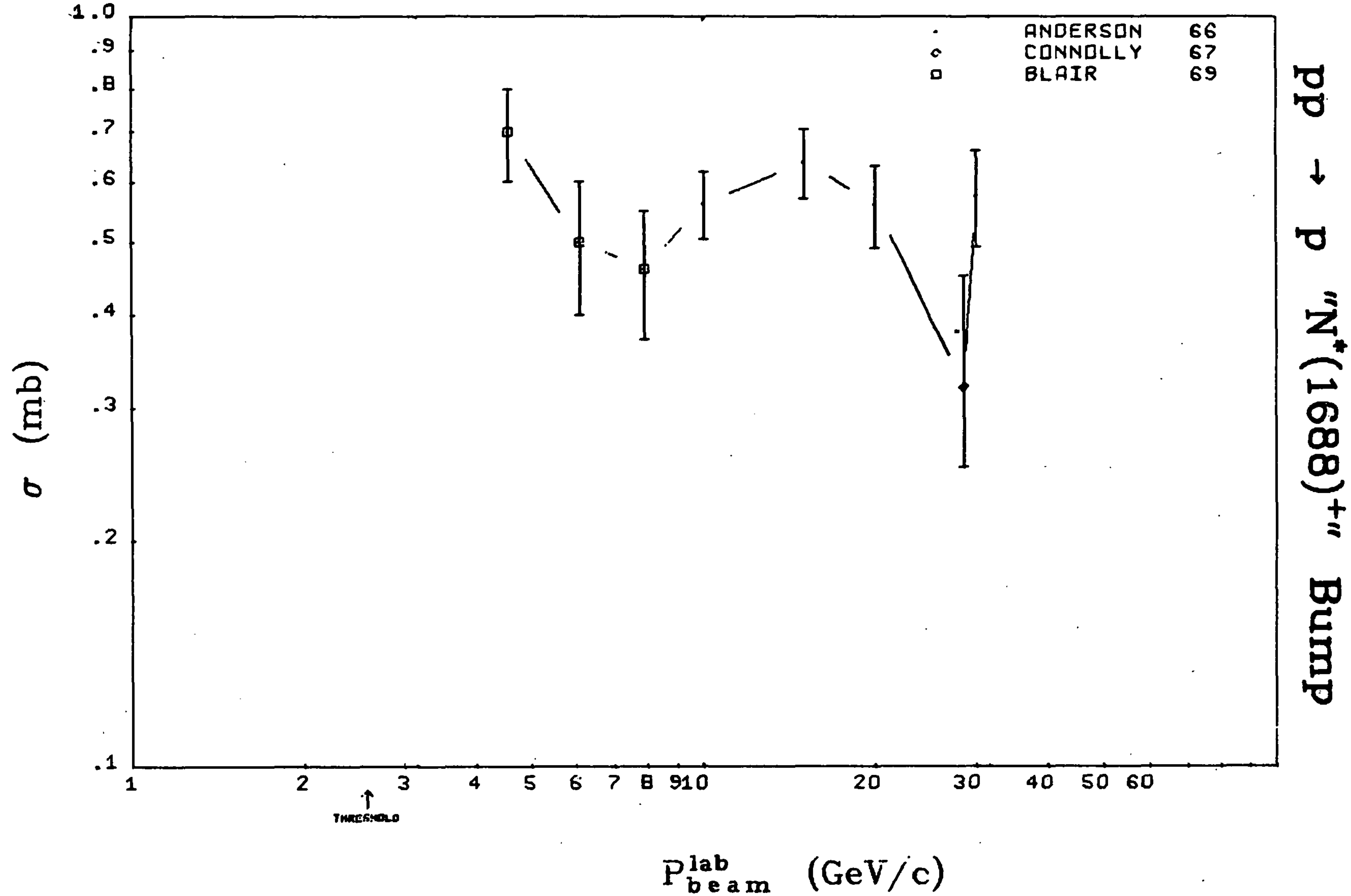


Fig. 22. Cross sections for pp → p "$N^*(1688)^+$". We have included only those experiments (mostly counters) that reported all decay modes. Experiments reporting only $p\pi^+\pi^-$ are tabulated on the facing page. Due to the existence of resonances in this region with both I = 1/2 and I = 3/2, we are unable to compute total cross sections from experiments reporting only one mode of decay. See discussion in text concerning background subtractions and differences in data from various detectors.

pp → p "$N^*(1688)^+$" Bump

MOMENTUM TRANSFER BETWEEN BEAM AND PROTON
(GEV/C)**2

BEAM MOMENTUM= 4.000 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.470	.66000	.09000
.520	.34000	.03000
.640	.45000	.04000
1.050	.23000	.03000
1.400	.16000	.01000
1.930	.12900	.00900

2Q SQUARE= 2.975
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12PER CENT

ANKENBRAND PR 170 1223(1968) CNTR

BEAM MOMENTUM= 4.550 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.091	1.45000	.04350
.098	1.85000	.05550
.116	.72000	.02160
.139	.75000	.02250
.157	1.60000	.04800
.171	1.80000	.05400
.186	1.05000	.03150
.198	.80000	.02400
.204	.62000	.01860
.216	.46000	.01380
.250	.66000	.01980
.270	.77000	.02310

2Q SQUARE= 3.479
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10PER CENT

BLAIR NC 63A 529(1969) CNTR

BEAM MOMENTUM= 5.020 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.670	.23000	.02000
.750	.18000	.02000
.920	.12000	.01000
1.330	.09000	.01000
1.550	.07800	.00800
1.730	.07400	.00700
2.390	.05100	.00400
2.740	.04300	.00800

2Q SQUARE= 3.911
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12PER CENT

ANKENBRAND PR 170 1223(1968) CNTR

BEAM MOMENTUM= 6.060 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.081	1.45000	.04350
.093	.96000	.02880
.127	.58000	.01740
.146	.88000	.02640
.168	.74000	.02220
.260	.52000	.01560

2Q SQUARE= 4.873
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10PER CENT

BLAIR NC 63A 529(1969) CNTR

BEAM MOMENTUM= 6.070 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.950	.09300	.00900
1.070	.08900	.00900
1.320	.05800	.00800
1.590	.04300	.00400
1.900	.02900	.00400
2.180	.02000	.00200
2.470	.01300	.00100
2.880	.01080	.00080
3.380	.00770	.00080
3.850	.00800	.00100

2Q SQUARE= 4.883
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12PER CENT

ANKENBRAND PR 170 1223(1968) CNTR

BEAM MOMENTUM= 7.120 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
1.230	.05000	.00700
1.380	.04500	.00600
1.590	.02800	.00400
2.080	.01000	.00200
2.380	.00700	.00100
2.790	.00400	.00100
3.860	.00240	.00040

2Q SQUARE= 5.858
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12PER CENT

ANKENBRAND PR 170 1223(1968) CNTR

BEAM MOMENTUM= 7.880 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.059	1.02000	.03060
.098	.90000	.02700
.102	.78000	.02340
.121	.78000	.02340
.124	.74000	.02220
.150	.62000	.01860
.183	.53000	.01590
.215	.42000	.01260
.250	.43000	.01290
.255	.36000	.01080
.287	.39000	.01170
.330	.32000	.00960
.370	.19000	.00570
.397	.17000	.00510
.454	.17000	.00510
.476	.09600	.00288
.500	.16700	.00501
.613	.08200	.00246
.640	.07200	.00216
.735	.10000	.00300

2Q SQUARE= 6.565
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10PER CENT

BLAIR NC 63A 529(1969) CNTR

BEAM MOMENTUM=19.200 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MICROBARNS/(GEV/C)**2)	
.550	100.00000	20.00000
.860	26.00000	5.20000
1.220	4.20000	.84000
1.640	.64000	.12800
2.100	.31000	.06200
2.620	.33000	.06600
3.180	.03500	.00700
3.770	.01800	.00360
5.720	.00071	.00035

2Q SQUARE= 17.156

ALLABY PL 288 229(1968) CNTR

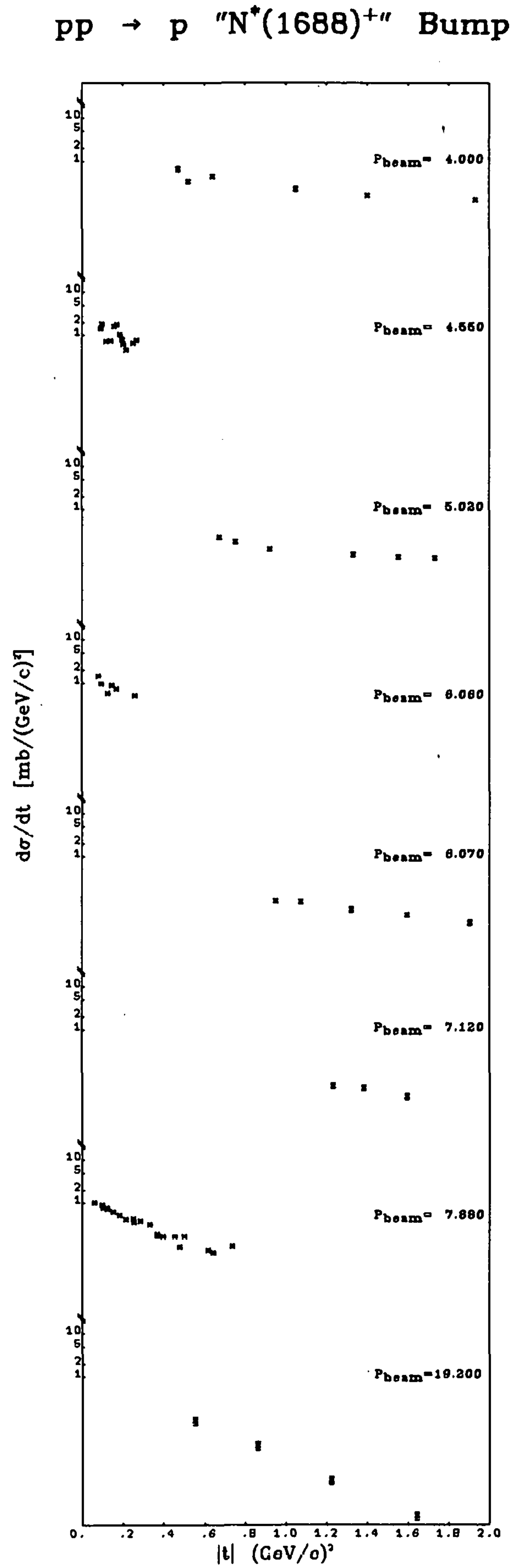


Fig. 23. Differential cross sections for pp → p "$N^*(1688)^+$."

Table III. Fits to dσ/dt for various pp quasi-two-body final states. These are the values the authors report when fitting their own data. Thus there may be some inconsistencies from experiment to experiment.

P_beam (GeV/c)	|t| min	|t| max	FORMULA	PARAMETERS							References	
2.85	.03	.160		A	15.000 ±	1.600	B	6.900 ±	1.200		BLAIR	69
4.55	.03	.270		A	6.900	.700	B	8.900	.900		BLAIR	69
6.00	.01	.110		A	2.960	.560	B	15.800	2.900		ANDERSON	66
6.06	.05	.260	X=A*EXP[B*T]	A	2.800	.500	B	10.000	1.000	pΔ+	BLAIR	69
7.88	.04	.340		A	2.100	.300	B	9.900	.600		BLAIR	69
10.00	.01	.130		A	1.600	.500	B	17.300	2.000		ANDERSON	66
15.00	.02	.130		A	1.500	1.000	B	21.100	4.400		ANDERSON	66
4.55	.04	.220		A	5.500	.800	B	14.000	1.300		BLAIR	69
6.06	.06	.160		A	8.800	2.900	B	20.700	2.700		BLAIR	69
6.070				B	10.400	1.000					TAN	68
7.88	.04	.145		A	5.900	2.500	B	22.100	4.100		BLAIR	69
10.00	.01	.110	X=A*EXP[B*T]	A	6.060	1.000	B	22.300	3.400	pN*(1470)	ANDERSON	66
15.00	.02	.140		A	4.800	.900	B	15.900	2.300		ANDERSON	66
20.00	.02	.140		A	4.750	1.200	B	14.400	2.500		ANDERSON	66
21.800		.250		B	18.000	2.300					JESPERSEN	68
30.00	.07	.130		A	8.820	4.200	B	23.500	5.100		ANDERSON	66
4.55	.05	.270		A	2.200	.300	B	5.400	.800		BLAIR	69
6.06	.06	.290		A	1.800	.400	B	7.100	1.100		BLAIR	69
7.88	.09	.484		A	.900	.100	B	5.200	.500		BLAIR	69
10.00	.30	.800	X=A*EXP[B*T]	A	.390	.120	B	3.950	.510	pN*(1520)	ANDERSON	66
15.00	.20	.900		A	.310	.070	B	3.880	.450		ANDERSON	66
20.00	.20	.900		A	.330	.070	B	3.830	.370		ANDERSON	66
30.00	.20	.900		A	.360	.100	B	4.300	.500		ANDERSON	66
4.55	.09	.270		A	2.100	.500	B	4.600	1.300		BLAIR	69
6.06	.08	.300		A	1.800	.500	B	5.600	1.300		BLAIR	69
7.88	.05	.500		A	1.300	.200	B	4.800	.400		BLAIR	69
10.00	.01	.800	X=A*EXP[B*T]	A	1.280	.100	B	4.500	.500	pN*(1688)	ANDERSON	66
15.00	.02	.600		A	1.610	.170	B	5.050	.380		ANDERSON	66
20.00	.04	.800		A	1.470	.200	B	5.250	.480		ANDERSON	66
30.00	.07	.900		A	1.790	.290	B	6.190	.500		ANDERSON	66

Fits to various pp dσ/dt's.

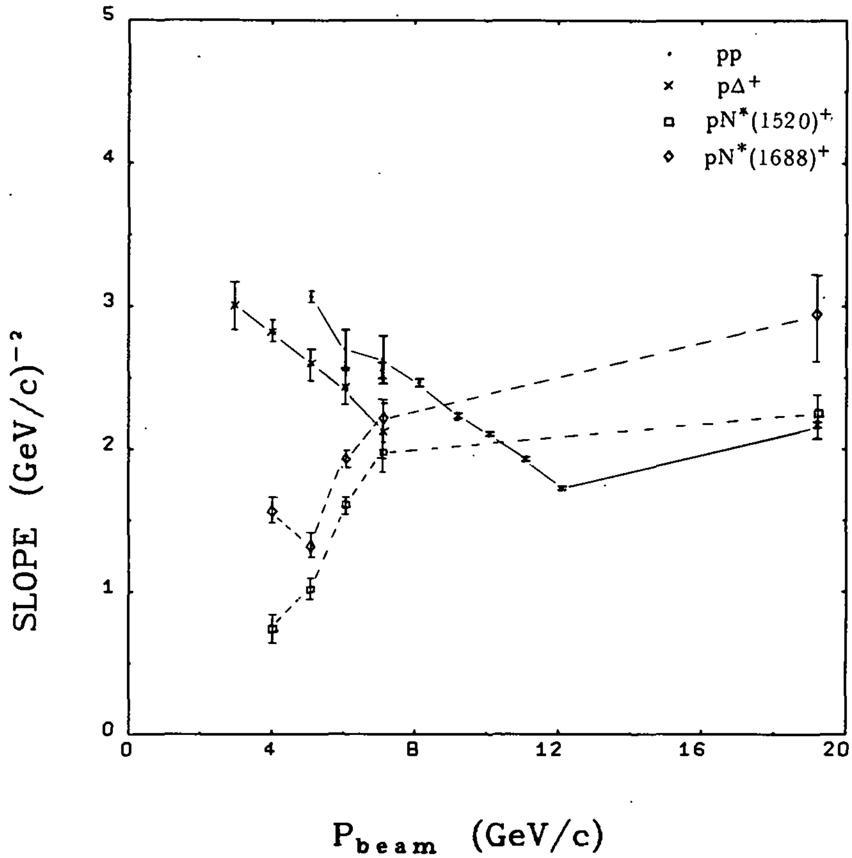


Fig. 24. Results of our least-squares fits to various pp quasi-two-body differential cross sections of the form $d\sigma/dt = Ae^{-v/v_0}$, where v is as defined in the text. The points at 19 GeV/c have been fitted over a somewhat different v region than were the lower-energy points.

P_{beam} (GeV/c)	SLOPE ($1/v_0$) $(GeV/c)^{-2}$		χ^2/N	
5.02	3.12 ±	.03	11.31	elastic
6.07	2.7	.14	1.53	
7.1	2.55	.06	1.67	
7.12	2.63	.17	1.31	
8.1	2.47	.03	4.84	
9.2	2.23	.02	6.78	
10.1	2.11	.01	9.35	
11.1	1.93	.01	12.38	
12.1	1.73	.01	11.76	
19.2	2.17	.02	1.72	
2.98	3.03	.18	3.13	$p\Delta^+$
4.0	2.80	.09	8.83	
5.02	2.59	.13	4.48	
6.07	2.44	.15	2.28	
7.12	2.12	.26	.34	
4.00	.73	.10	2.62	$pN^*(1520)^+$
5.02	1.04	.09	.45	
6.07	1.60	.06	.69	
7.12	1.91	.11	1.66	
19.2	2.22	.18	2.29	
4.00	1.55	.11	5.28	$pN^*(1688)^+$
5.02	1.31	.09	2.07	
6.07	1.87	.06	1.33	
7.12	2.22	.12	1.66	
19.2	2.95	.27	3.43	

$$pp \rightarrow \begin{cases} p\pi^+\Delta(1236)^0 \\ p\pi^-\Delta(1236)^{++} \end{cases}$$

P_{beam} (GeV/c)		$E_{c.m.}$ (GeV)	$\sigma_{p\pi^-\Delta^{++}}$ (mb)		References	
5.520	± .010	3.503	.280	± .040	ALEXANDER	67
5.970	.050	3.620	1.180	.200	CASO	68
6.900		3.851	2.300	.300	YEKUTIELI	69
10.010	.010	4.542	1.250	.140	ALMEIDA	68
19.000		6.120	.830	.150	BOGGILD	68
28.500		7.434	.600	.100	CONNOLLY	67

REFERENCES

1	ALEXANDER	67.....PR	154 1284	HBC
2	CONNOLLY	67.....BNL	11980	HBC
3	ALMEIDA	68.....PR	174 1638	HBC
4	BOGGILD	68.....SUB VNA		HBC
5	CASO	68.....NC	55A 66	HBC
6	YEKUTIELI	69.....REHC		HBC

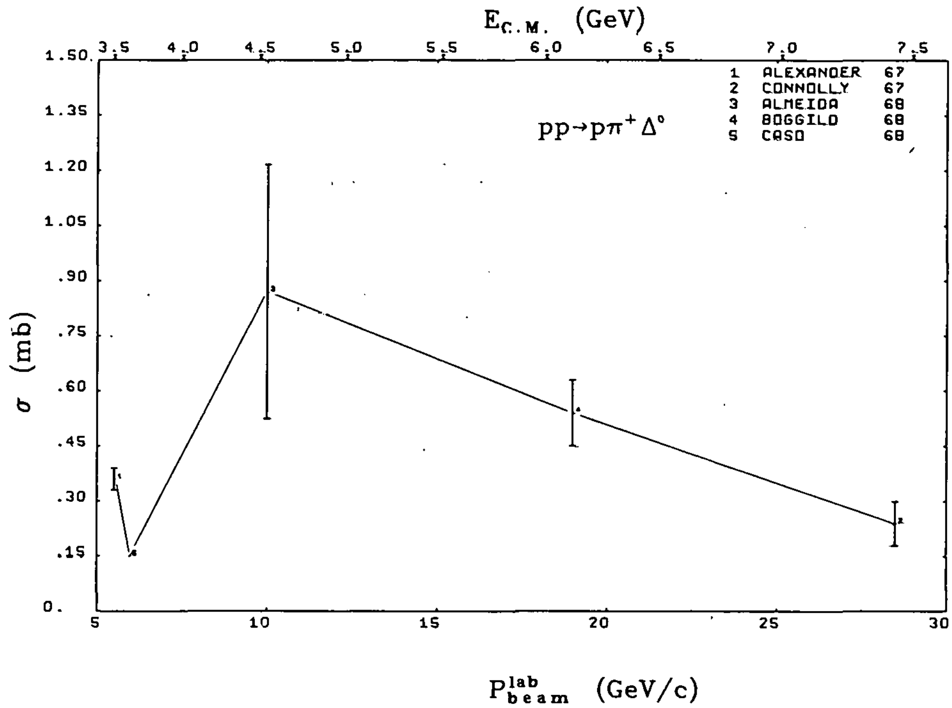
P_{beam} (GeV/c)	$\sigma_{p\pi^+\Delta^0}$ (mb) $\Delta^0 \rightarrow p\pi$		$\Delta^0 \rightarrow$ ALL MODES		References	
5.520	.120	± .010	(.360	± .030)	ALEXANDER	67
5.970	.050		(.150)		CASO	68
10.010	.290	.116	(.870	.348)	ALMEIDA	68
19.000	.180	.030	(.540	.090)	BOGGILD	68
28.500	.080	.020	(.240	.060)	CONNOLLY	67

REFERENCES

1	ALEXANDER	67.....PR	154 1284	HBC
2	CONNOLLY	67.....BNL	11980	HBC
3	ALMEIDA	68.....PR	174 1638	HBC
4	BOGGILD	68.....SUB VNA		HBC
5	CASO	68.....NC	55A 66	HBC

DATA IN PARENTHESES HAVE BEEN CORRECTED BY US.

$$pp \rightarrow \begin{cases} p\pi^+\Delta(1236)^0 \\ p\pi^-\Delta(1236)^{++} \end{cases}$$



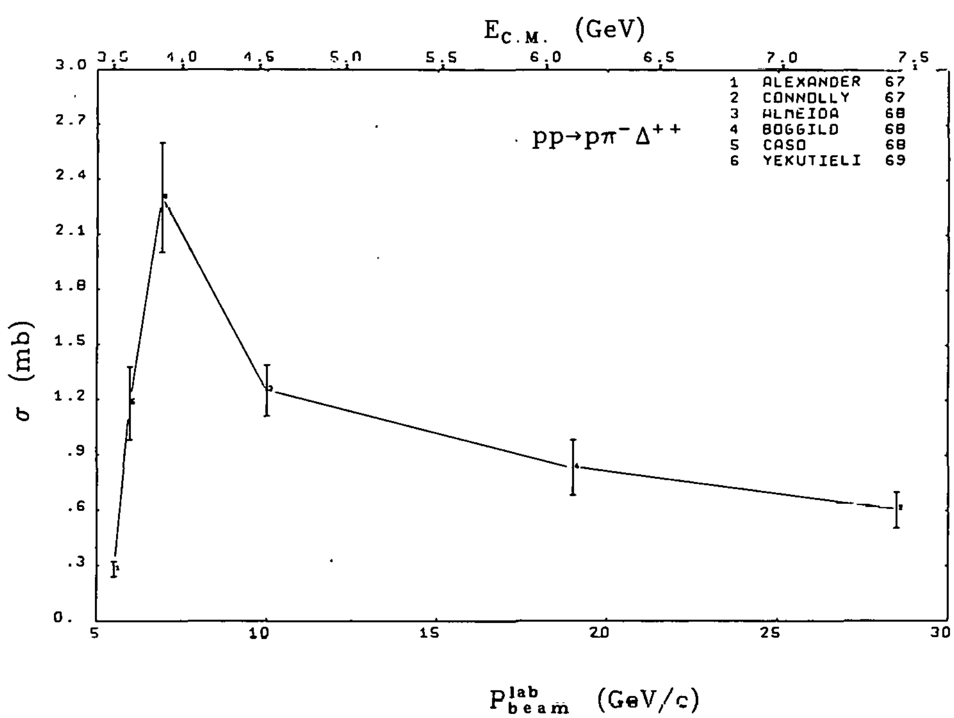


Fig. 25. Cross sections for (a) $pp \rightarrow p\pi^- \Delta(1236)^{++}$ and (b) $pp \rightarrow p\pi^+\Delta(1236)^0$, corrected for all decay modes. These do not contain double-resonance production. These data are from bubble chambers.

$$pp \rightarrow \begin{cases} \Delta(1236)^{++}\Delta(1236)^{0} \\ \Delta(1236)^{++}N^{*}(1520)^{0} \end{cases}$$

P_{beam} (GeV/c) $\sigma_{\Delta^{++}\Delta^{0}}$ (mb) References

(GEV/C)	$\Delta^0 \rightarrow p\pi^-$	$\Delta^0 \rightarrow$ ALL MODES	
5.520	.250 ± .C4C	(.750 ± .120)	ALEXANDER 67
5.970	.720 .150	(2.160 .450)	CASO 68
6.000	.660 .07C	(1.980 .210)	KINSEY 68
6.900	.420 .100	(1.260 .300)	YEKUTIELI 69
8.11C	.220 .051	(.660 .154)	KAYAS 68
19.000	.020 .C1C	(.060 .030)	BOGGILD 68
28.500	.020 .010	(.060 .030)	CONNOLLY 67

REFERENCES

1	ALEXANDER	67.....PR	154 1284	HBC
2	CONNOLLY	67.....BNL	11980	HBC
3	BOGGILD	68.....SUB VNA		HBC
4	CASO	60.....NC	55A 66	HBC
5	KAYAS	68.....NP	B5 169	HBC
6	KINSEY	68.....UCRL	17707	HBC
7	YEKUTIELI	69.....REHC		HBC

P_{beam} (GeV/c) $\sigma_{\Delta^{++}N^{*}(1520)^{0}}$ (mb) References

(GEV/C)	$N^{*0} \rightarrow p\pi^-$	$N^{*0} \rightarrow$ ALL MODES	
5.520	.020 ± .020	(.113 ± .113)*	ALEXANDER 67
5.97C	.230 .120	(1.302 .679)	CASO 68
6.000	.440 .050	(2.490 .283)	KINSEY 68
6.900	.230 .070	(1.302 .396)	YEKUTIELI 69
8.110	.130 .041	(.736 .229)	KAYAS 68
19.000	.020 .010	(.113 .057)	BOGGILD 68

REFERENCES

1	ALEXANDER	67.....PR	154 1284	HBC
2	BOGGILD	68.....SUD VNA		HBC
3	CASO	68.....NC	55A 66	HBC
4	KAYAS	68.....NP	B5 169	HBC
5	KINSEY	68.....UCRL	17707	HBC
6	YEKUTIELI	69.....REHO		HBC

DATA IN PARENTHESES HAVE BEEN CALCULATED BY US.

* The error (~8%) in $X = \frac{\Gamma(N^* \rightarrow N\pi)}{\Gamma(N^* \rightarrow \text{all modes})}$ has not been folded in the quoted errors.

$$pp \rightarrow \begin{cases} \Delta(1236)^{++}\Delta(1236)^{0} \\ \Delta(1236)^{++}N^{*}(1520)^{0} \end{cases}$$

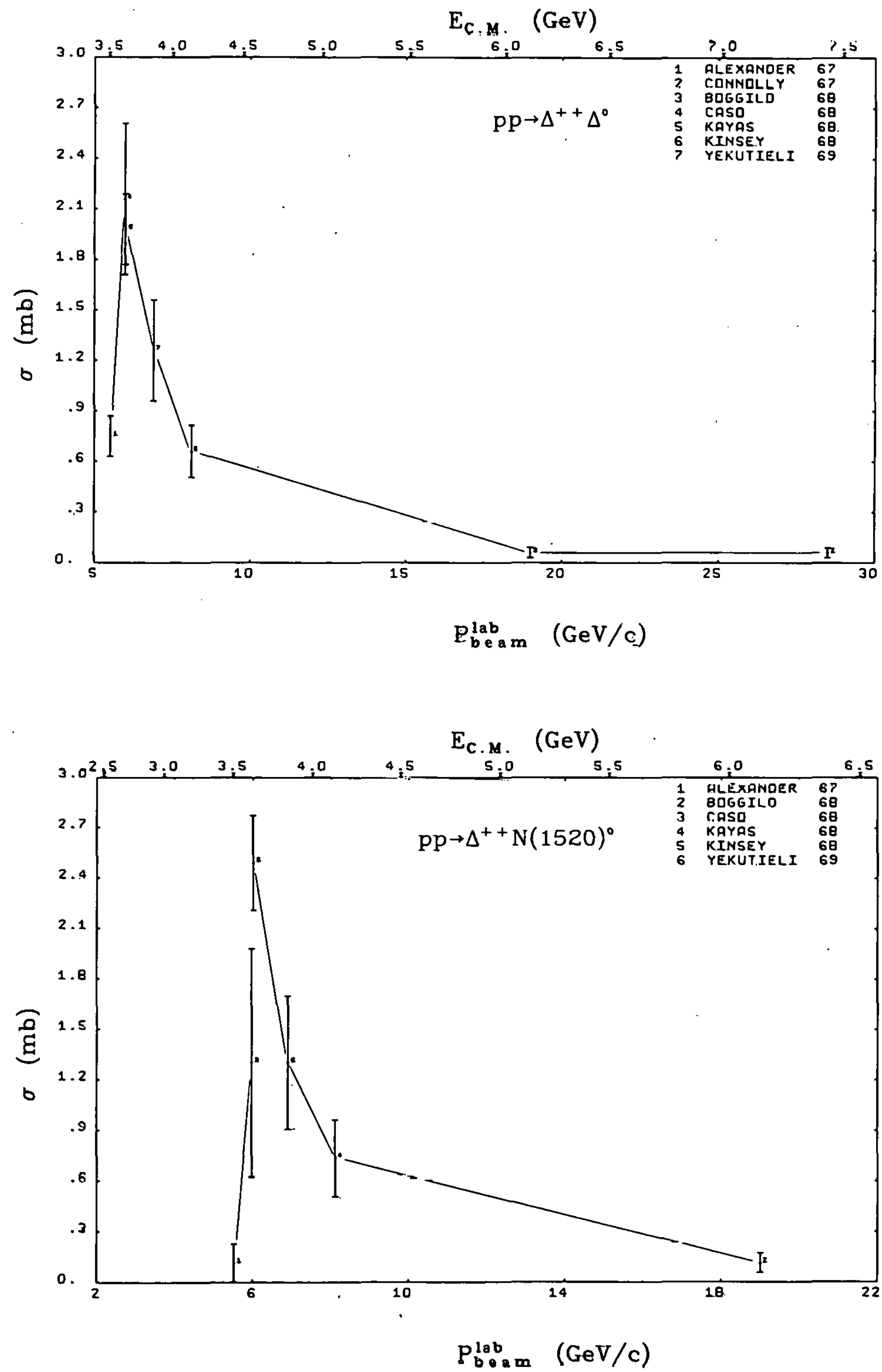


Fig. 26. Some double-resonance production cross sections in pp collisions. (a) $\Delta(1236)^{++}$ $\Delta(1236)^{0}$ and (b) $\Delta(1236)^{++}$ $N(1520)^{0}$. Both have been corrected for all modes. These data are from bubble chambers.

$pp \rightarrow pp \begin{cases} \omega \\ \eta \\ \rho \end{cases}$

P_{beam} (GeV/c)	$\sigma_{pp\omega}$ (mb) $\omega \rightarrow \pi^+\pi^-\pi^0$		$\omega \rightarrow$ ALL MODES		References	
4.000	.080 ±	.030	[.092 ±	.034]*	BODINI	68
5.520	.110	.020	[.126	.023]	ALEXANDER	67
5.970	.180	.050	[.207	.057]	CASO	68
6.600	.180	.023	[.207	.026]	COLTON	69
6.900	.140	.040	[.161	.046]	YEKUTIELI	69
10.010	.145	.030	[.167	.034]	ALMEIDA	68
28.500	.050	.010	[.057	.011]	CONNOLLY	67

REFERENCES

1	ALEXANDER	67.....PR	154 1284	HBC
2	CONNOLLY	67.....BNL	11980	HBC
3	ALMEIDA	68.....PR	174 1638	HBC
4	BODINI	68.....NC	58A 175	HBC
5	CASO	68.....NC	55A 66	HBC
6	COLTON	69.....UCRL	19330	HBC
7	YEKUTIELI	69.....REHO		HBC

P_{beam} (GeV/c)	$\sigma_{pp\eta}$ (mb) $\eta \rightarrow \pi^+\pi^-\pi^0$		$\eta \rightarrow$ ALL MODES		References	
4.000	.040 ±	.020	[.140 ±	.070]*	BODINI	68
5.520	.020	.010	[.070	.035]	ALEXANDER	67
5.970	.070	.050	[.245	.175]	CASO	68
6.600	.029	.009	[.101	.031]	COLTON	69
6.900	.040	.010	[.140	.035]	YEKUTIELI	69
10.010	.036	.015	[.126	.052]	ALMEIDA	68

REFERENCES

1	ALEXANDER	67.....PR	154 1284	HBC
2	ALMEIDA	68.....PR	174 1638	HBC
3	BODINI	68.....NC	58A 175	HBC
4	CASO	68.....NC	55A 66	HBC
5	COLTON	69.....UCRL	19330	HBC
6	YEKUTIELI	69.....REHO		HBC

P_{beam} (GeV/c)		$E_{c.m.}$ (GeV)	$\sigma_{pp\rho^0 \rightarrow \pi^+\pi^-}$ (mb)	References		
5.520	.010	3.503	.070 ± .050	ALEXANDER	67	} Not plotted.
6.110	.010	4.100	< .10	KAYAS	68	

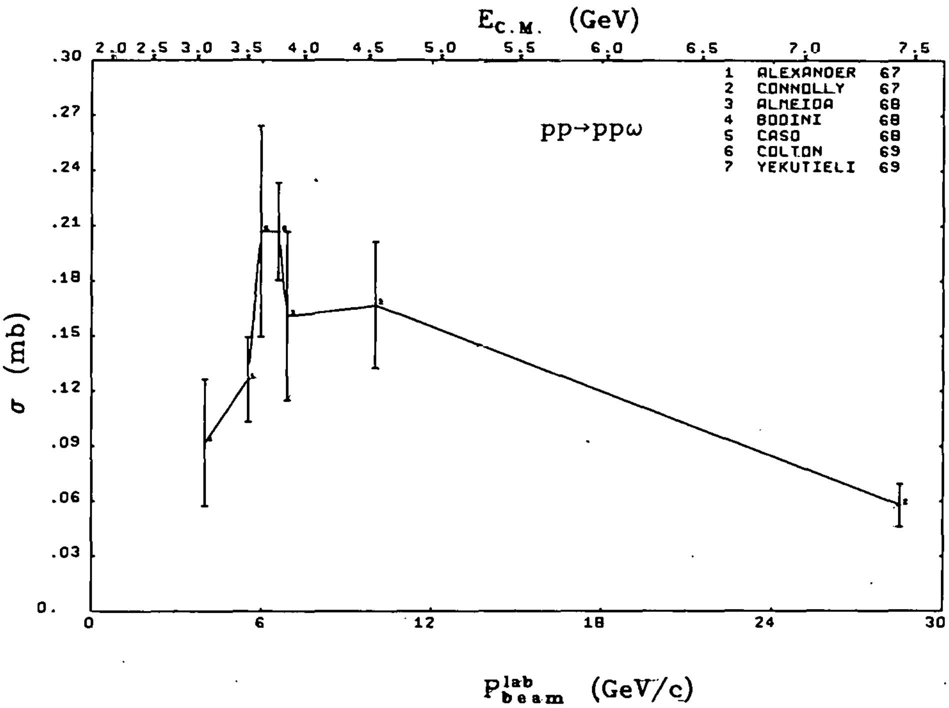
REFERENCES

1	ALEXANDER	67.....PR	154 1284		HBC
2	KAYAS	68......NP	B5 169	68	HBC

*The error in $X = \frac{\Gamma(\omega \rightarrow \pi^+\pi^-\pi^0)}{\Gamma(\omega \rightarrow \text{all modes})}$ (~1%) and $X = \frac{\Gamma(\eta \rightarrow \pi^+\pi^-\pi^0)}{\Gamma(\eta \rightarrow \text{all modes})}$ (~4%) have not been folded in the quoted errors.

DATA IN PARENTHESES HAVE BEEN CORRECTED BY US.

$$pp \to pp \begin{cases} \omega \\ \eta \\ \rho \end{cases}$$



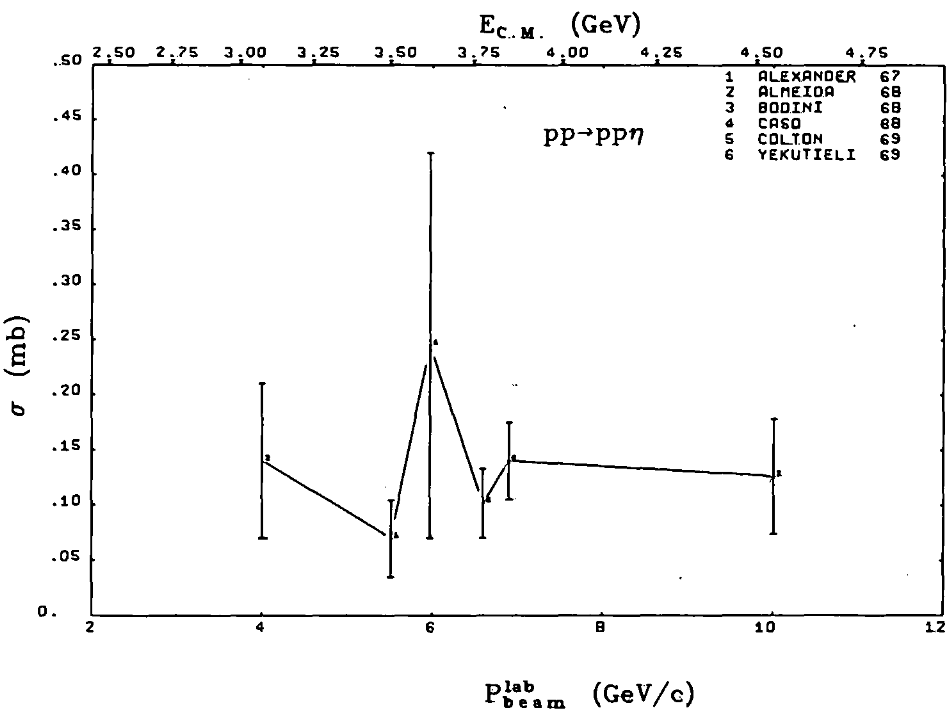
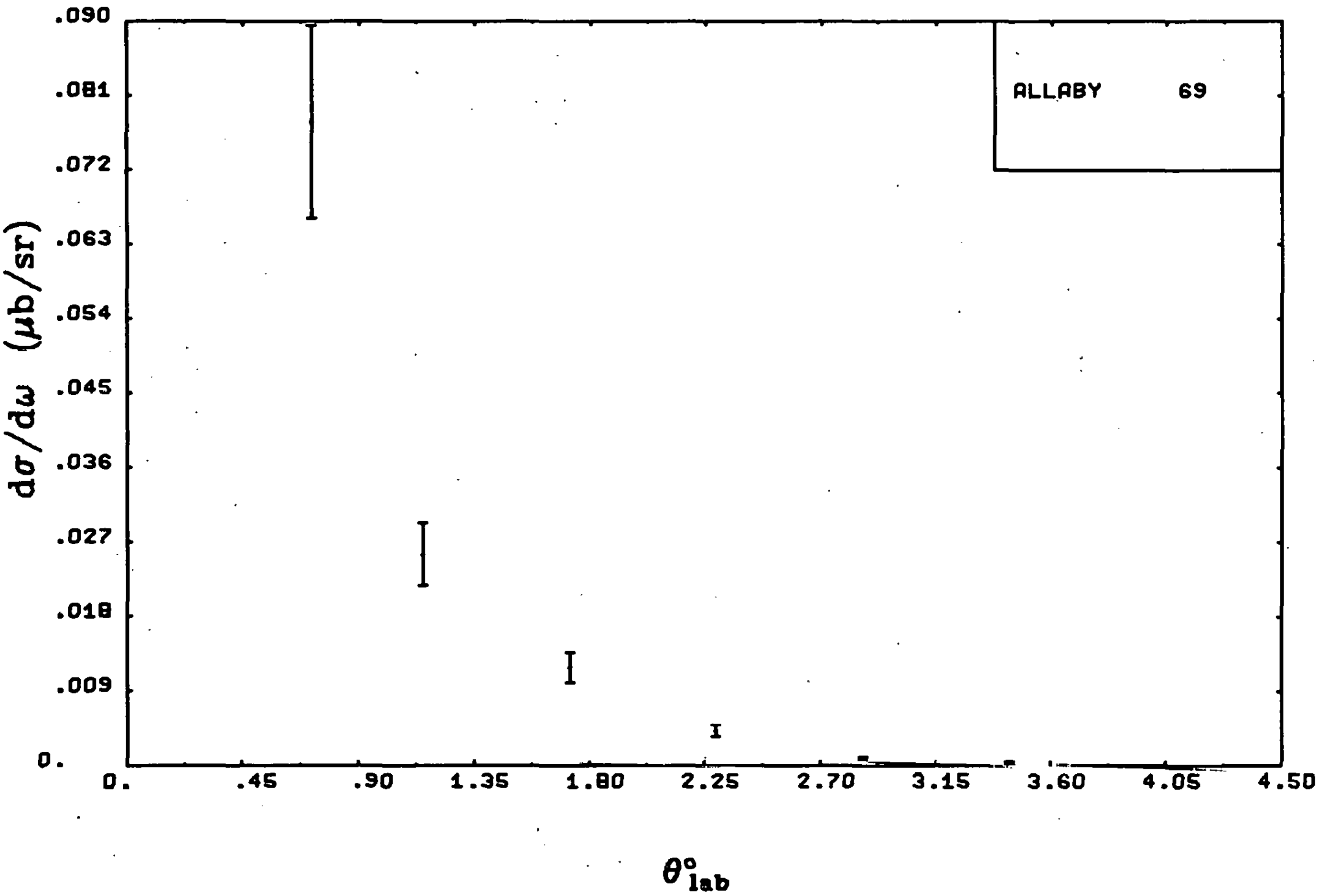


Fig. 27. Boson resonance production in pp interactions. (a) pp → ppω and (b) pp → ppη. Although the authors state that their cross sections are only for the decay $\eta \to \pi^+\pi^-\pi^0$, they have apparently not made any cuts to separate π^0's from γ's. Since at 4 to 10 GeV/c (where all of these experiments are done) in the bubble chamber the π^0's and γ's are readily confused, we believe that their numbers are really for the sum of the $\pi^+\pi^-\pi^0$ and $\pi^+\pi^-\gamma$ modes, and we have used this assumption in correcting to the total decays. Cross sections for ρ production are tabulated only.

$d\sigma/dt$ for $pp \to d\rho^+$

$P_{beam}^{lab} = 21.100$ GeV/c



DISTRIBUTION IN THE ANGLE OF THE DEUTERON WITH RESPECT TO THE BEAM DIRECTION IN THE LAB SYSTEM

BEAM MOMENTUM=21.100 GEV/C

THETA(DEG)	SIGMA +- DSIGMA (MICROBARNS/STERADIAN)	
.716	.078	.012
1.146	.025	.004
1.719	.012	.002
2.292	.004	.001
2.865	.001	.000
3.438	.000	.000

2Q SQUARE= 18.936
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12PER CENT

ALLABY PL 29B 198(1969) CNTR

Fig. 28. Differential cross sections for the $pp \to d\rho^+$.

pp Inelastic Interactions—Strange Particle Production

$pp \rightarrow p\Lambda K^+$

P_{beam} (GeV/c)		$E_{c.m.}$ (GeV)	$\sigma_{p\Lambda K^+}$ (mb)		References
2.807	± .005	2.705	.018	± .005	FICKINGER 62
3.349	.195	2.879	.024	.004	HOGAN 68
3.670	.037	2.978	.051	.012	LOUTTIT 61
4.950		3.349	.048	.004	BIERMAN 66
5.520	.010	3.503	.036	.010	ALEXANDER 67
5.970	.050	3.620	.059	.011	CASO 68
6.050	.060	3.640	.054	+ .003 − .005	CHINOWSKY 68
6.920	.075	3.856	.043	.008	ALEXANDER 68
7.870		4.078	.054	.007	FIREBAUGH 68

REFERENCES

1	LOUTTIT	61.....PR	123 1465	HBC
2	FICKINGER	62.....PR	125 2082	HBC
3	BIERMAN	66.....PR	147 922	HBC
4	ALEXANDER	67.....PR	154 1284	HBC
5	ALEXANDER	68.....NC	53A 455	HBC
6	CASO	68.....NC	55A 66	HBC
7	CHINOWSKY	68.....PR	165 1466	HBC
8	FIREBAUGH	68.....PR	172 1354	HBC
9	HOGAN	68.....PR	166 1472	CNTR

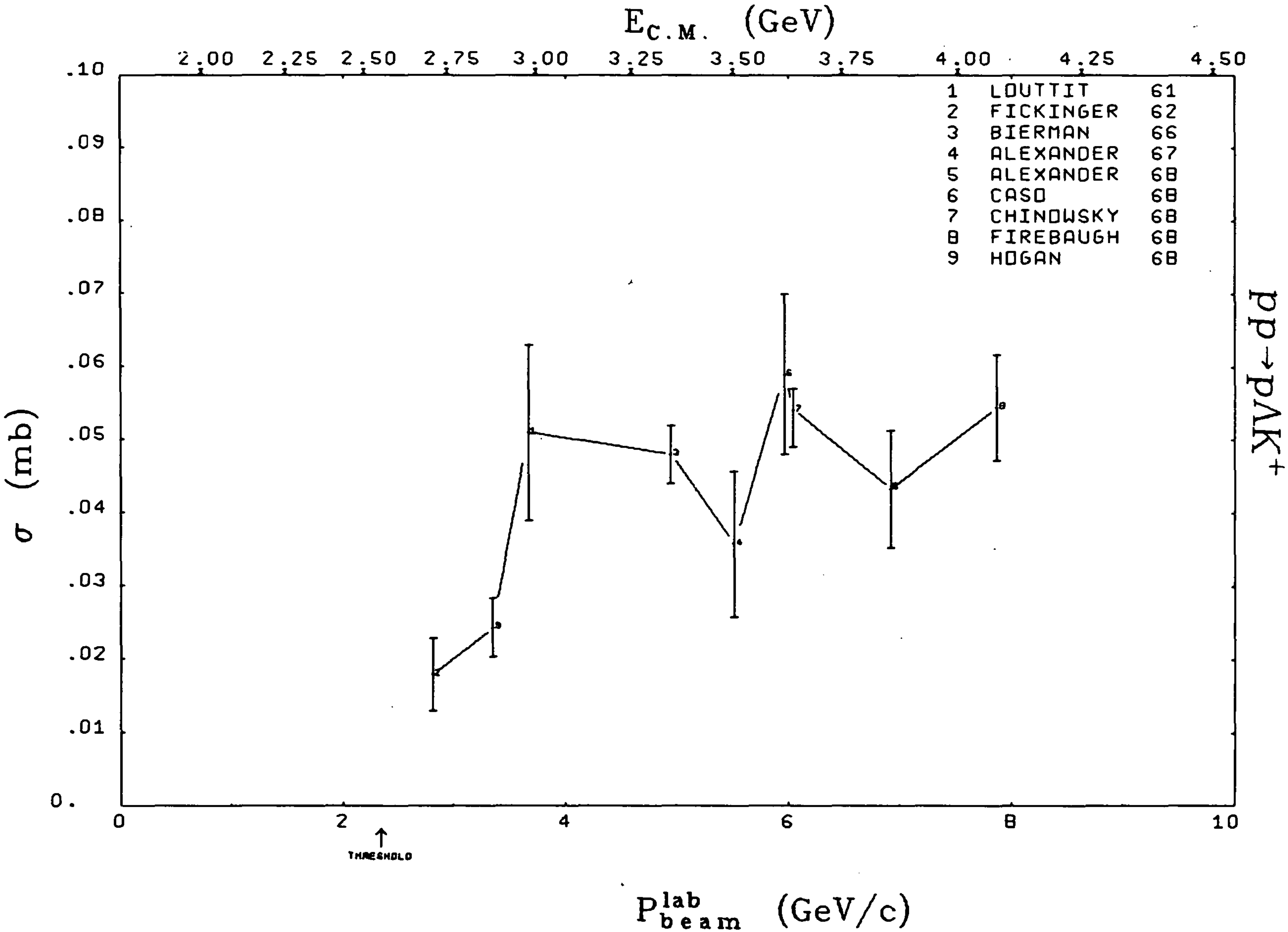


Fig. 29. Cross section for pp → pΛK^+, including any possible resonance contributions.

$$pp \rightarrow \begin{cases} p\Sigma^+K^0 \\ p\Sigma^0K^+ \end{cases}$$

(a)

P_{beam} (GeV/c)		$E_{c.m.}$ (GeV)	$\sigma_{p\Sigma^+K^o}$ (mb)		References	
3.670 ±	.037	2.978	.030 ±	.010	LOUTTIT	61
4.950		3.349	.017	.003	BIERMAN	66
4.950		3.349	.025	.002	SONDHI	68
5.520	.010	3.503	.004	.004	ALEXANDER	67
6.050	.060	3.640	.026	.004	CHINOWSKY	68
6.920	.075	3.856	.020	.007	ALEXANDER	68
7.870		4.078	.014	.005	FIREBAUGH	68
10.000		4.540	.060	.020	HOLMGREN	67

REFERENCES

1	LOUTTIT	61.....PR	123	1465	HBC
2	BIERMAN	66.....PR	147	922	HBC
3	ALEXANDER	67.....PR	154	1284	HBC
4	HOLMGREN	67.....NC	51A	305	HBC
5	ALEXANDER	68.....NC	53A	455	HBC
6	CHINOWSKY	68.....PR	165	1466	HBC
7	FIREBAUGH	68.....PR	172	1354	HBC
8	SONDHI	68.....PL	26B	645	HBC

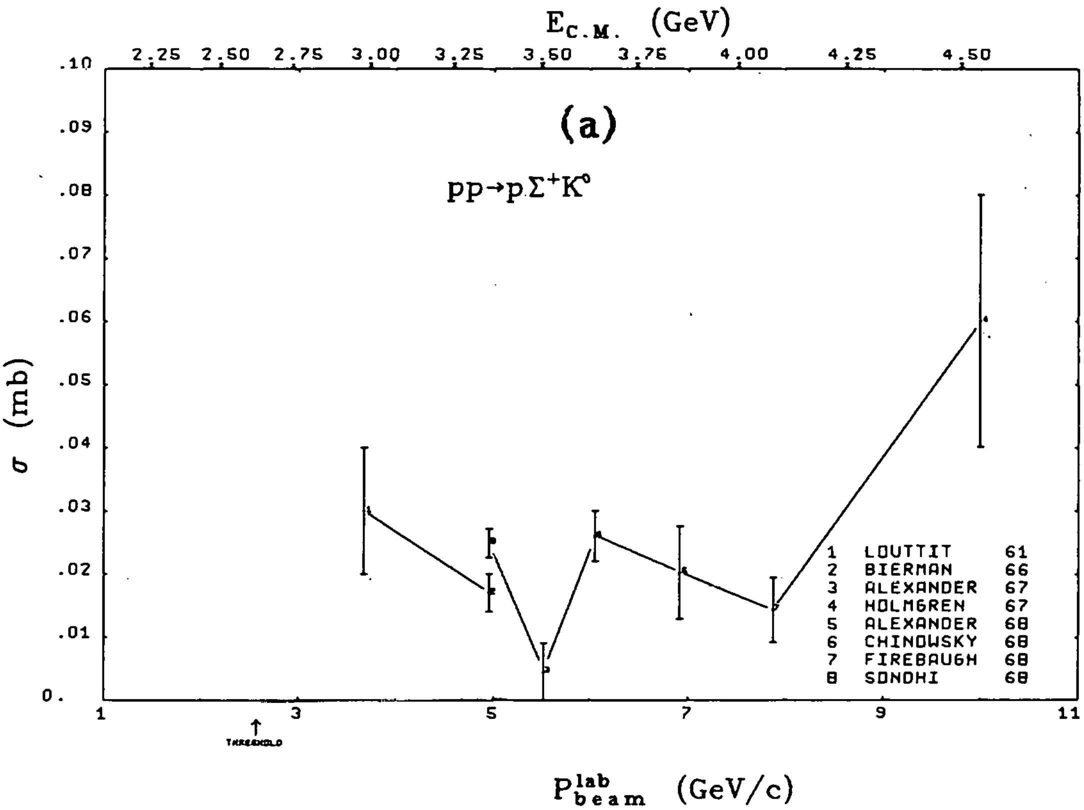
(b)

P_{beam} (GeV/c)		$E_{c.m.}$ (GeV)	$\sigma_{p\Sigma^oK^+}$ (mb)		References	
3.670 ±	.037	2.978	.013 ±	.007	LOUTTIT	61
4.950		3.349	.025	.003	BIERMAN	66
5.520	.010	3.503	.016	.007	ALEXANDER	67
5.970	.050	3.620	.012	.005	CASO	68
6.050	.060	3.640	.017	+ .004 − .002	CHINOWSKY	68
6.920	.075	3.856	.029	.007	ALEXANDER	68
7.870		4.078	.025	.005	FIREBAUGH	68

REFERENCES

1	LOUTTIT	61.....PR	123	1465	HBC
2	BIERMAN	66.....PR	147	922	HBC
3	ALEXANDER	67.....PR	154	1284	HBC
4	ALEXANDER	68.....NC	53A	455	HBC
5	CASO	68.....NC	55A	66	HBC
6	CHINOWSKY	68.....PR	165	1466	HBC
7	FIREBAUGH	68.....PR	172	1354	HBC

$$pp \rightarrow \begin{cases} p\Sigma^+K^0 \\ p\Sigma^0K^+ \end{cases}$$



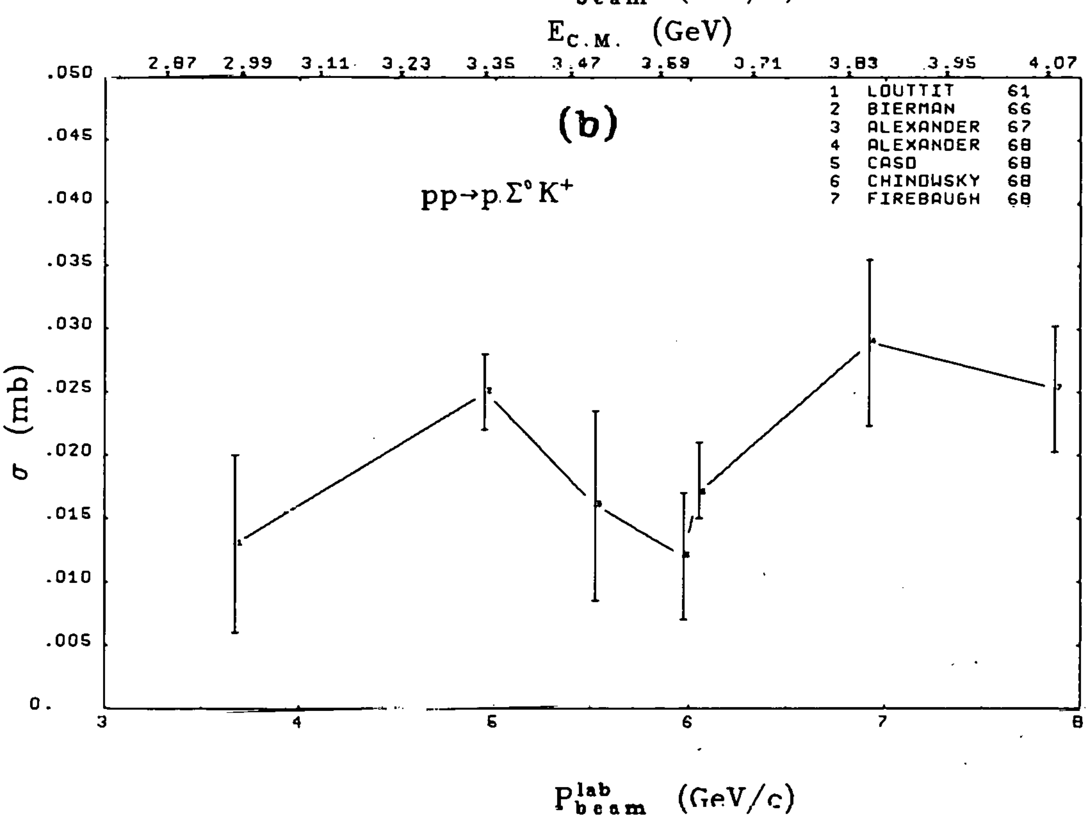


Fig. 30. (a) $pp \rightarrow p\,\Sigma^+ K^0$ and (b) $pp \rightarrow p\,\Sigma^0 K^+$ cross sections including any possible resonance contributions.

pp → NΛKπ

P_{beam} (GeV/c)		$E_{c.m.}$ (GeV)	$\sigma_{p\Lambda K^0\pi^+}$ (mb)		References	
4.950		3.349	.042	± .005	BIERMAN	66
5.520	± .010	3.503	.078	.013	ALEXANDER	67
5.970	.050	3.620	.071	.010	CASO	68
6.000	.007	3.627	.064	.006	KLEIN	68
6.920	.075	3.856	.090	.010	ALEXANDER	68
7.870		4.078	.072	.007	FIREBAUGH	68
10.000		4.540	.106	.029	HOLMGREN	67

REFERENCES

1	BIERMAN	66.....PR	147 922	HBC
2	ALEXANDER	67.....PR	154 1284	HBC
3	HOLMGREN	67.....NC	51A 305	HBC
4	ALEXANDER	68.....NC	53A 455	HBC
5	CASO	68.....NC	55A 66	HBC
6	FIREBAUGH	68.....PR	172 1354	HBC
7	KLEIN	68.....UCRL	18306	HBC

P_{beam} (GeV/c)		$E_{c.m.}$ (GeV)	$\sigma_{n\Lambda K^+\pi^+}$ (mb)		References	
4.950		3.349	.041	± .005	BIERMAN	66
5.520	± .010	3.503	.075	.016	ALEXANDER	67
6.000	.007	3.627	.049	.004	KLEIN	68
6.920	.075	3.856	.078	.011	ALEXANDER	68
7.870		4.078	.101	.010	FIREBAUGH	68

REFERENCES

1	BIERMAN	66.....PR	147 922	HBC
2	ALEXANDER	67.....PR	154 1284	HBC
3	ALEXANDER	68.....NC	53A 455	HBC
4	FIREBAUGH	68.....PR	172 1354	HBC
5	KLEIN	68.....UCRL	18306	HBC

P_{beam} (GeV/c)		$E_{c.m.}$ (GeV)	$\sigma_{p\Lambda K^+\pi^0}$ (mb)		References	
4.950		3.349	.028	± .003	BIERMAN	66
5.520	± .010	3.503	.062	.012	ALEXANDER	67
6.000	.007	3.627	.039	.006	KLEIN	68
6.920	.075	3.856	.074	.010	ALEXANDER	68
7.870		4.078	.077	.009	FIREBAUGH	68

REFERENCES

1	BIERMAN	66.....PR	147 922	HBC
2	ALEXANDER	67.....PR	154 1284	HBC
3	ALEXANDER	68.....NC	53A 455	HBC
4	FIREBAUGH	68.....PR	172 1354	HBC
5	KLEIN	68.....UCRL	18306	HBC

pp → $N\Lambda K\pi$

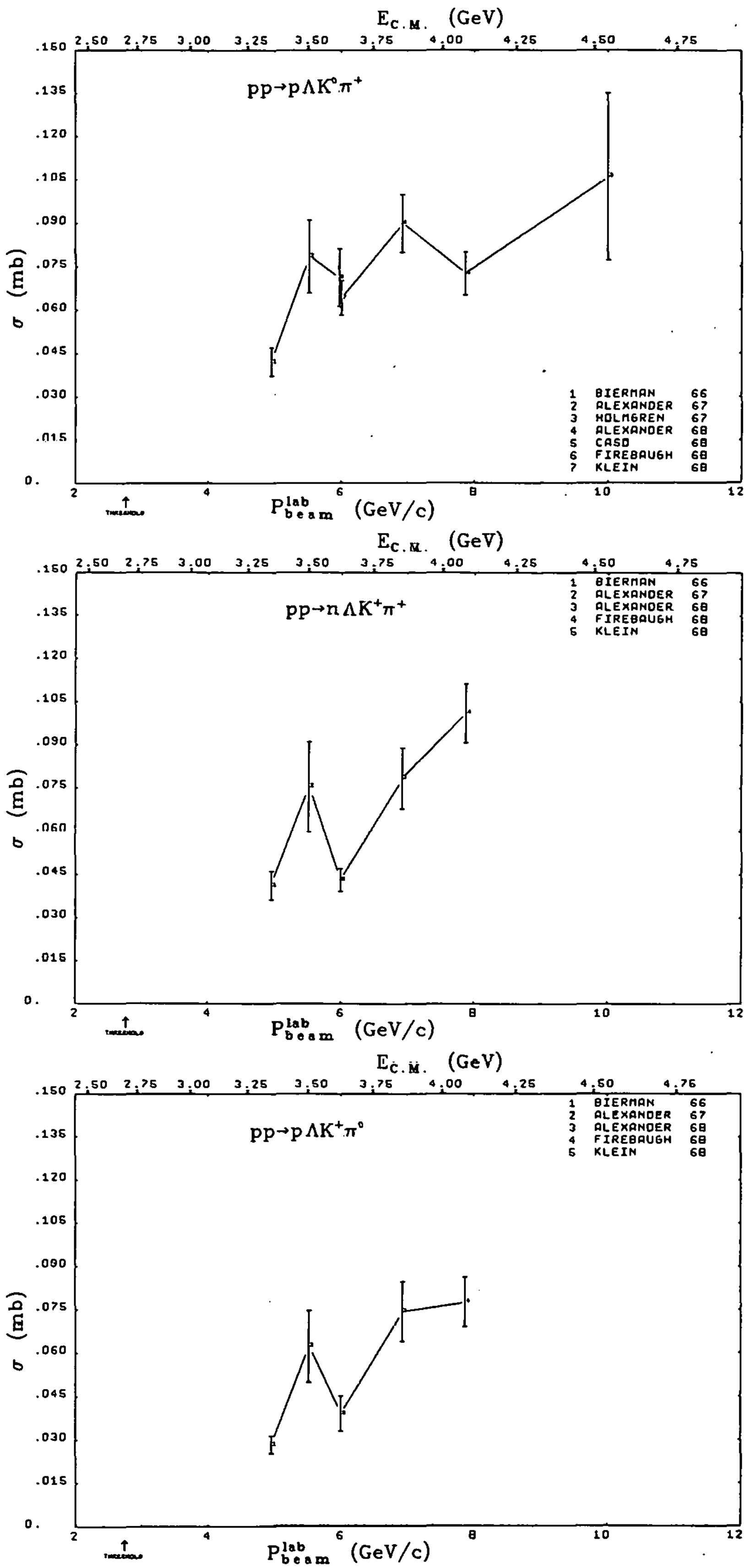


Fig. 31. The pp → $N\Lambda K\pi$ reaction cross sections.

$pp \rightarrow N\Sigma K^0\pi$

P_{beam} (GeV/c)		$E_{c.m.}$ (GeV)	$\sigma_{p\Sigma^oK^o\pi^+}$ (mb)		References	
4.950		3.349	.020 ±	.003	BIERMAN	66
5.520 ±	.010	3.503	.029	.012	ALEXANDER	67
5.970	.050	3.620	.016	.005	CASO	68
6.000	.007	3.627	.011	.002	KLEIN	68
6.920	.075	3.856	.054	.012	ALEXANDER	68
7.870		4.078	.029	.007	FIREBAUGH	68

REFERENCES

1	BIERMAN	66.....PR	147 922	HBC
2	ALEXANDER	67.....PR	154 1284	HBC
3	ALEXANDER	68.....NC	53A 455	HBC
4	CASO	68.....NC	55A 66	HBC
5	FIREBAUGH	68.....PR	172 1354	HBC
6	KLEIN	68.....UCRL	18306	HBC

P_{beam} (GeV/c)		$E_{c.m.}$ (GeV)	$\sigma_{n\Sigma^+K^o\pi^+}$ (mb)		References	
4.950		3.349	.007 ±	.002	BIERMAN	66
5.520 ±	.010	3.503	.004	.004	ALEXANDER	67
6.920	.075	3.856	.005	.004	ALEXANDER	68
7.870		4.078	.021	.006	FIREBAUGH	68
10.000		4.540	.049	.016	HOLMGREN	67

REFERENCES

1	BIERMAN	66.....PR	147 922	HBC
2	ALEXANDER	67.....PR	154 1284	HBC
3	HOLMGREN	67.....NC	51A 305	HBC
4	ALEXANDER	68.....NC	53A 455	HBC
5	FIREBAUGH	68.....PR	172 1354	HBC

P_{beam} (GeV/c)		$E_{c.m.}$ (GeV)	$\sigma_{p\Sigma^+K^o\pi^o}$ (mb)		References	
4.950		3.349	.007 ±	.002	BIERMAN	66
5.520 ±	.010	3.503	.009	.007	ALEXANDER	67
6.920	.075	3.856	.011	.005	ALEXANDER	68
7.870		4.078	.018	.006	FIREBAUGH	68
10.000		4.540	.031	.013	HOLMGREN	67

REFERENCES

1	BIERMAN	66.....PR	147 922	HBC
2	ALEXANDER	67.....PR	154 1284	HBC
3	HOLMGREN	67.....NC	51A 305	HBC
4	ALEXANDER	68.....NC	53A 455	HBC
5	FIREBAUGH	68.....PR	172 1354	HBC

pp → $N\Sigma K^0\pi$

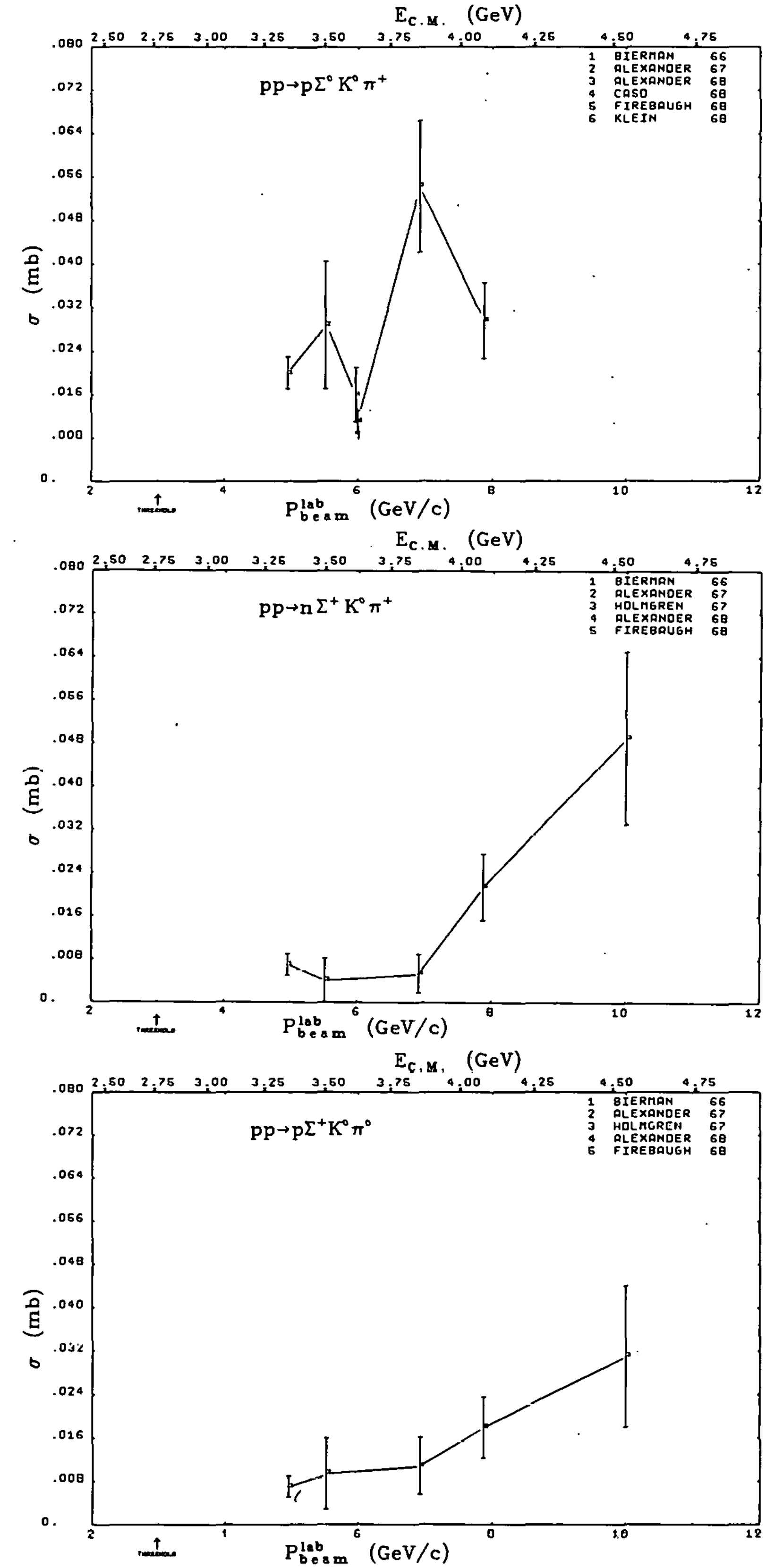


Fig. 32. The pp → $N\Sigma K^0\pi$ cross sections.

$$pp \rightarrow \begin{cases} ppK^0\bar{K}^0 \\ pnK^+\bar{K}^0 \end{cases}$$

P_{beam} (GeV/c)		$E_{c.m.}$ (GeV)	$\sigma_{ppK^0\bar{K}^0}$ (mb)		References	
4.950		3.349	.003	± .001	BIERMAN	66
5.520	± .010	3.503	.006	.004	ALEXANDER	67
5.970	.050	3.620	.005	.003	CASO	68
6.920	.075	3.856	.008	.004	ALEXANDER	68
7.870		4.078	.010	.003	FIREBAUGH	68
10.000		4.540	.033	.016	HOLMGREN	67

REFERENCES

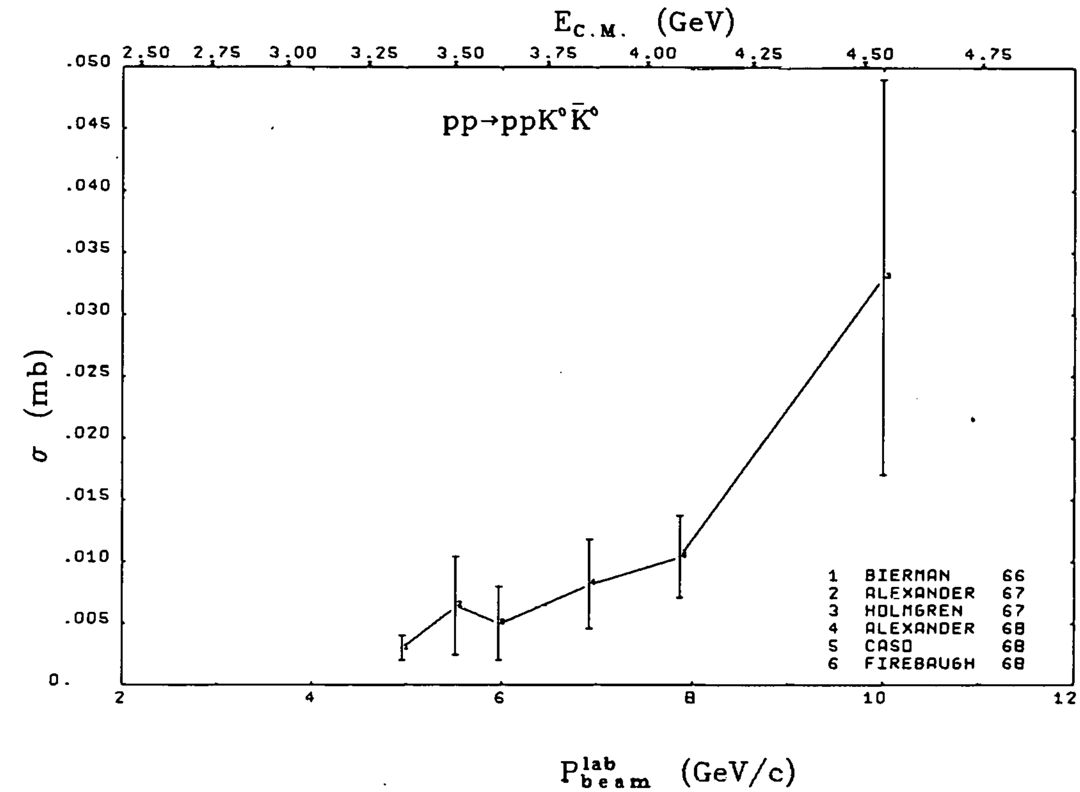
1	BIERMAN	66.....PR	147 922	HBC
2	ALEXANDER	67.....PR	154 1284	HBC
3	HOLMGREN	67.....NC	51A 305	HBC
4	ALEXANDER	68.....NC	53A 455	HBC
5	CASO	68.....NC	55A 66	HBC
6	FIREBAUGH	68.....PR	172 1354	HBC

P_{beam} (GeV/c)		$E_{c.m.}$ (GeV)	$\sigma_{pnK^+\bar{K}^0}$ (mb)		References	
4.950		3.349	.012	± .003	BIERMAN	66
5.520	± .010	3.503	.019	.010	ALEXANDER	67
5.970	.050	3.620	.013	.007	CASO	68
6.920	.075	3.856	.028	.008	ALEXANDER	68
7.870		4.078	.025	.007	FIREBAUGH	68

REFERENCES

1	BIERMAN	66.....PR	147 922	HBC
2	ALEXANDER	67.....PR	154 1284	HBC
3	ALEXANDER	68.....NC	53A 455	HBC
4	CASO	68.....NC	55A 66	HBC
5	FIREBAUGH	68.....PR	172 1354	HBC

$$pp \rightarrow \begin{cases} ppK^0\bar{K}^0 \\ pnK^+\bar{K}^0 \end{cases}$$



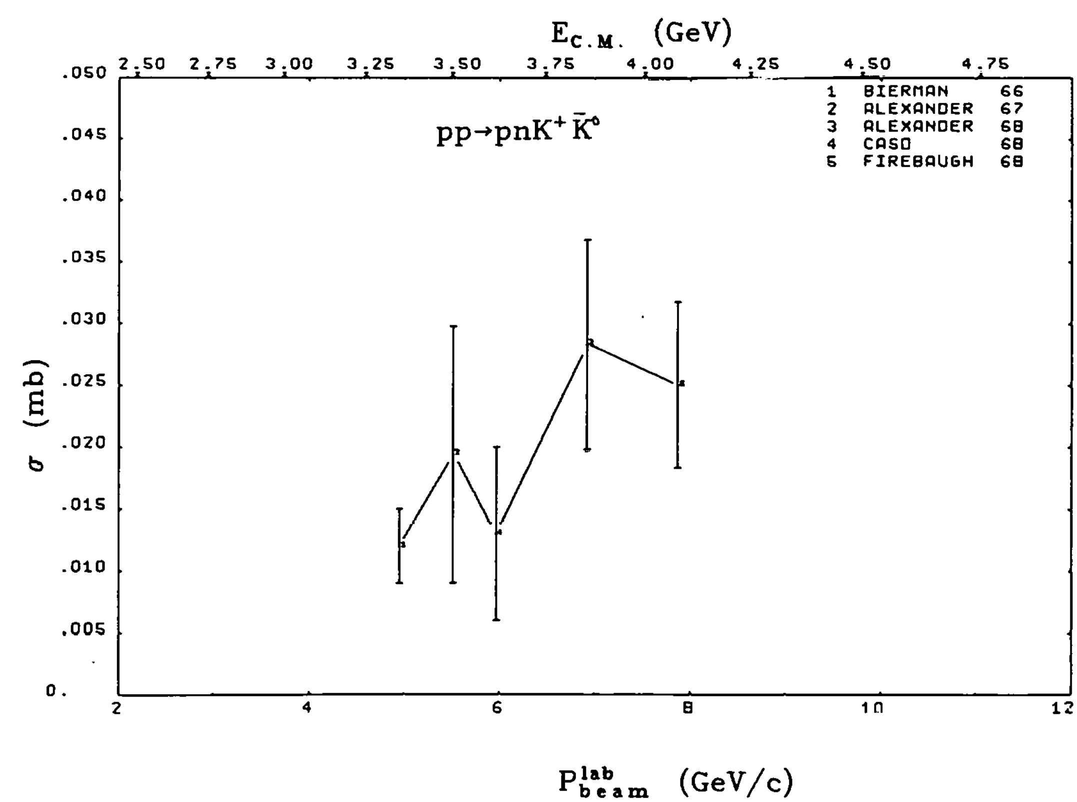


Fig. 33. $pp \rightarrow pp\,K^0\bar{K}^0$ and $pp \rightarrow pnK^+\bar{K}^0$ cross sections.

Table IV. Various pp strange-particle cross sections (not plotted).

P_{beam} (GeV/c)	$E_{c.m.}$ (GeV)	$\sigma_{ppK^+K^-}$ (mb)	References
6.600 ± .010	3.778	.034 ± .012	COLTON 68

REFERENCES
1 COLTON 68.....UCLA 1025 HBC

P_{beam} (GeV/c)	$E_{c.m.}$ (GeV)	$\sigma_{pnK^0\bar{K}^0\pi^+}$ (mb)	References
6.920 ± .075	3.856	.016 ± .011	ALEXANDER 68
7.870	4.078	.025 .012	FIREBAUGH 68
10.000	4.540	.053 .020	HOLMGREN 67

REFERENCES
1 HOLMGREN 67.....NC 51A 305 HBC
2 ALEXANDER 68.....NC 53A 455 HBC
3 FIREBAUGH 68.....PR 172 1354 HBC

P_{beam} (GeV/c)	$\sigma_{ppK^0\bar{K}^0\pi^+\pi^-}$ (mb)	$\sigma_{pnK^+\bar{K}^0\pi^+\pi^-}$ (mb)	$\sigma_{ppK^-K^0\pi^+\pi^0}$ (mb)	$\sigma_{pnK^-K^0\pi^+\pi^+}$ (mb)	References
6.920		.005 ± .004	.003 ± .002		ALEXANDER 68
7.870	.006 ± .003	.008 .004	.006 .003	.004 ± .003	FIREBAUGH 68
10.000	.009 .009				HOLMGREN 67

REFERENCES
1 HOLMGREN 67.....NC 51A 305 HBC
2 ALEXANDER 68.....NC 53A 455 HBC
3 FIREBAUGH 68.....PR 172 1354 HBC

P_{beam} (GeV/c)	$\sigma_{p\Sigma^+K^0\pi^+\pi^-}$ (mb)	$\sigma_{p\Sigma^-K^0\pi^+\pi^+}$ (mb)	$\sigma_{p\Sigma^0K^+\pi^+\pi^-}$ (mb)	$\sigma_{p\Lambda K^0\pi^+\pi^0}$ (mb)	$\sigma_{n\Lambda K^0\pi^+\pi^+}$ (mb)	$\sigma_{p\Lambda K^+\pi^+\pi^-}$ (mb)	References
4.950						.007 ± .002	BIERMAN 66
5.520	.004 ± .004		.002 ± .002	.017 ± .012		.021 .008	ALEXANDER 67
6.920	.010 .005	.008 ± .009	.014 .004	.040 .013	.030 ± .011	.028 .006	ALEXANDER 68
7.870	.015 .007	.025 .006	.021 .005	.067 .015	.020 .008	.049 .007	FIREBAUGH 68
10.000	.035 .013	.018 .007		.058 .014	.042 .014		HOLMGREN 67

REFERENCES
1 BIERMAN 66.....PR 147 922 HBC
2 ALEXANDER 67.....PR 154 1284 HBC
3 HOLMGREN 67.....NC 51A 305 HBC
4 ALEXANDER 68.....NC 53A 455 HBC
5 FIREBAUGH 68.....PR 172 1354 HBC

P_{beam} (GeV/c)	$\sigma_{p\Lambda K^0\pi^+\pi^+\pi^-}$ (mb)	$\sigma_{p\Lambda K^+\pi^+\pi^-\pi^0}$ (mb)	$\sigma_{n\Lambda K^+\pi^+\pi^+\pi^-}$ (mb)	$\sigma_{n\Sigma^+K^0\pi^+\pi^+\pi^-}$ (mb)	$\sigma_{p\Sigma^0K^0\pi^+\pi^+\pi^-}$ (mb)	References
5.520	.001 ± .001		.001 ± .002			ALEXANDER 67
6.920	.006 .003	.014 ± .004	.010 .003	.005 ± .008	.001 ± .002	ALEXANDER 68
7.870	.023 .004	.039 .006	.020 .005			FIREBAUGH 68
10.000	.023 .012			.005 .004		HOLMGREN 67

REFERENCES
1 ALEXANDER 67.....PR 154 1284 HBC
2 HOLMGREN 67.....NC 51A 305 HBC
3 ALEXANDER 68.....NC 53A 455 HBC
4 FIREBAUGH 68.....PR 172 1354 HBC

P_{beam} (GeV/c)	$\sigma_{pp\bar{K}^0K^0\pi^+\pi^-\pi^0}$ (mb)	$\sigma_{ppK^0\bar{K}^0\pi^0}$ (mb)	$\sigma_{p\Xi^-K^+K^+}$ (mb)	$\sigma_{pn\bar{K}^0K^0\pi^+\pi^+\pi^-}$ (mb)	References
10.000	.005 ± .005	.021 ± .011	.007 ± .005	.036 ± .018	HOLMGREN 67

REFERENCES
1 HOLMGREN 67.....NC HBC

P_{beam} (GeV/c)	$\sigma_{p\Sigma^-K^0\pi^+\pi^+\pi^0}$ (mb)	$\sigma_{n\Sigma^-K^0\pi^+\pi^+\pi^+}$ (mb)	$\sigma_{n\Lambda K^0\pi^+\pi^+\pi^+\pi^-}$ (mb)	$\sigma_{p\Lambda K^0\pi^+\pi^+\pi^-\pi^0}$ (mb)	References
10.000	.013 ± .006	.007 ± .004	.013 ± .008	.034 ± .011	HOLMGREN 67

REFERENCES
1 HOLMGREN 67.....NC HBC .....NC HBC

P_{beam} (GeV/c)	2p	4p	6p	8p	10p	12p	First Author	Reference Number
4.	34. 1±1. 1						Coletti	55
4.		7. 5±. 20	. 09±. 02				Bodini	42
6. 6		10. 5±. 46					Colton	141
6. 92	28. 4±. 3						Alexander	41
8. 1	26. 1±1. 4						Ginestet	131
28. 5			~5. 5	~2. 4	~. 45	~. 05	Connolly	97

Table V. Cross sections for various reactions of the type pp → n-prongs (not plotted).

nn Interactions

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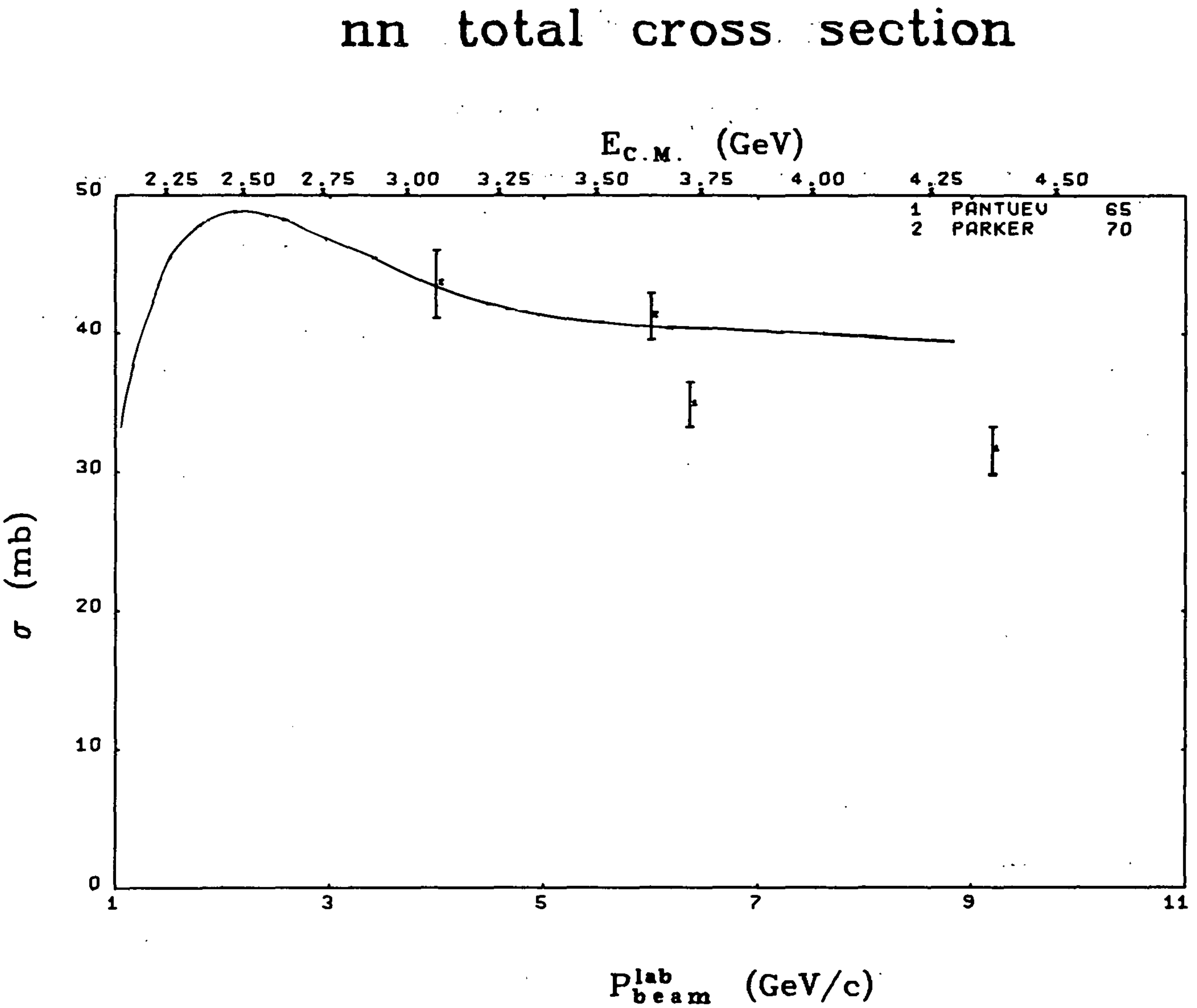


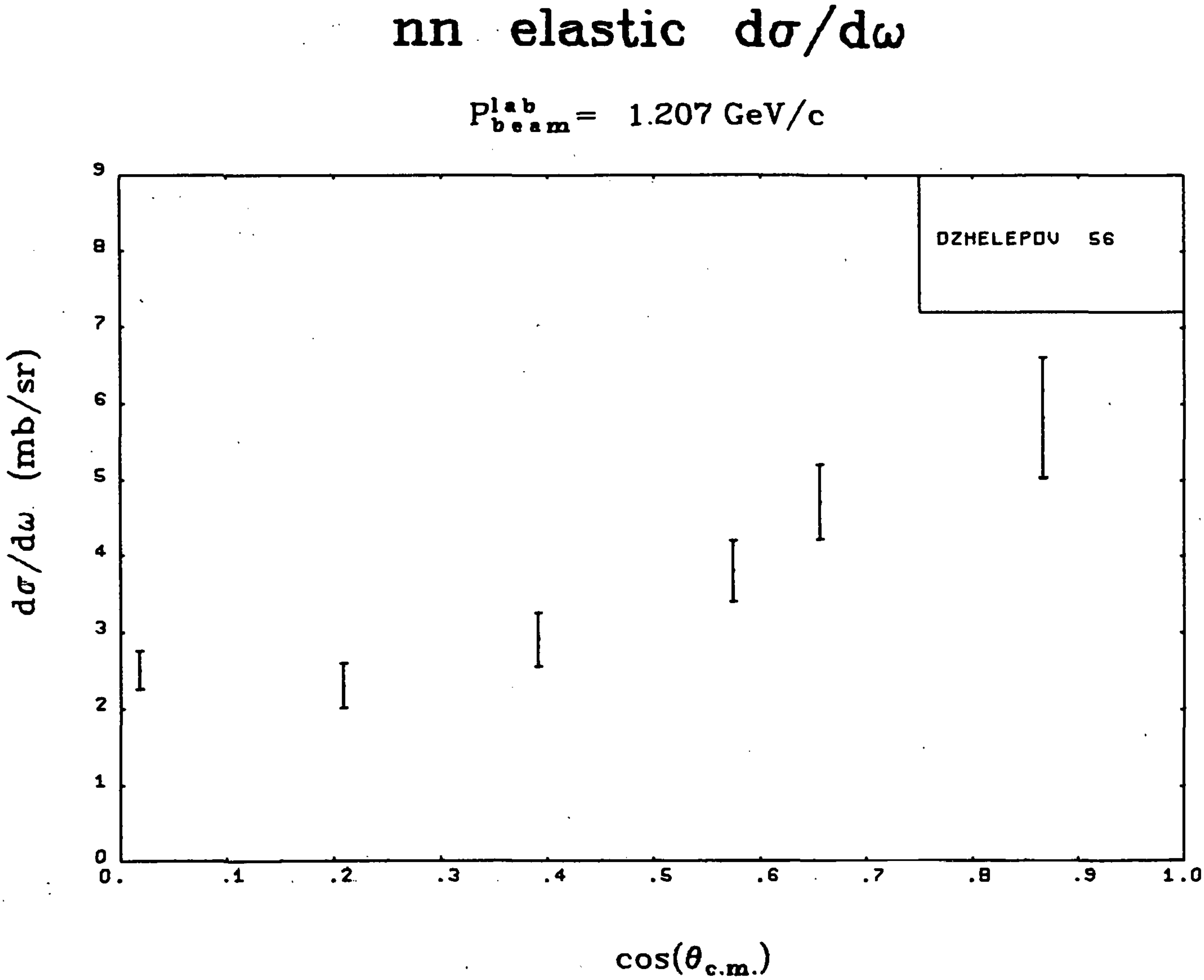
P_{beam} (GeV/c)	$E_{c.m.}$ (GeV)	σ_{total} (mb)		References	
4.000	3.080	43.500 ±	2.400	PARKER	70 $
6.000	3.630	41.200	1.700	PARKER	70 $
6.371	3.724	34.800	1.600	PANTUEV	65
9.192	4.374	31.500	1.700	PANTUEV	65

$ GLAUBER CORRECTION APPLIED

REFERENCES

1	PANTUEV	65.....SJNP	1	93	CNTR
2	PARKER	70.....PL	31B	246	CNTR

Fig. 34. nn total cross section. The smooth curve is the pp total cross section from Fig. 1.



DISTRIBUTION IN COS(THETA) OF THE SCATT BEAM WITH RESPECT TO THE BEAM DIRECTION IN THE C.M. SYSTEM

BEAM MOMENTUM= 1.207 GEV/C

COS(THETA)	SIGMA +- DSIGMA (MILLIBARNS/STERADIAN)	
.017	2.500	.250
.200	2.300	.300
.391	2.900	.350
.574	3.800	.400
.656	4.700	.500
.866	5.800	.800

2Q SQUARE= .554

DZHELEPOV CERN CONF 2 115(1956) CNTR

Fig. 35. nn elastic differential cross section. Because of the indistinguishability of the neutrons, this distribution is symmetric about cos $\theta_{c.m.}$ = 0.

np and pn Interactions

np, pn total cross sections

P_{beam} (GeV/c)	σ^T_{np} (mb)	±	σ^T_{pn} (mb)	±	References
.19	504.00	10.00			BARASHENKO 61 X
.27	223.00	7.60			BARASHENKO 61 X
.35	126.00	3.00			BARASHENKO 61 X
.42	76.00	1.70			BARASHENKO 61 X
.45	80.00	7.00			BARASHENKO 61 X
.56	46.40	1.20			BARASHENKO 61 X
.57	51.20	2.60			BARASHENKO 61 X
.64	42.70	.90	42.70	.90	KAZARINOV 63
.68	41.00	4.00			BARASHENKO 61 X
.88	35.60	.70			BARASHENKO 61 X
.93	34.00	2.00	33.00	2.00	DZHELEPOV 56
.97	33.70	1.30			BARASHENKO 61 X
1.09	35.00	2.00			DZHELEPOV 56
1.11			35.72	.26	BUGG 66 $
1.21	36.00	2.00			DZHELEPOV 56
1.26	37.00	4.00			DZHELEPOV 56
1.29			38.64	.20	BUGG 66 $
1.38	35.80	1.60			PALEVSKY 64
1.41			39.44	.14	BUGG 66 $
1.61			39.77	.13	BUGG 66 $
1.66			40.09	.13	BUGG 66 $
1.66			38.20	3.70	BATSON 59 $
1.78			40.56	.10	BUGG 66 $
1.86			41.22	.09	BUGG 66 $
1.94			41.53	.09	BUGG 66 $
1.95			41.48	.09	BUGG 66 $
2.08			41.90	.08	BUGG 66 $
2.21			42.17	.09	BUGG 66 $
2.28			42.50	.08	BUGG 66 $
2.36	38.30	2.10			PALEVSKY 64
2.45			42.68	.08	BUGG 66 $
2.59			42.89	.08	BUGG 66 $
2.68			42.96	.07	BUGG 66 $
2.70			42.93	.08	BUGG 66 $
2.82			43.02	.08	BUGG 66 $
2.86			43.04	.08	BUGG 66 $
2.96			43.11	.08	BUGG 66 $
2.99			43.11	.08	BUGG 66 $
3.00	40.30	1.40			PALEVSKY 64
3.00			41.67	.09	ABRAMS 69 $
3.05			42.98	.08	BUGG 66 $
3.11			43.23	.07	BUGG 66 $
3.14			43.12	.07	BUGG 66 $
3.27			(37.10	1.30)	DIDDENS 62
3.28			42.81	.07	BUGG 66 $
3.30			42.99	.07	BUGG 66 $
3.41	38.10	2.60			PANTUEV 65
3.44			42.58	.07	BUGG 66 $
3.55			42.52	.07	BUGG 66 $
3.62	39.40	3.30			PALEVSKY 64
3.91			42.52	.06	BUGG 66 $
4.00	43.10	.60			PARKER 70
4.04			42.49	.07	BUGG 66 $
4.26			42.28	.07	BUGG 66 $
4.30	40.40	1.90			ENGLER 68
4.51			(36.80	.90)	DIDDENS 62
4.55			42.25	.07	BUGG 66 $
4.75	43.40	1.60			PANTUEV 65
4.97			42.07	.07	BUGG 66 $
5.22			42.02	.05	BUGG 66 $
5.53			42.03	.07	BUGG 66 $
5.70	42.50	.60			PARKER 70
5.82			41.82	.07	BUGG 66 $
5.83			(37.00	.80)	DIDDENS 62
5.86	33.60	1.60			ATKINSON 61
6.00			42.60	1.70	GALBRAITH 65 $
6.37	41.20	1.70			KHACHATURY 63
6.37	41.20	1.70			PANTUEV 65
6.50	38.70	1.50			ENGLER 68
7.75			(37.60	1.60)	DIDDENS 62
7.78	39.30	1.70			PANTUEV 65
7.83			41.33	.08	BUGG 66 $
8.00			41.80	1.70	GALBRAITH 65 $
9.19	40.80	1.90			PANTUEV 65
9.19	41.20	2.60			OZHDYANI 62
9.90			(36.00	2.50)	ASHMORE 60
10.00	39.50	.50			ENGLER 68
10.00			41.50	1.70	GALBRAITH 65 $
12.00			40.40	1.70	GALBRAITH 65 $
14.00			40.20	1.70	GALBRAITH 65 $
14.60	37.10	1.20			KREISLER 68
15.80			(36.20	2.00)	ASHMORE 60
16.00			40.20	1.70	GALBRAITH 65 $
17.80	37.50	1.20			KREISLER 68
18.00			39.20	1.70	GALBRAITH 65 $
19.30			38.90	.70	BELLETTINI 65 $
20.00			38.70	1.70	GALBRAITH 65 $
21.60	37.70	.80			KREISLER 68
22.00			38.20	1.70	GALBRAITH 65 $
24.20			(35.50	2.00)	ASHMORE 60
27.00	38.90	.60			KREISLER 68

$ GLAUBER CORRECTION APPLIED
X DATA TAKEN FROM A REVUE ARTICLE

REFERENCES

1	DZHELEPOV	56.....CERN CONF	2	115	CNTR
2	BATSON	59.....P.ROY.SOC.	251	233	CC
3	ASHMORE	60.....PRL	5	576	CNTR
4	ATKINSON	61.....PR	123	1850	CNTR
5	BARASHENKO	61.....FP	9	549	
6	DIDDENS	62.....PRL	9	32	CNTR
7	OZHDYANI	62.....JETP	15	272	CNTR
8	KAZARINOV	63.....JETP	16	24	CNTR
9	KHACHATURY	63.....PL	7	80	CNTR
10	PALEVSKY	64.....PARIS CONF	1964	162	CNTR
11	BELLETTINI	65.....PL	19	341	SPRK.CNTR
12	GALBRAITH	65.....PR	138	B913	CNTR
13	PANTUEV	65.....SJNP	1	93	CNTR
14	BUGG	66.....PR	146	980	CNTR
15	ENGLER	68.....PL	278	599	CNTR
16	KREISLER	68.....PRL	20	468	CNTR
17	ABRAMS	69.....BNL	14125		CNTR
18	PARKER	70.....PL	318	246	CNTR

DATA IN PARENTHESES HAVE NOT BEEN INCLUDED IN THE FIGURE

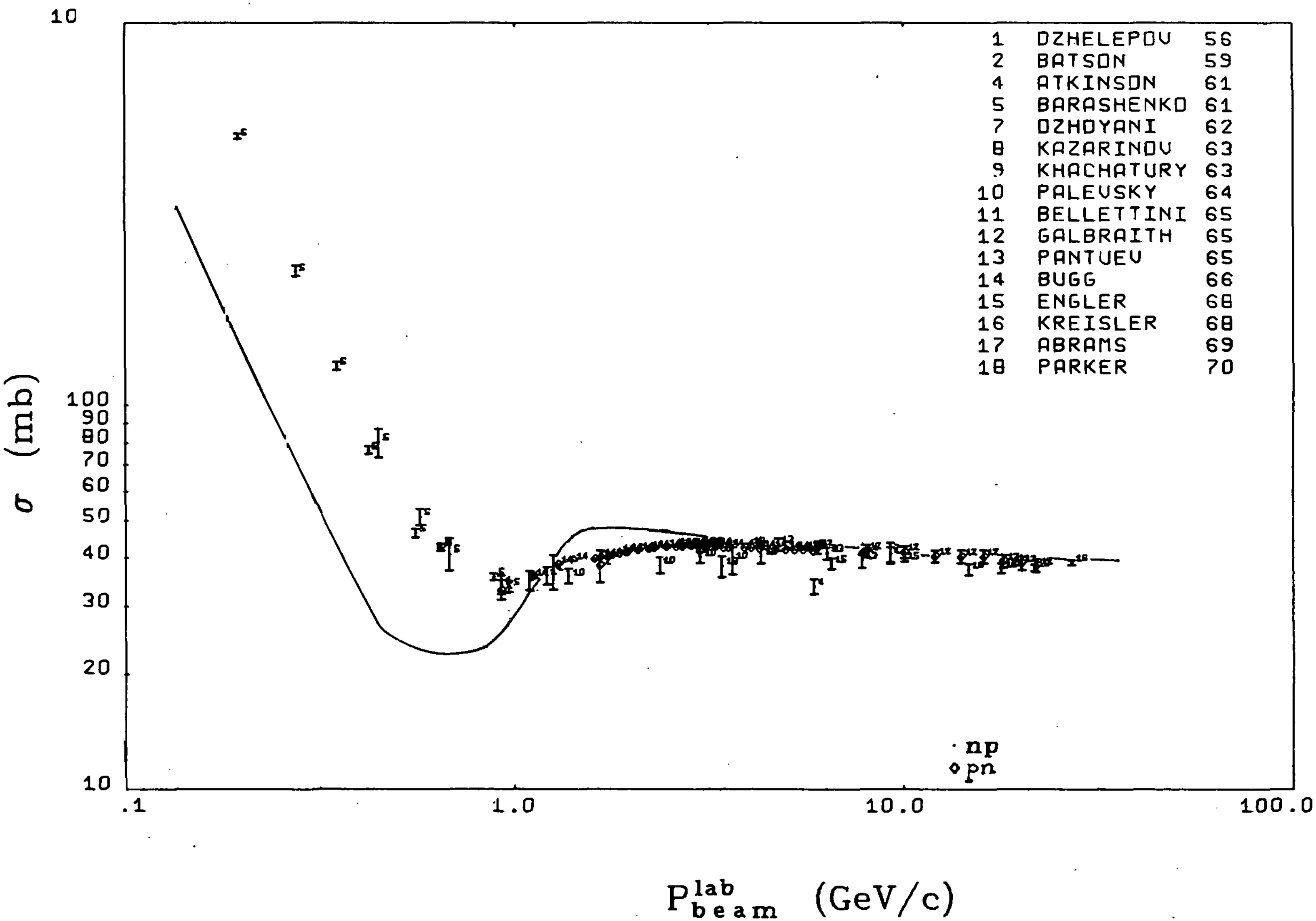
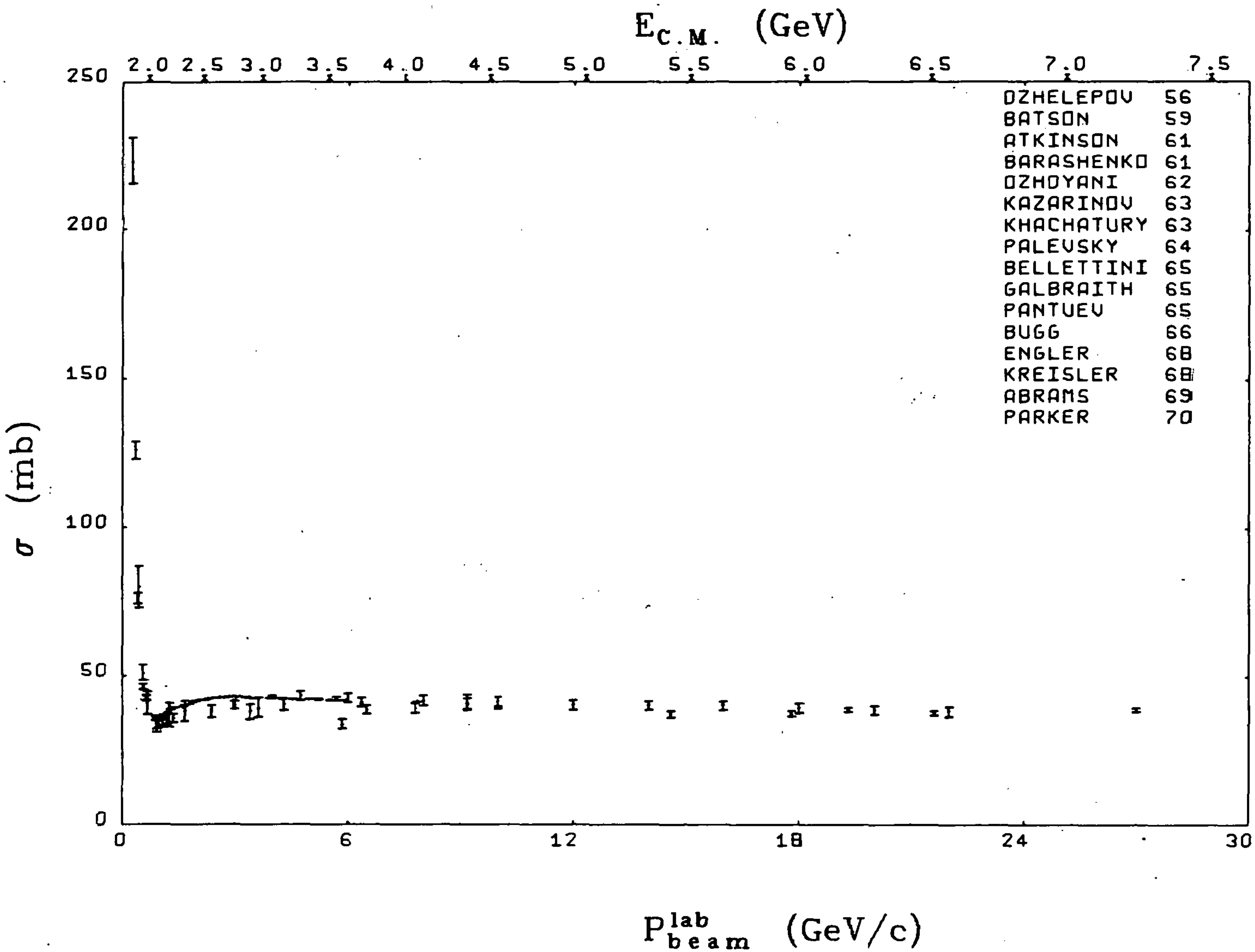


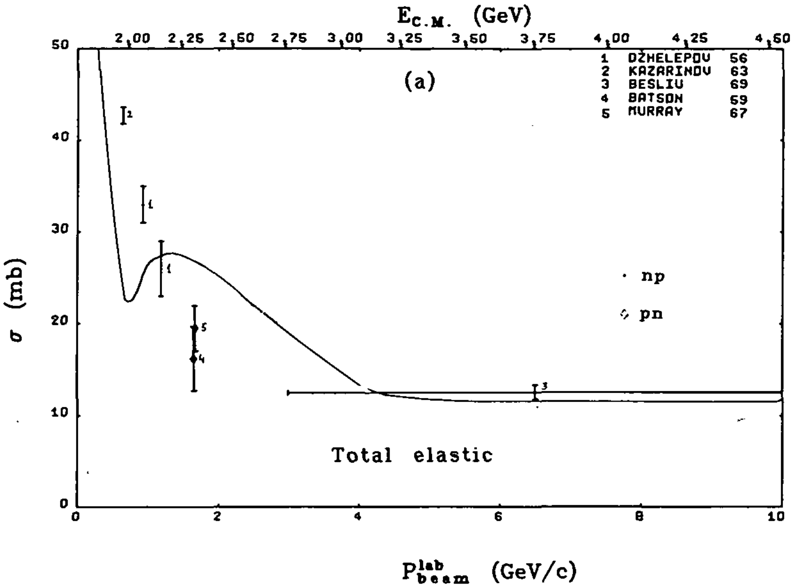
Fig. 36. np and pn total cross sections. (a) On log-log plot and (b) on a linear scale. We have plotted only those pn data that have had Glauber-type corrections applied. The accompanying table contains the non-Glauber corrected points as well. The solid curve in (a) is the pp total cross section from Fig. 1. In (b) we have not included symbols on the points in order not to mask the actual values.

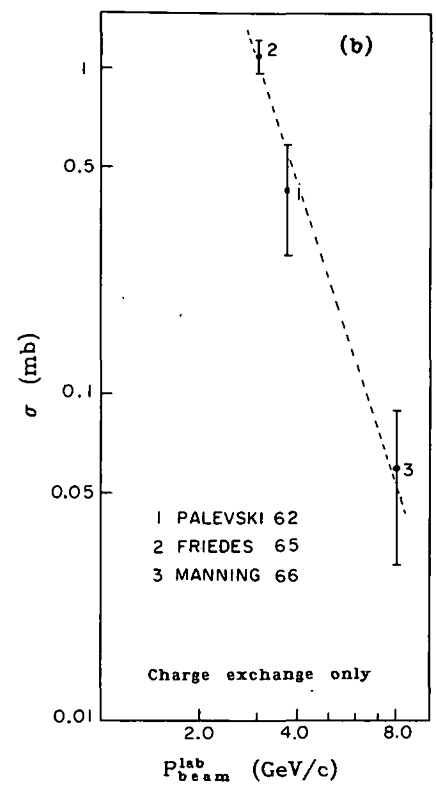


np, pn total cross sections

Fig. 36 (continued)

np } pn } elastic cross sections





P_{beam} (GeV/c)	$E_{c.m.}$ (GeV)	σ^{el}_{np} (mb)	References
.645	1.975	42.700 ± .900	KAZARINOV 63
.927	2.059	33.000 2.000	DZHELEPOV 56
1.194	2.148	26.000 3.000	DZHELEPOV 56
6.500 ± 3.500	3.753	12.500 .800	BESLIU 69

REFERENCES

1	DZHELEPOV	56.....CERN CONF	2	115	CNTR
2	KAZARINOV	63.....JETP	16	24	CNTR
3	BESLIU	69.....NC	59A	1	HLBC

P_{beam} (GeV/c)	$E_{c.m.}$ (GeV)	σ^{el}_{pn} (mb)	References
1.662	2.313	16.200 ± 3.500	BATSON 59 $
1.690	2.323	19.500 2.500	MURRAY 67 $

$ GLAUBER CORRECTION APPLIED

REFERENCES

1	BATSON	59.....P.ROY.SOC.	251	233	CC
2	MURRAY	67.....NC	49A	261	CNTR

P_{beam} (GeV/c)	$E_{c.m.}$ (GeV)	σ^{el}_{np} (mb)	References
3.000	2.768	1.100 ± .250	FRIEDES 65
3.671	2.979	.430 .160	PALEVSKY 62
8.000 ± .040	4.108	.060 .030	MANNING 66

REFERENCES

1	PALEVSKY	62.....PRL	9	509	CNTR
2	FRIEDES	65.....PRL	15	38	CNTR
3	MANNING	66.....NC	41A	167	SPRK

Fig. 37. Elastic cross sections for (a) all np and pn, and (b) np in the backward direction only (i. e., charge exchange). The pn data have had Glauber-type corrections applied. The solid curve in (a) represents the pp elastic data (Fig. 1). The dashed line in (b) represents our best fit to the data of $\sigma = Kp_{beam}^{-n}$ (n = 3.0 ± 0.6). Note the surprisingly few experiments that have been reported on these reactions.

np Forward elastic dσ/dt

MOMENTUM TRANSFER BETWEEN BEAM AND SCATT BEAM (GEV/C)**2

BEAM MOMENTUM= .645 GEV/C

****THIS DATA WAS READ FROM A GRAPH****

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.001	318.091	83.708
.003	277.911	23.438
.011	157.372	23.438
.025	140.630	16.742
.046	100.450	13.393
.100	83.708	10.045
.114	73.663	3.348
.145	66.967	3.348
.178	66.967	3.348
.211	73.663	3.348
.246	93.753	3.348
.276	110.495	6.697
.303	127.237	6.697
.331	157.372	6.697
.347	184.158	3.348
.360	234.383	3.348
.364	271.215	3.348
.367	308.046	6.697
.371	348.226	6.697
.373	381.710	6.697
.375	385.058	10.045

20 SQUARE= .188

KAZARINOV JETP 16 24(1963) CNTR

BEAM MOMENTUM= 1.194 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.098	42.720	2.309
.159	34.638	3.464
.224	26.556	1.963
.297	24.247	2.309
.385	18.474	1.501
.478	12.701	.924
.573	10.507	.693
.667	9.006	.577
.766	9.006	.577
.848	11.546	.808
.929	19.628	1.501
1.001	24.247	2.309
1.045	39.256	3.464
1.078	61.194	5.773
1.088	96.986	8.082

20 SQUARE= .544
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 13PER CENT

DZHELEPOV CERN CONF 2 115(1956) CNTR

BEAM MOMENTUM= 1.257 GEV/C

****THIS DATA WAS READ FROM A GRAPH****

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.009	88.226	11.693
.047	53.148	8.504
.113	39.330	2.126
.166	27.637	3.189
.235	23.385	2.126
.296	18.070	1.063
.389	15.944	1.063
.488	12.756	1.063
.601	11.693	1.063
.714	10.630	1.063
.803	10.630	1.063
.913	14.881	1.063
.994	17.007	1.063
1.075	27.637	2.126
1.127	37.204	3.189
1.147	42.518	3.189
1.162	49.959	4.252
1.173	63.778	4.252
1.180	70.155	4.252
1.187	85.237	5.315

20 SQUARE= .591
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10PER CENT

AMAGLOBELI JETP 37 1125(1960) CNTR

BEAM MOMENTUM(CENTRAL VALUE)= 1.975 GEV/C

BEAM MOMENTUM RANGES FROM 1.700 TO 2.250 GEV/C

MOM TR MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.100	.200	46.008	5.237
.200	.300	23.956	3.038
.300	.400	15.326	1.744
.400	.500	8.090	1.037
.500	.600	7.501	.918
.600	.700	3.336	.442
.700	.800	2.722	.457
.800	.900	1.957	.297
.900	1.000	1.536	.260
1.000	1.250	1.034	.176
1.250	1.550	1.077	.224

20 SQUARE= 1.171
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5PER CENT

PERL SLAC PUB-622 (1969) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= 2.241 GEV/C

BEAM MOMENTUM RANGES FROM 1.697 TO 2.785 GEV/C

****THIS DATA WAS READ FROM A GRAPH****

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.250	21.000	2.000
.350	8.000	1.000
.500	7.000	1.000
.600	2.550	5.000
.700	2.500	.450
.800	1.500	.400
.850	1.650	.450
1.000	.800	.300
1.200	.700	.100
1.450	.500	.100

20 SQUARE= 1.398

KREISLER PRL 16 1217(1966) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= 2.520 GEV/C

BEAM MOMENTUM RANGES FROM 2.250 TO 2.790 GEV/C

MOM TR MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.100	.200	49.933	5.295
.200	.300	19.447	2.073
.300	.400	13.582	1.681
.400	.500	7.128	.761
.500	.600	3.745	.468
.600	.700	2.397	.382
.700	.800	1.706	.223
.800	.900	1.090	.154
.900	1.000	1.051	.153
1.000	1.200	.636	.084
1.200	1.400	.506	.064
1.400	1.600	.353	.049
1.600	1.800	.270	.041
1.800	2.000	.299	.049
2.000	2.490	.391	.000

20 SQUARE= 1.642
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5PER CENT

PERL SLAC PUB-622 (1969) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= 3.050 GEV/C*

BEAM MOMENTUM RANGES FROM 2.790 TO 3.310 GEV/C

MOM TR MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.100	.200	44.437	6.030
.200	.300	18.111	1.553
.300	.400	8.262	1.003
.400	.500	6.267	.782
.500	.600	2.663	.391
.600	.700	1.927	.268
.700	.800	1.535	.259
.800	.900	1.223	.171
.900	1.000	.666	.103
1.000	1.200	.714	.083
1.200	1.400	.597	.075
1.400	1.600	.337	.040
1.600	1.800	.277	.035
1.800	2.200	.171	.020
2.200	2.600	.115	.015
2.600	3.000	.140	.025
3.000	3.430	.122	.031

20 SQUARE= 2.113
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5PER CENT

PERL SLAC PUB-622 (1969) SPRK

* FOR DISPLAY OF THESE DATA SEE FIG. 42

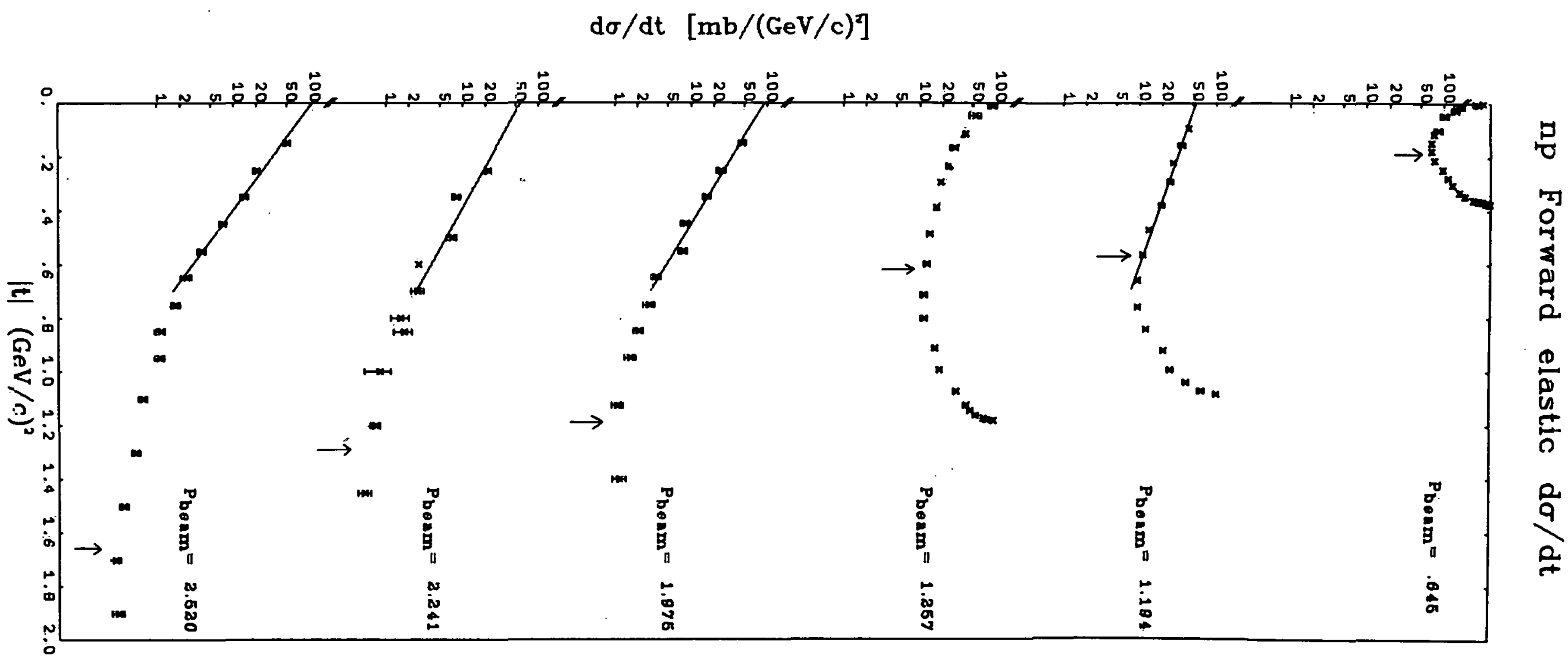


Fig. 38. np elastic differential cross section for $|t| \leq 2$ $(GeV/c)^2$. (t is the momentum transfer between the incoming and outgoing neutrons.) So as not to mask possible structures, systematic errors have not been included, even though they may have been given by the authors. Some distributions given originally as $d\sigma/d\omega$ vs. $\theta_{c.m.}$ have been transformed to $d\sigma/dt$ vs. t. One experiment (Besliu, Ref. 145) which reported numbers of events rather than $d\sigma/dt$ (and did not give a factor that would enable us to convert to $d\sigma/dt$) has not been included. The vertical arrows indicate the positions of $\theta_{c.m.} = 90$ deg. The lack of points in the forward direction in most experiments is due to the difficulty in detecting neutrons scattered through very small angles. The solid lines are the results of our least-squares fit to $d\sigma/dt = \left.\frac{d\sigma}{dt}\right|_{t=0} \cdot e^{bt}$, using data in the interval $|t| \leq 0.7$ $(GeV/c)^2$. The lack of small momentum-transfer data forced us to use a larger $|t|$ interval than we used in fitting the pp data. For a discussion of the limitations of these fits see the caption of the following figure (and the text).

np Forward elastic dσ/dt

MOMENTUM TRANSFER BETWEEN BEAM AND SCATT BEAM
(GEV/C)**2

BEAM MOMENTUM(CENTRAL VALUE)= 3.306 GEV/C

BEAM MOMENTUM RANGES FROM 2.785 TO 3.826 GEV/C

****THIS DATA WAS READ FROM A GRAPH****

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.250	24.000	2.000
.350	15.000	2.000
.450	5.400	.700
.550	5.600	.600
.650	2.650	.450
.750	1.100	.300
.900	1.150	.300
1.000	1.050	.250
1.200	.800	.150
1.400	.400	.100
1.800	.400	.050
2.500	.160	.030
3.200	.150	.040

2Q SQUARE= 2.343

KREISLER PRL 16 1217(1966) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= 3.570 GEV/C

BEAM MOMENTUM RANGES FROM 3.310 TO 3.830 GEV/C

MOM TR

MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.100	.200	43.885	3.679
.200	.300	15.932	1.214
.300	.400	8.703	.860
.400	.500	5.564	.729
.500	.600	3.327	.356
.600	.700	1.432	.188
.700	.800	.808	.143
.800	.900	.687	.142
.900	1.000	.654	.096
1.000	1.200	.442	.050
1.200	1.400	.232	.035
1.400	1.600	.218	.033
1.600	1.800	.164	.022
1.800	2.000	.130	.019
2.000	2.500	.084	.012
2.500	3.000	.081	.009
3.000	3.500	.045	.007
3.500	4.370	.059	.012

2Q SQUARE= 2.582
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5PER CENT

PERL SLAC PUB-622 (1969) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= 4.085 GEV/C

BEAM MOMENTUM RANGES FROM 3.830 TO 4.340 GEV/C

MOM TR

MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.100	.200	36.458	2.676
.200	.300	18.225	1.196
.300	.400	8.090	.708
.400	.500	4.257	.559
.500	.600	2.473	.337
.600	.700	1.559	.192
.700	.800	1.007	.141
.800	.900	.413	.090
.900	1.000	.612	.119
1.000	1.200	.256	.034
1.200	1.400	.227	.030
1.400	1.600	.171	.028
1.600	1.800	.109	.018
1.800	2.000	.072	.013
2.000	2.500	.050	.007
2.500	3.000	.037	.007
3.000	3.500	.026	.004
3.500	4.000	.023	.004
4.000	4.500	.019	.004
4.500	5.300	.055	.013

2Q SQUARE= 3.051
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5PER CENT

PERL SLAC PUB-622 (1969) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= 4.338 GEV/C

BEAM MOMENTUM RANGES FROM 3.826 TO 4.849 GEV/C

****THIS DATA WAS READ FROM A GRAPH****

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.200	18.000	2.000
.300	9.000	1.000
.400	4.300	.700
.550	2.700	.400
.700	1.400	.300
.800	.900	.200
.900	.600	.130
.950	.350	.110
1.100	.340	.060
1.400	.310	.070
1.750	.080	.020
2.500	.094	.800
3.500	.037	.010
4.600	.034	.006

2Q SQUARE= 3.283

KREISLER PRL 16 1217(1966) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= 4.595 GEV/C

BEAM MOMENTUM RANGES FROM 4.340 TO 4.850 GEV/C

MOM TR

MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.100	.200	34.847	2.177
.200	.300	11.930	.770
.300	.400	6.294	.490
.400	.500	3.037	.354
.500	.600	1.484	.217
.600	.700	.973	.121
.700	.800	.573	.080
.800	.900	.414	.068
.900	1.000	.248	.055
1.000	1.200	.210	.031
1.200	1.400	.117	.016
1.400	1.600	.078	.013
1.600	1.800	.055	.012
1.800	2.000	.025	.006
2.000	2.500	.021	.003
2.500	3.000	.014	.003
3.000	3.500	.011	.003
3.500	4.000	.009	.002
4.000	4.500	.012	.002
4.500	5.000	.012	.002
5.000	5.500	.005	.002
5.500	6.250	.020	.006

2Q SQUARE= 3.519
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5PER CENT

PERL SLAC PUB-622 (1969) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= 5.105 GEV/C

BEAM MOMENTUM RANGES FROM 4.850 TO 5.360 GEV/C

MOM TR

MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.110	.200	33.477	2.080
.200	.300	16.948	1.000
.300	.400	7.206	.523
.400	.500	3.464	.369
.500	.600	1.903	.264
.600	.700	1.036	.134
.700	.800	.545	.075
.800	.900	.568	.079
.900	1.000	.281	.055
1.000	1.200	.197	.035
1.200	1.400	.090	.014
1.400	1.600	.060	.011
1.600	1.800	.044	.010
1.800	2.000	.028	.009
2.000	2.500	.014	.002
2.500	3.000	.016	.003
3.000	3.500	.010	.002
3.500	4.180	.004	.001
4.330	5.000	.006	.002
5.000	5.500	.006	.002
5.500	6.000	.010	.003
6.000	6.500	.012	.003
6.500	7.180	.017	.005

2Q SQUARE= 3.989
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5PER CENT

PERL SLAC PUB-622 (1969) SPRK

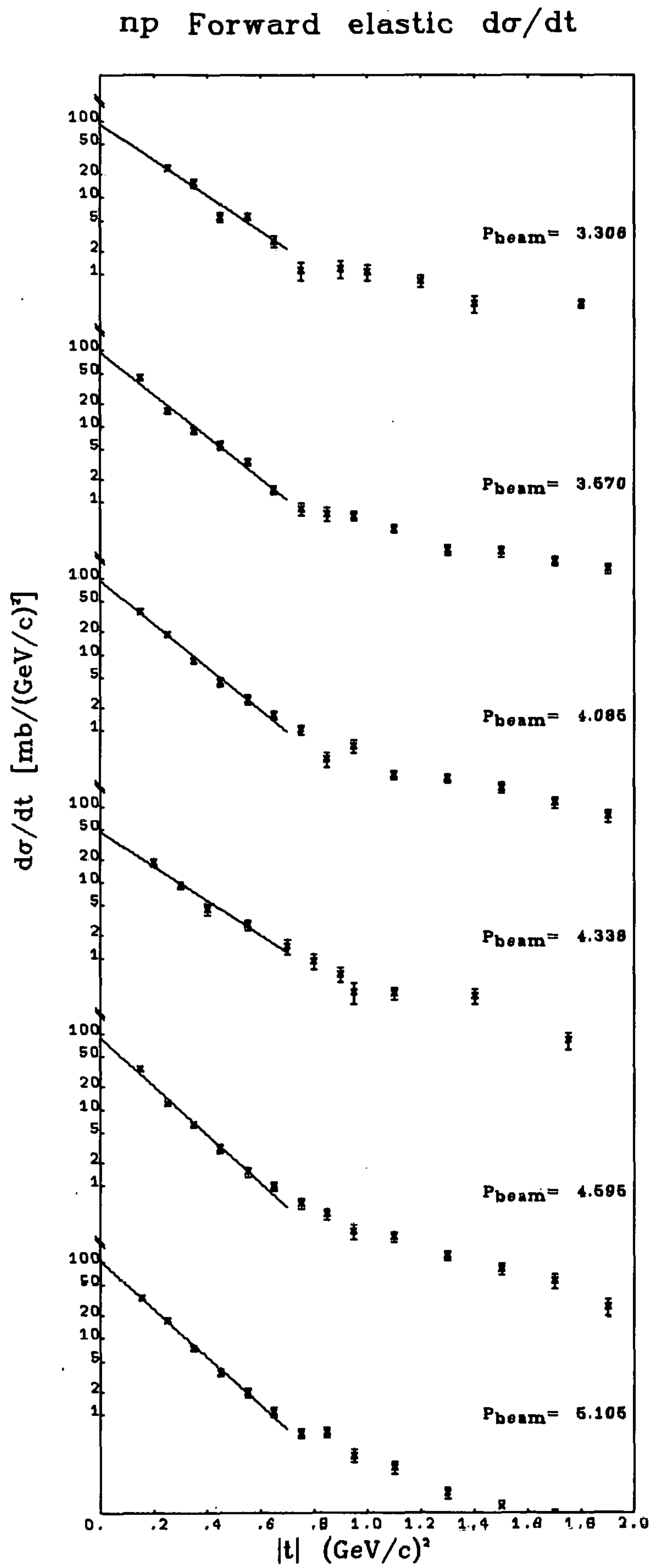


Fig. 38 (continued)

np Forward elastic $d\sigma/dt$

MOMENTUM TRANSFER BETWEEN BEAM AND SCATT BEAM
(GEV/C)**2

BEAM MOMENTUM(CENTRAL VALUE)= 5.357 GEV/C

BEAM MOMENTUM RANGES FROM 4.849 TO 5.865 GEV/C

****THIS DATA WAS READ FROM A GRAPH****

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.200	14.000	1.000
.350	6.500	.500
.450	4.000	.300
.550	.850	.140
.650	1.100	.100
.750	.440	.070
.850	.610	.100
1.000	.320	.080
1.150	.110	.020
1.350	.090	.020
1.750	.050	.010
2.500	.016	.004
3.600	.006	.002
4.700	.005	.002
5.500	.006	.003
6.500	.008	.003

2Q SQUARE= 4.221

KREISLER PRL 16 1217(1966) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= 5.615 GEV/C

BEAM MOMENTUM RANGES FROM 5.360 TO 5.870 GEV/C

MOM TR MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.110	.200	39.129	2.611
.200	.300	17.365	1.161
.300	.400	8.532	.583
.400	.500	4.792	.413
.500	.600	2.731	.302
.600	.700	1.480	.150
.700	.800	.791	.091
.800	.900	.455	.066
.900	1.000	.305	.056
1.000	1.200	.167	.030
1.200	1.400	.158	.024
1.400	1.600	.055	.010
1.600	1.800	.030	.007
1.800	2.000	.027	.008
2.000	2.500	.022	.004
2.500	3.000	.013	.002
3.000	3.500	.004	.002
3.500	4.480	.004	.001
4.990	6.000	.004	.001
6.000	6.500	.005	.002
6.500	7.000	.006	.002
7.000	7.500	.013	.004
7.500	7.970	.012	.005

2Q SQUARE= 4.460
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5PER CENT

PERL SLAC PUB-622 (1969) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= 6.120 GEV/C

BEAM MOMENTUM RANGES FROM 5.870 TO 6.370 GEV/C

MOM TR MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.130	.200	30.350	2.318
.200	.300	15.191	.970
.300	.400	6.116	.421
.400	.500	3.240	.283
.500	.600	2.269	.267
.600	.700	1.196	.118
.700	.800	.631	.078
.800	.900	.361	.050
.900	1.000	.160	.034
1.000	1.200	.111	.022
1.200	1.400	.005	.016
1.400	1.600	.030	.007
1.600	1.800	.022	.005
1.800	2.000	.021	.006
2.000	2.500	.012	.003
2.500	3.000	.006	.001
3.000	3.500	.005	.001
3.500	4.000	.006	.002
4.000	4.790	.001	.001
5.650	7.000	.002	.001
7.000	8.000	.005	.001
8.000	8.730	.012	.003

2Q SQUARE= 4.928
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5PER CENT

PERL SLAC PUB-622 (1969) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= 6.522 GEV/C

BEAM MOMENTUM RANGES FROM 5.865 TO 7.178 GEV/C

****THIS DATA WAS READ FROM A GRAPH****

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.250	14.000	1.000
.350	6.700	.500
.400	3.100	.200
.500	1.300	.200
.600	.930	.150
.700	.800	.130
.800	.400	.090
.900	.250	.060
1.100	.100	.030
1.350	.040	.012
1.700	.027	.008
2.500	.013	.003
3.500	.004	.001
4.400	.004	.002
6.300	.002	.001
7.500	.004	.002
8.800	.008	.003

2Q SQUARE= 5.301

KREISLER PRL 16 1217(1966) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= 6.775 GEV/C

BEAM MOMENTUM RANGES FROM 6.370 TO 7.180 GEV/C

MOM TR MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.170	.200	32.876	3.598
.200	.300	15.413	1.000
.300	.400	8.736	.578
.400	.500	3.901	.327
.500	.600	2.050	.252
.600	.700	1.177	.149
.700	.800	.709	.089
.800	.900	.382	.057
.900	1.000	.282	.049
1.000	1.200	.146	.026
1.200	1.400	.059	.017
1.400	1.600	.027	.011
1.600	1.800	.041	.009
1.800	2.000	.018	.005
2.000	2.500	.018	.004
2.500	3.000	.006	.002
3.000	3.500	.004	.001
3.500	4.000	.005	.002
4.000	5.090	.001	.001
6.360	7.250	.003	.001
7.350	8.500	.001	.001
8.500	9.630	.006	.002

2Q SQUARE= 5.536
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5PER CENT

PERL SLAC PUB-622 (1969) SPRK

BEAM MOMENTUM= 7.400 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.174	22.000	1.300
.223	15.400	1.000
.274	10.300	.860
.323	8.200	.750
.372	5.700	.660
.423	3.690	.540
.473	2.570	.560
.538	2.600	.460
.649	1.160	.340
.743	.764	.270
.851	.423	.210
.934	.208	.070

2Q SQUARE= 6.117

GIBBARD PRL 24 22(1970) SPRK+CNTR

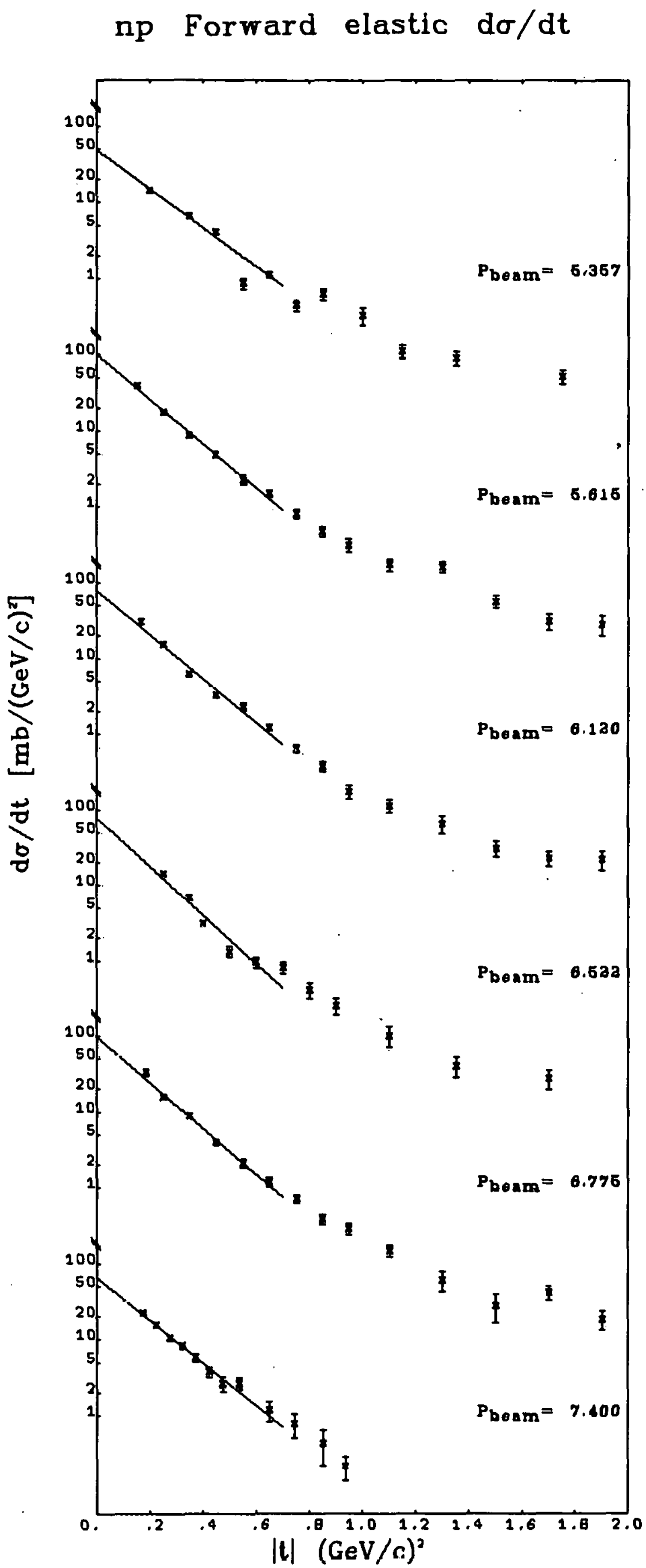


Fig. 38 (continued)

np Forward elastic dσ/dt

MOMENTUM TRANSFER BETWEEN BEAM AND SCATT BEAM
(GEV/C)**2

BEAM MOMENTUM(CENTRAL VALUE)= 9.895 GEV/C

BEAM MOMENTUM RANGES FROM 8.890 TO10.899 GEV/C

****THIS DATA WAS READ FROM A GRAPH****

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.350	6.600	.400
.450	3.100	.200
.550	1.700	.200
.650	.710	.090
.750	.350	.080
.850	.190	.050
.950	.090	.040
1.050	.062	.030
1.150	.026	.026
1.250	.018	.018

2Q SQUARE= 8.444

ENGLER PL 29B 321(1969) SPRK

BEAM MOMENTUM=11.400 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.175	21.000	.930
.224	15.500	.880
.274	10.600	.700
.323	7.180	.570
.374	5.340	.510
.422	3.500	.430
.474	2.590	.390
.545	1.830	.260
.651	.799	.170
.744	.426	.130
.846	.306	.110
.974	.173	.096
1.170	.069	.021
1.476	.034	.012

2Q SQUARE= 9.851

GIBBARD PRL 24 22(1970) SPRK+CNTR

BEAM MOMENTUM=15.400 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.175	20.700	.870
.223	14.100	.770
.273	10.000	.630
.323	7.460	.540
.373	5.130	.450
.423	3.200	.370
.474	2.180	.320
.549	1.540	.230
.649	.555	.140
.745	.294	.100
.846	.128	.067
.969	.056	.022
1.197	.010	.006
1.515	.019	.008

2Q SQUARE= 13.594

GIBBARD PRL 24 22(1970) SPRK+CNTR

BEAM MOMENTUM=19.400 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.223	14.800	.790
.274	9.940	.630
.323	6.620	.510
.374	4.880	.440
.423	3.580	.390
.473	2.380	.320
.550	1.140	.220
.638	.633	.140
.743	.328	.100
.851	.147	.069
.985	.062	.020
1.201	.036	.013
1.638	.002	.003

2Q SQUARE= 17.342

GIBBARD PRL 24 22(1970) SPRK+CNTR

BEAM MOMENTUM=23.400 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.227	11.700	.820
.273	6.560	.470
.324	4.610	.380
.373	3.030	.310
.422	2.160	.270
.474	1.370	.220
.550	.721	.150
.650	.421	.110
.743	.072	.039
.848	.110	.051
.982	.016	.009
1.185	.012	.006

2Q SQUARE= 21.091

GIBBARD PRL 24 22(1970) SPRK+CNTR

BEAM MOMENTUM=27.400 GEV/C

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
.325	4.840	.680
.373	3.080	.490
.422	2.190	.430
.472	1.370	.250
.553	.951	.260
.651	.391	.160
.738	.065	.026
.881	.012	.009

2Q SQUARE= 24.842

GIBBARD PRL 24 22(1970) SPRK+CNTR

np Forward elastic dσ/dt

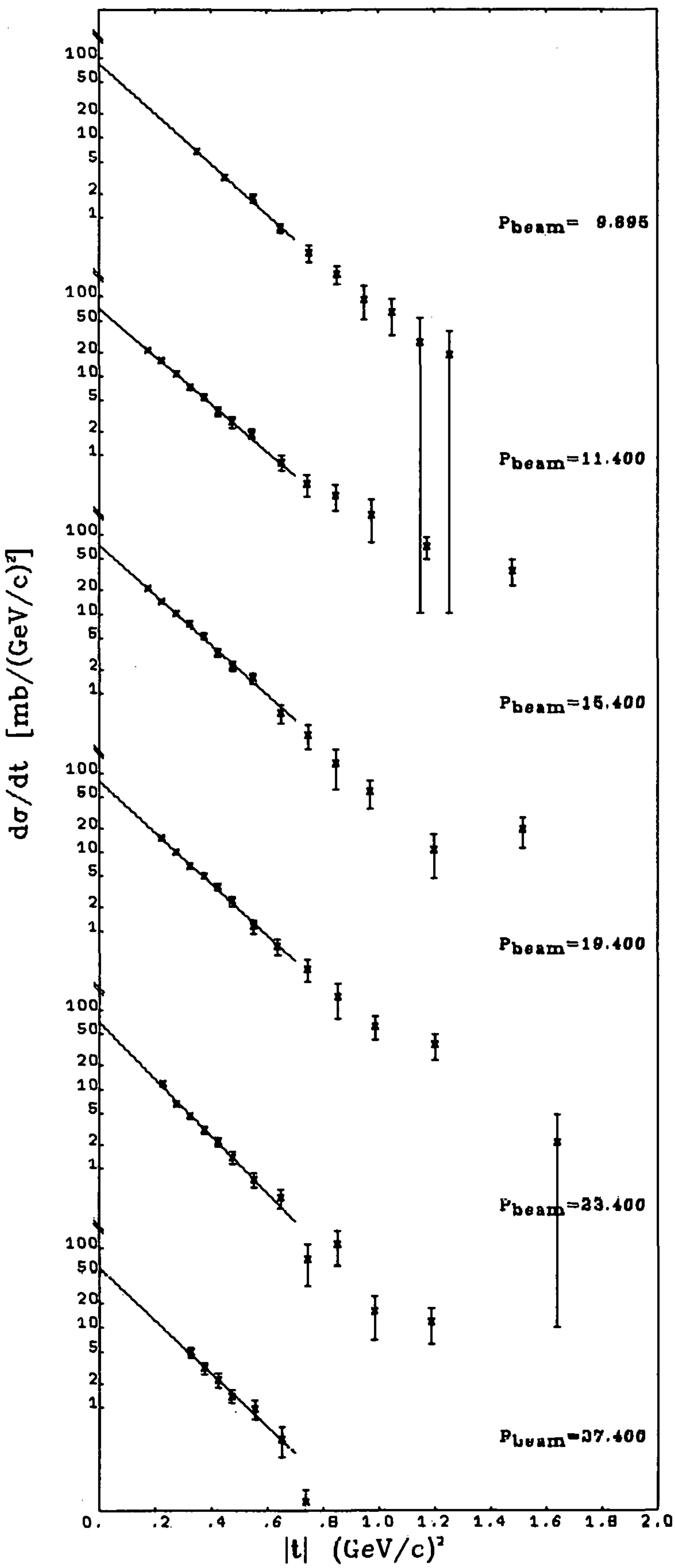
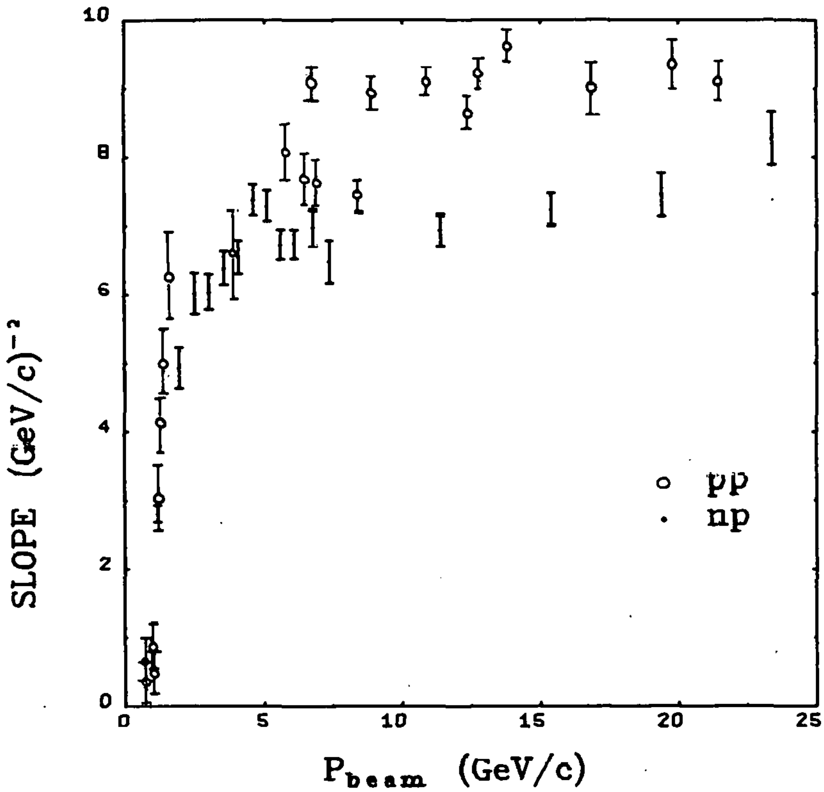


Fig. 38 (continued)

Fits to np forward elastic dσ/dt.



P_{beam} (GeV/c)	dσ/dt [t = 0] mb/(GeV/c)^2		SLOPE (GeV/c)$^{-2}$		χ^2/N
1.194	53.88	± 7.53	2.80	± .12	.96
1.975	88.70	11.93	4.93	.30	1.75
2.520	106.63	13.80	6.01	.30	1.50
3.050	91.76	10.36	6.03	.26	3.16
3.570	93.42	9.88	6.38	.25	3.94
4.085	91.84	9.01	6.54	.24	1.55
4.595	89.29	8.23	7.37	.23	4.96
5.105	101.09	9.29	7.28	.23	1.09
5.615	98.94	9.14	6.72	.21	2.23
6.120	79.04	7.62	6.73	.21	5.41
6.775	96.90	11.22	6.97	.27	1.88
7.400	65.31	5.95	6.47	.32	.74
11.400	70.74	4.96	6.92	.24	.28
16.400	72.83	5.03	7.23	.24	.42
19.400	77.38	8.11	7.65	.32	.27
23.400	68.69	8.82	8.26	.39	.88

Fig. 39. The slope (b) coefficient from our least squares fit to the forward np elastic differential cross section to the formula $d\sigma/dt = \frac{d\sigma}{dt}\Big|_{t=0} \cdot e^{bt}$ over the range $|t| \leq 0.7$ (GeV/c)^2. In the table χ^2/N is the chi-square of the fit divided by the number of degrees of freedom. We have tabulated and plotted values from only those distributions having $\chi^2/N \leq 6$. All experiments in this figure, except Dzhelepov (Ref.137), have normalized their data by using the optical theorem, taking various amounts of real parts. Thus a plot of the intercept, $d\sigma/dt|_{t=0}$ is meaningless in the present case, and we have not given it. A more serious consideration (since it can affect not only the intercept but also the slope) is the fact that dσ/dt has not been measured at small angles (i. e., small $|t|$ values). Thus there could be considerable structure that has not yet been uncovered. [See for example Fig. 43, which shows that the structure in the backward direction is very narrow indeed, starting at $|u| \leq 0.01$ (GeV/c)^2.] Therefore one must be very cautious about using the values from our fits above. For comparison we have also plotted our fits to the slopes of the pp elastic scattering (from Fig. 3b). For a discussion of the apparent difference between the np and pp data see the text. Fitted values of the slope, whenever given by the authors, are presented in Table VI.

Table VI. Fits reported by authors to their own np forward elastic scattering data. For our fits to these data see Fig. 39.

P_{beam} (GeV/c)	$\|t\|$ min	max	FORMULA	PARAMETERS			References	
1.697	.10	.400	X=A*EXP[-B*T]	B	-6.321 ±	.647	KREISLER	66
1.70	.10	.500	Y=A*EXP[-B*T]	B	-5.500	.800	PERL	69
1.70	.10	.400	Y=A*EXP[-B*T]	B	-5.660	.540	PERL	69
2.30	.10	.500	Y=A*EXP[-B*T]	B	-6.670	.810	PERL	69
2.30			Y=A*EXP[-B*T]	B	-6.220	.480	PERL	69
2.785	.10	.500	X=A*EXP[-B*T]	B	-5.527	.463	KREISLER	66
2.80	.10	.400	Y=A*EXP[-B*T]	B	-6.860	.480	PERL	69
2.80	.10	.500	Y=A*EXP[-B*T]	B	-8.480	.740	PERL	69
3.30	.10	.400	Y=A*EXP[-B*T]	B	-7.140	.460	PERL	69
3.30	.10	.500	Y=A*EXP[-B*T]	B	-8.230	.640	PERL	69
3.80	.10	.400	Y=A*EXP[-B*T]	B	-7.330	.430	PERL	69
3.80			Y=A*EXP[-B*T]	B	-7.480	.570	PERL	69
3.826	.10	.400	X=A*EXP[-B*T]	B	-6.655	.432	KREISLER	66
4.30	.10	.500	Y=A*EXP[-B*T]	B	-8.730	.490	PERL	69
4.30	.10	.400	Y=A*EXP[-B*T]	B	-8.250	.380	PERL	69
4.80	.10	.500	Y=A*EXP[-B*T]	B	-7.630	.480	PERL	69
4.80			Y=A*EXP[-B*T]	B	-7.650	.360	PERL	69
4.849			X=EXP[A+BT]	B	6.220	.310	ENGLER	69
4.849	.10	.500	X=A*EXP[-B*T]	B	-7.720	.411	KREISLER	66
5.40			Y=A*EXP[-B*T]	B	-7.110	.330	PERL	69
5.865	.10	.500	X=A*EXP[-B*T]	B	-7.562	.391	KREISLER	66
5.90	.10	.500	Y=A*EXP[-B*T]	B	-7.940	.370	PERL	69
6.40			Y=A*EXP[-B*T]	B	-7.310	.440	PERL	69
6.876			X=EXP[A+BT]	B	6.430	.480	ENGLER	69
7.400			Y=EXP[-A*ABS(T)]	A	7.010	.290	GIBBARD	70
8.890			X=EXP[A+BT]	B	7.140	.380	ENGLER	69
10.899			X=EXP[A+BT]	B	7.040	.460	ENGLER	69
11.400			Y=EXP[-A*ABS(T)]	A	7.120	.220	GIBBARD	70
12.905			X=EXP[A+BT]	B	7.640	.610	ENGLER	69
14.910			X=EXP[A+BT]	B	8.060	.880	ENGLER	69
15.400			Y=EXP[-A*ABS(T)]	A	7.290	.230	GIBBARD	70
19.400			Y=EXP[-A*ABS(T)]	A	7.310	.230	GIBBARD	70
23.400			Y=EXP[-A*ABS(T)]	A	8.570	.330	GIBBARD	70
27.400			Y=EXP[-A*ABS(T)]	A	8.580	.380	GIBBARD	70

pn elastic dσ/dt

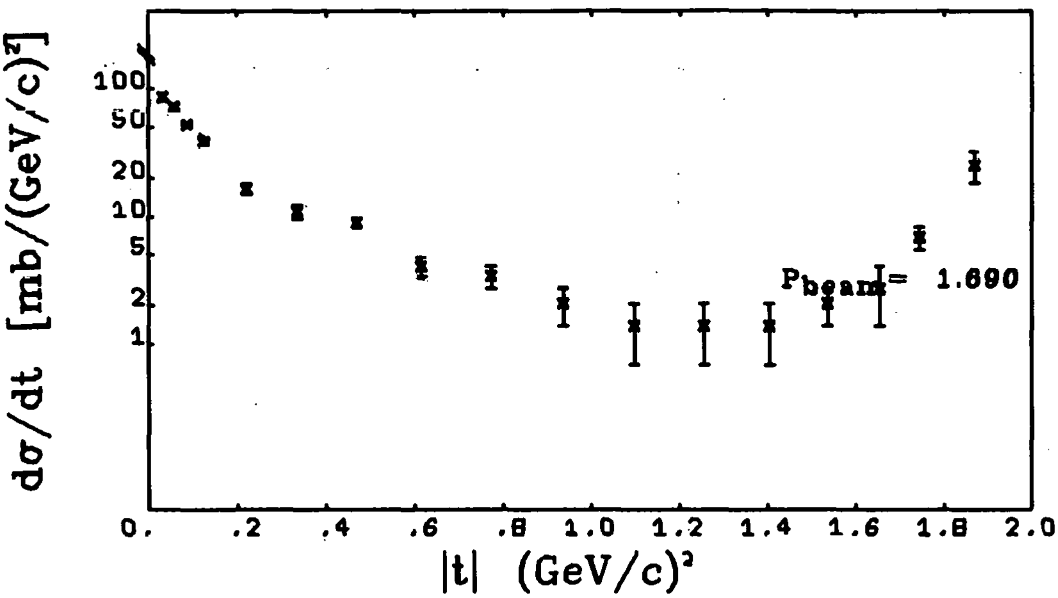


Fig. 40. pn elastic differential cross section. t is the momentum transfer between the outgoing and incoming protons.

MOMENTUM TRANSFER BETWEEN BEAM AND SCATT BEAM
(GEV/C)**2

BEAM MOMENTUM= 1.690 GEV/C

****THIS DATA WAS READ FROM A GRAPH****

MOM TRANSF	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
(0.	)EXTRAPOLATED POINT (106.894+-8.067)	
.032	84.708	5.378
.056	70.590	2.689
.088	51.766	1.345
.125	37.648	1.345
.219	16.135	1.345
.334	10.757	1.345
.467	8.740	.672
.615	4.034	.672
.772	3.361	.672
.935	2.017	.672
1.097	1.345	.672
1.254	1.345	.672
1.402	1.345	.672
1.535	2.017	.672
1.651	2.689	1.345
1.744	6.723	1.345
1.869	24.875	6.723

2Q SQUARE= .935

MURRAY NC 49A 261(1967) CNTR

pn } np } Re $f^{el}(0)/\mathrm{Im}\ f^{el}(0)$

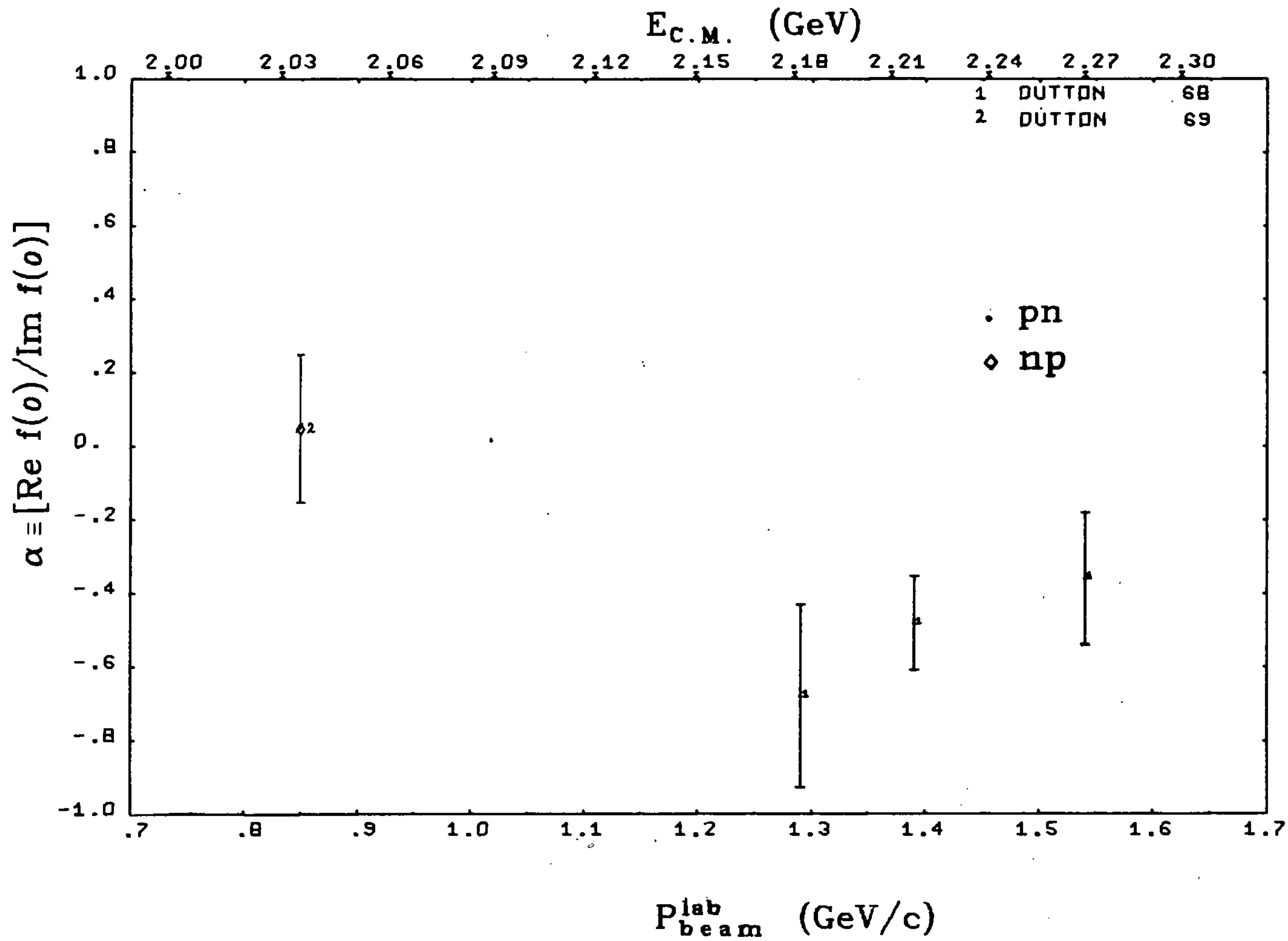


Fig. 41. Ratio of the real to the imaginary parts of the forward np elastic scattering amplitudes.

P_{beam} (GeV/c)	$E_{c.m.}$ (GeV)	α	$\pm\ \delta\alpha$	References	
.85	2.03	.05	.20	DUTTON	69
1.29	2.18	-.68	.25	DUTTON	68
1.39	2.22	-.48	.13	DUTTON	68
1.54	2.27	-.36	.18	DUTTON	68

REFERENCES

1	DUTTON	68.....PRL	21 1416	SPRK
2	DUTTON	69.....NP	B9 594	SPRK

np elastic $d\sigma/dt$

$(0 \leq |t| \leq 10)$

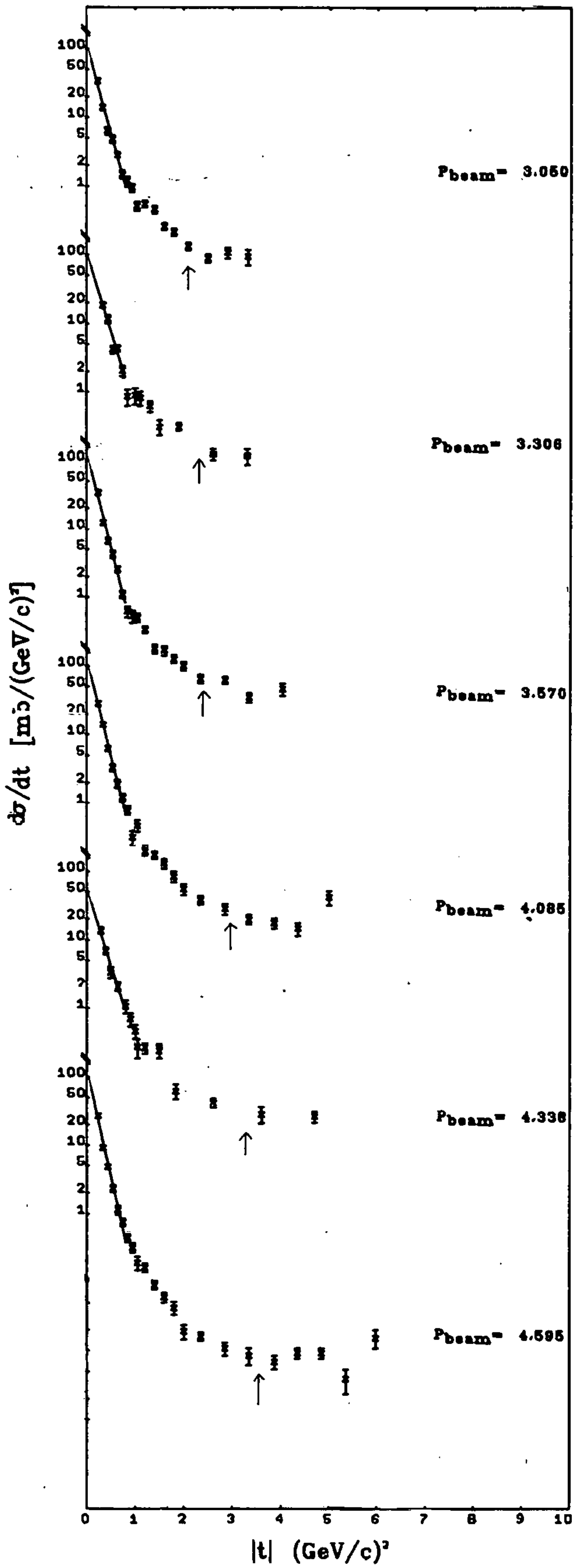


Fig. 42. np elastic differential cross sections for $d\sigma/dt$ beyond $|t| = 2\ (GeV/c)^2$. (t is the momentum transfer between the incoming and outgoing neutrons.) Those experiments reporting data at less than $|t| = 2\ (GeV/c)^2$ only, are presented in Fig. 38. See the caption to Fig. 38 for additional information on these data.

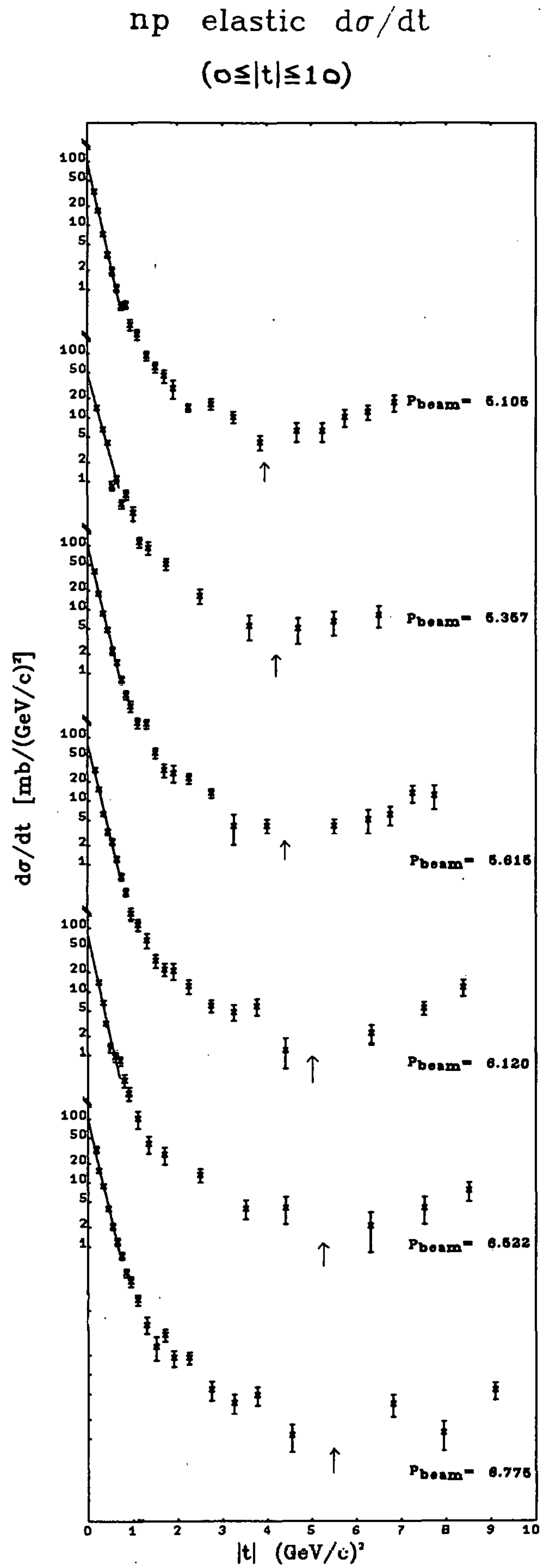


Fig. 42 (continued)

np backward dσ/du.

U BETWEEN BEAM AND SCATT TARG
(GEV/C)**2

BEAM MOMENTUM(CENTRAL VALUE)= .613 GEV/C

BEAM MOMENTUM RANGES FROM .600 TO .625 GEV/C

U	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
-.097	87.820	2.280
-.086	96.170	2.400
-.076	104.680	2.470
-.066	116.530	4.200
-.056	126.440	4.400
-.047	140.050	4.600
-.009	235.100	7.600
-.006	244.000	7.300
-.003	282.300	10.900
-.002	317.300	11.400
-.001	331.400	10.300
-.001	339.700	9.900
-.000	358.700	13.300
-.000	355.800	19.000

2Q SQUARE= .171
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 8PER CENT

SHEPARD PPAR 10 (1969) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= .637 GEV/C

BEAM MOMENTUM RANGES FROM .625 TO .650 GEV/C

U	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
-.117	71.200	2.800
-.105	85.000	2.310
-.093	86.710	2.280
-.082	95.210	2.400
-.071	108.550	4.100
-.061	120.360	4.300
-.051	130.280	4.500
-.043	133.890	4.600
-.010	231.700	7.400
-.006	231.400	7.200
-.004	271.700	10.800
-.003	278.400	10.700
-.002	317.000	10.200
-.001	346.200	10.000
-.000	374.200	13.000
-.000	396.700	22.600

2Q SQUARE= .184
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5PER CENT

SHEPARD PPAR 10 (1969) SPRK

BEAM MOMENTUM= .645 GEV/C

****THIS DATA WAS READ FROM A GRAPH****

U	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
-.374	318.091	83.708
-.372	277.911	23.438
-.364	157.372	23.438
-.350	140.630	16.742
-.329	100.450	13.393
-.276	83.708	10.045
-.261	73.663	3.348
-.230	66.967	3.348
-.197	66.967	3.348
-.165	73.663	3.348
-.130	93.753	3.348
-.100	110.495	6.697
-.072	127.237	6.697
-.044	157.372	6.697
-.029	184.158	3.348
-.015	234.383	3.348
-.011	271.215	3.348
-.008	308.046	6.697
-.004	348.226	6.697
-.002	381.710	6.697
.000	385.058	10.045

2Q SQUARE= .188

KAZARINOV JETP 16 24(1963) CNTR

BEAM MOMENTUM(CENTRAL VALUE)= .662 GEV/C

BEAM MOMENTUM RANGES FROM .650 TO .675 GEV/C

U	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
-.126	62.800	2.500
-.113	76.190	2.110
-.100	79.150	2.160
-.088	86.730	2.280
-.077	102.840	3.900
-.066	114.650	4.200
-.056	123.860	4.300
-.046	132.570	4.500
-.011	213.900	7.100
-.007	230.700	7.100
-.004	260.700	10.800
-.003	294.800	11.000
-.002	312.500	10.000
-.001	337.800	9.800
-.000	337.300	11.900
-.000	303.100	22.800

2Q SQUARE= .197
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 4PER CENT

SHEPARD PPAR 10 (1969) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= .688 GEV/C

BEAM MOMENTUM RANGES FROM .675 TO .700 GEV/C

U	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
-.135	54.700	2.300
-.121	65.180	1.940
-.108	68.580	1.970
-.095	73.290	2.020
-.082	85.480	3.610
-.071	107.150	4.010
-.060	110.890	4.110
-.049	114.830	4.110
-.011	180.800	6.300
-.007	218.000	6.800
-.004	236.400	9.800
-.003	276.900	10.400
-.002	275.600	9.500
-.001	300.900	8.900
-.000	318.400	11.400
-.000	354.300	21.200

2Q SQUARE= .211
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3PER CENT

SHEPARD PPAR 10 (1969) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= .712 GEV/C

BEAM MOMENTUM RANGES FROM .700 TO .725 GEV/C

U	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
-.144	51.800	2.200
-.130	58.830	1.850
-.116	62.650	1.900
-.102	69.060	1.920
-.088	77.390	3.310
-.076	81.440	3.410
-.064	98.250	3.720
-.053	96.180	3.720
-.043	111.010	4.020
-.018	154.100	6.000
-.012	164.000	5.900
-.008	196.600	6.400
-.005	204.100	9.000
-.003	242.300	9.600
-.002	249.700	8.900
-.001	276.100	8.400
-.000	300.000	10.900
-.000	288.600	17.600

2Q SQUARE= .225
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3PER CENT

SHEPARD PPAR 10 (1969) SPRK

np backward dσ/du.

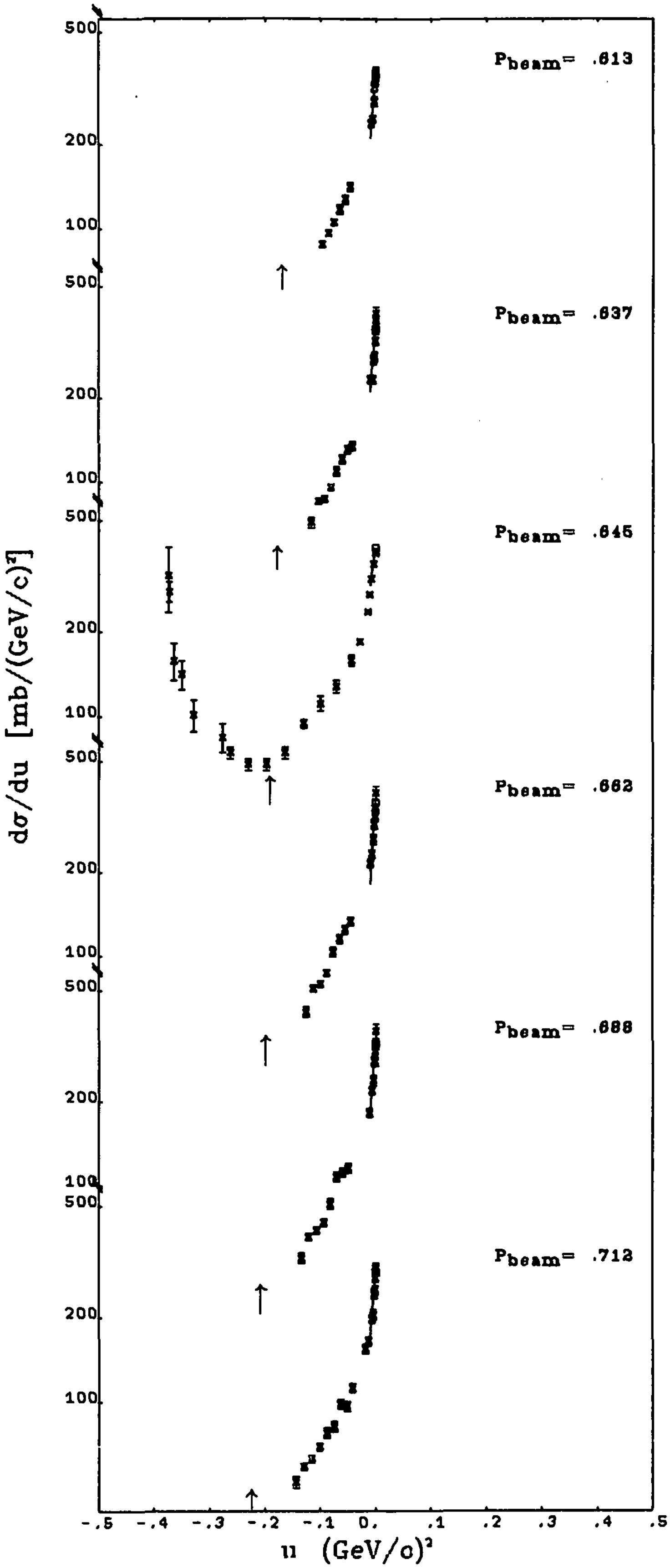


Fig. 43. np elastic scattering in the backward direction (i.e., "charge exchange" scattering). u is the momentum transfer between the incoming neutron and the outgoing proton. Most authors have given this data in terms of "t" (between the incident neutron and the outgoing proton), but we call it "u" to emphasize the fact that it is backward scattering. So as not to mask possible structures, systematic errors have not been included, even though they may have been given by the authors. Distributions given originally as $d\sigma/d\omega$ vs. $\theta_{c.m.}$ have been transformed to $d\sigma/du$ vs. u only when they contained data for $\cos\theta_{c.m.} < -0.6$.

Unlike in the forward direction, data in the backward direction go very close to the kinematical limit (i.e., $u = 0$), since forward-going protons are easier to detect than forward neutrons when using a neutron beam. A general feature of all of these data is the very abrupt change of slope near $u = -0.01\ (GeV/c)^2$ (independent of beam momentum). The solid lines are the results of our least-squares fit to $d\sigma/du = \frac{d\sigma}{du}\Big|_{u=0} \cdot e^{bu}$, using data in the interval $|u| \le 0.01\ (GeV/c)^2$. The square symbols on the graph represent the values of $d\sigma/du|_{u=0}$ obtained from our fits. The vertical arrows represent the u values for $\theta_{c.m.} = 90$ deg.

np backward dσ/du.

U BETWEEN BEAM AND SCATT TARG
(GEV/C)**2

BEAM MOMENTUM(CENTRAL VALUE)= .742 GEV/C

BEAM MOMENTUM RANGES FROM .725 TO .760 GEV/C

U	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
-.173	39.500	1.600
-.156	43.300	1.600
-.141	49.420	1.370
-.125	54.690	1.510
-.110	59.830	1.590
-.096	65.140	2.610
-.082	66.080	2.620
-.069	81.730	2.920
-.057	88.320	3.020
-.046	96.740	3.220
-.020	132.000	4.600
-.013	144.200	4.600
-.008	158.400	4.800
-.005	182.100	7.200
-.003	194.300	7.200
-.002	221.300	7.200
-.001	257.800	7.000
-.000	271.900	9.200
-.000	323.300	14.900

2Q SQUARE= .242
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3PER CENT

SHEPARD PPAR 10 (1969) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= .830 GEV/C

BEAM MOMENTUM RANGES FROM .810 TO .850 GEV/C

U	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
-.214	28.500	1.300
-.194	29.400	1.200
-.174	33.420	1.100
-.155	37.340	1.140
-.137	41.670	1.210
-.119	46.050	2.080
-.102	48.440	2.090
-.086	55.470	2.310
-.072	58.430	2.320
-.058	73.890	2.640
-.025	103.000	3.700
-.017	118.800	3.900
-.010	125.000	3.900
-.006	131.800	5.700
-.004	149.900	5.900
-.003	195.100	6.200
-.001	218.700	6.100
-.001	231.900	7.300
-.000	238.000	11.800

2Q SQUARE= .295
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 2PER CENT

SHEPARD PPAR 10 (1969) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= .875 GEV/C

BEAM MOMENTUM RANGES FROM .850 TO .900 GEV/C

U	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
-.259	23.200	1.100
-.237	22.800	1.000
-.214	23.700	1.000
-.193	25.900	1.000
-.172	29.000	1.100
-.151	36.040	.960
-.131	36.940	1.610
-.113	40.130	1.730
-.095	47.430	1.850
-.079	54.360	2.090
-.064	60.390	2.210
-.050	66.030	2.340
-.027	82.800	3.000
-.019	95.600	3.200
-.011	104.200	3.300
-.007	122.400	4.900
-.005	144.600	5.400
-.003	180.100	5.600
-.002	193.000	5.100
-.001	208.800	6.400
-.000	227.000	10.600

2Q SQUARE= .323
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 2PER CENT

SHEPARD PPAR 10 (1969) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= .925 GEV/C

BEAM MOMENTUM RANGES FROM .900 TO .950 GEV/C

U	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
-.505	31.420	1.510
-.482	30.600	1.410
-.460	29.090	1.320
-.436	26.880	1.320
-.412	24.480	1.230
-.289	20.100	1.000
-.262	19.900	1.000
-.238	21.400	1.000
-.214	21.500	1.000
-.191	24.400	1.000
-.169	29.940	.940
-.147	33.420	1.650
-.126	39.100	1.800
-.107	45.310	1.950
-.088	48.400	1.990
-.072	55.530	7.140
-.056	61.190	2.300
-.021	76.000	2.900
-.013	104.500	3.300
-.008	111.000	4.700
-.005	140.600	5.500
-.003	152.200	5.300
-.002	177.700	4.800
-.001	204.000	6.400
-.000	207.700	10.200

2Q SQUARE= .356
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 2PER CENT

SHEPARD PPAR 10 (1969) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= .975 GEV/C

BEAM MOMENTUM RANGES FROM .950 TO 1.000 GEV/C

U	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
-.577	33.660	1.610
-.553	29.090	1.410
-.531	28.470	1.410
-.504	27.370	1.320
-.479	23.010	1.220
-.454	22.320	1.130
-.428	18.970	1.030
-.318	15.900	.900
-.291	16.000	.900
-.265	15.200	.800
-.237	17.000	.900
-.211	20.700	.900
-.107	22.940	.810
-.162	25.530	1.410
-.140	30.970	1.550
-.118	33.520	1.700
-.098	40.570	1.850
-.079	45.660	1.880
-.062	56.150	2.150
-.048	59.880	2.310
-.023	75.000	2.900
-.014	91.300	3.100
-.009	107.300	4.700
-.006	120.100	4.800
-.004	143.700	4.800
-.002	165.600	4.600
-.001	182.600	6.000
-.000	195.600	10.000

2Q SQUARE= .389
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 2PER CENT

SHEPARD PPAR 10 (1969) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= 1.050 GEV/C

BEAM MOMENTUM RANGES FROM 1.000 TO 1.100 GEV/C

U	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
-.678	32.010	1.210
-.655	29.780	1.110
-.628	25.650	1.010
-.604	23.760	.920
-.574	21.980	.920
-.544	20.210	.830
-.515	17.500	.730
-.485	16.790	.740
-.363	12.400	.600
-.332	11.300	.500
-.302	12.200	.500
-.271	12.600	.500
-.242	15.900	.600
-.214	17.240	.500
-.186	18.750	.940
-.160	24.420	1.100
-.136	26.740	1.130
-.112	31.890	1.300
-.091	38.980	1.480
-.072	44.760	1.510
-.055	49.120	1.690
-.039	54.800	1.800
-.027	64.400	2.000
-.016	74.600	2.100
-.010	93.600	3.300
-.007	100.500	3.400
-.004	120.300	3.400
-.002	137.900	3.500
-.001	154.900	4.200
-.000	159.900	6.700

2Q SQUARE= .440
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 2PER CENT

SHEPARD PPAR 10 (1969) SPRK

np backward dσ/du.

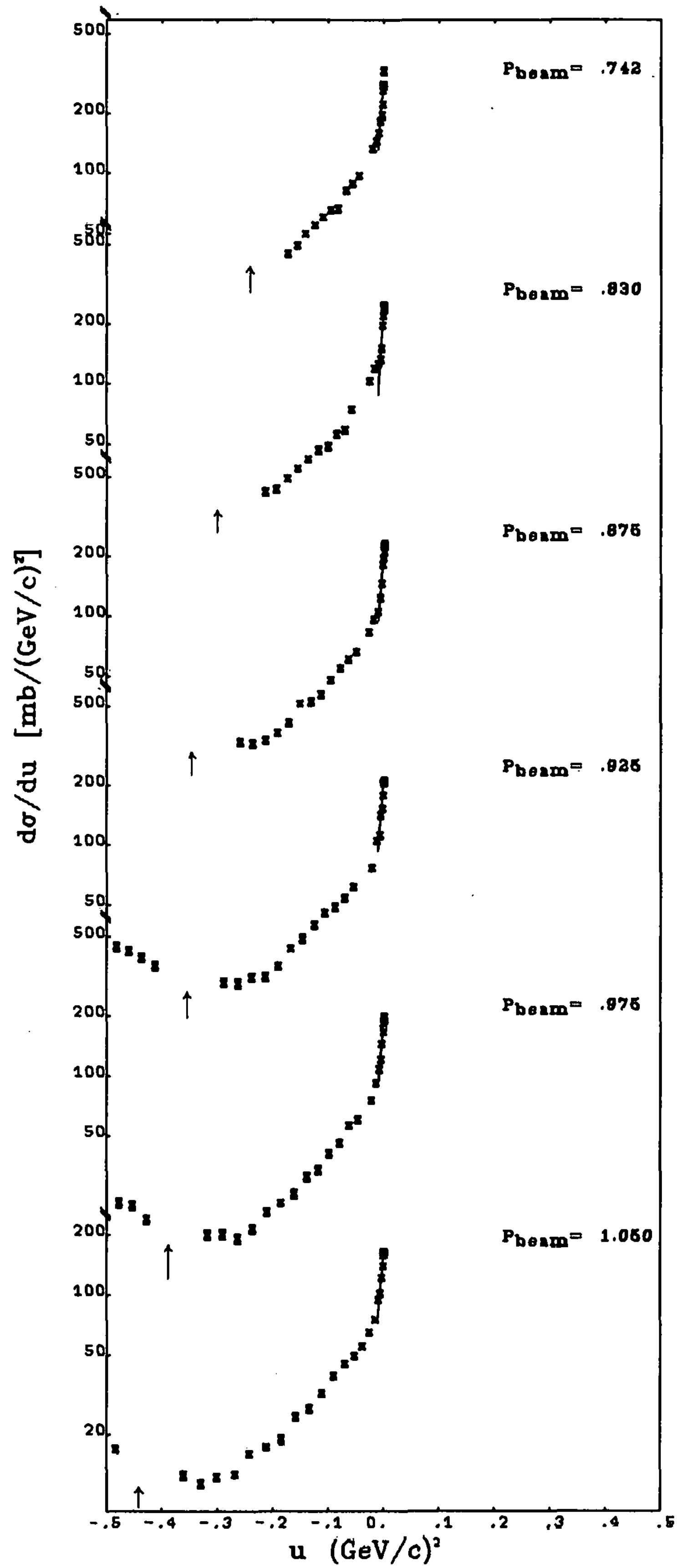


Fig. 43 (continued)

np backward dσ/du.

U BETWEEN BEAM AND SCATT TARG
(GEV/C)**2

BEAM MOMENTUM(CENTRAL VALUE)= 1.150 GEV/C

BEAM MOMENTUM RANGES FROM 1.100 TO 1.200 GEV/C

U	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
-.849	31.700	1.810
-.823	28.330	1.510
-.798	25.780	1.210
-.766	23.150	1.010
-.738	19.910	.910
-.709	17.890	.820
-.676	15.670	.820
-.643	13.220	.730
-.606	12.340	.630
-.573	10.810	.640
-.465	7.600	.500
-.431	7.200	.400
-.391	7.100	.400
-.356	7.700	.400
-.323	8.400	.400
-.289	10.130	.420
-.254	11.930	.420
-.222	12.730	.820
-.192	13.760	.840
-.161	16.720	.870
-.134	16.820	.890
-.109	23.510	1.050
-.085	28.450	1.230
-.065	33.280	.990
-.047	41.200	1.500
-.032	43.500	1.600
-.019	55.900	1.800
-.012	64.900	2.800
-.008	80.700	3.000
-.005	95.500	3.000
-.003	110.400	3.600
-.001	115.100	3.600
-.000	136.700	6.200

2Q SQUARE= .512
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3PER CENT

SHEPARD PPAR 10 (1969) SPRK

BEAM MOMENTUM= 1.257 GEV/C

****THIS DATA WAS READ FROM A GRAPH****

U	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
-1.173	88.226	11.693
-1.135	53.148	8.504
-1.069	39.330	2.126
-1.016	27.637	3.189
-.947	23.385	2.126
-.887	18.070	1.063
-.793	15.944	1.063
-.694	12.756	1.063
-.581	11.693	1.063
-.468	10.630	1.063
-.379	10.630	1.063
-.269	14.881	1.063
-.188	17.007	1.063
-.107	27.637	2.126
-.055	37.204	3.189
-.036	42.518	3.189
-.020	49.959	4.252
-.009	63.778	4.252
-.002	70.155	4.252
.000	85.037	5.315

2Q SQUARE= .591
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 19PER CENT

AMAGLOBELI JETP 37 1125(1960) CNTR

BEAM MOMENTUM(CENTRAL VALUE)= 1.300 GEV/C

BEAM MOMENTUM RANGES FROM 1.200 TO 1.400 GEV/C

U	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
-.997	34.110	2.110
-.963	29.550	1.510
-.930	24.180	1.110
-.895	18.800	.810
-.861	17.360	.810
-.824	14.190	.710
-.774	11.520	.620
-.735	10.060	.520
-.696	8.070	.420
-.656	7.320	.420
-.527	4.200	.300
-.486	4.000	.200
-.439	4.900	.300
-.399	4.900	.300
-.358	5.250	.250
-.313	5.610	.230
-.275	5.910	.370
-.238	6.140	.380
-.202	7.390	.380
-.167	9.180	.520
-.136	10.750	.520
-.107	15.540	.660
-.081	20.720	.570
-.059	25.740	.650
-.040	30.900	1.000
-.024	34.900	1.000
-.015	42.600	1.600
-.010	54.100	1.900
-.006	57.600	1.700
-.003	65.300	2.200
-.001	81.600	2.400
-.000	87.800	3.700

2Q SQUARE= .623
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 4PER CENT

SHEPARD PPAR 10 (1969) SPRK

BEAM MOMENTUM= 1.356 GEV/C

U	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
-.045	24.995	2.169
-.035	25.560	2.264
-.028	31.597	2.641
-.020	29.428	2.358
-.014	36.219	2.924
-.009	37.445	3.584
-.005	41.406	3.678
-.002	47.537	4.810
.000	58.006	5.093

2Q SQUARE= .666

LARSEN NC 18 1829(1960) CNTR

BEAM MOMENTUM(CENTRAL VALUE)= 1.500 GEV/C

BEAM MOMENTUM RANGES FROM 1.400 TO 1.600 GEV/C

U	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
-1.268	16.170	1.610
-1.230	12.780	1.010
-1.170	10.400	.710
-1.147	7.800	.610
-1.098	[illegible]	.410
-1.048	4.210	.310
-1.009	4.760	.310
-.955	3.140	.310
-.905	2.650	.210
-.856	2.360	.210
-.799	1.740	.220
-.743	2.200	.200
-.679	2.200	.200
-.636	2.200	.200
-.584	2.500	.200
-.522	3.700	.200
-.470	3.200	.200
-.420	2.570	.370
-.373	3.130	.380
-.313	3.950	.300
-.265	3.750	.390
-.223	5.770	.390
-.180	6.900	.530
-.143	9.390	.540
-.109	11.080	.430
-.079	14.100	.490
-.054	17.400	.800
-.032	21.200	.900
-.020	30.100	1.500
-.014	35.200	1.600
-.008	40.200	1.600
-.004	44.700	2.000
-.002	50.400	2.300
-.000	57.000	3.300

2Q SQUARE= .779
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 6PER CENT

SHEPARD PPAR 10 (1969) SPRK

BEAM MOMENTUM(CENTRAL VALUE)= 1.800 GEV/C

BEAM MOMENTUM RANGES FROM 1.600 TO 2.000 GEV/C

U	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
-1.624	8.450	1.010
-1.550	6.560	.810
-1.517	5.680	.510
-1.487	3.670	.310
-1.400	3.000	.210
-1.363	2.590	.310
-1.293	1.570	.210
-1.254	1.060	.110
-1.163	1.510	.220
-1.098	1.100	.110
-1.047	.890	.110
-.892	1.000	.100
-.831	1.100	.100
-.770	1.400	.100
-.694	1.500	.100
-.614	1.900	.200
-.559	1.410	.260
-.483	1.560	.260
-.437	1.980	.260
-.358	2.540	.270
-.290	3.110	.270
-.246	3.560	.270
-.192	5.390	.410
-.147	6.000	.320
-.107	8.160	.320
-.072	10.700	.600
-.044	14.200	.700
-.028	17.900	1.000
-.019	23.900	1.200
-.011	25.400	1.100
-.006	32.100	1.400
-.002	38.100	2.000
-.000	36.800	2.500

2Q SQUARE= 1.024
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 8PER CENT

SHEPARD PPAR 10 (1969) SPRK

BEAM MOMENTUM= 8.000 GEV/C

U	SIGMA +- DSIGMA (MILLIBARNS/(GEV/C)**2)	
-.475	.030	.010
-.424	.020	
-.375	.040	
-.329	.040	.010
-.286	.050	.010
-.246	.060	
-.209	.080	
-.174	.100	
-.143	.130	.020
-.129	.100	.030
-.117	.170	.030
-.107	.180	
-.097	.210	
-.087	.180	
-.078	.220	
-.069	.230	
-.061	.170	
-.054	.230	
-.046	.270	.040
-.040	.340	
-.034	.310	
-.028	.290	
-.023	.390	
-.018	.350	
-.014	.470	
-.011	.520	
-.008	.480	.050
-.005	.670	
-.003	.710	.060
-.002	.960	.060
-.001	.840	.060
-.000	.950	.090

2Q SQUARE= 6.676
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 30PER CENT

MANNING NC 41A 167(1966) SPRK

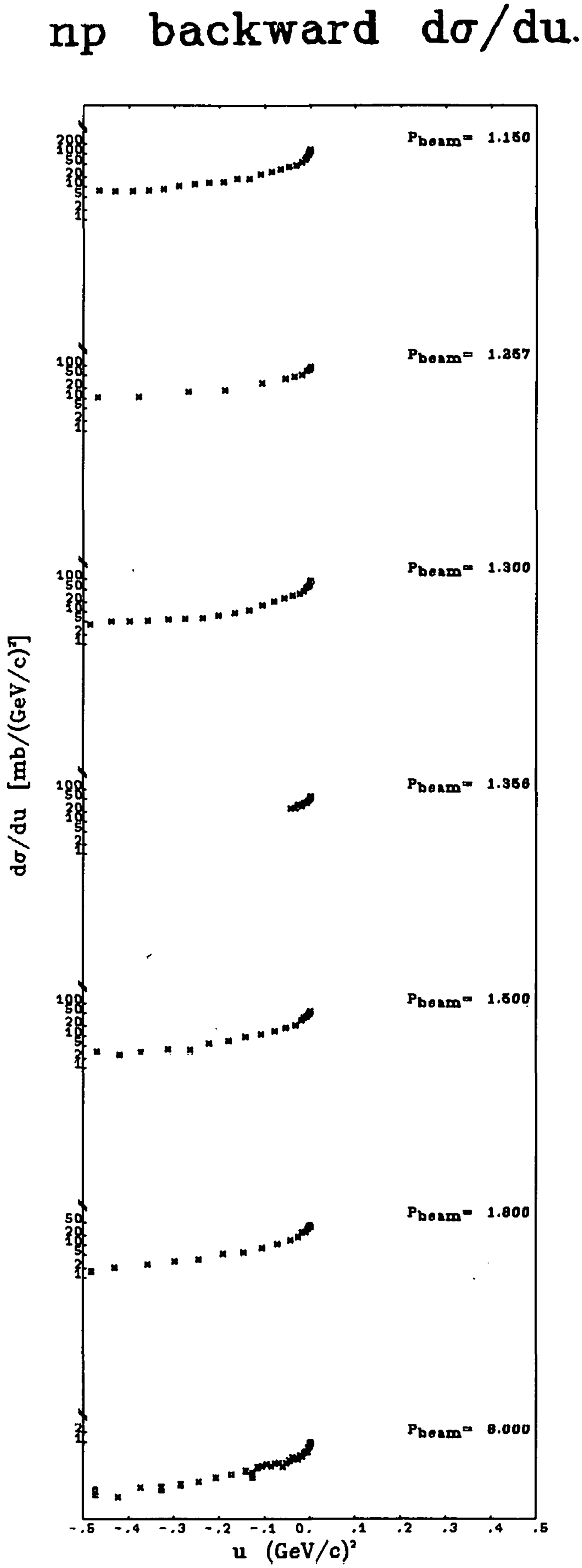


Fig. 43 (continued)

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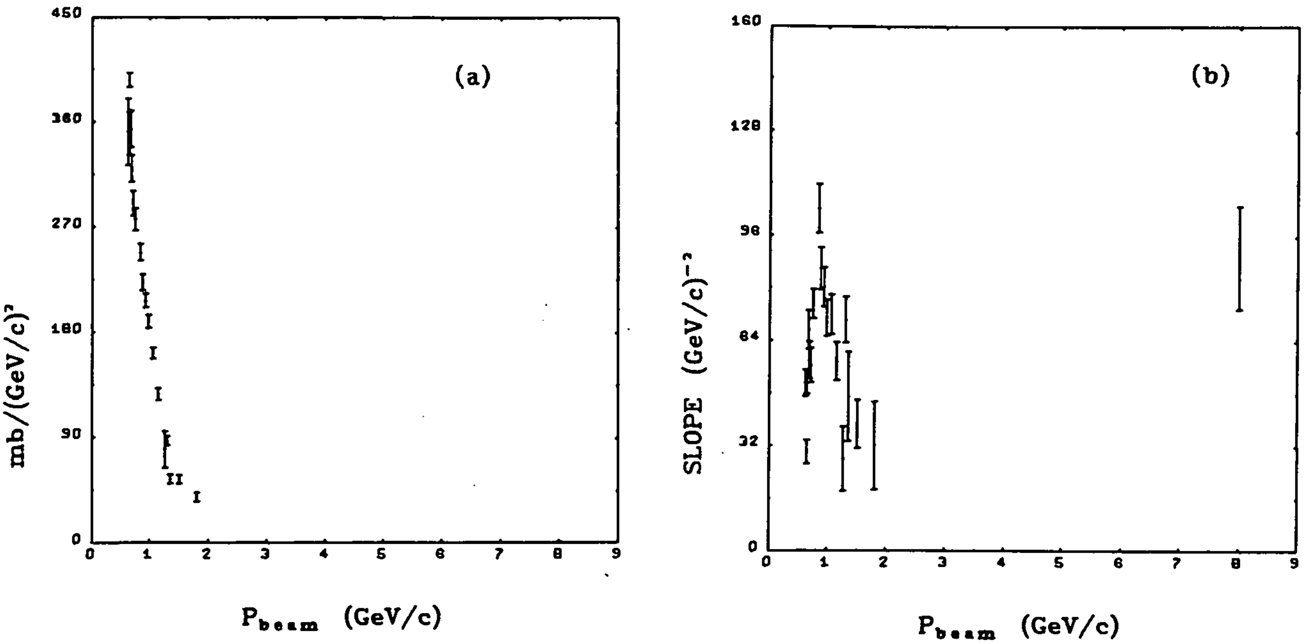
Fits to np backward elastic dσ/du.



P_{beam} (GeV/c)	dσ/du [u = 0] mb/(GeV/c)^2		SLOPE (GeV/c)$^{-2}$		χ^2/N
.613	391.98 ±	28.81	51.11 ±	4.08	2.34
.637	350.52	18.59	51.59	3.73	7.02
.645	395.91	6.61	30.18	3.66	1.17
.662	353.72	15.84	67.47	5.98	.73
.688	320.25	11.66	58.12	5.68	1.55
.712	290.46	10.67	56.56	5.45	1.78
.742	276.83	9.82	75.22	4.61	5.53
.830	248.40	7.42	110.0	7.57	1.06
.875	222.68	6.51	05.92	6.42	.60
.925	207.22	6.17	80.39	6.00	1.30
.975	189.76	5.76	71.04	5.59	.97
1.050	162.51	4.82	72.00	6.23	.15
1.150	127.40	4.99	57.63	5.80	1.77
1.257	80.30	15.78	28.08	9.86	2.35
1.300	87.53	4.24	70.46	7.08	2.42
1.356	54.83	3.85	47.01	13.67	.59
1.500	54.70	3.93	38.74	7.36	.89
1.800	39.23	3.86	32.19	13.43	1.32
8.000	.98	.30	89.55	15.90	2.07

Fig. 44. Coefficients from our least-squares fit of the np differential cross section in the backward direction to the formula $d\sigma/du = \left.\frac{d\sigma}{du}\right|_{u=0} \cdot e^{bu}$ over the range $|u| \leq 0.01\ (\text{GeV}/c)^2$. Systematic scaling errors in the data have been folded into the errors of $\left.\frac{d\sigma}{du}\right|_{u=0}$. In the table χ^2/N is the chi-square of the fit divided by the number of degrees of freedom. Notice the possible structure in the slope around 0.8 GeV/c. See text for a discussion of this effect. We have fit the intercept to $d\sigma/du|_{u=0} = Kp_{beam}^{-n}$ and find $n = 2.02 \pm 0.02$, with $\chi^2/N = 3.04$. We have not plotted this in (a) because it obscures the data.

Polarization in np elastic scattering

DISTRIBUTION IN COS(THETA) OF THE SCATT TARG WITH RESPECT TO THE BEAM DIRECTION IN THE C.M. SYSTEM

BEAM MOMENTUM= 1.500 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
.615	.743	-.420	.150
.743	.872	-.140	.040
.872	.923	-.040	.030
.923	.961	-.060	.040
.961	.987	-.100	.080

2Q SQUARE= .779
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 96PER CENT

ROBRISH PL 31B 617(1970) CNTR

BEAM MOMENTUM= 2.500 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
.631	.754	-.610	.240
.754	.815	-.360	.110
.815	.877	-.280	.060
.877	.938	-.170	.040
.938	.963	-.170	.040
.963	.982	-.170	.050
.982	.994	-.030	.060
.994	1.000	-.030	.120

2Q SQUARE= 1.624
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 96PER CENT

ROBRISH PL 31B 617(1970) CNTR

BEAM MOMENTUM= 3.500 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
.762	.841	-.260	.090
.841	.881	-.220	.090
.881	.921	-.310	.060
.921	.960	-.210	.040
.960	.976	-.270	.050
.976	.988	-.150	.050
.988	.996	-.170	.070
.996	1.000	.040	.120

2Q SQUARE= 2.519
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5PER CENT

ROBRISH PL 31B 617(1970) CNTR

BEAM MOMENTUM= 4.500 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
.825	.883	-.490	.070
.883	.913	-.340	.070
.913	.942	-.220	.050
.942	.971	-.140	.040
.971	.983	-.110	.050
.983	.991	-.090	.050
.991	.997	.040	.060
.997	1.000	-.110	.100

2Q SQUARE= 3.432
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 96PER CENT

ROBRISH PL 31B 617(1970) CNTR

BEAM MOMENTUM= 5.250 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
.854	.903	-.420	.090
.903	.927	-.170	.090
.927	.951	-.370	.070
.951	.976	-.280	.050
.976	.985	-.200	.060
.985	.993	-.260	.060
.993	.998	-.090	.070
.998	1.000	-.200	.120

2Q SQUARE= 4.123
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 96PER CENT

ROBRISH PL 31B 617(1970) CNTR

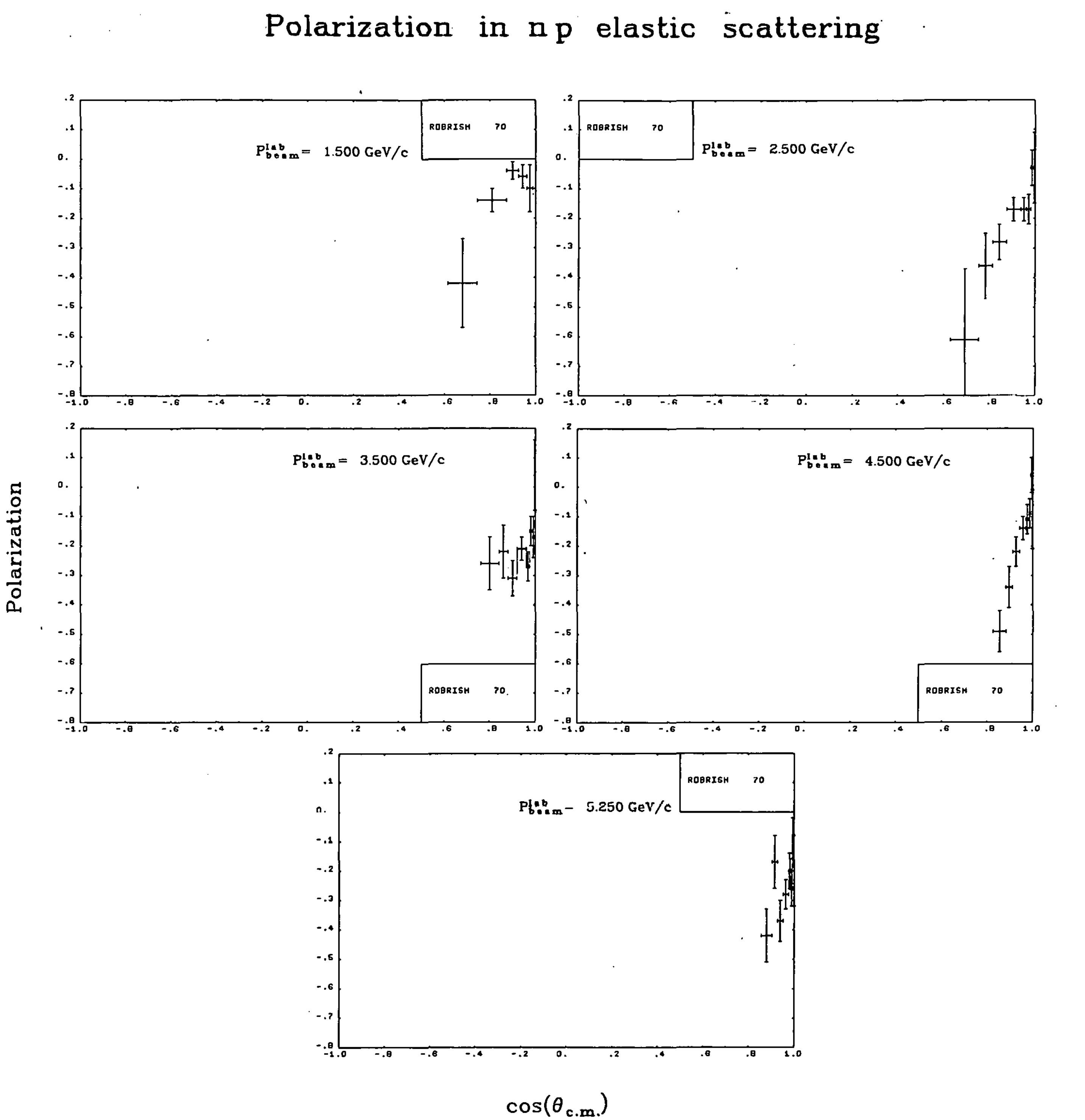


Fig. 45. Polarization in backwards np elastic scattering. θ is the angle between the incident neutron and the outgoing proton. This data is preliminary.

Polarization in pn elastic scattering

DISTRIBUTION IN COS(THETA) OF THE SCATT BEAM WITH RESPECT TO THE BEAM DIRECTION IN THE C.M. SYSTEM

BEAM MOMENTUM= .823 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
-.854	-.698	-.133	.031
-.737	-.558	-.174	.018
-.561	-.324	-.218	.016
-.302	-.035	-.239	.019
-.021	.255	-.114	.024
.262	.521	.093	.020
.574	.759	.287	.026
.768	.896	.421	.038

2Q SQUARE= .291
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3PER CENT

CHENG PR 163 1470(1967) CNTR

BEAM MOMENTUM= .954 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
-.861	-.757	-.104	.056
-.731	-.576	-.158	.018
-.546	-.340	-.272	.022
-.284	-.051	-.309	.025
-.002	.240	-.152	.026
.279	.509	.083	.032
.571	.750	.264	.023
.766	.897	.411	.087

2Q SQUARE= .376
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3PER CENT

CHENG PR 163 1470(1967) CNTR

BEAM MOMENTUM= 1.090 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
-.867	-.769	-.111	.017
-.727	-.576	-.147	.017
-.514	-.327	-.263	.017
-.239	-.035	-.264	.018
.051	.254	-.155	.017
.332	.518	.090	.017
.579	.738	.255	.016
.775	.886	.297	.024

2Q SQUARE= .470
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3PER CENT

CHENG PR 163 1470(1967) CNTR

BEAM MOMENTUM= 1.219 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
-.872	-.772	-.090	.023
-.721	-.572	-.241	.023
-.505	-.327	-.345	.030
-.232	-.038	-.315	.031
.052	.249	-.155	.028
.335	.512	.084	.030
.584	.735	.251	.041
.777	.891	.364	.040

2Q SQUARE= .564
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3PER CENT

CHENG PR 163 1470(1967) CNTR

BEAM MOMENTUM= 1.343 GEV/C

COS(THETA) MINIMUM	MAXIMUM	POLARIZ+-DPOL	
-.849	-.747	-.146	.019
-.674	-.527	-.247	.019
-.443	-.267	-.411	.032
-.165	.033	-.352	.026
.120	.324	-.068	.030
.392	.589	.157	.033
.629	.792	.305	.017
.807	.922	.334	.027

2Q SQUARE= .658
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3PER CENT

CHENG PR 163 1470(1967) CNTR

Polarization in pn elastic scattering

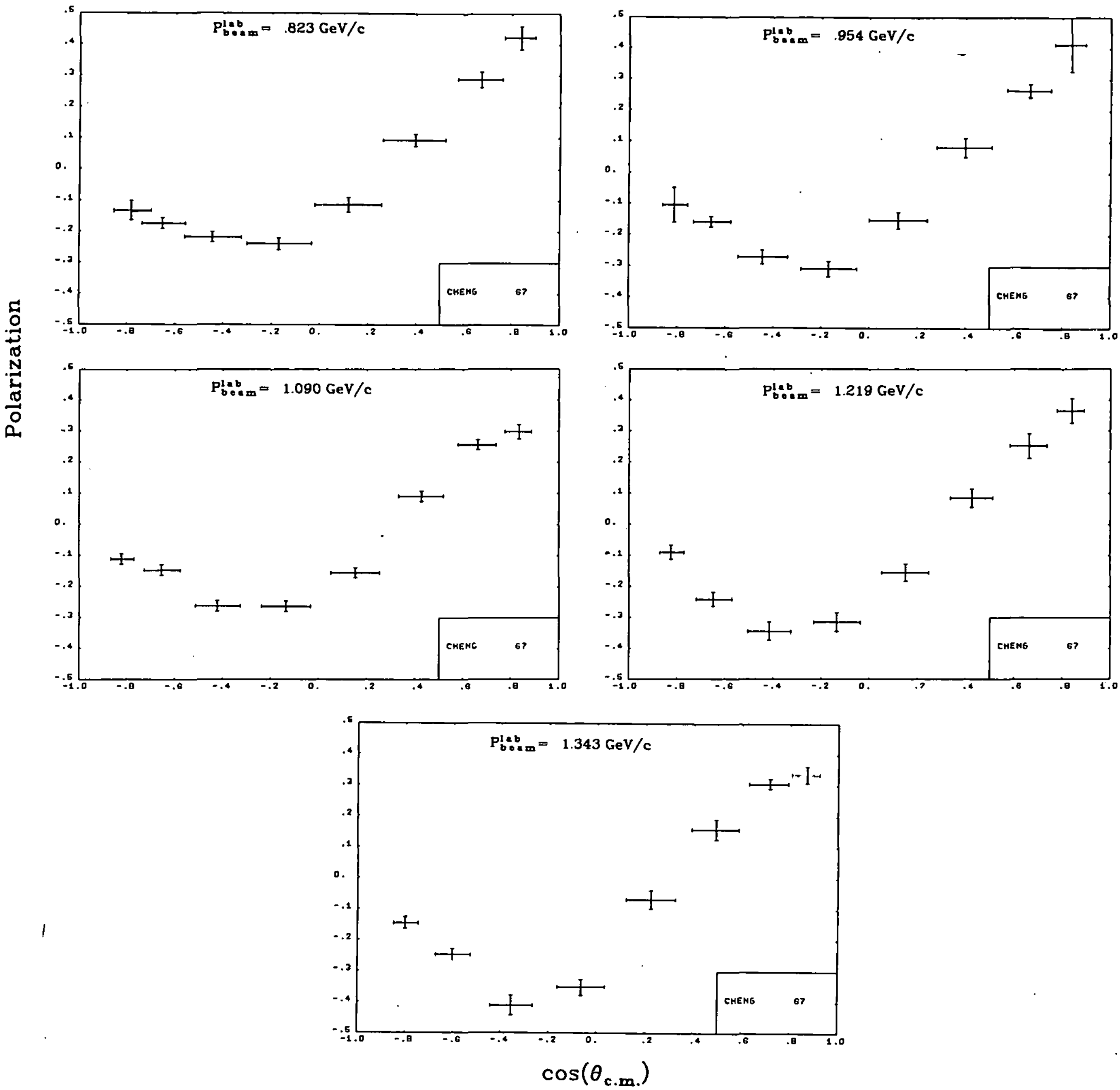


Fig. 46. Polarization in pn elastic scattering. θ is the angle between the incoming and outgoing proton in the grand c. m. The data have been corrected for deuteron effects.

Table VII. Various pn inelastic cross sections (not plotted).

P_{beam} (GeV/c)	$E_{c.m.}$ (GeV)	$\sigma_{pn\pi^0}$ (mb)	$\sigma_{nn\pi^+}$ (mb)	References
1.662	2.313	14.300 ± 3.500	4.300 ± 1.100	BATSON 59 $

$ GLAUBER CORRECTION APPLIED

REFERENCES

1	BATSON	59.....P.ROY.SOC.	251 233	CC

P_{beam} (GeV/c)	$E_{c.m.}$ (GeV)	$\sigma_{pp\pi^-}$ (mb)	References
1.662	2.313	2.700 ± .600	BATSON 59 $
1.825 ± .045	2.370	2.570 .140	BRUNT 69 $
2.110 .045	2.470	2.680 .190	BRUNT 69 $
7.000	3.877	1.010 .130	SHAPIRA 68

$ GLAUBER CORRECTION APPLIED

REFERENCES

1	BATSON	59.....P.ROY.SOC.	251 233	CC
2	SHAPIRA	68.....PRL	21 1835	DBC
3	BRUNT	69.....PR	187 1856	HBC

P_{beam} (GeV/c)	$E_{c.m.}$ (GeV)	$\sigma_{pn\pi^+\pi^-}$ (mb)	References
1.825 ± .045	2.370	.770 ± .070	BRUNT 69 $
2.110 .045	2.470	1.750 .200	BRUNT 69 $
6.980	3.873	3.720 .220	SHAPIRA 70 $

$ GLAUBER CORRECTION APPLIED

REFERENCES

1	BRUNT	69.....PR	187 1856	HBC
2	SHAPIRA	70.....REHO		HBC

P_{beam} (GeV/c)	$E_{c.m.}$ (GeV)	$\sigma_{pp\pi^-\pi^0}$ (mb)	References
1.035 ± .045	2.370	.160 ± .030	BRUNT 69 $
2.110 .045	2.470	.350 .040	BRUNT 69 $

$ GLAUBER CORRECTION APPLIED

REFERENCES

1	BRUNT	69.....PR	187 1856	HBC

P_{beam} (GeV/c)	$E_{c.m.}$ (GeV)	$\sigma_{pN^*(1470)^0}$ (mb)	References
		$N^{*0} \to p\pi^-$	
7.000	3.877	.500	SHAPIRA 68

REFERENCES

1	SHAPIRA	68.....PRL	21 1835	DBC

P_{beam} (GeV/c)	$E_{c.m.}$ (GeV)	$\sigma_{\Delta^{++}\Delta^-}$ (mb)	References
		$\Delta^- \to n\pi^-$	
6.980	3.873	1.100 ± .200	SHAPIRA 70 $

$ GLAUBER CORRECTION APPLIED

REFERENCES

1	SHAPIRA	70.....REHO		HBC

NN Interactions in the I = 0 State

NN total cross section (I=0)

P_{beam} (GeV/c)		$E_{c.m.}$ (GeV)	σ^T_{NN} (mb)		References	
1.11	± .01	2.12	36.75	± .75	BUGG	66
1.29	.01	2.18	34.42	.52	BUGG	66
1.41	.01	2.22	32.99	.38	BUGG	66
1.61	.01	2.29	32.22	.36	BUGG	66
1.66	.01	2.31	32.76	.35	BUGG	66
1.78	.01	2.35	33.68	.26	BUGG	66
1.86	.01	2.38	35.04	.23	BUGG	66
1.94	.01	2.41	35.76	.24	BUGG	66
1.95	.01	2.41	35.61	.22	BUGG	66
2.08	.01	2.46	36.68	.22	BUGG	66
2.21	.01	2.50	37.54	.26	BUGG	66
2.20	.01	2.53	38.44	.21	BUGG	66
2.45	.01	2.59	39.52	.20	BUGG	66
2.59	.01	2.63	40.24	.19	BUGG	66
2.68	.01	2.66	40.62	.19	BUGG	66
2.70	.01	2.67	40.72	.19	BUGG	66
2.82	.01	2.71	41.08	.19	BUGG	66
2.86	.01	2.72	41.21	.19	BUGG	66
2.96	.01	2.75	41.66	.19	BUGG	66
2.99	.01	2.77	41.85	.19	BUGG	66
3.00		2.77	38.57	.23	ABRAMS	69
3.05	.02	2.78	41.64	.19	BUGG	66
3.11	.02	2.80	42.33	.19	BUGG	66
3.14	.02	2.81	42.19	.18	BUGG	66
3.28	.02	2.86	42.03	.18	BUGG	66
3.30	.02	2.86	42.31	.18	BUGG	66
3.44	.02	2.91	41.96	.18	BUGG	66
3.55	.02	2.94	42.05	.16	BUGG	66
3.91	.02	3.05	42.75	.15	BUGG	66
4.04	.02	3.09	42.86	.17	BUGG	66
4.26	.02	3.16	42.76	.17	BUGG	66
4.55	.02	3.24	43.03	.17	BUGG	66
4.97	.02	3.35	42.98	.17	BUGG	66
5.22	.03	3.42	42.87	.13	BUGG	66
5.53	.03	3.50	43.19	.17	BUGG	66
5.82	.03	3.58	42.80	.17	BUGG	66
7.83	.04	4.07	42.58	.20	BUGG	66

REFERENCES

1	BUGG	66.....PR	146 980	CNTR
2	ABRAMS	69.....BNL	14125	CNTR

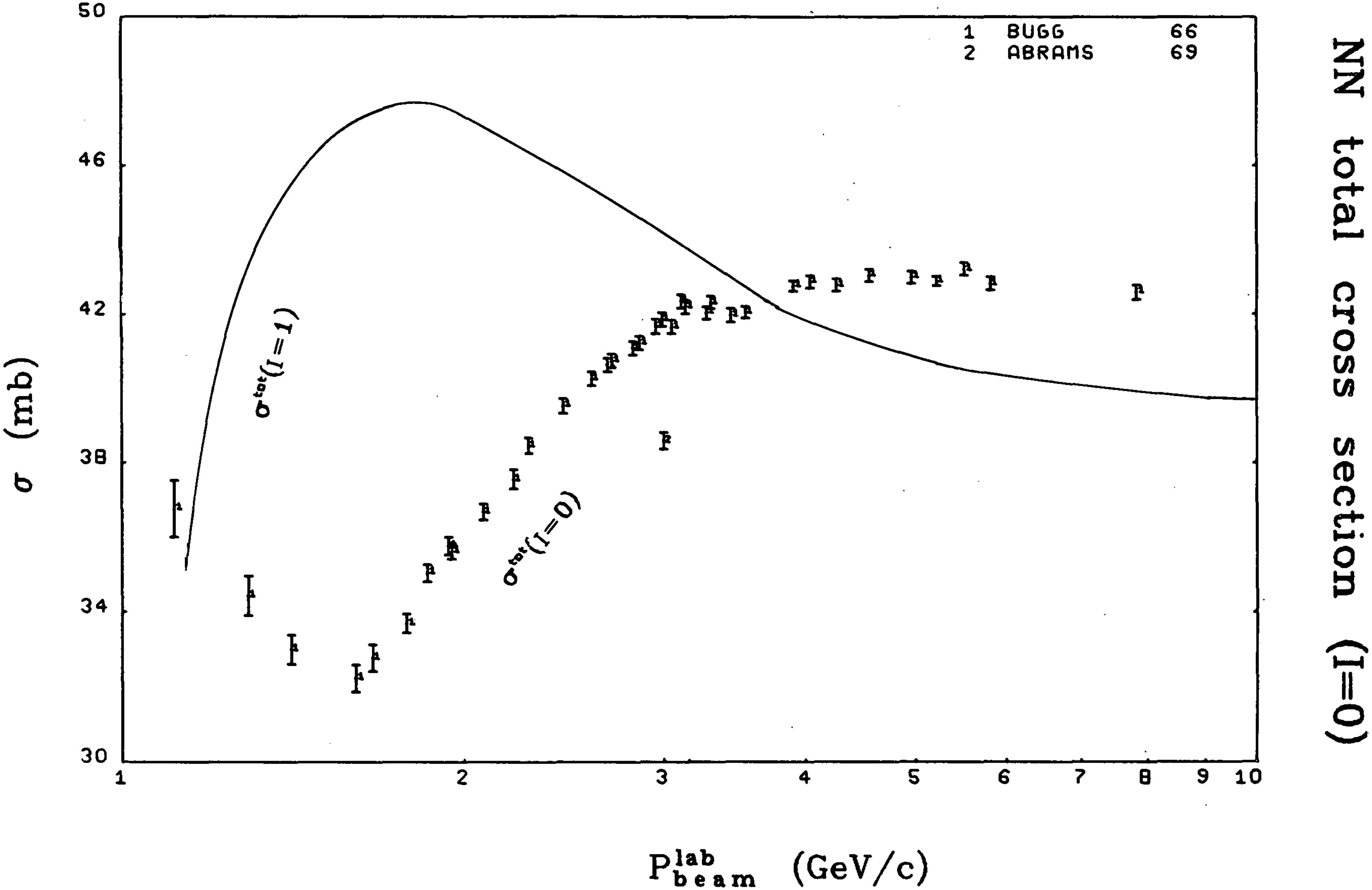


Fig. 47. NN total cross section in the I = 0 state. The solid line represents the I = 1 total cross section [i. e., the σ^{total}(pp) from Fig. 1].

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ND Interactions

pd } nd } total cross sections

P_{beam} (GeV/c)		$E_{c.m.}$ (GeV)	σ^T_{pd} (mb)		References	
1.111	± .006	3.138	67.209	± .090	BUGG	66
1.289	.006	3.221	76.905	.110	BUGG	66
1.408	.007	3.277	80.490	.057	BUGG	66
1.607	.008	3.373	82.472	.063	BUGG	66
1.660	.008	3.398	82.889	.063	BUGG	66
1.780	.009	3.456	83.377	.052	BUGG	66
1.858	.009	3.493	84.039	.047	BUGG	66
1.940	.010	3.532	84.260	.046	BUGG	66
1.952	.010	3.538	84.280	.047	BUGG	66
2.079	.010	3.599	84.526	.047	BUGG	66
2.212	.011	3.662	84.524	.047	BUGG	66
2.280	.011	3.694	84.624	.047	BUGG	66
2.450	.012	3.773	84.239	.047	BUGG	66
2.592	.013	3.839	84.212	.047	BUGG	66
2.680	.013	3.879	84.085	.044	BUGG	66
2.704	.014	3.890	83.912	.047	BUGG	66
2.819	.014	3.942	83.846	.047	BUGG	66
2.857	.014	3.959	83.790	.047	BUGG	66
2.958	.015	4.004	83.602	.047	BUGG	66
2.994	.015	4.020	83.452	.047	BUGG	66
3.000		4.023	81.780	.658	ABRAMS	69
3.054	.015	4.047	83.289	.047	BUGG	66
3.110	.016	4.072	83.328	.047	BUGG	66
3.142	.016	4.086	83.166	.047	BUGG	66
3.277	.016	4.145	82.489	.047	BUGG	66
3.303	.017	4.156	82.730	.047	BUGG	66
3.444	.017	4.217	81.960	.047	BUGG	66
3.546	.018	4.261	81.710	.047	BUGG	66
3.908	.020	4.412	81.107	.033	BUGG	66
4.037	.020	4.465	80.930	.047	BUGG	66
4.265	.021	4.558	80.417	.047	BUGG	66
4.552	.023	4.672	80.125	.047	BUGG	66
4.966	.025	4.832	79.632	.047	BUGG	66
5.221	.026	4.928	79.578	.037	BUGG	66
5.526	.028	5.041	79.316	.047	BUGG	66
5.824	.029	5.150	79.091	.047	BUGG	66
6.000	.105	5.213	77.400	1.300	GALBRAITH	65
7.835	.039	5.830	77.858	.052	BUGG	66
8.000	.140	5.882	76.200	1.300	GALBRAITH	65
10.000	.175	6.486	75.800	1.300	GALBRAITH	65
12.000	.210	7.038	74.400	1.300	GALBRAITH	65
14.000	.245	7.551	74.000	1.300	GALBRAITH	65
16.000	.280	8.031	73.700	1.300	GALBRAITH	65
18.000	.315	8.485	72.800	1.300	GALBRAITH	65
19.300		8.767	74.100	.700	BELLETTINI	65
20.000	.350	8.915	72.100	1.300	GALBRAITH	65
22.000	.385	9.326	71.600	1.300	GALBRAITH	65

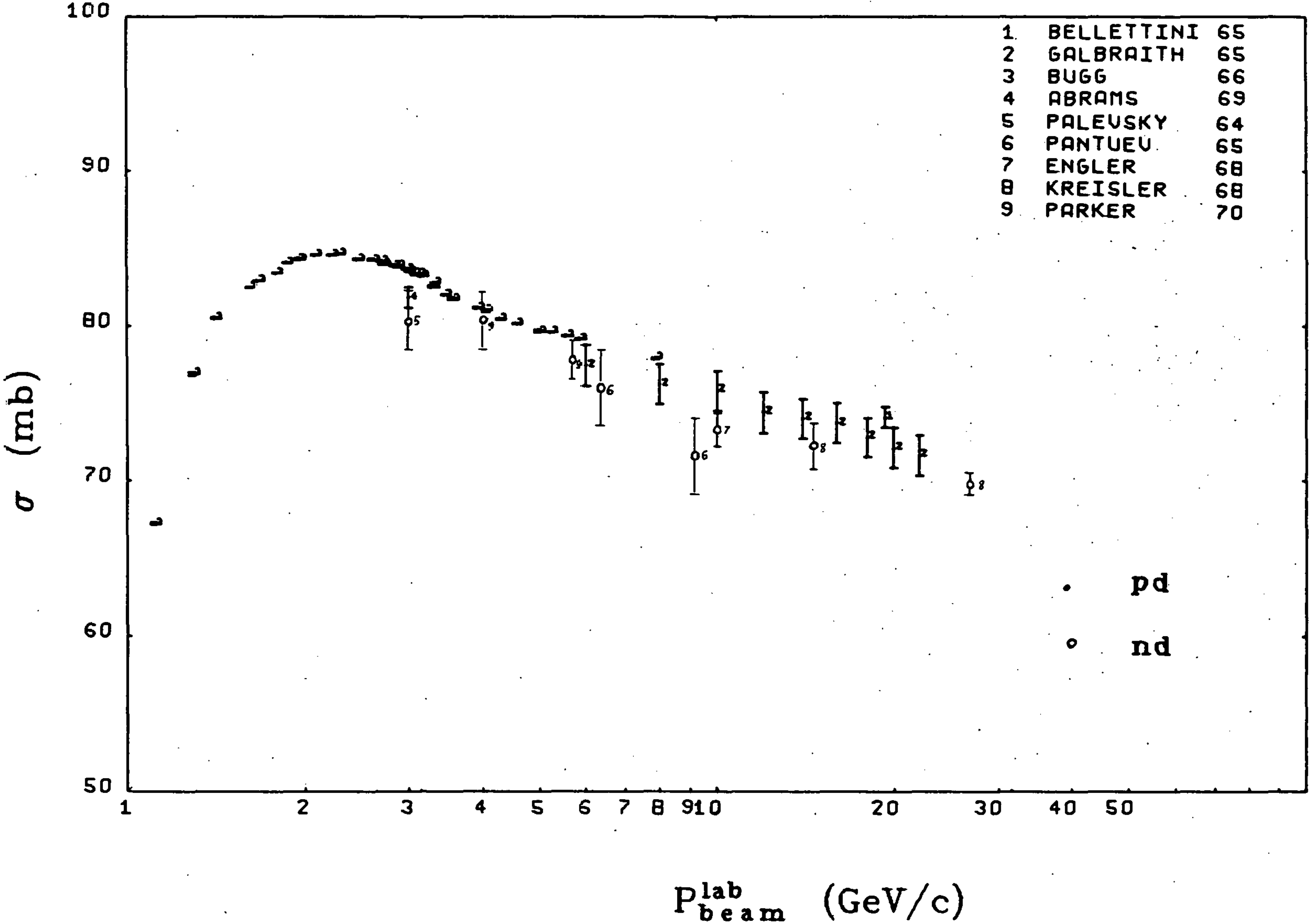
REFERENCES

1	BELLETTINI 65.....PL	19	341	SPRK,CNTR
2	GALBRAITH 65.....PR	138	B913	CNTR
3	BUGG 66.....PR	146	980	CNTR
4	ABRAMS 69.....BNL	14125		CNTR

P_{beam} (GeV/c)		$E_{c.m.}$ (GeV)	σ^T_{nd} (mb)		References	
2.996		4.022	80.300	± 1.900	PALEVSKY	64
4.000	± .600	4.451	80.300	1.900	PARKER	70
5.700	.600	5.105	77.800	1.300	PARKER	70
6.371		5.343	76.000	2.400	PANTUEV	65
9.192		6.249	71.600	2.500	PANTUEV	65
10.000		6.486	73.300	1.100	ENGLER	68
14.600		7.698	72.200	1.500	KREISLER	68
27.000		10.282	69.700	.700	KREISLER	68

REFERENCES

1	PALEVSKY 64.....PARIS CONF	1964	162	CNTR
2	PANTUEV 65.....SJNP	1	93	CNTR
3	ENGLER 68.....PL	27B	599	CNTR
4	KREISLER 68.....PRL	20	468	CNTR
5	PARKER 70.....PL	31B	246	CNTR



pd} nd} total cross sections

Fig. 48. pd and nd total cross sections. According to isospin invariance these should be equal.

pd elastic dσ/dΩ (very forward angles)

DISTRIBUTION IN THE ANGLE OF THE SCATT BEAM WITH RESPECT TO THE BEAM DIRECTION IN THE LAB SYSTEM

BEAM MOMENTUM= 1.290 GEV/C

THETA(DEG)

MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/STERADIAN)	
1.117	1.232	1072.000	96.000
1.232	1.346	756.000	82.000
1.346	1.461	653.000	70.000
1.461	1.576	622.000	63.000
1.576	1.690	447.000	54.000
1.690	1.805	392.000	52.000
1.805	1.919	392.000	29.000
1.919	2.034	382.000	27.000
2.034	2.149	363.000	26.000
2.149	2.263	350.000	25.000
2.263	2.378	394.000	25.000
2.378	2.492	340.000	23.000
2.492	2.607	334.000	23.000
2.607	2.722	389.000	23.000
2.722	2.836	364.000	23.000
2.836	2.951	348.000	22.000
2.951	3.065	311.000	21.000

2Q SQUARE= 1.128

DUTTON PRL 21 1416(1968) SPRK

BEAM MOMENTUM= 1.390 GEV/C

THETA(DEG)

MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/STERADIAN)	
1.060	1.175	791.000	63.000
1.175	1.289	607.000	43.000
1.289	1.404	520.000	34.000
1.404	1.518	511.000	32.000
1.518	1.633	482.000	29.000
1.633	1.748	424.000	27.000
1.748	1.862	395.000	25.000
1.862	1.977	357.000	24.000
1.977	2.091	347.000	22.000
2.091	2.206	312.000	21.000
2.206	2.320	326.000	21.000
2.320	2.435	298.000	20.000
2.435	2.550	297.000	19.000
2.550	2.664	296.000	19.000
2.664	2.779	292.000	19.000
2.779	2.893	302.000	19.000
2.893	3.008	268.000	18.000
3.008	3.123	247.000	17.000
3.123	3.237	289.000	18.000
3.237	3.352	257.000	17.000
3.352	3.466	250.000	17.000
3.466	3.581	252.000	17.000
3.581	3.696	228.000	16.000
3.696	3.810	274.000	16.000
3.810	3.925	249.000	16.000

2Q SQUARE= 1.271

DUTTON PRL 21 1416(1968) SPRK

BEAM MOMENTUM= 1.540 GEV/C

THETA(DEG)

MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/STERADIAN)	
1.003	1.117	856.000	87.000
1.117	1.232	536.000	64.000
1.232	1.346	458.000	57.000
1.346	1.461	458.000	50.000
1.461	1.576	499.000	47.000
1.576	1.690	440.000	24.000
1.690	1.805	436.000	22.000
1.805	1.919	401.000	21.000
1.919	2.034	413.000	20.000
2.040	2.154	392.000	20.000
2.149	2.263	347.000	18.000
2.263	2.378	346.000	18.000
2.378	2.492	338.000	18.000
2.492	2.607	311.000	17.000
2.607	2.722	336.000	17.000
2.722	2.836	324.000	16.000
2.836	2.951	356.000	16.000
2.951	3.065	361.000	16.000
3.065	3.180	327.000	16.000
3.180	3.295	306.000	16.000
3.295	3.409	314.000	16.000
3.409	3.524	278.000	15.000
3.524	3.638	277.000	15.000
3.638	3.753	307.000	15.000
3.753	3.867	273.000	15.000
3.867	3.982	253.000	14.000
3.982	4.097	254.000	14.000

2Q SQUARE= 1.494

DUTTON PRL 21 1416(1968) SPRK

BEAM MOMENTUM= 1.690 GEV/C

THETA(DEG)

MINIMUM	MAXIMUM	SIGMA +- DSIGMA (MILLIBARNS/STERADIAN)	
1.117	1.232	598.000	39.000
1.232	1.346	546.000	36.000
1.346	1.461	471.000	33.000
1.461	1.576	494.000	32.000
1.576	1.690	395.000	28.000
1.690	1.805	356.000	27.000
1.805	1.919	332.000	25.000
1.919	2.034	359.000	26.000
2.034	2.149	346.000	25.000
2.149	2.263	317.000	23.000
2.263	2.378	344.000	23.000
2.378	2.492	286.000	22.000
2.492	2.607	304.000	22.000
2.607	2.722	290.000	23.000
2.722	2.836	323.000	23.000

2Q SQUARE= 1.725

DUTTON PL 25B 245(1967) SPRK

pd elastic dσ/dΩ (very forward angles)

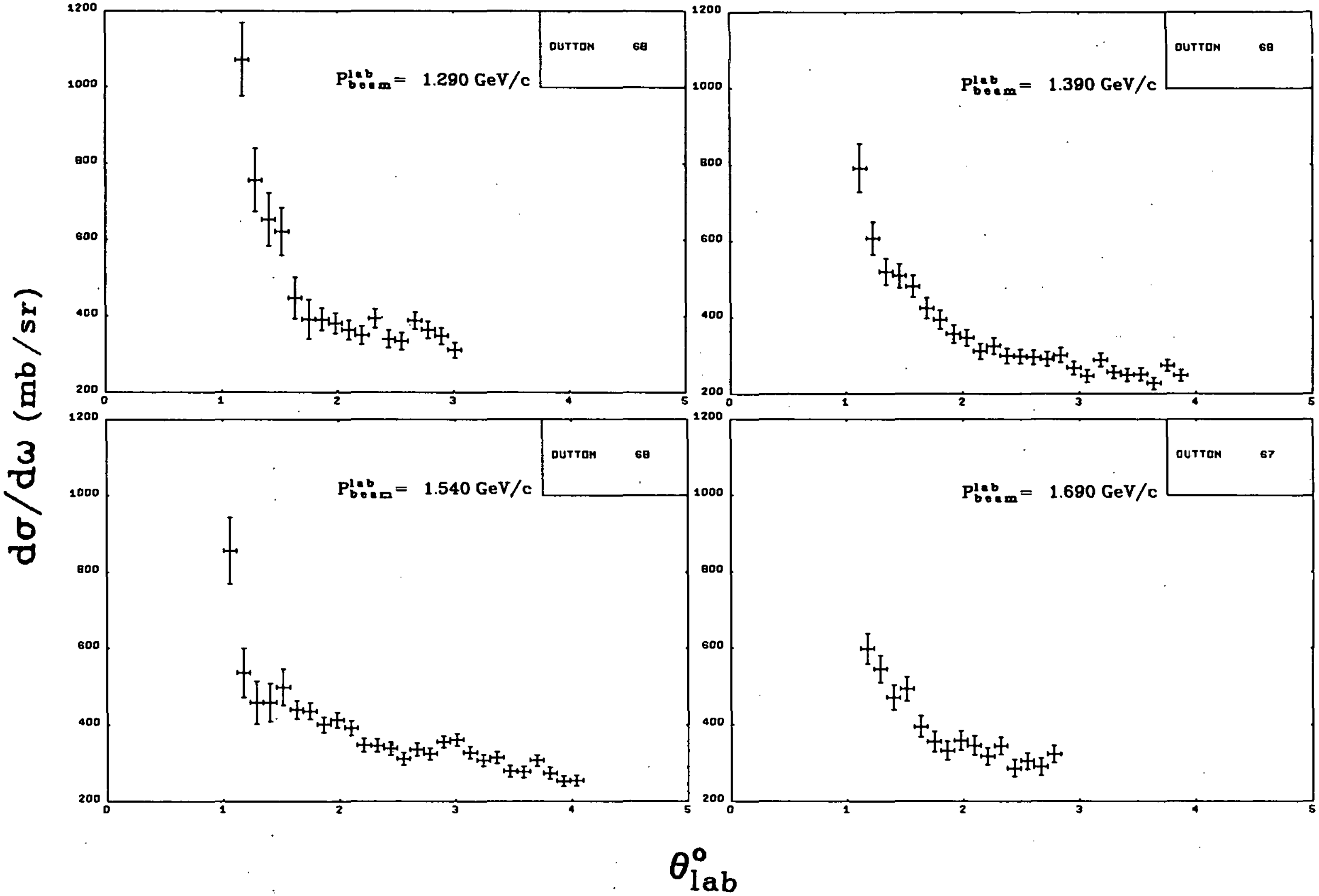


Fig. 49. Small-angle pd elastic differential cross sections in the Coulomb-nuclear interference region. θ is the angle between the incoming and outgoing proton. The main purpose of such experiments is to accurately measure parameters related to the forward nuclear elastic amplitudes.

pd elastic $d\sigma/d\omega$

DISTRIBUTION IN COS(THETA) OF THE SCATT BEAM WITH RESPECT TO THE BEAM DIRECTION IN THE C.M. SYSTEM

BEAM MOMENTUM= 1.194 GEV/C

COS(THETA)	SIGMA +- DSIGMA (MILLIBARNS/STERADIAN)	
-.971	.172	.026
-.947	.168	.007
-.911	.172	.008
-.899	.121	.009
-.862	.117	.018
-.793	.071	.007
-.705	.037	.003
-.588	.020	.003
-.438	.022	.002
-.352	.023	.003
-.257	.028	.002
-.156	.039	.005
-.047	.045	.002
.066	.055	.003
.182	.071	.003
.297	.083	.005
.423	.091	.005
.492	.081	.005
.539	.091	.005
.605	.110	.010
.648	.150	.010
.708	.270	.020
.711	.380	.020
.801	.820	.070
.833	1.240	.100
.878	3.100	.500
.904	3.700	.600
.938	6.900	.600
.938	7.700	.600
.957	11.900	1.900

2Q SQUARE= .993

VINCENT PRL 24 236(1970) CNTR

BEAM MOMENTUM= 1.696 GEV/C

COS(THETA)	SIGMA +- DSIGMA (MICROBARNS/STERADIAN)	
-.885	12.990	.420
-.875	10.930	.360
-.850	8.800	.290
-.825	7.990	.260
-.800	6.820	.220
-.750	4.520	.150
-.700	3.300	.110
-.650	2.840	.090
-.600	2.700	.120
-.550	2.150	.130
-.500	1.990	.070

2Q SQUARE= 1.734
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10PER CENT

COLEMAN PR 164 1655(1967) CNTR

BEAM MOMENTUM= 2.032 GEV/C

COS(THETA)	SIGMA +- DSIGMA (MICROBARNS/STERADIAN)	
-.895	4.500	.330
-.875	4.070	.350
-.850	3.470	.260
-.825	3.390	.230
-.800	2.220	.110
-.750	1.490	.150
-.700	1.080	.110
-.650	1.000	.100
-.600	.800	.080
-.550	.560	.060
-.500	.660	.060
-.460	.500	.050

2Q SQUARE= 2.270
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10PER CENT

COLEMAN PR 164 1655(1967) CNTR

BEAM MOMENTUM= 2.251 GEV/C

COS(THETA)	SIGMA +- DSIGMA (MICROBARNS/STERADIAN)	
-.900	2.050	.210
-.875	1.730	.170
-.850	1.060	.120
-.800	.760	.080
-.750	.630	.060
-.700	.490	.040
-.650	.300	.030
-.600	.340	.030
-.550	.290	.030
-.500	.290	.030

2Q SQUARE= 2.630
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10PER CENT

COLEMAN PR 164 1655(1967) CNTR

BEAM MOMENTUM= 2.784 GEV/C

COS(THETA)	SIGMA +- DSIGMA (MICROBARNS/STERADIAN)	
.565	4.970	.150
.600	7.110	.210
.650	12.180	[illegible]
.700	22.790	.680
.750	36.420	1.090
.800	51.550	1.550
.850	64.650	1.940
.875	78.090	2.520

2Q SQUARE= 3.537
PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10PER CENT

COLEMAN PR 164 1655(1967) CNTR

Table VIII. pd elastic cross section (not plotted).

P_{beam} (GeV/c)	$E_{c.m.}$ (GeV)	$\sigma_{elastic}$ (mb)		References
19.300	8.767	9.200	.300	BELLETTINI 65

REFERENCES

1 BELLETTINI 65.....PL 19 341 SPRK,CNTR

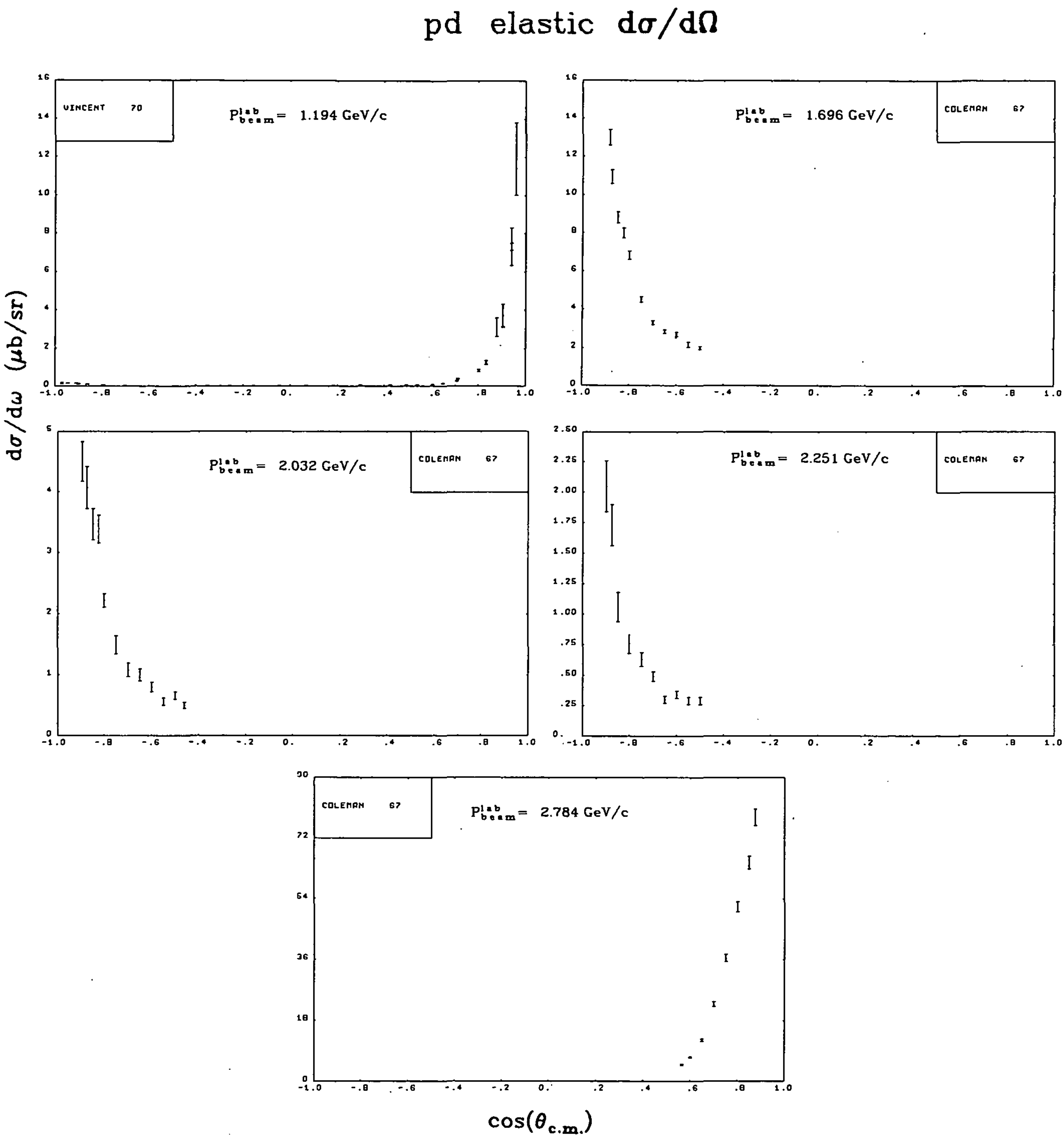


Fig. 50. pd elastic differential cross sections. θ is the angle between the incoming and outgoing proton.

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Section III.

DATA LISTINGS

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In this section we present a listing of all the NN articles on our DATA TAPE. These are the actual data used in forming the graphs and tables in Section II. The information is presented article-by-article, just as we store it.

We debated for some time whether or not we should give these listings because they are rather lengthy. As an experiment, we decided to put them in the first few editions. If you find them useful, let us know.

Actually, these listings do contain a large amount of information not included in the tables and graphs already presented in Section II.

- In particular there are a number of articles giving mass spectra etc., for which we have punched no data but have punched the bibliographic information and keywords. A person interested in nucleon interactions may find many of these papers quite useful. (These papers are not referred to in any way in Section II.)
- In addition we have also punched the title and abstract for every article, to assist you in your selection of articles for further reading.
- Also in this section you will find comments on many pieces of data—it is in general not yet practical to present these comments in Section II.
- Many articles give data that we feel we cannot meaninfgully compile at present (only partially corrected, integrated only over a certain interval, etc.). These data have in many cases been punched and will be found in this section.
- You will also find in this section, data reported as upper and lower limits, approximate values, etc.
- We also indicate here how background-resonance separations were made and the values of the parameters used (or fitted).
- Occasionally we do not use the data as originally given in the article. This section tells exactly where our data came from (private communications, unpublished companion report, etc.).
- The size of an experiment is frequently indicated by the total number of pictures taken, or by the number of events in various distributions.
- To give you an idea of the scope of a particular article, KEYWORDS are included for each article. These words can also be used to form classified indices (see Section IV).
- Some papers give fitted values for various parameters in which we are interested. These fits will be found in this section.

To repeat, the above items are some of the things you will find in this section that are not presented in Section II.

We have also found that theses are frequently hard to come by. Thus we feel that our listing of theses may help give their data greater distribution than they might otherwise have. We would like to make the general appeal that a copy of all particle physics theses be sent to us.

Finally this section may serve the useful function of permitting the reader to easily check on the accuracy of our input data. The data is arranged article-by-article, and in most cases we have indicated [in square brackets] the exact location of the data in the article (i. e., the figure, table, or page number). If you find any errors or misinterpretations, please let us know as soon as possible.

As for the organization of the information in this section, we should first mention that the order of the articles is "random," and has no physical meaning. The order is, however, the same as given in the Reference list, and as given in the Indices in Section IV.

Above the double line in each article you will find the title, authors and institutions, abstract (if the article had one), citations, KEY WORDS, comments, beam information, etc.

Below the double line in each article appear the data. We generally enter the data in exactly the same units as given by the authors. (This is done primarily to facilitate the verification of the data.) If we do alter the data in any way, we indicate this fact by an appropriate comment.

Occasionally authors give the same data in two different forms. We punch both, if we feel that both forms are useful, and display them side-by-side in the listings that follow.

We have tried to be particularly careful about including systematic errors, whenever given by the authors. We have also tried to indicate exactly how resonance and background separations have been made. In some cases it is quite unclear from the original article and we have had to contact the authors directly.

Another reason for contacting authors has been to get tables of data that correspond to the published graphs. If we are unable to get tables from an author, or if the article is more than a couple of years old, we read the data off the published graph, and then include the warning that "This data was read from a graph." (In some cases the tables we received have been more up to date than the published graphs.)

Because of the limitations imposed by not having a printer with Greek letters, we have had to spell out many symbols. One exception is, however, the abbreviation for microbarns, μb: we use "UB." We hope that we will be able, in the near future, to use a more complete set of characters, so that our output will be easier to read.

1 TOTAL CROSS-SECTIONS FOR N P ANC N D SCATTERING AT 10 GEV/C NEUTRON MOMENTUM. [PHYS. LETTERS 27B, 599 (1968)]

J.ENGLER,K.HORN,J.KONIG,F.MONNIG,P.SCHLUDECKER,H.SCHOPPER,P.SIEVERS, H.ULLRICH [TECHNISCHE UNIV. KARLSRUHE, KARLSRUHE, GERMANY]
K.RUNGE [EURCPEAN ORG. FOR NUC. RES., GENEVA, SWITZERLAND]

ABSTRACT THE TOTAL NEUTRON CROSS-SECTIONS WERE MEASURED WITH HIGH PRECISICN FOR HYDROGEN AND DEUTERIUM. AT AN AVERAGE NEUTRON MOMENTUM OF 10 GEV/C WE OBTAINED THE TOTAL CROSS SECTIONS FOR NP = 39.5 +- 0.5 MB AND ND = 73.3 +- 1.1 MB. THESE VALUES ARE IN EXCELLENT AGREEMENT WITH PP AND PD TOTAL CROSS SECTIONS. NO ENERGY DEPENDENCE WAS FOUND FOR NP CROSS SECTION BETWEEN 4 AND 10 GEV/C.

CITATIONS
PHYS. REV. 100, 242 (1955), PHYS. REV. 135, B358 (1964), PHYS. REV. LETTERS 20, 468 (1968), PHYS. REV. 138, B913 (1965), PHYS. REV. LETTERS 19, 857 (1967), CERN MPS/ALO-7 (1963), CERN TH 851, ZURN. EKSP. TEOR. FIZ. 42, 392 (1962), JETP 15 272 (1962), ZURN. EKSP. TEOR. FIZ. 45, 1808 (1963), JETP 18 1239 (1964), INT'L. CONGRESS ON NUCLEAR PHYSICS,PARIS,FRANCE 162 (1964), AND PHYS. REV. 101, 427 (1956).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM NO. 1 IS NEUTRON CN PROTCN FROM 4.3 TO 10.0 GEV/C.
NO. 2 IS NEUTRON ON DEUTERON AT 10 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - CROSS SECTION

- -

NEUTRON PROTON TOTAL CROSS SECTION. [TABLE 1B]

LABORATORY BEAM MOMENTUM GEV/C [1]	MILLI-BARNS
4.3	40.4 +- 1.9
6.5	38.7 1.5
10.0	39.5 .5

[1] MEAN VALUES.

- -

NEUTRON DEUTERON TOTAL CROSS SECTION. [PAGE 601]

LABORATORY BEAM MOMENTUM GEV/C [1]	MILLI-BARNS
10.	73.3 +- 1.1

[1] MEAN VALUE.

2 TOTAL NEUTRON-PROTON INTERACTION CROSS SECTION AT 5.5 GEV. [PHYS. LETTERS 7, 80 (1963)]

M.N.KHACHATURYAN,V.S.PANTUYEV [JOINT INST. FOR NUCL. RESEARCH, DUBNA, USSR]

CITATIONS
JETP 42 392 (1963), JETP 42 909 (1962), JETP 44 1411 (1963), REVIEW OF SCIENTIFIC INSTRUMENTS 32, 949 (1961), UCRL 8559 (1958), PHYS. REV. 123, 1850 (1961), AND PHYS. REV. 98, 1369 (1955).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS NEUTRON ON HYDROGEN COMPOUND FROM 5.053 TO 7.380 GEV/C. (BEAM KINETIC ENERGY = 4.2 TO 6.5 GEV)

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - CROSS SECTION

- -

NEUTRON PROTON TOTAL CROSS SECTION. [PAGE 81]

LABORATORY BEAM ENERGY GEV [1]	MILLI-BARNS
5.5	41.2 +- 1.7

[1] MEAN VALUE.

3 NEUTRON-PROTON SCATTERING AND THE DETEPMINATION OF THE PION-NUCLEON COUPLING CONSTANT. (NUOVO CIMENTO 18, 1039 (1960))

R.R.LARSEN (U.C. LAWRENCE RAD. LAB., BERKELEY, CALIF., USA)

CITATIONS
PHYS. REV. 112, 1380 (1958), UCRL 8148 (1958), REVIEW OF SCIENTIFIC INSTRUMENTS 26, 229 (1955), ZURN. EKSP. TEOR. FIZ. 21, 1113 (1951), UCRL 8523 (1958), AND PHYS. REV. 116, 226 (1959).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM NO. 1 IS NEUTRON CN PROTON AT 1.356 GEV/C. (BEAM KINETIC ENERGY = .71 GEV)
NO. 2 IS NEUTRON ON DEUTERON AT 1.356 GEV/C. (BEAM KINETIC ENERGY = .71 GEV)

THIS EXPERIMENT USES COUNTERS.

GENERAL COMMENTS ON THIS ARTICLE
1 THE DIFFERENTIAL CROSS SECTION WAS MEASURED IN THE CHARGE EXCHANGE REGION (CENTER OF MASS SCATTERING ANGLE BETWEEN 160 AND 180 DEGREES).

KEY WORDS - DIFFERENTIAL CROSS SECTION FITS

COMPOUND KEY WORDS - FITS DIFFERENTIAL CROSS SECTION

- -

ELASTIC DIFFERENTIAL CRCSS SECTION FOR NEUTRCN PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = .71 GEV (MEAN VALUE).

THETA DEGREES	D-SIGMA/D-OMEGA MB/SR	
180.00	6.15 +-	.54
175.89	5.04	.51
172.94	4.39	.39
170.80	3.97	.38
168.25	3.84	.31
165.90	3.12	.25
163.25	3.35	.28
161.37	2.71	.24
158.90	2.65	.23

THETA IS THE ANGLE THAT THE NEUTRON MAKES WITH THE BEAM IN THE GRAND C.M.

4 THE REAL PART OF THE PROTON-NEUTRON SCATTERING AMPLITUDE AT 19.3 GEV/C. (PHYS. LETTERS 19, 341 (1965))

G.BELLETTINI,G.COCCONI,A.N.DIDDENS,E.LILLETHUN,G.MATTHIAE,J.P.SCANLON, A.M.WETHERELL (EUROPEAN ORG. FOR NUC. RES., GENEVA, SWITZERLAND)

CITATIONS
PHYS. LETTERS 14, 164 (1965), CERN 64-30 (1964), PHYS. REV. 138, B913 (1965), INT.CON. ON NUC.FORCES...UNIV. COLLEGE, LONDON 1 233 (1959), PHYS. REV. 135, B358 (1964), PHYS. REV. 112, 618 (1958), NUOVO CIMENTO 11, 670 (1959), AND DUBNA E-1820 (1964).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON DEUTERON AT 19.3 GEV/C.

THIS EXPERIMENT USES SPARK CHAMBERS AND COUNTERS.

KEY WORDS - CROSS SECTION DIFFERENTIAL CROSS SECTION

- -

PROTON DEUTERON TOTAL CROSS SECTION. (PAGE 342)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS
19.3	74.1 +- .7

- -

PROTON NEUTRON TOTAL CROSS SECTION. (PAGE 343)
CLAUBER CORRECTION APPLIED

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS
19.3	38.9 +- .7

- -

PROTON DEUTERON ELASTIC CROSS SECTION. (PAGE 344)

(THE QUASI ELASTIC C.S.HAS BEEN REMOVED)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS
19.3	9.2 +- .3

5 NEUTRON-NUCLEON INTERACTIONS IN THE GEV ENERGY REGION. (INT'L. CONGRESS ON NUCLEAR PHYSICS,PARIS,FRANCE 1964 162 (1964))

H.PALEVSKY,J.L.FRIEDES,R.J.SUTTER,R.E.CHRIEN,H.R.MUETHER (BROOKHAVEN NAT. LAB., UPTON, L.I., N. Y., USA)

CITATIONS
PHYS. REV. LETTERS 9, 509 (1962), PHYS. LETTERS 4, 19 (1963), PHYS. REV. LETTERS 11, 88 (1963), PHYS. REV. LETTERS 11 , 444 (1963), DUBNA D1329 (1963), PHYS. REV. 103, 211 (1956), AND PHYS. REV. LETTERS 9, 32 (1962).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM NO. 1 IS NEUTRON ON PROTON FROM 1.380 TO 3.620 GEV/C. (BEAM KINETIC ENERGY = .73 TO 2.80 GEV)
NO. 2 IS NEUTRON ON DEUTERON AT 2.996 GEV/C. (BEAM KINETIC ENERGY = 2.2 GEV)

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - CROSS SECTION

NEUTRON PROTON TOTAL CROSS SECTION. (PAGE 163)

LABORATORY BEAM ENERGY GEV	MILLI-BARNS
.73	35.8 +- 1.6
1.60	38.3 2.1
2.20	40.3 1.4
2.80	39.4 3.3

NEUTRON DEUTERON TOTAL CROSS SECTION. (PAGE 163)

LABORATORY BEAM ENERGY GEV	MILLI-BARNS
2.2	80.3 +- 1.9

6 AN INVESTIGATION OF THE REACTION PP-D PI+ AT AN INCIDENT PROTON ENERGY OF 990 MEV. (PHYS. LETTERS 11, 253 (1964))

K.R.CHAPMAN,T.W.JONES,Q.H.KHAN,J.S.C.MCKEE,H.B.VAN DER RAAY,Y.TANIMURA (BIRMINGHAM UNIV., BIRMINGHAM, ENGLAND)

CITATIONS
ZURN. EKSP. TEOR. FIZ. 34, 767 (1958), UNIV. OF MICH. TECH. REPORT 16, AND DOKL. AKAD. NAUK. SSSR 100 673 (1955).

ARTICLE READ BY ODETTE BENARY IN 4/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 1.68 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - CROSS SECTION DIFFERENTIAL CROSS SECTION

CROSS SECTION FOR PROTON PROTON - DEUTERON PI+. (PAGE 253)

LABORATORY BEAM ENERGY GEV	MICRO-BARNS
.99	560. +- 30.

7 NEUTRAL-PION PRODUCTION FROM PROTON-PROTON COLLISIONS AT 735 MEV. (PHYS. REV. 131, 2713 (1963))

R.J.CENCE,D.L.LIND,G.D.MEAD,B.J.MOYER (U.C. LAWRENCE RAD. LAB., BERKELEY, CALIF., USA)

ABSTRACT AN INVESTIGATION HAS BEEN MADE OF THE REACTION PP-PP PIO AT AN INCIDENT PROTON ENERGY OF 735 MEV. THE EXTERNAL PROTON BEAM OF THE 184-IN. SYNCHROCYCLOTRON BOMBARDED A LIQUID-HYDROGEN TARGET. GAMMA-RAY ENERGY SPECTRA WERE MEASURED AT LABORATORY ANGLES OF 6, 32, AND 60 DEG WITH RESPECT TO THE PROTON BEAM. TWO HIGH-RESOLUTION PAIR SPECTROMETERS WERE USED TO MAKE THESE MEASUREMENTS. COMPUTER CODES WERE USED TO MAKE ALL NECESSARY CORRECTIONS TO THE DATA AND DETERMINE THE FINAL SPECTRA. NO EVIDENCE IS FOUND FOR HIGH-ENERGY GAMMA RAYS PRODUCED FROM ANY SOURCE OTHER THAN NEUTRAL-PION DECAY. THE CROSS SECTION FOR PIO PRODUCTION WAS MEASURED TO BE 3.46 +- 0.25 MB. BY USE OF THE METHOD OF LEAST SQUARES, ANGULAR AND MOMENTUM DISTRIBUTIONS OF THE NEUTRAL PION IN THE TWO-PROTON BARYCENTRIC SYSTEM WERE DETERMINED FROM THE PHOTON SPECTRA. THE PION ANGULAR DISTRIBUTION IS GIVEN BY D-SIGMA /D-OMEGA = (SIGMA-T/4 PI)(0.834 + 0.099 (3 COS-SQUARED THETA) + 0.067 (5-COS**4 THETA)), WHERE THETA IS THE BARYCENTRIC ANGLE OF EMISSION. PION MOMENTUM DISTRIBUTIONS ARE GIVEN FOR THREE ANGLES. THE RESULTS ARE SHOWN TO GIVE REASONABLE AGREEMENT WITH THE ISOBAR MODEL.

CITATIONS
PHYS. REV. 92, 780 (1953), PHYS. REV. 92, 749 (1953), UCRL 1637 (1952), ANNUAL REV. OF NUCLEAR SCIENCE 4, 219 (1954), PHYS. REV. 96, 139 (1954), JETP 9 1179 (1959), PHYS. REV. 109, 1716 (1958), CARNEGIE INST. OF TECH. REPORT NYO-7108 (1956), PHYS. REV. 88, 632 (1952), PHILOSOPHICAL MAGAZINE 2 215 (1957), PROC. OF THE ROYAL SOCIETY OF LONDON A251, 218 (1959), PHYS. REV. 107, 283 (1957), JETP 5 618 (1957), PHYS. REV. 113, 1339 (1959), JETP 5 779 (1957), UCRL 10187 (1962), UCRL 9292 (1960), UCRL 10781 (1963), UCRL 8000 (1957), PROC. OF THE ROYAL SOCIETY OF LONDON A146, 83 (1934), PHYS. REV. 93, 788 (1954), PHYS. REV., AND 105, 1874 (1957),.

ARTICLE READ BY ODETTE BENARY IN 5/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 1.39 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - CROSS SECTION ANGULAR DISTRIBUTION

CROSS SECTION FOR PROTON PROTON - PROTON PROTON PIO. (PAGE 2717)

LABORATORY BEAM ENERGY GEV	MILLI-BARNS
.735	3.46 +- .25

8 SEARCH FOR DIBARYON RESONANT STATES (PHYS. REV. 147, 922 (1966))

E.BIERMAN,A.P.COLLERAINE,U.NAUENBERG (PRINCETON UNIV., PRINCETON, N. J., USA, AND PRINCETON-PENN. PROTON ACCEL., PRINCETON, N.J.,USA)

ABSTRACT A SEARCH FOR DIBARYON RESONANT STATES WAS CARRIED OUT IN PP COLLISIONS AT 5.0 BEV/C IN THE 80-IN BROOKHAVEN BUBBLE CHAMBER. A TOTAL OF ABOUT 1400 EVENTS WAS MEASURED AND ANALYZED. WE WERE NOT ABLE TO DETECT ANY EFFECT WHICH COULD BE CONSTRUED AS BEING DUE TO A DIBARYON RESONANCE. WE OBSERVED THE Y*(1) AND THE N*++ RESONANCE. WE ALSO OBSERVE THE EFFECT OF THE 1688*++ RESONANCE IN ITS (LAMBDA-O,K+) DECAY MODE. OUR DATA ARE CONSISTENT WITH THE ONE-PION-EXCHANGE MODEL.

CITATIONS
PHYS. REV. 131, 2239 (1963), PHYS. LETTERS 11, 164 (1964), BULL. AM. PHYS. SOC. 10, 517 (1965), PHYS. REV. LETTERS 14 , 604 (1965), PHYS. REV. LETTERS 13, 355 (1964), PHYS. REV. 123, 1465 (1961), BNL OC-H-10, CERN 60-33, CERN 61-29, PHYS. REV. 128, 1836 (1962), BNL BC-04-3-B, PHYS. REV. 120, 988 (1960), PHYS. REV. 125, 1048 (1962), PHYS. REV. 133, B458 (1964), PHYS. REV. LETTERS 15, 468 (1965), NUOVO CIMENTO 34, 735 (1964), NUOVO CIMENTO 34, 1644 (1964), AND PHYS. REV. LETTERS 8, 140 (1962).

ARTICLE READ BY ODETTE BENARY IN 4/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 4.95 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 80 IN. (H) BUBBLE CHAMBER.

KEY WORDS - CROSS SECTION DALITZ PLOT MASS SPECTRUM MODELS ANGULAR DISTRIBUTION STRANGE PARTICLES 'N*(1688)' Y*(1385)

- -

(TABLE 1)

LABORATORY BEAM MOMENTUM = 4.95 GEV/C.

REACTION	MICRO-BARNS		NO. EVENTS
PROTON PROTON -			
PROTON LAMBDA K+	48. +-	4.	173
PROTON SIGMAO K+	25.	3.	91
PROTON LAMBDA K+ PIO	28.	3.	112
NEUTRON LAMBDA K+ PI+	41.	5.	163
PROTON LAMBDA PI+ KO	42.	5.	198
PROTON PI+ KO SIGMAO	20.	3.	36
PROTON SIGMA+ KO	17.	3.	31
PROTON PIO SIGMA+ KO	7.	2.	13
NEUTRON PI+ SIGMA+ KO	7.	2.	14
PROTON PI+ K+ PI- LAMBDA	7.	2.	24
PROTON K+ NEUTRON KOBAR	12.	3.	21
PROTON PROTON KO KOBAR	3.	1.	10

9 ELASTIC SCATTERING OF PROTONS, ANTIPROTONS, NEGATIVE PIONS, AND NEGATIVE KAONS AT HIGH ENERGIES. (PHYS. REV. LETTERS 15, 45 (1965))

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CLOSELY RELATED REFERENCES
CONTINUATION OF PREVIOUS EXPERIMENT IN PHYS. REV. LETTERS 11, 425 (1963).

ADDITIONAL CITATIONS
PHYS. REV. LETTERS 10, 376 (1963), NUCLEAR INSTRUMENTS AND METHODS 30, 45 (1964), PHYS. REV. LETTERS 11, 503 (1963), PHYS. REV. LETTERS 8, 173 (1962), PHYS. REV. LETTERS 7, 184 (1961), PHYS. REV. LETTERS 7, 352 (1961), PHYS. REV. 129, 2285 (1963), PHYS. REV. LETTERS 12, 206 (1964), AND PHYS. REV. 138, B1167 (1964).

ARTICLE READ BY ODETTE BENARY IN 6/67, AND VERIFIED BY LEROY PRICE.

BEAM NO. 1 IS PROTON ON PROTON FROM 10.94 TO 24.63 GEV/C.
NO. 2 IS PI- ON PROTON FROM 14.84 TO 25.34 GEV/C.
NO. 3 IS ANTI-PROTON ON PROTON FROM 11.80 TO 15.91 GEV/C.
NO. 4 IS K- ON PROTON FROM 11.88 TO 15.91 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - DIFFERENTIAL CROSS SECTION FITS

COMPOUND KEY WORDS - FITS DIFFERENTIAL CROSS SECTION

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 10.94 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2	
.200	13.190 +-	.320
.263	8.100	.230
.333	4.660	.160
.411	2.570	.110
.493	1.411	.076
.582	.641	.048
.679	.393	.039
.782	.178	.026
.891	.094	.018

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 14.93 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2	
.216	11.480 +-	.230
.284	6.670	.160
.360	3.480	.100
.444	1.752	.064
.534	.886	.039
.631	.402	.024
.736	.189	.016

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 19.84 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2	
.230	9.290 +-	.280
.302	5.140	.190
.383	2.640	.120
.474	1.269	.070
.569	.552	.042
.674	.291	.030
.787	.100	.018

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 21.88 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2	
.235	8.980 +-	.280
.309	4.820	.180
.392	2.250	.100
.485	1.100	.063
.583	.494	.038
.691	.209	.024
.807	.096	.016

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 24.63 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2	
.254	7.560 +-	.340
.334	3.740	.210
.424	1.712	.122
.525	.824	.074
.632	.203	.036
.748	.110	.028

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 10.94 GEV/C.
FITTED FORMULA IS D-SIGMA/D-T = EXP(A + B(T) + C(T**2))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

FITTED VALUE

A = 4.25 +- .09
B = 8.56 +- .47
C = 1.20 +- .54

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 14.93 GEV/C.
FITTED FORMULA IS D-SIGMA/D-T = EXP(A + B(T) + C(T**2))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

FITTED VALUES

A = 4.32 +- .10
B = 8.89 +- .52
C = .98 +- .62

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 19.84 GEV/C.
FITTED FORMULA IS D-SIGMA/D-T = EXP(A + B(T) + C(T**2))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

FITTED VALUES

A = 4.19 +- .15
B = 8.68 +- .79
C = .70 +- .92

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 21.88 GEV/C.
FITTED FORMULA IS D-SIGMA/D-T = EXP(A + B(T) + C(T**2))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

FITTED VALUES

A = 4.38 +- .16
B = 9.63 +- .78
C = 1.56 +- .89

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 24.63 GEV/C.
FITTED FORMULA IS D-SIGMA/D-T = EXP(A + B(T) + C(T**2))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

FITTED VALUES

A = 4.09 +- .30
B = 7.97 +- 1.56
C = .82 +- 1.83

10 PROTON-PROTON INTERACTIONS AT 2.75 BEV. (PHYS. REV. 103, 1484 (1956))

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ABSTRACT 212 INTERACTIONS OF 2.75-BEV PROTONS HAVE BEEN OBSERVED IN A HYDROGEN-FILLED DIFFUSION CLOUD CHAMBER. THE DATA INDICATE AN ELASTIC CROSS SECTION OF 15 MILLIBARNS, WITH ABOUT 9 MILLIBARNS CROSS SECTION FOR SINGLE PION PRODUCTION, 13 MILLIBARNS FOR DOUBLE, AND 4 FOR TRIPLE. THERE IS ONE EXAMPLE OF QUADRUPLE PION PRODUCTION. ONE DEFINITE EXAMPLE OF THE PRODUCTION OF HEAVY UNSTABLE PARTICLES WAS OBSERVED, AND TWO DOUBTFUL CASES. THE MEDIAN ELASTIC SCATTERING ANGLE WAS 19 DEG. IN THE C.M. SYSTEM. ANGLE AND MOMENTUM DISTRIBUTIONS FOR INELASTIC EVENTS ARE CONSISTENT WITH THOSE OBSERVED AT LOWER ENERGIES.

CITATIONS
PHYS. REV. 103, 1472 (1956), PHYS. REV. 103, 1479 (1956), PHYS. REV. 103, 1489 (1956), REVIEW OF SCIENTIFIC INSTRUMENTS 25, 996 (1955), PHYS. REV. 103, 212 (1956), REV. MOD. PHYS. 27, 1 (1955), PHYS. REV. 98, 121 (1955), AN PHYS. REV. 99, 261 (1955).

ARTICLE READ BY ODETTE BENARY IN 3/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 3.57 GEV/C.

THIS EXPERIMENT USES A CLOUD CHAMBER.

KEY WORDS - CROSS SECTION DIFFERENTIAL CROSS SECTION

- -

(PAGE 1485)

LABORATORY BEAM ENERGY = 2.75 +- .10 GEV.

REACTION	MILLI-BARNS	NO. EVENTS
PROTON PROTON +		
TOTAL	35. + 8. - 5.	64
ELASTIC	15. (1)	61
TOTAL INELASTIC	26. (1)	150

(1) VALUE IS APPROXIMATE ONLY.

11 THE REAL PART OF THE FORWARD AMPLITUDE IN PROTON-PROTON SCATTERING AT 1.7 GEV/C. (PHYS. LETTERS 12, 252 (1964))

J.D.DOWELL,R.J.HOMER,Q.F.KHAN,W.K.MCFARLANE,J.S.C.MCKEE,A.W.O'DELL (BIRMINGHAM UNIV., BIRMINGHAM, ENGLAND)

CLOSELY RELATED REFERENCES
SEE ALSO SIENNA CONFERENCE 683 (1963).

ADDITIONAL CITATIONS
PHYS. REV. LETTERS 9, 108 (1962), PHYS. LETTERS 1, 41 (1962), NUOVO CIMENTO 28, 943 (1963), NUOVO CIMENTO 20, 1049 (1961), PHYS. REV. 118, 579 (1960), PHYS. REV. LETTERS 9, 425 (1963), NUOVO CIMENTO 23, 690 (1962), NUCLEAR INSTRUMENTS AND METHODS 17, 1 (1962). NUOVO CIMENTO 18, 818 (1960), KYOTO UNIVERSITY RFIP-31 (1963), PHYS. LETTERS 285 (1964), PHYS. REV. 111, 1178 (1958), SIENNA CONFERENCE 593 (1963), PHYS. LETTERS 3, 184 (1963), ANNALS OF PHYSI 3, 190 (1958), NUC. PHYS. 9, 60C (1959), JETP 18 412 (1964), AND SIENNA CONFERENCE 598 (1963).

ARTICLE READ BY ODETTE BENARY IN 10/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 1.7 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - REAL (AMPLITUDE)/IMAGINARY (AMPLITUDE) DIFFERENTIAL CROSS SECTION

- -

THE RE/IM RATIO FOR THE FORWARD ELASTIC AMPLITUDE FOR PROTON PROTON. (PAGE 254)

LABORATORY BEAM MOMENTUM GEV/C	ALPHA
1.7	-.007 +- .070

12 PROTON-PROTON SCATTERING AT VERY SMALL ANGLES AT 24 GEV/C. (PHYS. LETTERS 13, 78 (1964))

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H.WINZELER (EUROPEAN ORG. FOR NUC. RES., GENEVA, SWITZERLAND)

CITATIONS
ANNALS OF PHYSICS 3, 190 (1958), PHYS. REV. LETTERS 11, 425 (1963), AND PHYS. LETTERS 7, 73 (1963).

ARTICLE READ BY ODETTE BENARY IN 10/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 24 GEV/C.

THIS EXPERIMENT USES EMULSIONS.

KEY WORDS - REAL (AMPLITUDE)/IMAGINARY (AMPLITUDE) DIFFERENTIAL CROSS SECTION

- -

THE RE/IM RATIO FOR THE FORWARD ELASTIC AMPLITUDE FOR PROTON PROTON. [PAGE 79]

LABORATORY BEAM MOMENTUM GEV/C	ALPHA
24.	-.19 +- .C9

13 NUCLEON-NUCLEON TOTAL CROSS SECTIONS FROM 1.1 TO 8 GEV/C. [PHYS. REV. 146, 980 (1966)]

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R.F.GEORGE,K.F.RILEY,R.J.TAPPER (CAVENDISH LAB., CAMB. UNIV., CAMBRIDGE, ENGLAND)

ABSTRACT MEASUREMENTS HAVE BEEN MADE OF THE TOTAL CROSS SECTIONS SIGMA(P-P) AND SIGMA(P-D) OVER THE LABORATORY MOMENTUM RANGE 1.1 TO 8 GEV/C, WITH RELATIVE ERRORS OF 0.1 PER CENT. THE ABSOLUTE ACCURACIES OF THESE CROSS SECTIONS ARE LIMITED TC 0.3 PER CENT BY LACK OF INFORMATION WHICH WILL ALLOW THE COULOMB-NUCLEAR INTERFERENCE TO BE CALCULATED ACCURATELY. VALUES OF THE TOTAL CROSS SECTIONS SIGMA(P-N) AND SIGMA(I=0) ARE DEDUCED BY ASSUMING THE GLAUBER CORRECTION. STRUCTURE IS OBSERVED IN SIGMA(P-P) NEAR A MASS VALUE OF 2.75 GEV/C-SQUARED; ITS INTERPRETATION IS DISCUSSED. SIGMA(I=0) RISES RAPIDLY IN THE RANGE 2.3 TO 2.9 GEV/C-SQUARED, AND THIS IS ATTRIBUTED TO THE ONSET OF STRONG INELASTIC SCATTERING.

CLOSELY RELATED REFERENCES
THIS ARTICLE SUPERSEDES PHYS. REV. LETTERS 15, 214 (1965).

ADDITIONAL CITATIONS
PHYS. REV. 103, 211 (1956), PHYS. REV. 125, 701 (1962), DOKL. AKAD. NAUK. SSSR 104 380 (1955), PHYS. REV. LETTERS 9, 32 (1962), PHYS. REV. 138, B913 (1965), PHYS. REV. LETTERS 7, 185 (1961), DOKL. AKAD. NAUK. SSSR 104 717 (1955), SOVIET JNP 1 93 (1965), INT'L. CONGRESS ON NUCLEAR PHYSICS,PARIS,FRANCE 2 162 (1964), NUOVO CIMENTO 34, 825 (1964), PHYS. REV. LETTERS 11, 425 (1963), PHYS. REV. LETTERS 9, 108 (1962), PHYS. LETTERS 14, 54 (1965), RUTHERFORD HIGH ENERGY LAB. NIRL/R/95, REVIEW OF SCIENTIFIC INSTRUMENTS 24, 72 (1953), PHYS. REV. LETTERS 13, 205 (1964), PHYS. LETTERS 13, 78 (1964), PHYS. REV. LETTERS 14, 74 (1965), PHYS. LETTERS 13, 93 (1964), SIENNA CONFERENCE 1 683 (1963), PHYS. LETTERS 12, 252 (1964), PHYS. LETTERS 14, 164 (1965), PHYS. LETTERS 8, 285 (1964), PHYS. LETTERS 20, 203 (1966), PHYS. REV. LETTERS 5, 263 (1960), PHYS. REV. 112, 2077 (1958), SOVIET JNP 1 379 (1965), PHYS. REV. 100, 242 (1955), SIENNA CONFERENCE 1 634 (1963), PHYS. REV. 142, 1195 (1966), PHYS. REV. 123, 1393 (1961), PROC. OF THE ROYAL SOCIETY OF LONDON A244, 491 (1958), NUOVO CIMENTO 27, 1450 (1963), PHYS. REV. 123, 216C (1961), PHYS. REV. 125, 2082 (1962), PHYS. REV. 125, 2091 (1962), PHYS. REV. 133, B1017 (1964), PHYS. REV. 138, B67C (1965), NUOVO CIMENTO 30, 240 (1963), PHYS. REV. LETTERS 13, 668 (1964), PHYS. LETTERS 11, 164 (1964), AND PHYS. REV. LETTERS 14, 604 (1965).

ARTICLE READ BY ODETTE BENARY IN 4/67, AND VERIFIED BY LEROY PRICE.

BEAM NO. 1 IS PROTON ON PROTON FROM 1.111 TO 7.835 GEV/C.
NO. 2 IS PROTON ON DEUTERON FROM 1.111 TO 7.835 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS • CROSS SECTION REAL (AMPLITUDE)/IMAGINARY (AMPLITUDE)

- -

PROTON PROTON TOTAL CROSS SECTION. [TABLE 2]
COULOMB CORRECTIONS APPLIED

LABORATORY BEAM MOMENTUM GEV/C	PER CENT	MILLI-BARNS	
1.111	+- .5	34.C29	+- .170
1.289	.5	43.234	.113
1.408	.5	46.487	.052
1.607	.5	47.476	.C58
1.660	.5	47.553	.058
1.780	.5	47.490	.046
1.858	.5	47.455	.041
1.940	.5	47.357	.C46
1.952	.5	47.409	.041
2.079	.5	47.224	.C41
2.212	.5	46.985	.046
2.280	.5	46.669	.041
2.419	.5	46.130	.041
2.450	.5	45.827	.041
2.592	.5	45.533	.C41
2.680	.5	45.331	.C41
2.704	.5	45.174	.041
2.819	.5	45.0C8	.041
2.857	.5	44.928	.041
2.958	.5	44.651	.041
2.994	.5	44.466	.041
3.054	.5	44.401	.041
3.110	.5	44.188	.C41
3.131	.5	44.156	.041
3.142	.5	44.114	.041
3.277	.5	43.610	.C41
3.303	.5	43.669	.041
3.444	.5	43.138	.041
3.546	.5	42.978	.C37
3.731	.5	42.680	.041
3.908	.5	42.316	.C41
4.C37	.5	42.136	.041
4.265	.5	41.765	.C41
4.552	.5	41.457	.041
4.783	.5	41.377	.037
4.966	.5	41.165	.C41
5.221	.5	41.171	.032
5.526	.5	40.878	.041
5.824	.5	40.848	.041
7.835	.5	40.075	.052

PROTON NEUTRON TOTAL CROSS SECTION. (TABLE 5)

* * THIS DATA SHOULD NOT BE USED * * (VALUES ARE APPROXIMATE ONLY)
GLAUBER + FERMI MOTION CORRNS. APPLIED

LABORATORY BEAM MOMENTUM GEV/C	PER CENT	MILLI-BARNS (1)
1.111	+- .5	35.22
1.289	.5	38.76
1.408	.5	39.61
1.607	.5	39.61
1.660	.5	39.97
1.780	.5	40.51
1.858	.5	41.20
1.940	.5	41.54
1.952	.5	41.49
2.079	.5	41.95
2.212	.5	42.27
2.280	.5	42.57
2.450	.5	42.65
2.592	.5	42.91
2.680	.5	43.00
2.704	.5	42.97
2.819	.5	43.06
2.857	.5	43.09
2.958	.5	43.17
2.994	.5	43.17
3.054	.5	43.04
3.110	.5	43.27
3.142	.5	43.17
3.277	.5	42.84
3.303	.5	43.00
3.444	.5	42.56
3.546	.5	42.52
3.908	.5	42.56
4.037	.5	42.51
4.265	.5	42.27
4.552	.5	42.24
4.966	.5	42.08
5.221	.5	42.03
5.526	.5	42.04
5.824	.5	41.83
7.835	.5	41.33

(1) VALUES ARE APPROXIMATE ONLY.

PROTON NEUTRON TOTAL CROSS SECTION. (TABLE 5)
GLAUBER CORRECTION APPLIED

LABORATORY BEAM MOMENTUM GEV/C	PER CENT	MILLI-BARNS	
1.111	+- .5	35.720	+- .260
1.289	.5	38.640	.200
1.408	.5	39.440	.140
1.607	.5	39.779	.120
1.660	.5	40.090	.130
1.780	.5	40.559	.106
1.050	.5	41.224	.090
1.940	.5	41.530	.090
1.952	.5	41.479	.087
2.079	.5	41.905	.085
2.212	.5	42.174	.092
2.280	.5	42.500	.081
2.450	.5	42.684	.077
2.592	.5	42.850	.076
2.680	.5	42.961	.074
2.704	.5	42.933	.076
2.819	.5	43.017	.076
2.857	.5	43.037	.076
2.958	.5	43.112	.076
2.994	.5	43.115	.076
3.054	.5	42.979	.076
3.110	.5	43.226	.075
3.142	.5	43.118	.074
3.277	.5	42.812	.072
3.303	.5	42.986	.072
3.444	.5	42.302	.070
3.546	.5	42.522	.069
3.908	.5	42.525	.057
4.037	.5	42.455	.068
4.265	.5	42.276	.069
4.552	.5	42.255	.069
4.966	.5	42.069	.068
5.221	.5	42.017	.053
5.526	.5	42.034	.069
5.824	.5	41.821	.070
7.835	.5	41.328	.080

PROTON DEUTERON TOTAL CROSS SECTION. (TABLE 4)
COULOMB CORRECTIONS APPLIED

LABORATORY BEAM MOMENTUM GEV/C	PER CENT	MILLI-BARNS	
1.111	+- .5	67.209	+- .090
1.289	.5	76.905	.110
1.408	.5	80.490	.057
1.607	.5	82.472	.063
1.660	.5	82.889	.063
1.780	.5	83.377	.052
1.858	.5	84.039	.047
1.940	.5	84.260	.046
1.952	.5	84.280	.047
2.079	.5	84.526	.047
2.212	.5	84.524	.047
2.280	.5	84.624	.047
2.450	.5	84.239	.047
2.592	.5	84.212	.047
2.680	.5	84.085	.044
2.704	.5	83.912	.047
2.819	.5	83.846	.047
2.857	.5	83.790	.047
2.958	.5	83.602	.047
2.994	.5	83.452	.047
3.054	.5	83.289	.047
3.110	.5	83.328	.047
3.142	.5	83.166	.047
3.277	.5	82.489	.047
3.303	.5	82.730	.047
3.444	.5	81.960	.047
3.546	.5	81.710	.047
3.908	.5	81.107	.033
4.037	.5	80.930	.047
4.265	.5	80.417	.047
4.552	.5	80.125	.047
4.966	.5	79.632	.047
5.221	.5	79.578	.037
5.526	.5	79.316	.047
5.824	.5	79.091	.047
7.835	.5	77.858	.052

- -

I = 0 NUCLEON NUCLEON TOTAL CROSS SECTION. (TABLE 5)
COULOMB CORRECTIONS APPLIED

LABORATORY BEAM MOMENTUM GEV/C	PER CENT	MILLI-BARNS	
1.111	+- .5	36.75	+- .75
1.289	.5	34.42	.52
1.408	.5	32.99	.38
1.607	.5	32.22	.36
1.660	.5	32.76	.35
1.780	.5	33.68	.26
1.858	.5	35.04	.23
1.940	.5	35.76	.24
1.952	.5	35.61	.22
2.079	.5	36.68	.22
2.212	.5	37.54	.26
2.280	.5	38.44	.21
2.450	.5	39.52	.20
2.592	.5	40.24	.19
2.680	.5	40.62	.19
2.704	.5	40.72	.19
2.819	.5	41.08	.19
2.857	.5	41.21	.19
2.958	.5	41.66	.19
2.994	.5	41.85	.19
3.054	.5	41.64	.19
3.110	.5	42.33	.19
3.142	.5	42.19	.18
3.277	.5	42.03	.18
3.303	.5	42.31	.18
3.444	.5	41.96	.18
3.546	.5	42.05	.16
3.908	.5	42.75	.15
4.037	.5	42.86	.17
4.265	.5	42.76	.17
4.552	.5	43.03	.17
4.966	.5	42.58	.17
5.221	.5	42.87	.13
5.526	.5	43.19	.17
5.824	.5	42.80	.17
7.835	.5	42.58	.20

14 SMALL-ANGLE ELASTIC SCATTERING OF 24.5 GEV/C PROTONS ON HYDROGEN NUCLEI. (PHYS. LETTERS 7, 73 (1963))

P.BREITENLOHNER,P.EGLI,H.HOFER,W.KOCH,M.NIKOLIC,J.PAHL,A.PALLINGER, E.PALLINGER,M.SCHNEEBERGER,R.SCHNEEBERGER,H.WINZELER (UNIV. BERN, BERN, SWITZERLAND)
G.CZAPEK, G.KELLNER (UNIV. WIEN, WIEN, AUSTRIA)

CITATIONS
NUOVO CIMENTO 10, 525 (1958), PHYS. REV. LETTERS 7, 185 (1961), PHYS. REV. LETTERS 10, 413 (1963), JETP 37 651 (1959) PHYS. REV. LETTERS 9, 108 (1962), PHYS. REV. LETTERS 10, 376 (1963), PHYS. LETTERS 1, 29 (1962), AND PHYS. REV. LETTERS 9, 183 (1962).

ARTICLE READ BY ODETTE BENARY IN 4/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 24.5 GEV/C.

THIS EXPERIMENT USES A HYDROGEN BUBBLE CHAMBER AND EMULSIONS.

KEY WORDS • CROSS SECTION DIFFERENTIAL CROSS SECTION

(PAGE 75)

LABORATORY BEAM MOMENTUM = 24.5 GEV/C.

REACTION	MILLI-BARNS
PROTON PROTON •	
TOTAL	39.3 +- .8
ELASTIC	8.8 .3

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (PAGE 75)

LABORATORY BEAM MOMENTUM = 24.5 GEV/C.
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

FITTED VALUES

B = 9.0 +- .3

15 HIGH-ENERGY, SMALL-ANGLE, PP AND P-BAR P SCATTERING, AND PP TOTAL CROSS SECTIONS. (PHYS. REV. LETTERS 19, 857 (1967))

K.J.FOLEY,R.S.JONES,S.J.LINDENBAUM,W.A.LOVE,S.OZAKI,E.D.PLATNER, C.A.QUARLES,E.H.WILLEN (BROOKHAVEN NAT. LAB., UPTON, L.I., N. Y., USA)

CITATIONS
PHYS. REV. LETTERS 19, 193 (1967), PHYS. REV. LETTERS 19, 330 (1967), PHYS. LETTERS 14, 164 (1965), PHYS. LETTERS 19, 705 (1966), PHYS. REV. 146, 980 (1966), PHYS. REV. LETTERS 7, 185 (1961), PHYS. REV. 138, B913 (1965), PHYS. LETTERS 13, 78 (1964), NUOVO CIMENTO 38, 95 (1965), PHYS. LETTERS 14, 54 (1965), PHYS. LETTERS 13, 93 (1964), PHYS. REV. LETTERS 14, 74 (1965), PHYS. LETTERS 13, 185 (1964), AND PHYS. LETTERS 8, 285 (1964).

ARTICLE READ BY ODETTE BENARY IN 11/67, AND VERIFIED BY LEROY PRICE.

BEAM NO. 1 IS PROTON ON PROTON FROM 7.82 TO 26.00 GEV/C.
NO. 2 IS ANTI-PROTON ON PROTON AT 12 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS • CROSS SECTION REAL (AMPLITUDE)/IMAGINARY (AMPLITUDE)

PROTON PROTON TOTAL CROSS SECTION. (TABLE 1)

LABORATORY BEAM MOMENTUM GEV/C	PER CENT	MILLI-BARNS	
7.82 +-	.2	40.34 +-	.12
9.80	.2	39.84	.12
11.90	.2	39.62	.12
14.01	.2	39.42	.12
16.03	.2	39.23	.12
17.91	.2	39.18	.12
20.22	.2	39.C5	.12
20.46	.2	39.C9	.12
22.00	1.0	38.88	.12
24.00	1.0	38.89	.12
26.00	1.0	38.90	.12

16 ANALYSIS OF PP • PP PI+ PI- AT 16 GEV/C BY THE MULTI-REGGE-POLE EXCHANGE MODE. (PHYS. REV. LETTERS 22, 248 (1969))

J.G.RUSHBROOKE,J.R.WILLIAMS (CAVENDISH LAB., CAMB. UNIV., CAMBRIDGE, ENGLAND)

ABSTRACT EXPERIMENTAL DISTRIBUTIONS FOR THE REACTION PP→PP PI+ PI- AT 16 GEV/C ARE CONSISTENT WITH PREDICTIONS OF A REGGE-POLE MODEL INCORPORATING EXCHANGE OF A REGGEIZED PION. THE TREIMAN-YANG ANGLE DISTRIBUTION AFFORDS A DISTINCTIVE TEST IN FAVOR OF PION REGGEIZATION FOR THIS REACTION.

CITATIONS
PHYS. REV. LETTERS 19, 614 (1967), PHYS. REV. 163, 1572 (1967), NUOVO CIMENTO 27, 1450 (1963), PHYS. REV. LETTERS 21, 701 (1968), PHYS. REV. LETTERS 20, 964 (1968), AND PHYS. REV. LETTERS 20, 1078 (1968).

ARTICLE READ BY ODETTE BENARY IN 2/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 16 GEV/C.

THIS EXPERIMENT USES THE CERN 2M (H) BUBBLE CHAMBER.

KEY WORDS • CROSS SECTION MODELS MASS SPECTRUM ANGULAR DISTRIBUTION

CROSS SECTION FOR PROTON PROTON - PROTON PROTON PI+ PI-. (PAGE 251)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS
16.	1.66 + .13 - .C6

17 SCATTERING OF PROTONS BY DEUTERIUM FROM 1.C TO 2.0 BEV. (PHYS. REV. 164, 1655 (1967))

E.COLEMAN,R.M.HEINZ,O.E.OVERSETH,D.E.PELLETT (UNIV. OF MICHIGAN, ANN ARBOR, MICH., USA)

ABSTRACT THE DIFFERENTIAL CROSS SECTIONS FOR PROTON-DEUTERON ELASTIC SCATTERING AT HIGH MOMENTUM TRANSFERS HAVE BEEN MEASURED AT INCIDENT PROTON KINETIC ENERGIES FROM 1 TO 2 BEV IN A COUNTER EXPERIMENT.THE DIFFERENTIAL CROSS SECTIONS FOR BACKWARD ELASTIC SCATTERING AT INCIDENT KINETIC ENERGIES OF 1.0, 1.3, AND 1.5 BEV HAVE BEEN MEASURED FOR VALUES OF THE COSINE OF THE CENTER-OF-MASS PROTON SCATTERING ANGLE (COS THETA*) FROM -0.5 TO -0.9, WHICH CORRESPONDS TO VALUES OF THE FOUR-MOMENTUM TRANSFER SQUARED (-T) FROM 2.6 TO 5.0 (BEV/C)-SQUARED. A BACKWARD PEAK IS OBSERVED, AND THE CROSS SECTION DECREASES RAPIDLY WITH INCREASING ENERGY. AT 2.0 BEV, THE FORWARD ELASTIC DIFFERENTIAL CROSS SECTION HAS BEEN MEASURED FOR -T FROM 0.44 TO 1.54 (BEV/C)-SQUARED, OR COS THETA* FROM 0.875 TO 0.565. A SHOULDERLIKE DEPARTURE FROM THE FORWARD DIFFRACTION PEAK IS OBSERVED.

CLOSELY RELATED REFERENCES
CONTINUATION OF PREVIOUS EXPERIMENT IN PHYS. REV. LETTERS 16, 761 (1966).

ADDITIONAL CITATIONS
PHYS. REV. LETTERS 17, 827 (1966), PHYS. REV. 142, 1195 (1966), PHYS. REV. 138, B619 (1965), PHYS. REV. 140, B1291 (1965), PHYS. REV. 130, 276 (1963), PHYS. REV. 126, 831 (1962), PHYS. LETTERS 24B, 598 (1967), JETP 5 371 (1957), PHYS. REV. LETTERS 13, 59 (1964), BULL. AM. PHYS. SOC. 10, 19 (1965), PHYS. REV. 143, 1340 (1966), PHYS. REV. 133, B1507 (1964), PHYS. REV. 111, 1386 (1958), PHYS. REV. 103, 211 (1956), NUC. PHYS. 12, 629 (1959), NUC. PHYS. 1, 379 (1965), AND JETP 3 8 (1966).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON DEUTERON FROM 1.696 TO 2.784 GEV/C. (BEAM KINETIC ENERGY = 1 TO 2 GEV)

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - DIFFERENTIAL CROSS SECTION FITS MODELS

COMPOUND KEY WORDS - FITS DIFFERENTIAL CROSS SECTION

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON DEUTERON. (TABLE 2)

LABORATORY BEAM ENERGY = 1. GEV.

COS(THETA)	D-SIGMA/D-OMEGA UB/SR (1)	
-.885	12.99 +-	.42
-.875	10.93	.36
-.850	8.80	.29
-.825	7.99	.26
-.800	6.82	.22
-.750	4.52	.15
-.700	3.30	.11
-.650	2.84	.09
-.600	2.70	.12
-.550	2.15	.13
-.500	1.99	.09

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10 PER CENT.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON DEUTERON. (TABLE 2)

LABORATORY BEAM ENERGY = 1.3 GEV.

COS(THETA)	D-SIGMA/D-OMEGA UB/SR (1)	
-.895	4.50 +-	.33
-.875	4.07	.35
-.850	3.47	.26
-.825	3.39	.23
-.800	2.22	.11
-.750	1.49	.15
-.700	1.08	.11
-.650	1.00	.10
-.600	.80	.08
-.550	.56	.06
-.500	.66	.06
-.460	.50	.05

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10 PER CENT.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON DEUTERON. (TABLE 2)

LABORATORY BEAM ENERGY = 1.5 GEV.

COS(THETA)	D-SIGMA/D-OMEGA UB/SR (1)	
-.900	2.05 +-	.21
-.875	1.73	.17
-.850	1.06	.12
-.800	.76	.08
-.750	.63	.06
-.700	.49	.04
-.650	.30	.03
-.600	.34	.03
-.550	.29	.03
-.500	.29	.03

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10 PER CENT.

ELASTIC DIFFERENTIAL CRCSS SECTION FCR PROTON DEUTERON. (TABLE 3)

LABORATORY BEAM ENERGY = 2. GEV.

COS(THETA)	C-SIGMA/C-OMEGA UB/SR (1)	
.875	78.09 +-	2.52
.850	64.65	1.94
.800	51.55	1.55
.750	36.42	1.09
.700	22.79	.68
.650	12.18	.37
.60C	7.11	.21
.565	4.97	.15

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRANC C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERRCR CF +- 10 PER CENT.

18 STRUCTURE IN THE ANGULAR DISTRIBUTION OF HIGH ENERGY PROTON-PROTON SCATTERING. (PHYS. LETTERS 28B, 67 (1968))

J.V.ALLABY,F.BINON,A.N.DIDDENS,P.DUTEIL,A.KLOVNING,R.MEUNIER,J.P.PEIGNEUX, E.J.SACHARIDIS,K.SCHLUPMANN,M.SPIGHEL,J.P.STRO
A.M.THORNDI KE,A.M.WETHERELL (EURCPEAN ORG. FOR NUC. RES., GENEVA, SWITZERLAND)

ABSTRACT RESULTS ARE PRESENTED ON MEASUREMENTS OF ELASTIC PROTON-PROTON SCATTERING AT 19.2 AND 21.1 GEV/C IN THE ANGULAR REGION WHERE PREVIOUSLY STRUCTURE HAD BEEN OBSERVED AT LOWER ENERGIES.

CLOSELY RELATED REFERENCES
CONTINUATION OF PREVICUS EXPERIMENT IN PHYS. LETTERS 25B, 156 (1967).

ADDITIONAL CITATIONS
UCRL 16275 (1966), PHYS. REV. 170, 1223 (1968), PHYS. LETTERS 27B, 49 (1968), CERN MPS/H/68-1 (1968), NUCLEAR INSTRUMENTS AND METHCDS 22, 165 (1963), BNL 11360 (1967), NUOVO CIMENTO 38, 60 (1965), PHYS. REV. 152, 1162 (1966), PHYS. REV. LETTERS 17, 1105 (1966), PHYS. REV. 159, 1138 (1967), INT. CONF. ON H.E. PHYS.,NUC.STRUCTURE,RCHOVOTH 340 (1967), PHYS. REV. 170, 1591 (1968), PHYS. REV. LETTERS 20, 637 (1968), PHYS. REV. LETTERS 20, 1213 (1968), CERN TH-892, CERN TH-914, AND CERN TH-909.

ARTICLE READ BY OCETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON CN PROTON FROM 19.20 TO 21.12 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS • DIFFERENTIAL CROSS SECTION

- -
- -

ELASTIC DIFFERENTIAL CRCSS SECTICN FCR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 19.2 GEV/C.

T (GEV/C)**2	D-SIGMA/D-T UB/(GEV/C)**2 (1)	PER CENT
.0575	48500. +-	6
.1555	31600	6
.2290	10300.	6
.3788	4170.	6
.4461	160C.	6
.5112	965.	6
.5805	546.	6
.6540	295.	6
.7316	149.	6
.8133	76.	6
.8990	37.	6
.9886	18.	6
1.0820	1C.	6
1.1000	6.	6
1.2810	4.	6
1.3850	4.	6
1.4940	3.	6
1.6060	3.	6
1.7210	2.	6
1.8400	2.	6
1.9620	2.	6
2.0880	2.	6
2.2160	1.	6
2.3400	1.	6
2.4830	1.	6
2.6200	1.	6
2.7610	1.	6
3.0500	0.	6
3.3490	0.	6
3.6580	C.	6
3.9760	0.	6
4.3020	0.	6
4.6360	0.	6
4.9760	0.	6
5.3230	0.	6
5.6760	C.	6
6.0330	0.	6

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 8 PER CENT.

ELASTIC DIFFERENTIAL CROSS SECTION FCR PROTON PROTON. [TABLE 1]

LABORATORY BEAM MOMENTUM = 21.12 GEV/C.

T (GEV/C)**2	D-SIGMA/C-T UB/(GEV/C)**2 [1]	PER CENT
.C696	3930C. +-	4
.1776	14400.	4
.2769	600C.	4
.3975	215C.	4
.5391	690.	4
.7012	212.	4
.7898	89.	4
.8834	40.	4
.9818	18.	4
1.0850	10.	4
1.1930	5.	4
1.3050	4.	4
1.4230	3.	4
1.5440	3.	4
1.6700	3.	4
1.800C	2.	4
1.9340	2.	4

T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING PROTON] AND THE [OUTGOING PROTON].

[1] PLUS POSSIBLE SYSTEMATIC ERRCR OF +- 8 PER CENT.

19 SIGMA PRODUCTION IN PP COLLISIONS AT 5 GEV/C. [PHYS. LETTERS 26B, 645 (1968)]

I.SCNOHI [PRINCETON-PENN. PROTON ACCEL., PRINCETON, N.J.,USA]

ABSTRACT THE CROSS SECTION FOR THE REACTION PP + SIGMA+ K+ N AT 5 GEV/C IS MEASURED TO BE 48.1 +- 3.5 MICROBARNS. THE K SIGMA MASS SPECTRUM SHOWS AN ENHANCEMENT AT 1.86 GEV, WHICH MAY BE DUE TO THE DELTA(1920) RESONANCE. ADEQUACY OF THE ONE-PION EXCHANGE MODEL FOR THE REACTION IS DISCUSSED. THE CROSS SECTION FOR THE REACTION PP + SIGMA+ KO P IS FOUND TO BE 24.9 +- 2.3 MICROBARNS.

CITATIONS
ATHENS CONFERENCE 72 (1965), CERN DD 63/12, CERN DD 62/10, AND PHYS. REV. 147, 922 (1966).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON CN PROTON AT 4.95 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 80 IN. (H) BUBBLE CHAMBER. A TOTAL OF 120000 PICTURES ARE REPORTED ON.

GENERAL COMMENTS ON THIS ARTICLE
1 THE K SIGMA INVARIANT MASS SPECT. SHOWS AN ENHANCEMENT WHICH MAY BE DUE TO THE N*(1920) RESONANCE.

KEY WORDS + CROSS SECTICN DALITZ PLOT MASS SPECTRUM ANGULAR DISTRIBUTION MODELS
BARYON RESONANCE WITH Y=1 AT 1860 MEV

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[PAGE 645]

LABORATORY BEAM MOMENTUM = 4.95 GEV/C.

REACTION	MICRO-BARNS
PROTON PROTON +	
SIGMA+ K+ NEUTRON	48.1 +- 3.5
SIGMA+ KO PROTON	24.9 2.3

20 POLARIZATION IN PROTON-PROTON SCATTERINGS AT 735 MEV. [PHYS. REV. 148, 1280 (1966)]

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ABSTRACT NEW MEASUREMENTS BY CHENG OF P-C POLARIZATION AS A FUNCTION OF ANGLE AND INCIDENT PROTON ENERGY ALLOW US TO REDUCE UNCERTAINTY IN OUR PREVIOUSLY REPORTED MEASUREMENT OF PP POLARIZATION. ON THE BASIS OF THIS NEW INFORMAT ION, IT IS CONCLUDED THAT THE PP POLARIZATION AT 735 MEV REACHES A MAXIMUM OF (60 +- 2) PER CENT.

CLOSELY RELATED REFERENCES
THIS ARTICLE SUPERSEDES PART OF PHYS. REV. 137, B620 (1965).

ADDITIONAL CITATIONS
PHYS. REV. 137, B620 (1965), UCRL 11926 (1965), BULL. AM. PHYS. SOC. 10, 717 (1965), AND PHYS. REV. 148, 1289 (1966).

ARTICLE READ BY ODETTE BENARY IN 4/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 1.385 GEV/C.

THIS EXPERIMENT USES CCUNTERS.

GENERAL COMMENTS ON THIS ARTICLE
1 FIRST SCATTERING ON HYDROGEN, SECOND SCATTERING ON CARBON.

KEY WORDS + POLARIZATION

- -

ELASTIC POLARIZATION FOR PROTON PROTON.

LABORATORY BEAM ENERGY = .735 GEV (APPROXIMATELY).

(THIS DATA REPLACES VALUES GIVEN EARLIER IN MCMANIGAL,ET AL., PHYS. REV. 137, B620 (1965))

THETA DEGREES	POLARIZATION	
4.5	.248 +-	.013
6.0	.352	.014
7.3	.387	.011
8.6	.421	.015
10.0	.468	.013
11.5	.530	.017
13.0	.543	.015
15.3	.574	.018
16.4	.602	.023
18.0	.559	.023
20.5	.591	.027

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE LAB.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

21 PRODUCTION OF THE N*(1470) IN PD +P(SPECTATOR) PP PI- AT 7.0 GEV/C. (PHYS. REV. LETTERS 21, 1835 (1968))

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ABSTRACT WE SEE A SIGNIFICANT PEAK (M = 1.446 +- 0.011 GEV, GAMMA = 198 +- 40 MEV), CONSISTENT WITH A I = 1/2, J = 1/2 STATE, IN THE P PI- MASS DISTRIBUTION OF THE REACTION PD + P(SPECTATOR) PP PI- AT 7.0 GEV/C. WE INTERPRET IT AS THE N*(1470) PRODUCED IN THE REACTION PN + PN*0(1470) (N*0(1470) + P PI-) IN DEUTERIUM. THE PRODUCTION OF THE N*(1470) IS STRONGLY PERIPHERAL AND FAVORS I = 0 EXCHANGE. A DISCUSSION OF THIS PEAK IN TERMS OF DOUBLE-REGGE-POLE EXCHANGE MECHANISM IS PRESENTED.

CITATIONS
PHYS. LETTERS 18, 342 (1965), HEIDELBERG CONFERENCE 79 (1967), NUOVO CIMENTO 50A, 1000 (1967), NUOVO CIMENTO 35, 1052 (1965), PHYS. LETTERS 18, 167 (1965), PHYS. REV. LETTERS 16, 855 (1966), PHYS. REV. LETTERS 17, 789 (1966), PHYS. REV. LETTERS 19, 397 (1967), PHYS. REV. LETTERS 12, 340 (1964), PHYS. REV. LETTERS 20, 164 (1968), PHYS. REV. LETTERS 21, 697 (1968), REV. MOD. PHYS. 40, 77 (1968), PHYS. REV. LETTERS 17, 884 (1966), PHYS. REV. LETTERS 21, 701 (1968), PHYS. REV. 146, 980 (1966), HANDBUCH DER PHYSIK 39 1 (1957), UCRL 9691 (1961), PHYS. REV. 156, 1685 (1967), PHYS. REV. LETTERS 21, 444 (1968), NUOVO CIMENTO 34, 1644 (1964), PHYS. REV. LETTERS 16, 1217 (1966), PHYS. REV. LETTERS 19, 614 (1967), NUOVO CIMENTO 49A, 157 (1967), AND PHYS. REV. 166, 1768 (1968).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON DEUTERON AT 7 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 80 IN. (H) BUBBLE CHAMBER. A TOTAL OF 48000 PICTURES ARE REPORTED ON.

GENERAL COMMENTS ON THIS ARTICLE
1 NORMALIZED TO COUNTER EXPERIMENTS

KEY WORDS = CROSS SECTION MASS SPECTRUM ANGULAR DISTRIBUTION FITS MODELS

COMPOUND KEY WORDS = FITS ANGULAR DISTRIBUTION

- -
- -

CROSS SECTION FOR PROTON NEUTRON = PROTON PROTON PI-. (PAGE 1835)

(NOT CORRECTED FOR DEUTERON EFFECTS.)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS
7.	1.01 +- .12

- -

CROSS SECTION FOR PROTON NEUTRON = PROTON N*(1470)0. (PAGE 1838)
N*(1470)0 = PROTON PI- (1)

(NOT CORRECTED FOR DEUTERON EFFECTS.)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS (2)
7.	.5

(1) FITTED FOR MASS AND/OR WIDTH (MASS = 1.446 GEV; WIDTH = .198 GEV), AND THEN TOOK ONLY EVENTS ABOVE (FITTED) BACKGROUND.
(2) VALUE IS APPROXIMATE ONLY.

22 DIFFERENTIAL CROSS SECTIONS FOR THE REACTIONS PP → D PI+ AND PP → D RHO+ AT 21 GEV/C. (PHYS. LETTERS 29B, 198 (1969))

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ABSTRACT RESULTS ARE PRESENTED FROM AN EXPERIMENT IN WHICH HIGH-ENERGY DEUTERONS, PRODUCED BY PROTON-PROTON INTERACTIONS AT 21.1 GEV/C INCIDENT MOMENTUM, WERE DETECTED OVER A RANGE OF ANGLES FROM 12.5 MRAD TO 60 MRAD IN THE LABORATORY SYSTEM. FROM THE MOMENTUM SPECTRA OF THE DEUTERONS, THE FINAL STATES D PI+ AND D RHO+ HAVE BEEN IDENTIFIED. THE ANGULAR DISTRIBUTION FOR THESE REACTIONS ARE PRESENTED AND COMPARED WITH PREVIOUS DATA AT LOWER ENERGIES.

CLOSELY RELATED REFERENCES
CONTINUATION OF PREVIOUS EXPERIMENT IN VIENNA CONFERENCE 353 (1968), AND CERN NP-66-2 (1966).

ADDITIONAL CITATIONS
PHYS. REV. 95, 638 (1954), DOKL. AKAD. NAUK. SSSR 100 673 (1955), PHYS. REV. 133, B1016 (1964), PHYS. LETTERS 11, 253 (1964), PHYS. REV. 167, 1232 (1968), PHYS. LETTERS 11, 161 (1964), PHYS. REV. LETTERS 11, 474 (1963), PHYS. LETTERS 7, 222 (1963), PHYS. REV. LETTERS 21, 853 (1968), PHYS. REV. 142, 918 (1966), PHYS. REV. LETTERS 17, 100 (1966), PHYS. REV. 165, 1442 (1968), PHYS. REV. 136, B779 (1964), PHYS. LETTERS 28B, 67 (1968), ANNUAL REV. OF NUCLEAR SCIENCE 13, 261 (1963), NUCLEAR INSTRUMENTS AND METHODS 22, 165 (1963), REVIEW OF SCIENTIFIC INSTRUMENTS 35, 1523 (1964), PHYS. REV. LETTERS 18, 89 (1967), PHYS. REV. LETTERS 9, 133 (1962), PHYS. REV. 154, 1284 (1967), PHYS. REV. 161, 1387 (1967), NUOVO CIMENTO 55, 66 (1968), PHYS. LETTERS 22, 528 (1966), PHYS. REV. 134, B454 (1964), NUC. PHYS. B7, 37 (1968), PHYS. REV. LETTERS 21, 389 (1968), PHYS. REV. LETTERS 22, 102 (1969), AND VIENNA CONFERENCE 376 (1968).

ARTICLE READ BY ODETTE BENARY IN 6/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 21.1 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS • CROSS SECTION DIFFERENTIAL CROSS SECTION FITS

COMPOUND KEY WORDS • FITS DIFFERENTIAL CROSS SECTION

- -

(PAGE 200)

LABORATORY BEAM MOMENTUM = 21.1 GEV/C +- 2(PER CENT).

REACTION	MICRO-BARNS (1)
PROTON PROTON →	
DEUTERON PI+	.0151 +- .0015
DEUTERON RHO(765)+	.0159 .0024

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12 PER CENT.

- -

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → DEUTERON PI+. (TABLE 1)

LABORATORY BEAM MOMENTUM = 21.1 GEV/C +- 2(PER CENT).

THETA RADIANS	D-SIGMA/D-OMEGA UB/SR (1)	PER CENT
.0125	.0773 +-	15
.0200	.0282	15
.0300	.0103	15
.0400	.0033	15
.0500	.0009	20
.0600	.0006	20

THETA IS THE ANGLE THAT THE DEUTERON MAKES WITH THE BEAM IN THE LAB.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12 PER CENT.

- -

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → DEUTERON RHO(765)+. (TABLE 1)

LABORATORY BEAM MOMENTUM = 21.1 GEV/C +- 2(PER CENT).

THETA RADIANS	D-SIGMA/D-OMEGA UB/SR (1)	PER CENT
.0125	.0778 +-	15
.0200	.0255	15
.0300	.0118	15
.0400	.0043	15
.0500	.0008	20
.0600	.0004	20

THETA IS THE ANGLE THAT THE DEUTERON MAKES WITH THE BEAM IN THE LAB.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12 PER CENT.

- -

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → DEUTERON PI+. (TABLE 1)

LABORATORY BEAM MOMENTUM = 19.2 GEV/C +- 2(PER CENT).

THETA RADIANS	D-SIGMA/D-OMEGA UB/SR (1)	PER CENT
.04	.0048 +-	15

THETA IS THE ANGLE THAT THE DEUTERON MAKES WITH THE BEAM IN THE LAB.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12 PER CENT.

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON - DEUTERON RHO(765)+. (TABLE 1)

LABORATORY BEAM MOMENTUM = 19.2 GEV/C +- 2(PER CENT).

THETA RADIANS	D-SIGMA/D-OMEGA UB/SR [1] PER CENT
.04	.0049 +- 15

THETA IS THE ANGLE THAT THE DEUTERON MAKES WITH THE BEAM IN THE LAB.

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12 PER CENT.

- -

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON - DEUTERON PI+. (TABLE 1)

LABORATORY BEAM MOMENTUM = 19.4 GEV/C +- 2(PER CENT).

THETA RADIANS	D-SIGMA/D-OMEGA UB/SR [1] PER CENT
.025	.02 +- 30

THETA IS THE ANGLE THAT THE DEUTERON MAKES WITH THE BEAM IN THE LAB.

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12 PER CENT.

23 SCATTERING OF 200 MEV NEUTRONS BY PROTONS. (JETP 16 24 (1963))

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ABSTRACT THE TOTAL AND THE DIFFERENTIAL CROSS SECTIONS FOR THE SCATTERING OF 200 MEV (EFFECTIVE ENERGY) NEUTRONS BY PROTONS WERE MEASURED. THE TOTAL CROSS SECTION IS (42.7 +- 0.9) X 10**-27 CM-SQUARED. THE FUNCTION SIGMA(THETA) IS APPRECIABLY ASYMMETRIC WITH RESPECT TO THE ANGLE THETA = 90 DEG. THE PION-NUCLEON INTERACTION CONSTANT, DETERMINED FROM THE ANGULAR DISTRIBUTIONS OF THE SCATTERED PARTICLES, IS F-SQUARED = 0.08 +- 0.02.

CITATIONS
JETP 37 1587 (1959), JETP 10 1125 (1959), PHYS. REV. 116, 226 (1959), JETP 38 660 (1960), JETP 11 474 (1960), JETP 39 949 (1960), JETP 12 657 (1961), JETP 41 197 (1961), JETP 14 143 (1962), PHYS. REV. 72, 1008 (1948), REV. MOD. PHYS. 30 360 (1958), JETP 34 53 (1958), JETP 7 37 (1958), PHYS. REV. 88, 15 (1952), AND JINR D-573 (1960).

ARTICLE READ BY ODETTE BENARY IN 1/65, AND VERIFIED BY LEROY PRICE.

BEAM IS NEUTRON ON HYDROGEN COMPOUND AT .654 GEV/C. (BEAM KINETIC ENERGY = .205 GEV)

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - CROSS SECTION DIFFERENTIAL CROSS SECTION

- -

(PAGE 24)

LABORATORY BEAM ENERGY = .2 GEV (MEAN VALUE).

REACTION	MILLI-BARNS
NEUTRON PROTON -	
TOTAL	42.7 +- .9
ELASTIC	42.7 .9 [1]

[1] AT THIS ENERGY, THIS IS THE ONLY CHANNEL OPEN..

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (FIGURE 2)

LABORATORY BEAM ENERGY = .2 GEV (MEAN VALUE).

. THIS DATA WAS READ FROM A GRAPH .

THETA DEGREES	D-SIGMA/D-OMEGA MB/SR	
7.	9.5 +-	2.5
10.	8.3	.7
20.	4.7	.7
30.	4.2	.5
41.	3.0	.4
62.	2.5	.3
67.	2.2	.1
77.	2.0	.1
87.	2.0	.1
97.	2.2	.1
108.	2.8	.1
118.	3.3	.2
128.	3.8	.2
140.	4.7	.2
148.	5.5	.1
157.	7.0	.1
160.	8.1	.1
163.	9.2	.2
168.	10.4	.2
172.	11.4	.2
180.	11.5	.3

THETA IS THE ANGLE THAT THE NEUTRON MAKES WITH THE BEAM IN THE GRAND C.M.

24 POLARIZATION PARAMETER IN P-P SCATTERING FROM 328 TO 736 MEV. (PHYS. REV. 148, 1285 (1966))

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ABSTRACT THE POLARIZATION PARAMETER IN ELASTIC PROTON-PROTON SCATTERING HAS BEEN MEASURED USING AN UNPOLARIZED PROTON BEAM AND A POLARIZED PROTON TARGET. MEASUREMENTS WERE TAKEN AT LABORATORY KINETIC ENERGIES OF 328, 614, 679, AND 736 MEV IN THE ANGULAR REGIONS FROM 33 TO 110 CEGREES CENTER-OF-MASS. THE RESULTS INDICATE THAT THE MAXIMUM POLARIZATION AT A GIVEN ENERGY INCREASES IN THE REGION FROM 328 TO 679 MEV. AT 328 MEV THE RESULTS ARE IN GOOD AGREEMENT WITH THOSE OF A PREVICUS EXPERIMENT AT 315 MEV PERFORMED BY THE DOUBLE-SCATTERING TECHNIQUE.

CITATIONS
ANNUAL REV. OF NUCLEAR SCIENCE 10, 291 (1960), PHYS. LETTERS 3, 265 (1963), PHYS. REV. 138, B291 (1965), BULL. AM. PHYS. SOC. 9, 724 (1964), ANNUAL REV. OF NUCLEAR SCIENCE 6, 443 (1956), PHYS. REV. 148, 1297 (1966), PHYS. LETTERS 2, 310 (1962), PHYS. LETTERS 7, 293 (1963), UCRL 11149, PRCG. NUCL. TECH. INSTR. 1 173 (1964), KYOTO UNIVERSITY RIFP-30 (1963), UCRL 11565, AND PHYS. REV. 105, 200 (1957).

ARTICLE READ BY ODETTE BENARY IN 4/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON HYDROGEN COMPOUND FROM .850 TO 1.386 GEV/C. TARGET IS POLARIZED 40 PER CENT (NORMAL TO THE BEAM DIRECTION).

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - POLARIZATION

- -

ELASTIC POLARIZATION FOR PROTON PROTCN. (TABLE 2)

LABORATORY BEAM ENERGY = .614 +- .0C5 GEV.

THETA DEGREES		POLARIZATION (1)	
58.0	+- 2.0	.505	+- .C19
62.8	2.0	.492	.019
66.2	2.0	.413	.C20
67.5	2.0	.463	.C19
71.9	2.0	.325	.018
72.3	2.0	.357	.C19
77.6	2.0	.238	.016
83.5	2.0	.091	.015

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 19 PER CENT.

- -

ELASTIC POLARIZATION FOR PROTON PRCTCN. (TABLE 3)

LABORATORY BEAM ENERGY = .679 +- .007 GEV.

THETA DEGREES		POLARIZATION (1)	
38.8	+- 1.0	.578	+- .028
41.9	1.0	.578	.019
45.0	1.0	.583	.C17
48.1	1.0	.596	.017
51.2	1.0	.570	.013
54.3	1.0	.529	.013
57.4	1.0	.484	.018
60.5	1.0	.430	.C17
63.7	1.0	.399	.018
66.7	1.0	.363	.C19
70.8	1.0	.293	.C30
73.7	1.0	.274	.027
76.7	1.0	.247	.031
79.6	1.0	.151	.036
02.6	1.0	.073	.C44

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRANC C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF + 6.5 - 5.8 PER CENT.

- -

ELASTIC POLARIZATICN FOR PROTON PROTON. (TABLE 4)

LABORATORY BEAM ENERGY = .736 +- .0C5 GEV.

THETA DEGREES		POLARIZATION (1)	
32.5	+- 1.0	.579	+- .049
35.6	1.0	.579	.C28
38.8	1.0	.553	.017
42.0	1.0	.560	.C14
45.1	1.0	.559	.015
48.3	1.0	.528	.011
51.4	1.0	.520	.011
54.6	1.0	.497	.013
57.7	1.0	.458	.013
60.9	1.0	.473	.014
65.5	1.0	.419	.018
68.4	1.0	.365	.017
71.4	1.0	.342	.C18
74.3	1.0	.304	.018
77.2	1.0	.231	.018
8C.2	1.0	.180	.018
83.2	1.0	.144	.023

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS CF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF + 6.5 - 5.8 PER CENT.

- -

ELASTIC POLARIZATION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = .328 +- .006 GEV.

THETA DEGREES		POLARIZATION (1)	
49.1	+- 1.0	.389	+- .045
52.2	1.0	.349	.031
55.3	1.0	.324	.025
58.4	1.0	.317	.022
61.6	1.0	.255	.020
64.8	1.0	.256	.027
68.1	1.0	.191	.024
71.4	1.0	.165	.023
74.7	1.0	.187	.023
85.3	1.0	.163	.035
88.9	1.0	.016	.027
92.6	1.0	-.008	.025
96.5	1.0	-.054	.024
100.6	1.0	-.094	.027

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF + 6.5 - 5.8 PER CENT.

25 TOTAL CROSS SECTIONS OF PROTONS WITH MOMENTUM BETWEEN 10 AND 28 GEV/C. (PHYS. REV. LETTERS 5, 576 (1960))

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CITATIONS
HELVETICA PHYSICA ACTA 33 544 (1960), REVIEW OF SCIENTIFIC INSTRUMENTS 25, 1070 (1954), PHYS. REV. LETTERS 5, 333 (1960), AND PHYS. REV. LETTERS 3, 568 (1959).

ARTICLE READ BY ODETTE BENARY IN 4/67, AND VERIFIED BY LEROY PRICE.

BEAM NO. 1 IS PROTON ON HYDROGEN COMPOUND FROM 9.9 TO 28.4 GEV/C.
NO. 2 IS PROTON ON DEUTERIUM COMPOUND FROM 9.9 TO 24.2 GEV/C.

THIS EXPERIMENT USES COUNTERS.

GENERAL COMMENTS ON THIS ARTICLE
1 FOR THE P-N MEASUREMENTS H2O AND D2O TARGETS WERE USED.

KEY WORDS - CROSS SECTION

- -
- -

PROTON PROTON TOTAL CROSS SECTION. (FIGURE 2)

LABORATORY BEAM MOMENTUM GEV/C	PER CENT	MILLI-BARNS	
9.9	+- 2.5	39.4	+- 1.5
12.4	2.5	39.0	1.5
15.8	2.5	38.7	1.5
17.7	2.5	39.7	1.5
19.4	2.5	39.7	1.5
21.4	2.5	39.4	1.5
24.2	2.5	38.7	1.5
28.4	2.5	39.9	1.5

- -

PROTON NEUTRON TOTAL CROSS SECTION. (FIGURE 2)

(P-N CROSS SECTION WAS MEASURED USING D2O AND H2O TARGETS. GLAUBER CORRECTION NOT APPLIED.)

LABORATORY BEAM MOMENTUM GEV/C	PER CENT	MILLI-BARNS	
9.9	+- 2.5	38.0	+- 2.5
15.8	2.5	36.2	2.0
24.2	2.5	35.5	2.0

26 PRODUCTION OF K MESONS IN THREE-BODY STATES IN PROTON-PROTON INTERACTIONS AT 6 BEV/C. (PHYS. REV. 165, 1466 (1968))

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ABSTRACT ANALYSIS OF 9700 EVENTS, CONTAINING AT LEAST ONE OBSERVED NEUTRAL OR CHARGED DECAY, PRODUCED BY 6-BEV/C PROTONS IN THE LRL 72-IN. LIQUID-HYDROGEN BUBBLE CHAMBER HAS YIELDED 1746 EXAMPLES OF THE REACTION PROTON-PROTON →HYPERON K-MESON NUCLEON. PRODUCTION CROSS SECTIONS FOR THESE THREE-BODY REACTIONS ARE AS FOLLOWS -- LAMBDA K+ P = 54(-5 +3) MICROBARNS; SIGMA-0 K+ P = 17(-2 +4) MICROBARNS; SIGMA+ K0 P = 26 +- 4 MICROBARNS; SIGMA+ K+ N = 57 +- 7 MICROBARNS. STRONG N* PRODUCTION IS OBSERVED IN ALL CHANNELS. IN PARTICULAR, ONE OR MORE T = 1/2 RESONANT STATES WITH MASS NEAR 1700 MEV/C-SQUARED, DECAYING INTO LAMBDA K+, AND A T = 3/2 RESONANCE WITH MASS 1920 MEV/C-SQUARED, DECAYING INTO SIGMA+ K+, ARE PRODUCED. IN ALL CASES THE DATA ARE CONSISTENT WITH A PRODUCTION PROCESS DOMINATED BY A SINGLE-PION-EXCHANGE MECHANISM. NO EVIDENCE IS FOUND FOR A DIBARYON STATE IN EITHER THE LAMBDA-PROTON OR SIGMA-NUCLEON SYSTEM.

CITATIONS
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ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 6 GEV/C.

THIS EXPERIMENT USES THE L.R.L. 72 IN. (H) BUBBLE CHAMBER. A TOTAL OF 500000 PICTURES ARE REPORTED ON.

GENERAL COMMENTS ON THIS ARTICLE
1 CONSIDERABLE NUCLEON ISOBAR PRODUCTION (N*(1920) AND N*(1688)) OBSERVED IN THE K+ SIGMA+ , AND K+ LAMBDA EFFECTIVE MASS DISTRIBUTIONS.

KEY WORDS • CROSS SECTION ANGULAR DISTRIBUTION DALITZ PLOT MASS SPECTRUM MODELS

- -

(TABLE 1)

LABORATORY BEAM MOMENTUM = 6.05 +- .06 GEV/C.

REACTION	MICRO-BARNS
PROTON PROTON →	
LAMBDA PROTON K+	54. + 3. - 5.
SIGMA0 PROTON K+	17. + 4. - 2.
SIGMA+ PROTON K0	26. 4. (1)
SIGMA+ K+ NEUTRON	57. 7.

(1) BASED ON EVENTS WHERE THE K0 DECAY IS SEEN..

27 NP ELASTIC CHARGE EXCHANGE IN THE BEV ENERGY REGION. (PHYS. REV. LETTERS 9, 509 (1962))

H.PALEVSKY,J.A.MOORE,R.L.STEARNS,H.R.MUETHER,R.J.SUTTER,R.E.CHRIEN,A.P.JAIN K.OTNES (BROOKHAVEN NAT. LAB., UPTON, L.I., N. Y., USA)

CLOSELY RELATED REFERENCES
PART OF THIS ARTICLE SUPERSEDED BY PHYS. REV. LETTERS 15, 38 (1965).

ADDITIONAL CITATIONS
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ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS NEUTRON ON PROTON FROM 2.828 TO 3.672 GEV/C. (BEAM KINETIC ENERGY = 2.04 TO 2.85 GEV)

THIS EXPERIMENT USES COUNTERS.

KEY WORDS • CROSS SECTION DIFFERENTIAL CROSS SECTION

- -

NEUTRON PROTON ELASTIC CROSS SECTION. (PAGE 511)

DATA IS INTEGRATED OVER COS(THETA) FROM -1. TO 0.. THETA IS THE ANGLE THAT THE NEUTRON MAKES WITH THE BEAM IN THE GRAND C.M.

(THIS DATA SHOULD NOT BE USED - MORE RECENT VALUES MAY BE FOUND IN FRIEDES, ET AL., PHYS. REV. LETTERS 15, 38 (1965))

LABORATORY BEAM ENERGY GEV	MILLI-BARNS
2.04	.65 +- .15

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NEUTRON PROTON ELASTIC CROSS SECTION. (PAGE 511)

DATA IS INTEGRATED OVER COS(THETA) FROM -1. TO 0.. THETA IS THE ANGLE THAT THE NEUTRON MAKES WITH THE BEAM IN THE GRAND C.M.

LABORATORY BEAM ENERGY GEV	MILLI-BARNS
2.85	.43 +- .16

28 PROTON-PROTON INTERACTIONS AT 810 MEV. (PHYS. REV. 103, 1472 (1956))

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ABSTRACT 244 EXAMPLES OF PROTON-PROTON SCATTERING HAVE BEEN OBSERVED BY USING THE HYDROGEN-FILLED DIFFUSION CLOUD CHAMBER OF THE BROOKHAVEN CLOUD CHAMBER GROUP. THE MEAN ENERGY OF THE INCIDENT PROTONS WAS MEASURED TO BE 810 +- 100 MEV. THE REACTIONS OBSERVED WERE (1) PP - PP, 126 EXAMPLES, (2) PP - P N PI+, 84 EXAMPLES, (3) PP - D PI+, 1 EXAMPLE, AND (4) PP - PP PIO, 5 EXAMPLES, WITH 28 EXAMPLES WHICH CAN BE EITHER REACTION (2) OR (4). THE TOTAL PROTON PROTON CROSS SECTION WAS DETERMINED TO BE 45 +- 6 MB. THE RATIO R OF THE CROSS SECTION FOR PI+ PRODUCTION TO THAT FOR PIO PRODUCTION IS 17 +- 8. AN ELASTIC DIFFERENTIAL DISTRIBUTION STRONGLY PEAKED IN THE FORWARD DIRECTION WAS OBTAINED. ANGLE AND MOMENTUM DISTRIBUTIONS OF PARTICLES AND ANGULAR CORRELATIONS BETWEEN PAIRS OF PARTICLES FROM REACTION (2) ARE PRESENTED. NO INTERACTIONS LEADING TO THE PRODUCTION OF MORE THAN ONE MESON OR OF HEAVY UNSTABLE PARTICLES WERE IDENTIFIED.

CITATIONS
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ARTICLE READ BY ODETTE BENARY IN 3/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 1.48 GEV/C.

THIS EXPERIMENT USES A CLOUD CHAMBER. A TOTAL OF 17500 PICTURES ARE REPORTED ON.

KEY WORDS - CROSS SECTION DIFFERENTIAL CROSS SECTION

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- -

PROTON PROTON TOTAL CROSS SECTION. (PAGE 1475)

LABORATORY BEAM ENERGY GEV	MILLI-BARNS	NO. EVENTS
.81 +- .10	45. +- 6.	856

29 NUCLEON AND NUCLEAR CROSS SECTIONS FOR POSITIVE PIONS AND PROTONS ABOVE 1.4 BEV/C. (PHYS. REV. 125, 701 (1962))

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ABSTRACT TOTAL (PI+ P) AND (PP) CROSS SECTIONS IN THE MOMENTUM RANGE 1.4 TO 4.0 GEV/C ARE PRESENTED. THESE MEASUREMENTS, WITH AN ACCURACY OF APPROXIMATELY 2 PER CENT, WERE MADE AT THE BERKELEY BEVATRON BY USING COUNTER TECHNIQUES. PIONS WERE DISTINGUISHED FROM PROTONS BY MEANS OF A GAS-FILLED CERENKOV COUNTER. THE (PI+ P) TOTAL CROSS SECTION WAS FOUND TO BE ALMOST CONSTANT ABOVE 2.0 BEV/C AT A VALUE NEAR 29 MB. THE (PP) CROSS SECTION DECREASES GRADUALLY FROM 47.5 MB TO 41.7 MB OVER THE MOMENTUM RANGE COVERED. TRANSMISSION MEASUREMENTS OF PI+ NUCLEUS AND P NUCLEUS CROSS SECTIONS IN BOTH GOOD AND POOR GEOMETRY WERE MADE AT 3.0 BEV/C. THE RESULTS ARE COMPARED WITH THE PREDICTIONS OF THE OPTICAL MODEL. IN CONTRAST TO MOST PREVIOUS WORK AT HIGH ENERGIES, AN ESSENTIALLY EXACT SOLUTION OF THE WAVE EQUATION FOR A POTENTIAL WELL WITH A DIFFUSE EDGE WAS USED. THE VALUES OF THE IMAGINARY PART OF THE OPTICAL POTENTIAL THAT BEST FIT THE EXPERIMENTAL DATA ARE IN GOOD AGREEMENT WITH THE PREDICTED VALUES. NO STRONG CONCLUSION REGARDING THE REAL PART OF THE POTENTIAL WAS POSSIBLE. ABSORPTION AND TOTAL ELASTIC SCATTERING CROSS SECTIONS FOR BE, C, AL, AND CU ARE PRESENTED. THE TOTAL ELASTIC SCATTERING CROSS SECTIONS FROM THIS EXPERIMENT DISAGREE WITH WIKNER'S FOR PI- NUCLEUS SCATTERING.

CLOSELY RELATED REFERENCES
THIS ARTICLE SUPERSEDES PHYS. REV. LETTERS 3, 568 (1959).

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ARTICLE READ BY ODETTE BENARY IN 6/67, AND VERIFIED BY LEROY PRICE.

BEAM NO. 1 IS PROTON ON PROTON FROM 1.42 TO 4.00 GEV/C.
NO. 2 IS PI+ ON PROTON FROM 1.42 TO 4.00 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - CROSS SECTION FITS MODELS

COMPOUND KEY WORDS - FITS MODELS

- -
- -

PROTON PROTON TOTAL CROSS SECTION. (TABLE 1)

LABORATORY BEAM MOMENTUM GEV/C	PER CENT	MILLI-BARNS	
1.42 +-	2.5	46.20	+ .50 - .45
1.60	2.5	47.50	+ 1.02 - .61
1.73	2.5	46.20	+ .82 - .46
1.89	2.5	46.80	+ 1.51 - .68
2.05	2.5	45.30	+ 1.12 - .47
2.47	2.5	45.10	+ .83 - .45
2.97	2.5	44.50	+ .46 - .42
3.58	2.5	43.20	+ .43 - .43
4.00	2.5	41.60	+ .62 - .62

30 K+ MESON PRODUCTION IN PP COLLISIONS AT 2.5-3.0 GEV. (PHYS. REV. 166, 1472 (1968))

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ABSTRACT DIFFERENTIAL CROSS SECTIONS AS A FUNCTION OF MOMENTUM ARE PRESENTED FOR THE PRODUCTION OF K+ MESONS IN PP COLLISIONS AT INCIDENT PRCTON ENERGIES OF 2.54, 2.88, AND 3.03 GEV. THE MEASUREMENTS WERE MADE AT 20 DEG., 30 DEG., AND 40 DEG. RELATIVE TO THE DIRECTION OF THE INTERNAL PROTON BEAM OF THE PRINCETON-PENNSYLVANIA ACCELERATOR. AT 2.54 GEV, THE RESULTS FOLLOW CLOSELY THE PREDICTIONS FROM PHASE SPACE (WITH 60 PER CENT K+ SIGMA N AND 40 PER CENT K+ LAMBDA P IN THE FINAL STATE.) AT 2.88 AND 3.03 GEV, HOWEVER, THERE IS A DEFINITE DISAGREEMENT WITH PHASE SPACE. THE DATA ARE COMPARED TO THE PREDICTIONS OF THREE MODELS -- (1) A MODEL BASED ON THE ASSUMPTION THAT K'S ARE PRODUCED VIA PP + K+ X+, WHERE X+ IS A B=2, S = -1 RESONANCE WHICH DECAYS INTO A NUCLEON+HYPERON; (2) THE ISOBAR MODEL; AND (3) THE ONE-PION-EXCHANGE MODEL. MODEL (1) IS FOUND TO BE INCONCLUSIVE, MODEL (2) IS INADEQUATE, AND MODEL (3) IS PARTLY SUCCESSFUL IN PREDICTING TOTAL CROSS SECTIONS, BUT NOT IN INTERPRETING THE DETAILED EXPERIMENTAL OBSERVATIONS.

CITATIONS
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ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON FROM 3.308 TO 3.825 GEV/C. (BEAM KINETIC ENERGY = 2.5 TO 3.0 GEV)

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - CROSS SECTION   DIFFERENTIAL CROSS SECTION   MODELS   MASS SPECTRUM

CROSS SECTION FOR PROTON PROTON - K+ LAMBDA PROTON + K+ SIGMA NUCLEON. (TABLE 2)

LABORATORY BEAM ENERGY GEV	MICRO-BARNS
2.54 +- .02	61. +- 10.

CROSS SECTION FOR PROTON PROTON - K+ LAMBDA PROTON + K+ SIGMA NUCLEON + K+ SIGMA NUCLEON PION + K+ LAMBDA NUCLEON PION. (TABLE 2)

LABORATORY BEAM ENERGY GEV	MICRO-BARNS
2.88 +- .02	123. +- 21.

CROSS SECTION FOR PROTON PROTON - K+ LAMBDA PROTON + K+ SIGMA NUCLEON + K+ SIGMA NUCLEON PION + K+ LAMBDA NUCLEON PION. (TABLE 2)

LABORATORY BEAM ENERGY GEV	MICRO-BARNS
3.03 +- .02	160. +- 29.

(PAGE 1477)

LABORATORY BEAM ENERGY = 2.54 +- .02 GEV.

REACTION	FRACTION PER CENT (1)
PROTON PROTON -	
K+ LAMBDA PROTON	40.
K+ SIGMA NUCLEON	60.

(1) THESE FRACTIONS SHOULD BE MULTIPLIED BY 61. +- 10. TO GET CROSS SECTIONS IN MICROBARNS.

31 STRANGE-PARTICLE PRODUCTION IN 8-BEV/C PROTON-PROTON INTERACTIONS. (PHYS. REV. 172, 1354 (1968))

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ABSTRACT A SYSTEMATIC SURVEY OF STRANGE-PARTICLE FINAL STATES PRODUCED BY 8-BEV/C PROTONS WAS MADE IN THE BNL 80-IN. HYDROGEN BUBBLE CHAMBER. CROSS SECTIONS WERE MEASURED FOR SOME 33 REACTIONS. THE RATIO OF THE CROSS SECTION FOR THE K K-BAR CHANNELS TO THE TOTAL STRANGE-PARTICLE CROSS SECTION WAS MEASURED TO BE 0.12 AND APPEARS TO BE RISING IN THIS MOMENTUM REGION. THE TOTAL CROSS SECTION FOR STRANGE-PARTICLE PRODUCTION IS ESTIMATED AS 1.8 +- 0.2 MB. COMPARISON IS MADE OF THE DATA WITH THE PREDICTIONS OF THE ONE-PION-EXCHANGE MODEL, AND AT LEAST PARTIAL AGREEMENT OCCURS FOR THE K+ P LAMBDA AND PI K N SIGMA FINAL STATES. THE K P SIGMA STATES APPEAR TO CONTAIN N*(1924) - K SIGMA, AND THE PI K N LAMBDA STATES ALL INCLUDE Y*(1385) PRODUCTION WITH THE PI+ KO P LAMBDA STATE ALSO CONTAINING N*(1236) AND K*(890) PRODUCTION. AN EXAMINATION OF THE FIVE- AND SIX-BODY K, LAMBDA STATES INDICATES STRONG Y*(1385) AND N*(1236) PRODUCTION. FINALLY, ALL FINAL STATES CONTAINING A K AND A LAMBDA SHOW A DEPENDENCE ON M(K,LAMBDA) WHICH IS WELL PARAMETERIZED BY A BREIT-WIGNER SHAPE WITH M(0) = 1777 MEV AND GAMMA = 345 MEV. THIS BEHAVIOR IS INTERPRETED AS BEING CONSISTENT WITH ONE-PION EXCHANGE AS THE DOMINANT MECHANISM FOR THESE REACTIONS.

CITATIONS
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ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 7.87 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 80 IN. (H) BUBBLE CHAMBER. A TOTAL OF 37000 PICTURES ARE REPORTED ON.

KEY WORDS - CROSS SECTION ANGULAR DISTRIBUTION DALITZ PLOT MASS SPECTRUM MODELS DELTA(1238) DELTA(1920) K*(890) Y*(1385) STRANGE PARTICLES

- -

(TABLE 1)

LABORATORY BEAM MOMENTUM = 7.87 GEV/C.

REACTION	MICRO-BARNS	
PROTON PROTON -		
K+ PROTON LAMBDA	54.4 +-	7.3
K+ PROTON SIGMA0	25.2	5.0
K0 PROTON SIGMA+	14.3	5.1
PROTON PROTON K0 K0BAR	10.4	3.3
K+ PROTON K0BAR NEUTRON	25.0	6.7
PI+ K+ LAMBDA NEUTRON	101.0	10.3
K+ PROTON LAMBDA PI0	77.5	8.7
PI+ PROTON K0 LAMBDA	72.4	7.4
PI+ PROTON K0 SIGMA0	29.5	7.0
PI+ SIGMA+ K0 NEUTRON	21.4	6.2
PROTON SIGMA+ K0 PI0	17.9	5.7
K+ PROTON SIGMA+ PI-	37.4	7.8
PI+ K+ PROTON SIGMA-	31.6	6.9
PI+ PROTON K0 K0BAR NEUTRON	24.8	12.4
K+ PROTON PROTON PI- K0BAR	9.8	4.6
PI+ PROTON PROTON K- K0	13.8	5.2
PI+ K+ PROTON PI- LAMBDA	49.0	7.2
PI+ PROTON K0 LAMBDA PI0	67.4	15.0
PI+ PI+ K0 LAMBDA NEUTRON	20.2	0.5
PI+ K+ PROTON PI- SIGMA0	21.4	4.8
K+ PROTON SIGMA+ PI- PI0	17.3	7.1
PI+ PROTON SIGMA+ PI- K0	14.7	7.4
PI+ K+ SIGMA+ PI- NEUTRON	28.8	9.1
PI+ K+ PROTON SIGMA- PI0	22.2	4.6
PI+ PI+ PROTON SIGMA- K0	24.7	5.6
PI+ PI+ K+ SIGMA- NEUTRON	6.8	2.6
PI+ PROTON PROTON PI- K0 K0BAR	6.3	2.8
PI+ K+ PROTON PI- K0BAR NEUTRON	7.8	3.9
PI+ PROTON PROTON K- K0 PI0	5.9	3.4
PI+ PI+ PROTON K- K0 NEUTRON	3.9	2.8
PI+ PI+ PROTON PI- K0 LAMBDA	23.1	4.2
PI+ K+ PROTON PI- LAMBDA PI0	39.5	6.3
PI+ PI+ K+ PI- LAMBDA NEUTRON	20.3	6.7

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(PAGE 1356)

LABORATORY BEAM MOMENTUM = 7.87 GEV/C.

REACTION	MILLI-BARNS	
PROTON PROTON -		
TOTAL	39.6 +-	1.3
STRANGE PARTICLES	1.8	.2

32 5-BEV NEUTRON CROSS SECTIONS IN HYDROGEN AND OTHER ELEMENTS [PHYS. REV. 123, 1850 (1961)]

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ABSTRACT THIS EXPERIMENT MEASURED THE NEUTRON TOTAL AND REACTION CROSS SECTIONS AT 5.0 BEV. TRANSMISSION MEASUREMENTS WERE MADE IN GOOD AND POOR GEOMETRY. THE HIGH ENERGY NEUTRON BEAM WAS PRODUCED WHEN THE BEVATRON CIRCULATING PROTON BEAM STRUCK A COPPER TARGET. NEUTRONS WERE IDENTIFIED BY THEIR PRODUCTION OF PIONS IN A BERYLLIUM BLOCK. THE PIONS WERE THEN DETECTED BY A COUNTER TELESCOPE INCLUDING A GAS CERENKOV COUNTER. THE THRESHOLD OF THIS GAS CERENKOV COUNTER DEFINED THE MEAN EFFECTIVE NEUTRON ENERGY AT 5.0 +- 0.4 BEV, WITH THE HALF-INTENSITY POINTS OF THE NEUTRON ENERGY DISTRIBUTION AT 5.9 AND 4.2 BEV. THE CROSS SECTIONS MEASURED FOR THE VARIOUS ELEMENTS ARE(IN MILLIBARNS)

	PB	SN	CU	AL	C	H
SIGMA(T)	2534 +- 105	1986 +- 88	1158 +- 34	614 +- 33	319 +- 20	33.6 +- 1.6
SIGMA(R)	1670 +- 79		586 +- 25	381 +- 27	235 +- 16	

THE 5-BEV TOTAL CROSS SECTIONS ARE 20 PER CENT BELOW THE TOTAL CROSS-SECTIONS MEASURED AT 1.4 BEV BY COOR ET AL., WHEREAS THE REACTION CROSS SECTIONS REMAIN ESSENTIALLY CONSTANT AS A FUNCTION OF ENERGY ABOVE 300 MEV. THIS BEHAVIOR OF THE CROSS SECTIONS CAN BE INTERPRETED BY A GENERALIZED DIFFRACTION THEORY DEVELOPED BY GLASSGOLD AND GRIEDER.

CITATIONS
PHYS. REV. 98, 1369 (1955), PHYS. REV. 98, 1393 (1955), PHYS. REV. 107, 859 (1957), PHYS. REV. LETTERS 2, 169 (1959), REVIEW OF SCIENTIFIC INSTRUMENTS 30, 1004 (1959), UCRL 8559 (1958), PHYS. REV. 114, 1374 (1959), UCRL 3289 (1956), NUOVO CIMENTO 4, 359 (1956), PHYS. REV. 107, 1121 (1957), J. WASH. ACAD. SCI. 29 416 (1939), PHYS. REV. 105, 1587 (1957), AM. PHYS. 10 100 (1960), PHYS. REV. 75, 1352 (1949), PHYS. REV. 98, 1387 (1955), REV. MOD. PHYS. 28, 214 (1956), AND REV. MOD. PHYS. 30, 430 (1958).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS NEUTRON ON PROTON AT 5.865 GEV/C. (BEAM KINETIC ENERGY = 5 GEV)

THIS EXPERIMENT USES COUNTERS.

KEY WORDS + CROSS SECTION MODELS

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- -

NEUTRON PROTON TOTAL CROSS SECTION. [PAGE 1850]

LABORATORY BEAM ENERGY GEV (1)	MILLI-BARNS
5.	33.6 +- 1.6

(1) MEAN VALUE.

33 TOTAL CROSS SECTIONS FOR INTERACTION OF NEUTRONS WITH PROTONS AND NEUTRONS FROM 2.6 TO 8.3 BEV. [SOVIET JNP 1 93 (1965)]

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ABSTRACT WE HAVE MEASURED THE TOTAL CROSS SECTIONS FOR INTERACTION OF NEUTRONS HAVING MEAN EFFECTIVE ENERGIES OF 2.6, 3.9, 5.5, 6.9, AND 8.3 BEV WITH PROTONS AND NEUTRONS UNDER CONDITIONS OF GOOD GEOMETRY (THETA = 0.228 DEG.). WE HAVE OBTAINED THE FOLLOWING VALUES

E(N)	2.6 BEV	3.9 BEV	5.5 BEV	6.9 BEV	3.3 BEV
TOT. C.S. (NP) MB	38.1 +- 2.6	43.4 +- 11.6	41.2 +- 1.7	39.3 +- 1.7	40.8 +- 1.9
TOT. C.S. (NN) MB			34.8 +- 1.6		31.5 +- 1.7

CITATIONS
PHYS. REV. 98, 1369 (1955), PHYS. REV. 123, 1850 (1961), BULL. AM. PHYS. SOC. 9, 94 (1964), INSTRUMENTS AND EXPERIMENTAL TECHNIQUES 2 382 (1961), JETP 42 392 (1962), JETP 15 272 (1962), UCRL 8559, INSTRUMENTS AND EXPERIMENTAL TECHNIQUES 6 1025 (1964), PHYS. REV. 95, 1026 (1954), REVIEW OF SCIENTIFIC INSTRUMENTS 32, 949 (1961), J. WASH. ACAD. SCI. 29 416 (1939), BULL. AM. PHYS. SOC. 1, 385 (1956), NUOVO CIMENTO 4, 359 (1956), PHYS. REV. LETTERS 8, 142 (1962), JETP 44 2184 (1963), JETP 17 1466 (1963), PHYS. REV. LETTERS 7, 185 (1961), PHYS. REV. 100, 242 (1955), NUC. PHYS. 6, 348 (1958), AND PHYS. REV. 103, 211 (1956).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM NO. 1 IS NEUTRON ON HYDROGEN COMPOUND FROM 3.413 TO 9.192 GEV/C. (BEAM KINETIC ENERGY = 2.6 TO 8.3 GEV)
NO. 2 IS NEUTRON ON DEUTERIUM COMPOUND FROM 6.371 TO 9.192 GEV/C. (BEAM KINETIC ENERGY = 5.5 TO 8.3 GEV)

THIS EXPERIMENT USES COUNTERS.

KEY WORDS + CROSS SECTION

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- -

NEUTRON PROTON TOTAL CROSS SECTION. [TABLE 2]

LABORATORY BEAM ENERGY GEV (1)	MILLI-BARNS	
2.6	38.1 +-	2.6
3.9	43.4	1.6
5.5	41.2	1.7
6.9	39.3	1.7
8.3	40.8	1.9

(1) MEAN VALUES.

- -

NEUTRON NEUTRON TOTAL CROSS SECTION. [TABLE 3]

(NOT CORRECTED FOR DEUTERIUM EFFECTS.)

LABORATORY BEAM ENERGY GEV (1)	MILLI-BARNS	
5.5	34.8 +-	1.6
8.3	31.5	1.7

(1) MEAN VALUES.

NEUTRON DEUTERON TOTAL CROSS SECTION. [PAGE 99]

LABORATORY BEAM ENERGY GEV [1]	MILLI-BARNS
5.5	76.0 +- 2.4
8.3	71.6 2.5

[1] MEAN VALUES.

34 POLARIZATION IN PP ELASTIC SCATTERING AT LARGE MOMENTUM TRANSFERS. [PHYS. REV. LETTERS 21, 651 (1968)]

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ABSTRACT MEASUREMENTS OF THE POLARIZATION IN PP ELASTIC SCATTERING HAVE BEEN MADE AT 5.15 GEV/C OVER THE RANGE -T = 0.2 TO 1.8 (GEV/C)-SQUARED. THE DATA ARE COMPARED WITH A REGGE-POLE MODEL, AND WITH THE DIFFRACTION MODEL OF DURAND AND LIPES IN WHICH THE ABSORPTIVE PART OF THE PP INTERACTION IS DERIVED FROM THE ELECTROMAGNETIC FORM FACTOR OF THE PROTON. THE LATTER MODEL REPRODUCES THE T DEPENDENCE OF THE EXPERIMENTAL DATA IN A QUALITATIVE WAY.

CITATIONS
PHYS. LETTERS 24B, 77 (1967), PHYS. REV. 148, 1297 (1966), PHYS. REV. 161, 1374 (1967), PHYS. REV. 164, 1672 (1967), REV. MOD. PHYS. 39, 531 (1967), UCRL 16275 (1966), PHYS. REV. 165, 1615 (1968), AND PHYS. REV. LETTERS 20, 637 (1968) .

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON HYDROGEN COMPOUND AT 5.15 GEV/C. TARGET IS POLARIZED 55 PER CENT (NORMAL TO THE BEAM DIRECTION).

THIS EXPERIMENT USES COUNTERS.

KEY WORDS + POLARIZATION MODELS

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ELASTIC POLARIZATION FOR PROTON PROTON. [FIGURE 1]

LABORATORY BEAM MOMENTUM = 5.15 GEV/C.

. THIS DATA WAS READ FROM A GRAPH .

-T (GEV/C)**2	POLARIZATION [1]
.22	.22 +- .01
.28	.21 .01
.34	.19 .01
.40	.18 .01
.48	.17 .01
.56	.12 .02
.67	.12 .02
.75	.15 .03
.83	.13 .03
.92	.14 .05
1.02	.20 .05
1.12	.24 .07
1.23	.26 .08
1.36	.15 .10
1.47	.25 .10
1.57	.18 .13
1.75	.32 .13

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10 PER CENT.

35 SEARCH FOR FLUCTUATIONS IN THE ANGULAR DISTRIBUTION OF PROTON-PROTON SCATTERING AT 16.9 GEV/C. [PHYS. LETTERS 23, 389 (1966)]

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ABSTRACT MEASUREMENTS OF THE ANGULAR DISTRIBUTION OF PROTON-PROTON ELASTIC SCATTERING AT 16.9 GEV/C FROM 67 DEG. TO 90 DEG. IN THE C.M.S. ARE PRESENTED. THE DATA ARE FITTED BY AN EXPONENTIAL IN THE TRANSVERSE MOMENTUM, EXP -(P SIN THETA/B) WITH B = (225 +- 4) MEV/C AND DO NOT DISPLAY THE CHARACTERISTIC FLUCTUATION PREDICTED BY ERICSON'S STATISTICAL MODEL.

CLOSELY RELATED REFERENCES
DATA SUPERSEDED BY PHYS. LETTERS 25B, 156 (1967).

ADDITIONAL CITATIONS
CERN DL 65-10, CERN NP/66-2, PHYS. REV. 128, 2392 (1962), ANNUAL REV. OF NUCLEAR SCIENCE 13, 261 (1963), PHYS. LETTERS 13, 190 (1964), PHYS. REV. 138, B165 (1965), UCRL 11441, UCRL 16275, NUOVO CIMENTO 27, 856 (1963), NUOVO CIMENTO 27, 208 (1963), NUOVO CIMENTO 33, 643 (1964), PHYS. LETTERS 8, 287 (1964), NUOVO CIMENTO 35, 216 (1965), NUOVO CIMENTO 35, 1211 (1965), NUOVO CIMENTO 35, 1050 (1965), CERN TH 406 (1964), CERN 66/TH/686, ANNALS OF PHYSICS 23, 390 (1963), PHYS. REV. 85, 947 (1952), PHYS. REV. 105, 302 (1957), CERN 65-22, AND REV. MOD. PHYS. 36, 655 (1964).

ARTICLE READ BY ODETTE BENARY IN 5/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 16.9 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS + DIFFERENTIAL CROSS SECTION FITS

COMPOUND KEY WORDS + FITS DIFFERENTIAL CROSS SECTION

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- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PPOTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 16.9 GEV/C.

(THIS DATA SHOULD NOT BE USED - MORE RECENT VALUES MAY BE FOUND IN ALLABY, ET AL., PHYS. LETTERS 25B, 156 (1967))

THETA DEGREES	D-SIGMA/D-OMEGA NANOBARNS/SR (1)	
67.	1.85 +-	.04
70.	1.45	.05
72.	1.31	.05
75.	1.11	.04
77.	.95	.03
80.	.85	.04
82.	.79	.03
85.	.74	.04
90.	.69	.04

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7 PER CENT.

36 NEUTRAL STRANGE-PARTICLE PRODUCTION IN PP COLLISIONS AT 6.92 GEV/C. (NUOVO CIMENTO 53A, 455 (1968))

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ABSTRACT NEUTRAL STRANGE PARTICLE PRODUCTION IN PP COLLISIONS AT 6.92 GEV/C HAS BEEN STUDIED IN THE 80 IN. HBC AT BNL. PARTIAL CROSS-SECTIONS FOR THE DIFFERENT CHANNELS ARE GIVEN. NO EVIDENCE FOR HYPERON-NUCLEON RESONANCES HAS BEEN OBSERVED. STRONG PRODUCTION OF N*(1236) AND Y*(1385) HAS BEEN SEEN IN THE FOUR- AND FIVE-BODY FINAL STATES, WHICH HAS BEEN ANALYZED IN TERMS OF A ONE-PION-EXCHANGE MECHANISM.

CITATIONS
PHYS. REV. LETTERS 13, 355A (1964), PHYS. REV. 154, 1284 (1967), PHYS. REV. 147, 922 (1966), AND NUOVO CIMENTO 24, 453 (1962).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 6.92 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 80 IN. (H) BUBBLE CHAMBER. A TOTAL OF 64000 PICTURES ARE REPORTED ON.

KEY WORDS + CROSS SECTION DELTA(1238) Y*(1385) MASS SPECTRUM MODELS ANGULAR DISTRIBUTION STRANGE PARTICLES

(TABLE 1)

LABORATORY BEAM MOMENTUM = 6.920 +- .075 GEV/C.

REACTION	MICRO-BARNS		NO. EVENTS
PROTON PROTON +			
LAMBDA PROTON K+	43.3 +-	8.0	29.6
SIGMAO PROTON K+	28.9	6.6	19.1
SIGMA+ PROTON KO	20.2	7.4	7.4
PROTON PROTON KOBAR KO	8.2	3.6	5.2
NEUTRON PROTON KOBAR K+	28.3	8.5	11.0
SIGMAO PROTON KO PI+	54.3	12.1	20.2
SIGMA+ NEUTRON KO PI+	5.3	3.6	2.1
SIGMA+ PROTON KO PIO	10.8	5.3	4.2
LAMBDA NEUTRON K+ PI+	78.2	10.6	54.2
LAMBDA PROTON KO PI+	89.8	10.1	78.3
LAMBDA PROTON K+ PIO	74.1	10.4	50.7
NEUTRON PROTON KOBAR KO PI+	15.7	10.8	2.1
PROTON PROTON KOBAR K+ PI-	16.0	6.4	6.3
SIGMA+ PROTON KO PI+ PI-	10.5	5.1	4.2
SIGMA- PROTON KO PI+ PI+	8.3	4.7	3.1
SIGMAO PROTON K+ PI+ PI-	13.7	4.3	10.2
LAMBDA PROTON KO PI+ PIO	39.6	12.8	9.5
LAMBDA NEUTRON KO PI+ PI+	29.6	10.9	7.4
LAMBDA PROTON K+ PI+ PI-	28.1	6.4	19.2
NEUTRON PROTON KOBAR K+ PI+ PI-	5.4	3.8	2.1
PROTON PROTON KO K- PI+ PIO	2.6	2.5	1.1
LAMBDA PROTON KO PI+ PI+ PI-	6.2	2.6	5.6
LAMBDA PROTON K+ PI+ PI- PIO	14.2	4;3	10.9
LAMBDA NEUTRON K+ PI+ PI+ PI-	10.1	3.5	8.4
SIGMA+ NEUTRON KO PI+ PI+ PI-	2.6	2.5	1.1
SIGMAO PROTON KO PI+ PI+ PI-	1.3	1.8	.5

37 PROTON-PROTON DIFFERENTIAL CRCSS SECTION FROM 600 TO 1800 MEV/C. [PRINCETON-PENN ACCELERATOR PPAR-11 (1969)]

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ABSTRACT PROTON-PROTON ELASTIC DIFFERENTIAL CROSS SECTIONS HAVE BEEN MEASURED IN THE 34 DEG. BEAM LINE OF THE 3-GEV PRINCETON-PENNSYLVANIA ACCELERATOR FOR INCIDENT LAB MOMENTA OF 600 TO 1800 MEV/C AND CENTER-OF-MASS ANGLES OF 5 DEG. TO 90 DEG. THE MOMENTA OF THE PROTONS INCIDENT ON A LIQUID-HYDROGEN TARGET WERE MEASURED BY TIME-OF-FLIGHT TECHNIQUES. THE MOMENTA AND SCATTERING ANGLES OF THE RECOIL PRCTONS WERE MEASURED BY A SPECTROMETER CONSISTING OF TWO SETS OF MAGNETOSTRICTIVE WIRE SPARK CHAMBERS PLACED AT THE ENTRANCE AND EXIT OF AN ANALYZING MAGNET. A KINEMATICAL RECONSTRUCTION WAS PERFORMED FOR EACH EVENT BY AN ON-LINE PDP-7 COMPUTER WHICH ALSO RECORDED THE RAW DATA AND MONITORED VARIOUS ASPECTS OF THE EXPERIMENTAL EQUIPMENT. A MORE DETAILED OFF-LINE ANALYSIS RESULTED IN NORMALIZED DIFFERENTIAL CROSS SECTIONS. THE DIFFERENTIAL CROSS SECTIONS WERE COMPARED WITH SIMPLE MODELS FOR PP SCATTERING WHICH PROVED TO BE INADEQUATE TC EXPLAIN MANY OF THE EXPERIMENTAL DETAILS.

CITATIONS
REV. MOD. PHYS. 30, 364 (1958), ATOMIC ENERGY RES. ESTAB., HARWELL, REPORT 135 (1961), ATOMIC ENERGY RES. ESTAB., HARWELL, REPORT 149 (1966), PHYS. REV. 169, 1149 (1968), NUOVO CIMENTO 49A, 261 (1967), PROGR. THEORET. PHYS. (KYOTO) 31 615 (1964), DUBNA CONFERENCE 24 (1964), ANNALS OF PHYSICS 10, 100 (1960), PHYS. REV. 72, 1009 (1947), SLAC 66 (1966), PHYS. REV. 130, 1571 (1963), NUOVO CIMENTO 57A, 190 (1968), PHYS. REV. LETTERS 7, 394 (1961), PHYS. REV. LETTERS 8, 41 (1962), NUOVO CIMENTO 14, 951 (1959), NUOVO CIMENTO 18, 947 (1960), CERN 67-16 (1967), PHYS. REV. 163, 1603 (1967), NUCLEAR INSTRUMENTS AND METHODS 46, 197 (1967), PHYS. REV. 148, 1315 (1966), PRINCETON-PENN ACCELERATOR PPAR-3 (1968), PRINCETON-PENN ACCELERATOR PPA0279-0 (1966), PRINCETON-PENN ACCELERATOR PPAR-10 (1969). PHYS. REV. 120, 2250 (1960), JETP 23 52 (1966), PHYS. LETTERS 12, 252 (1964), DUBNA CONFERENCE 61 (1964), PHYS. LETTERS 8, 285 (1964), PHYS. REV. LETTERS 15, 45 (1965), AND PHYS. REV. 132, 1252 (1963).

ARTICLE READ BY ODETTE BENARY IN 12/69, ANC VERIFIED BY LEROY PRICE.

BEAM IS PRCTON ON PROTON FROM .6 TO 1.8 GEV/C.

THIS EXPERIMENT USES SPARK CHAMBERS.

KEY WORDS - DIFFERENTIAL CROSS SECTION FITS MODELS

COMPOUND KEY WORDS - FITS DIFFERENTIAL CROSS SECTION

ELASTIC DIFFERENTIAL CRCSS SECTION FOR PROTON PROTON. [TABLE III]

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM .600 TO .699 GEV/C.

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2 [1]	
.050	.099	122.5 +-	7.5
.100	.149	95.4	8.3
.150	.199	128.3	6.3

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- .4 PER CENT.

ELASTIC DIFFERENTIAL CRCSS SECTICN FCR PROTON PROTON. (TABLE IV)

DATA IS AVERAGED OVER LABCRATORY BEAM MOMENTUM FROM .8CC TO .899 GEV/C.

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2 (1)	
.05C	.099	89.5 +-	4.0
.100	.149	8C.7	4.5
.150	.199	76.6	3.2
.20C	.249	84.3	3.7
.250	.299	81.8	4.9

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTCN) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- .6 PER CENT.

- -

ELASTIC DIFFERENTIAL CRCSS SECTION FCR PROTON PROTON. (TABLE V)

DATA IS AVERAGED OVER LABCRATORY BEAM MOMENTUM FROM .900 TO .999 GEV/C.

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2 (1)	
.C5C	.099	76.1 +-	3.8
.100	.149	67.8	5.3
.150	.199	71.2	4.2
.200	.249	63.9	3.5
.250	.299	66.6	2.8
.300	.349	66.3	3.2

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) ANC THE (OUTGOING PROTCN).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 1.2 PER CENT.

- -

ELASTIC DIFFERENTIAL CRCSS SECTICN FCR PROTON PROTON. (TABLE VI)

DATA IS AVERAGED OVER LABCRATORY BEAM MOMENTUM FROM 1.000 TO 1.099 GEV/C.

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2 (1)	
.050	.099	58.1 +-	2.9
.100	.149	63.6	3.3
.150	.199	56.5	3.5
.200	.249	58.6	3.7
.25C	.299	54.4	2.4
.300	.349	46.9	2.3
.350	.399	49.5	2.6
.400	.449	50.9	3.0

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCCMING PROTON) ANC THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 2.1 PER CENT.

- -

ELASTIC DIFFERENTIAL CRCSS SECTION FCR PROTON PROTON. (TABLE VII)

DATA IS AVERAGED OVER LABORATORY BEAM MCMENTUM FRCM 1.100 TO 1.199 GEV/C.

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2 (1)	
.050	.099	53.3 +-	2.8
.100	.149	52.7	2.0
.150	.199	43.7	2.8
.200	.249	45.1	3.6
.250	.299	46.1	2.5
.300	.349	41.4	2.1
.350	.399	36.3	2.0
.400	.449	33.6	2.0
.450	.499	40.4	2.4
.500	.549	50.9	2.9

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCCMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS PCSSIBLE SYSTEMATIC ERROR OF +- 2.3 PER CENT.

- -

ELASTIC DIFFERENTIAL CRCSS SECTION FCR PROTON PROTON. (TABLE VIII)

DATA IS AVERAGED OVER LABCRATORY BEAM MOMENTUM FROM 1.200 TO 1.299 GEV/C.

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2 (1)	
.C50	.099	62.2 +-	3.7
.100	.149	54.1	3.3
.150	.199	47.2	3.2
.200	.249	39.7	3.1
.250	.299	33.9	3.4
.30C	.349	36.C	4.2
.350	.399	26.4	4.6
.40C	.449	25.5	1.7
.450	.499	22.4	1.7
.50C	.549	25.2	1.8
.550	.599	24.C	1.9
.600	.649	24.1	1.4

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 2.4 PER CENT.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE IX)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM 1.300 TO 1.399 GEV/C.

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2 [1]	
.050	.099	80.6 +-	3.9
.100	.149	63.8	3.7
.150	.199	46.6	3.2
.200	.249	38.6	3.2
.250	.299	40.8	3.7
.300	.349	28.0	4.1
.350	.399	23.0	1.7
.400	.449	18.8	1.5
.450	.499	15.3	1.4
.500	.549	15.1	1.4
.550	.599	13.5	1.4
.600	.649	14.0	1.5
.650	.699	11.8	1.4

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 2.8 PER CENT.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE X)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM 1.400 TO 1.499 GEV/C.

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2 [1]	
.050	.099	89.1 +-	5.0
.100	.149	68.5	4.3
.150	.199	54.6	4.0
.200	.249	42.7	3.6
.250	.299	32.1	3.6
.300	.349	22.6	3.3
.350	.399	19.8	4.5
.400	.449	19.3	1.7
.450	.499	16.4	1.5
.500	.549	12.7	1.4
.550	.599	10.5	1.3
.600	.649	8.5	1.2
.650	.699	10.4	1.4
.700	.749	5.5	1.1

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 2.5 PER CENT.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE XI)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM 1.500 TO 1.599 GEV/C.

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2 [1]	
.050	.099	93.5 +-	5.5
.100	.199	55.3	4.9
.200	.299	31.6	3.1
.300	.399	19.3	2.9
.400	.499	14.0	1.3
.500	.599	8.8	1.1
.600	.699	7.0	1.1
.700	.799	6.8	1.1
.800	.899	7.1	.9
.900	.999	6.6	1.1

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 1.4 PER CENT.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE XII)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM 1.600 TO 1.699 GEV/C.

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2 [1]	
.050	.099	93.8 +-	6.2
.100	.199	58.5	6.1
.200	.299	28.8	4.7
.300	.399	13.7	3.5
.500	.599	8.3	1.2
.600	.699	5.6	1.3
.700	.799	4.6	1.0
.800	.899	4.6	.9
.900	.999	5.6	1.1

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 1.1 PER CENT.

- -

ELASTIC DIFFERENTIAL CRCSS SECTICN FCR PRCTON PRCTON. [TABLE XIII]

DATA IS AVERAGED CVER LABORATORY BEAM MOMENTUM FROM 1.700 TO 1.799 GEV/C.

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2 [1]	
.050	.099	98.5 +-	9.1
.100	.199	46.0	8.9
.200	.299	27.2	8.7
.300	.399	16.9	7.7
.500	.599	6.8	1.3
.600	.699	6.2	1.2
.700	.799	6.5	1.3
.800	.899	4.8	1.5
.900	.999	5.0	1.6

T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING PROTON] AND THE [OUTGOING PROTON].

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 1.1 PER CENT.

FIT TO ELASTIC DIFFERENTIAL CRCSS SECTION FOR PROTON PROTON. [TABLE 14]

DATA IS FIT OVER LABCRATCRY BEAM MOMENTUM FROM .800 TO .899 GEV/C.
FITTED FORMULA IS D-SIGMA/D-T = A*EXP[-BT+CT**2]

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING PROTON] AND THE [OUTGOING PROTON].

FITTED VALUE

A = 87.1 +- 5.1
B = -.96 +- .55
C = 2.91 +- 1.81

FIT TO ELASTIC DIFFERENTIAL CRCSS SECTICN FOR PROTON PROTON. [TABLE 14]

DATA IS FIT CVER LABCRATCRY BEAM MOMENTUM FROM .900 TO .999 GEV/C.
FITTED FORMULA IS D-SIGMA/D-T = A*EXP[-BT+CT**2]

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING PROTON] ANC THE [OUTGOING PROTON].

FITTED VALUES

A = 78.8 +- 4.7
B = -1.17 +- .57
C = 1.89 +- 1.69

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PRCTON. [TABLE 14]

DATA IS FIT CVER LABORATORY BEAM MOMENTUM FROM 1.000 TO 1.099 GEV/C.
FITTED FORMULA IS D-SIGMA/D-T = A*EXP[-BT+CT**2]

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING PROTON] AND THE [OUTGOING PROTON].

FITTED VALUES

A = 64.7 +- 3.6
B = -1.00 +- .52
C = .72 +- 1.31

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PRCTON. [TABLE 14]

DATA IS FIT OVER LABCRATCRY BEAM MOMENTUM FROM 1.100 TO 1.199 GEV/C.
FITTED FORMULA IS D-SIGMA/D-T = A*EXP[-BT+CT**2]

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING PROTON] AND THE [OUTGOING PROTON].

FITTED VALUES

A = 60.4 +- 3.4
B = -2.01 +- .47
C = 2.10 +- .99

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. [TABLE 14]

DATA IS FIT OVER LABORATORY BEAM MOMENTUM FROM 1.200 TO 1.299 GEV/C.
FITTED FORMULA IS D-SIGMA/D-T = A*EXP[-BT+CT**2]

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING PROTON] ANC THE [OUTGOING PROTON].

FITTED VALUES

A = 79.6 +- 4.7
B = -4.38 +- .44
C = 3.96 +- .72

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. [TABLE 14]

DATA IS FIT OVER LABORATORY BEAM MOMENTUM FROM 1.300 TO 1.399 GEV/C.
FITTED FORMULA IS D-SIGMA/D-T = A*EXP[-BT+CT**2]

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING PROTON] AND THE [OUTGOING PROTON].

FITTED VALUES

A = 107.4 +- 5.8
B = -5.76 +- .41
C = 3.68 +- .69

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. [TABLE 14]

DATA IS FIT OVER LABORATORY BEAM MOMENTUM FROM 1.400 TO 1.499 GEV/C.
FITTED FORMULA IS D-SIGMA/D-T = A*EXP[-BT+CT**2]

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING PROTON] AND THE [OUTGOING PROTON].

FITTED VALUES

A = 116.1 +- 7.1
B = -5.45 +- .46
C = 2.04 +- .79

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. [TABLE 14]

DATA IS FIT OVER LABORATORY BEAM MOMENTUM FROM 1.500 TO 1.599 GEV/C.
FITTED FORMULA IS D-SIGMA/D-T = A*EXP[-BT+CT**2]

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING PROTON] AND THE [OUTGOING PROTON].

FITTED VALUES

A = 126.2 +- 9.6
B = -6.51 +- .34
C = 3.56 +- .39

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. [TABLE 14]

DATA IS FIT OVER LABORATORY BEAM MOMENTUM FROM 1.600 TO 1.699 GEV/C.
FITTED FORMULA IS D-SIGMA/D-T = A*EXP[-BT+CT**2]

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING PROTON] AND THE [OUTGOING PROTON].

FITTED VALUES

A = 137.0 +- 11.7
B = -7.20 +- .49
C = 3.80 +- .57

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. [TABLE 14]

DATA IS FIT OVER LABORATORY BEAM MOMENTUM FROM 1.700 TO 1.799 GEV/C.
FITTED FORMULA IS D-SIGMA/D-T = A*EXP[-BT+CT**2]

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING PROTON] AND THE [OUTGOING PROTON].

FITTED VALUES

A = 140.9 +- 15.7
B = -7.66 +- .59
C = 4.39 +- .72

38 EVIDENCE FOR A N*(1450) IN PP COLLISIONS AT 10 GEV/C. [NUOVO CIMENTO 50A, 1000 (1967)]

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CLOSELY RELATED REFERENCES
DATA SUPERSEDED BY PHYS. REV. 174, 1638 (1968).

ADDITIONAL CITATIONS
CERN TH 705 (1966), UCRL 8030 JAN. (1967), PHYS. LETTERS 8, 134 (1964), PHYS. LETTERS 8, 137 (1964), PHYS. REV. LETTERS 13, 555 (1964), PHYS. REV. LETTERS 14, 1043 (1965), PHYS. LETTERS 18, 167 (1965), NUOVO CIMENTO 35, 1052 (1965), PHYS. REV. LETTERS 16, 855 (1966), PHYS. REV. LETTERS 17, 709 (1966), PHYS. LETTERS 23, 386 (1966), NUOVO CIMENTO 24 , 493 (1962), NUOVO CIMENTO 39, 169 (1965), NUOVO CIMENTO 27, 1450 (1963), NUOVO CIMENTO 30, 240 (1963), DUBNA CONFERENCE 1 148 (1964), DESY 67/4 (1967), PHYS. REV. 150, 1292 (1966), PHYS. REV. LETTERS 7, 199 (1961), PHYS. REV. LETTERS 13, 169 (1964), PHYS. LETTERS 15, 281 (1965), PHYS. REV. LETTERS 17, 884 (1966), NUOVO CIMENTO 40, 839 (1965) , PHYS. REV. 154, 1284 (1967), NUOVO CIMENTO 47A, 232 (1967), PHYS. LETTERS 20, 554 (1966), PHYS. REV. LETTERS 16, 863 (1966), NUOVO CIMENTO 34, 1644 (1964), PHYS. LETTERS 18, 342 (1965), PHYS. LETTERS 12, 76 (1964), AND PHYS. REV. 139, B1566 (1965).

ARTICLE READ BY ODETTE BENARY IN 9/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 10.01 GEV/C.

THIS EXPERIMENT USES THE SACLAY 81 CM (H) BUBBLE CHAMBER. A TOTAL OF 80000 PICTURES ARE REPORTED ON.

KEY WORDS - CROSS SECTION MASS SPECTRUM N*(1470)P11 MODELS

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- -

(FROM PAGE 1001 AND PAGE 1005)

LABORATORY BEAM MOMENTUM = 10.01 +- .01 GEV/C.

(THIS DATA SHOULD NOT BE USED - MORE RECENT VALUES MAY BE FOUND IN ALMEIDA ET AL., PHYS. REV. 174, 1638 (1968))

REACTION	MILLI-BARNS	NO. EVENTS
PROTON PROTON +		
PROTON PROTON PI+ PI-	2.40 +- .20	1133
PROTON NEUTRON PI+	3.70 .40	657
PROTON N*(1470)+	.18 .04	
N*(1470)+ • PROTON PI+ PI- [1]		
PROTON N*(1470)+	.18 .12	
N*(1470)+ • NEUTRON PI+ [2]		

[1] FITTED FOR MASS AND/OR WIDTH (MASS = 1.450 GEV; WIDTH = .220 GEV), AND THEN TOOK ONLY EVENTS ABOVE (FITTED) BACKGROUND.
[2] FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH (MASS = 1.450 GEV; WIDTH = .220 GEV) AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.

39 PRODUCTION OF THE NUCLEON ISOBARS 1236, 1410, 1518, AND 1688 MEV IN PROTON-PROTON COLLISIONS AT 2.85, 4.55, 6.06, AND 7.88 GEV/C. (PHYS. REV. LETTERS 17, 789 (1966))

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W.S.CHAPMAN,P.I.P.KALMUS,J.LITT,M.C.MILLER,D.B.SCOTT,H.J.SHERMAN (QUEEN MARY COLLEGE, LONDON, ENGLAND)
A.ASTBURY,T.G.WALKER (RUTHERFORD HIGH EN. LAB., CHILTON,DID.BERK.ENGLAND)

ABSTRACT MOMENTUM SPECTRA OF PROTONS SCATTERED INELASTICALLY IN PROTON-PROTON COLLISIONS WERE OBTAINED IN AN EXTERNAL BEAM AT NIMROD USING INCIDENT PROTON MOMENTA OF 2.85, 4.55, 6.06, AND 7.88 GEV/C AND VARIOUS SCATTERING ANGLES IN THE RANGE 22 TO 144 MRAD. THERE IS EVIDENCE FOR THE PRODUCTION OF THE 1410 MEV ISOBAR AT SMALL ANGLES. THE WELL-KNOWN ISOBARS OF MASS VALUES 1236, 1518, AND 1688 MEV ARE ALSO SEEN. THE DIFFERENTIAL CROSS SECTIONS ARE PRESENTED FOR THE PRODUCTION OF THESE ISOBARS. THEY ARE ANALYZED IN TERMS OF THE USUAL VARIABLES S AND T. FITS TO THE OBSERVED MOMENTUM SPECTRA INDICATE FOR THE N*(1410) A MASS OF 1410 +- 15 MEV AND A WIDTH OF 125 +- 20 MEV.

CLOSELY RELATED REFERENCES
DATA SUPERSEDED BY NUOVO CIMENTO 63A, 529 (1969).

ADDITIONAL CITATIONS
PHYS. REV. LETTERS 4, 611 (1960), PHYS. REV. 128, 1823 (1962), PHYS. REV. LETTERS 7, 450 (1961), PHYS. LETTERS 8, 134 (1964), PHYS. LETTERS 18, 167 (1965), NUOVO CIMENTO 35, 1052 (1965), PHYS. REV. LETTERS 16, 855 (1966), REV. MOD. PHYS. 37, 633 (1965), PHYS. LETTERS 8, 137 (1964), PHYS. REV. LETTERS 13, 555 (1964), PHYS. REV. LETTERS 14, 1043 (1965), PHYS. REV. LETTERS 12, 340 (1964), PHYS. REV. 138, B190 (1965), PHYS. LETTERS 12, 76 (1964), PHYS. LETTERS 11, 339 (1964), AND PHYS. REV. LETTERS 14, 881 (1965).

ARTICLE READ BY ODETTE BENARY IN 5/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON FROM 2.85 TO 7.88 GEV/C.

THIS EXPERIMENT USES COUNTERS.

GENERAL COMMENTS ON THIS ARTICLE
1 NO DATA PUNCHED FOR THIS ARTICLE BECAUSE SAME DATA ARE MORE RECENTLY REPORTED IN NC 63A, 529(1969)

KEY WORDS • CROSS SECTION

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- -

* * * * * * * * * * * * * * * * * * * *
* NO DATA PUNCHED FOR THIS ARTICLE *
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40 DISCONTINUOUS BEHAVIOUR IN LARGE ANGLE PROTON-PROTON ELASTIC SCATTERING AT HIGH ENERGIES. (PHYS. LETTERS 25B, 156 (1967))

J.V.ALLABY,G.COCCONI,A.N.DIDDENS,A.KLOVNING,G.MATTHIAE,E.J.SACHARIDIS, A.M.WETHERELL (EUROPEAN ORG. FOR NUC. RES., GENEVA, SWITZERLAND)

ABSTRACT MEASUREMENTS OF ELASTIC PROTON-PROTON DIFFERENTIAL CROSS SECTIONS FOR ANGLES BETWEEN 65 DEG. AND 90 DEG. C.M.S. HAVE BEEN MADE AT 8, 9, 10, 11, 14, 15 AND 21 GEV/C. THE SHAPE OF THE ANGULAR DISTRIBUTION IS FOUND TO CHANGE SUDDENLY BETWEEN 8 AND 11 GEV/C. AN INTERPRETATION OF THIS DISCONTINUOUS BEHAVIOUR IN TERMS OF THE REACTIVE EFFECTS OF BARYON-ANTIBARYON PAIR PRODUCTION IS PROPOSED.

CLOSELY RELATED REFERENCES
THIS ARTICLE SUPERSEDES PHYS. LETTERS 23, 389 (1966).
PART OF THIS ARTICLE SUPERSEDED BY CERN 68-7 580, AND CERN HADRON CONFERENCE 1 580 (1968).

ADDITIONAL CITATIONS
CERN TH 406 (1964), ANNUAL REV. OF NUCLEAR SCIENCE 11, 183 (1966), UCRL 16275, UCRL 11441, PHYS. REV. 128, 2392 (1962), ANNUAL REV. OF NUCLEAR SCIENCE 13, 261 (1963), PHYS. LETTERS 13, 190 (1964), PHYS. REV. 138, B165 (1963), UCRL 17257 , PHYS. REV. LETTERS 17, 1105 (1966), PHYS. LETTERS 8, 80 (1964), AND PHYS. REV. LETTERS 12, 257 (1964).

ARTICLE READ BY ODETTE BENARY IN 10/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON FROM 8.1 TO 21.3 GEV/C.

THIS EXPERIMENT USES COUNTERS.

GENERAL COMMENTS ON THIS ARTICLE
1 AT 8, 9, AND 10 GEV/C, CH2 TARGETS WERE USED.

KEY WORDS • DIFFERENTIAL CROSS SECTION FITS

COMPOUND KEY WORDS • FITS DIFFERENTIAL CROSS SECTION

- -
- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 8.1 GEV/C.

(THIS DATA SHOULD NOT BE USED - MORE RECENT VALUES MAY BE FOUND IN ALLABY, ET AL., CERN 68-7 580 (1968))

THETA DEGREES	D-SIGMA/D-OMEGA UB/SR [1]
68.8	.543 +- .016
72.2	.455 .020
76.2	.323 .010
82.2	.214 .007

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7.14 PER CENT.

- -

ELASTIC DIFFERENTIAL CRCSS SECTION FCR PROTON PROTON. [TABLE 1]

LABORATORY BEAM MOMENTUM = 9.1 GEV/C.

[THIS DATA SHOULD NOT BE USED - MCRE RECENT VALUES MAY BE FOUND IN ALLABY, ET AL., CERN 68-7 580 (1968)]

THETA DEGREES	D-SIGMA/D-OMEGA UB/SR [1]	
68.1	.188 +-	.005
74.2	.118	.C03
82.2	.094	.C03

THETA IS THE ANGLE THAT THE PROTCN MAKES WITH THE BEAM IN THE GRAND C.M.

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7.14 PER CENT.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FCR PROTON PROTON. [TABLE 1]

LABORATORY BEAM MOMENTUM = 10. GEV/C.

[THIS DATA SHOULD NOT BE USEC - MORE RECENT VALUES MAY BE FOUND IN ALLABY, ET AL., CERN 68-7 580 (1968)]

THETA DEGREES	D-SIGMA/D-OMEGA UB/SR [1]	
67.	.1062 +-	.0017
70.	.0791	.0017
75.	.0589	.C015
83.	.0494	.0011

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7.14 PER CENT.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FCR PROTON PROTON. [TABLE 1]

LABORATORY BEAM MOMENTUM = 11. GEV/C.

[THIS DATA SHOULD NOT BE USEC - MORE RECENT VALUES MAY BE FOUND IN ALLABY, ET AL., CERN 68-7 580 (1968)]

THETA DEGREES	D-SIGMA/D-OMEGA UB/SR [1]	
73.	.0360 +-	.0C09
78.	.0296	.0C07
86.	.0269	.CC09

THETA IS THE ANGLE THAT THE PROTCN MAKES WITH THE BEAM IN THE GRAND C.M.

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7.14 PER CENT.

- -

ELASTIC DIFFERENTIAL CRCSS SECTICN FOR PROTON PROTON. [TABLE 1]

LABORATORY BEAM MOMENTUM = 14.29 GEV/C.

(THESE VALUES HAVE BEEN CORRECTED ACCORDING TO CERN 68-7 VOL. 1, PAGE 580.)

THETA DEGREES	D-SIGMA/D-OMEGA NANOBARNS/SR [1]	
67.	8.11 +-	.25
71.	6.27	.20
77.	4.47	.15
90.	3.54	.10

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7.14 PER CENT.

- -

ELASTIC DIFFERENTIAL CROSS SECTICN FCR PROTCN PROTON. [TABLE 1]

LABORATORY BEAM MOMENTUM = 16.9 GEV/C.

[THIS DATA REPLACES VALUES GIVEN EARLIER IN ALLABY ET AL., PHYS. LETTERS 23, 389 (1966)]

(THESE VALUES HAVE BEEN CCRRECTED ACCORDING TO CERN 68-7 VOL.1, PAGE 580.)

THETA DEGREES	D-SIGMA/D-OMEGA NANCBARNS/SR [1]	
67.	2.15 +-	.04
70.	1.69	.C6
72.	1.53	.C5
75.	1.29	.C4
77.	1.10	.03
80.	.98	.04
82.	.92	.03
85.	.87	.04
90.	.80	.05

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7.14 PER CENT.

- -

ELASTIC CIFFERENTIAL CRCSS SECTICN FCR PROTCN PROTON. [TABLE 1]

LABORATORY BEAM MOMENTUM = 19.3 GEV/C.

(THESE VALUES HAVE BEEN CCRRECTED ACCORDING TO CERN 68-7 VOL. 1, PAGE 580.)

THETA DEGREES	D-SIGMA/C-OMEGA NANCBARNS/SR [1]	
64.	.723 +-	.C3C
69.	.419	.028
75.	.25C	.C21
90.	.199	.018

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7.14 PER CENT.

- -

ELASTIC DIFFERENTIAL CRCSS SECTICN FCR PROTON PROTON. [TABLE 1]

LABORATORY BEAM MOMENTUM = 21.3 GEV/C.

(THESE VALUES HAVE BEEN CCRRECTED ACCORDING TO CERN 68-7 VOL. 1, PAGE 580.)

THETA DEGREES	C-SIGMA/D-OMEGA NANCBARNS/SR [1]	
66.	.231 +-	.C19
70.	.142	.012
75.	.106	.008
87.	.064	.CC9

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

[1] PLUS POSSIBLE SYSTEMATIC ERRCR OF +- 7.14 PER CENT.

41 ELASTIC SCATTERING ANC SINGLE-PION PRODUCTION IN PROTON-PRCTCN INTERACTIONS AT 6.92 BEV/C. [PHYS. REV. 173, 1322 (1968)]

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ABSTRACT ELASTIC SCATTERING AND SINGLE-PICN PRODUCTION IN PP COLLISIONS AT 6.92 BEV/C WERE STUDIED IN THE BNL 80-IN. HYDROGEN BUBBLE CHAMBER. PARTIAL CROSS SECTIONS FOR THE DIFFERENT FINAL STATES ARE GIVEN. THE REACTION PP→ NEUTRON N*(1238)++ WITH SIGMA = 1.9 +- 0.3 MB IS ANALYZED AND IS IN AGREEMENT WITH THE MODIFIED CNE-PION EXCHANGE MODEL. SINGLE-PION PRODUCTION CAN BE EXPLAINED AS DUE MAINLY TC TWO CHANNELS -- (A) PP→N*(1238)++ NEUTRON AND (B) PP→P(N PI+) OR PP→P(P PIO), WHERE THE (N PI+) AND (P PIO) PAIRS ARE IN AN I = 1/2 STATE.

CLOSELY RELATED REFERENCES
SEE ALSO NUOVO CIMENTO 53, 455 (1968).

ADDITIONAL CITATIONS
PHYS. REV. 154, 1284 (1967), PHYS. REV. 146, 980 (1966), PHYS. REV. 144, 1122 (1966), PHYS. REV. 160, 1410 (1967), NUOVO CIMENTO 33, 309 (1964), PHYS. REV. 151, 1306 (1966), UCRL 18010 (1967), PHYS. REV. 168, 1773 (1968), PHYS. REV. 125, 2082 (1962), PHYS. REV. 162, 1320 (1967), NUOVO CIMENTO 49A, 475 (1967), NUOVO CIMENTO 53A, 232 (1968), PHYS. REV. LETTERS 16, 855 (1966), ANC PHYS. REV. LETTERS 17, 789 (1966).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 6.92 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 80 IN. (H) BUBBLE CHAMBER. A TOTAL OF 64000 PICTURES ARE REPORTED ON.

KEY WORDS • CROSS SECTION DIFFERENTIAL CROSS SECTION FITS ANGULAR DISTRIBUTION MASS SPECTRUM MODELS DENSITY MATRIX DALITZ PLOT REAL (AMPLITUDE)/IMAGINARY (AMPLITUDE) DELTA(1238)

COMPOUND KEY WORDS • FITS DIFFERENTIAL CROSS SECTION

- -
- -

[FROM PAGE 1322, TABLE 1, AND PAGE 1326]

LABORATORY BEAM MOMENTUM = 6.920 +- .075 GEV/C.

REACTION	MILLI-BARNS		NO. EVENTS
PROTON PROTON →			
TOTAL	42.6 +-	1.3	20000
ELASTIC	11.4	.5	
PROTON NEUTRON PI+	5.2	.4	
PROTCN PROTON PIO	2.0	.2	
NEUTRON DELTA(1238)++	1.9	.3	
DELTA(1238)++ → PROTON PI+ [1]			
2 PRONGS	28.4	.3	

[1] FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (FIGURE 2)

LABORATORY BEAM MOMENTUM = 6.920 +- .075 GEV/C.

. THIS DATA WAS READ FROM A GRAPH .

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2 [1]		NO. EVENTS
.01	.02	14.0	+- 2.6	28.0
.02	.03	40.0	4.5	80.0
.03	.04	50.0	5.0	100.0
.04	.05	68.0	5.8	136.0
.05	.06	50.0	5.0	100.0
.06	.07	54.0	5.2	108.0
.07	.08	48.0	4.9	96.0
.08	.09	43.0	4.6	86.0
.09	.10	50.0	5.0	100.0
.10	.11	40.0	4.5	80.0
.11	.12	31.0	3.9	62.0
.12	.13	24.0	3.5	48.0
.13	.14	29.0	3.8	58.0
.14	.15	22.0	3.3	44.0
.15	.16	18.0	3.0	36.0
.16	.17	28.0	3.7	56.0
.17	.18	27.0	3.7	54.0
.18	.19	20.0	3.2	40.0
.19	.20	12.0	2.4	24.0
.20	.21	15.0	2.7	30.0
.21	.22	13.0	2.5	26.0
.22	.23	14.0	2.6	28.0
.23	.24	13.0	2.5	26.0
.24	.25	6.0	1.7	12.0
.25	.26	13.5	2.6	27.0
.26	.27	11.0	2.3	22.0
.27	.28	12.0	2.4	24.0
.28	.29	10.5	2.3	21.0
.29	.30	17.0	2.9	34.0
.30	.31	13.5	2.6	27.0
.31	.32	14.0	2.6	28.0
.32	.33	10.0	2.2	20.0
.33	.34	8.0	2.0	16.0
.34	.35	5.0	1.6	10.0
.35	.36	4.0	1.4	8.0
.36	.37	6.0	1.7	12.0
.37	.38	5.0	1.6	10.0
.38	.39	2.7	1.2	5.4
.39	.40	2.0	1.0	4.0
.40	.41	3.0	1.2	6.0
.41	.42	6.0	1.7	12.0
.42	.43	2.0	1.0	4.0
.43	.44	4.5	1.5	9.0
.44	.45	5.0	1.6	10.0
.45	.46	4.5	1.5	9.0
.46	.47	4.5	1.5	9.0
.47	.48	1.0	.7	2.0
.49	.50	1.0	.7	2.0
.50	.51	1.0	.7	2.0
.51	.52	.5	.5	1.0
.52	.53	1.5	.9	3.0
.53	.54	.5	.5	1.0
.54	.55	1.0	.7	2.0
.55	.56	1.5	.9	3.0
.56	.57	1.0	.7	2.0
.57	.58	.5	.5	1.0
.58	.59	1.5	.9	3.0
.59	.60	.5	.5	1.0
.60	.61	1.5	.9	3.0
.61	.62	1.5	.9	3.0

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

[1] COUNTS WERE MULTIPLIED BY .5 TO GET THESE. ERRORS ARE TAKEN AS PROPORTIONAL TO THE SQUARE-ROOT OF THE COUNTS.

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (PAGE 1324)

LABORATORY BEAM MOMENTUM = 6.920 +- .075 GEV/C.

DATA IS FIT OVER -T FROM .04 TO .12 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(B[T])

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 89.3 +- 6.7
B = 7.7 +- .5

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (PAGE 1323)

LABORATORY BEAM MOMENTUM = 6.920 +- .075 GEV/C.

DATA IS FIT OVER -T FROM .04 TO .50 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(B[T]+C[T**2])

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 94.0 +- 2.5
B = 9.03 +- .15
C = 3.68 +- .60

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → DELTA(1238)++ NEUTRON. (FIGURE 8)
DELTA(1238)++ → PROTON PI+ (1)

LABORATORY BEAM MOMENTUM = 6.920 +- .075 GEV/C.

(BACKGROUND ESTIMATED TO BE <15 PER CENT.)

. THIS DATA WAS READ FROM A GRAPH .

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2
.000	.025	11.0
.025	.050	13.0
.050	.075	13.5
.075	.100	7.0
.100	.125	3.7
.125	.150	4.7
.150	.175	1.7
.175	.200	4.0
.200	.225	3.0
.225	.250	1.4
.250	.275	2.0
.275	.300	1.6
.300	.325	2.4
.325	.350	.0
.350	.375	1.0
.375	.400	.4
.400	.425	.0
.425	.450	1.0
.450	.475	.5
.475	.500	.3
.500	.525	.6
.525	.550	.4
.550	.575	.6
.575	.600	.4

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (DELTA(1238)++).

(1) COUNTED ALL EVENTS IN MASS BAND.

42 A BUBBLE-CHAMBER STUDY OF PROTON-PROTON COLLISIONS AT 4 GEV/C. II. - MULTIPLE PION PRODUCTION. (NUOVO CIMENTO 58A, 175 (1968))

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ABSTRACT ABOUT 50,000 PICTURES WERE TAKEN IN THE 81 CM SACLAY HYDROGEN BUBBLE CHAMBER EXPOSED AT THE CERN PROTON-SYNCHROTRON TO A SEPARATED BEAM OF 4 GEV/C INCIDENT MOMENTUM PROTONS. CROSS-SECTIONS FOR THE VARIOUS CHANNELS FOR MULTIPLE PION PRODUCTION ARE REPORTED, AS WELL AS PRODUCTION CROSS-SECTIONS FOR BARYON AND BOSON RESONANCES, TAKING INTO ACCOUNT THE PERIPHERAL BEHAVIOUR OF THE INTERACTION IN THE EVALUATION OF THE BACKGROUND. ALL THE CHANNELS APPEAR TO BE DOMINATED BY THE N*(1236) ISOBAR PRODUCTION, WHILE THE PRESENCE OF HIGHER ISOBARS DOES NOT SEEM TO AFFECT APPRECIABLY THE GENERAL FEATURES OF THE DIFFERENT REACTIONS. THE ONLY CLEAR EVIDENCE AMONG THE BOSON RESONANCES IS FOR ETA (SIGMA(ETA) = (0.04 +- 0.02) MB) AND OMEGA (SIGMA(OMEGA) = (0.08 +- 0.03) MB). THERE IS NO STRONG EVIDENCE FOR THE I = 5/2 ISOBAR AROUND 1.58 GEV/C-SQUARED. FINALLY AN ANALYSIS OF REACTIONS PRODUCING MORE THAN ONE NEUTRAL PARTICLE HAS BEEN TRIED, ALLOWING AN ESTIMATE OF THE MEAN MULTIPLICITIES FOR BOTH CHARGED AND UNCHARGED PIONS.

CLOSELY RELATED REFERENCES
THIS ARTICLE SUPERSEDES SIENNA CONFERENCE 1 348 (1963).
THIS ARTICLE SUPERSEDES PART OF PHYS. LETTERS 16, 75 (1965).
CONTINUATION OF PREVIOUS EXPERIMENT IN NUOVO CIMENTO 49A, 479 (1967).

ADDITIONAL CITATIONS
NUOVO CIMENTO 43A, 1210 (1966), UCRL 8030 JAN. (1968), CERN 65-7 (1965), CERN 66-18 (1966), CERN TH 837 (1967), PHYS. REV. LETTERS 17, 884 (1966), PHYS. REV. 138B, 190 (1965), PHYS. REV. LETTERS 15, 468 (1965), NUOVO CIMENTO 55A, 66 (1968), NUOVO CIMENTO 50A, 1000 (1967), NUOVO CIMENTO 24, 453 (1962), CORAL GABLES CONFERENCE 89 (1965), PHYS. REV. LETTERS 15, 207 (1965), PHYS. LETTERS 21, 582 (1966), AND PHYS. REV. 154, 1284 (1967).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 4 GEV/C.

THIS EXPERIMENT USES THE SACLAY 81 CM (H) BUBBLE CHAMBER. A TOTAL OF 50000 PICTURES ARE REPORTED ON.

KEY WORDS → CROSS SECTION ANGULAR DISTRIBUTION FITS MASS SPECTRUM DALITZ PLOT MODELS
DELTA(1238) ETA(548) OMEGA(783) 'N*(1688)' N*(1520)D13

COMPOUND KEY WORDS → FITS ANGULAR DISTRIBUTION

(TABLE 1)

LABORATORY BEAM MOMENTUM = 4. GEV/C.

REACTION	MILLI-BARNS		NO. EVENTS
PROTON PROTON →			
PROTON PROTON PI+ PI-	2.95 +-	.15	1206
PROTON PROTON PI+ PI- PI0	1.10	.10	448
PROTON NEUTRON PI+ PI+ PI-	1.60	.10	636
PROTON NEUTRON PI+ MM≥1PI0	3.60	.60	985
PROTON PROTON MM≥2PI0	1.20	.30	203
NEUTRON NEUTRON PI+ PI+ MM≥0PI0	1.50	.30	254
4 PRONGS	7.50	.20	3066
6 PRONGS	.09	.02	46

CROSS SECTION FOR PROTON PROTON → PROTON NUCLEON RHO(765) PION. (PAGE 489)

LABORATORY BEAM MOMENTUM GEV/C	MICRO-BARNS
4.	< 150.

(PAGE 490)

LABORATORY BEAM MOMENTUM = 4. GEV/C.

REACTION	MILLI-BARNS
PROTON PROTON →	
PROTON PROTON ETA(548)	.04 +- .02
ETA(548) → PI+ PI- PIO [1]	
PROTON PROTON OMEGA(783)	.08 .03
OMEGA(783) → PI+ PI- PIO [2]	

[1] FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.
[2] FITTED FOR MASS AND/OR WIDTH [MASS = .784 GEV; WIDTH = .014 GEV], AND THEN TOOK ONLY EVENTS ABOVE (FITTED) BACKGROUND.

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(PAGE 491)

LABORATORY BEAM MOMENTUM = 4. GEV/C.

REACTION	MILLI-BARNS
PROTON PROTON →	
DELTA(1238)++ N*(1520)0	.04 +- .04
DELTA(1238)++ → PROTON PI+ [1]	
N*(1520)0 → PROTON PI- PIO [1]	
DELTA(1238)++ 'N*(1688)0'	.12 .07
DELTA(1238)++ → PROTON PI+ [1]	
'N*(1688)0' → PROTON PI- PIO [1]	

[1] FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.

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(PAGE 493)

LABORATORY BEAM MOMENTUM = 4. GEV/C.

REACTION	MICRO-BARNS
PROTON PROTON →	
DELTA(1238)++ DELTA(1238)- PI+	640. +- 160.
DELTA(1238)++ → PROTON PI+ [1]	
DELTA(1238)- → NEUTRON PI- [1]	
DELTA(1238)++ NEUTRON PI+ PI-	< 30.
DELTA(1238)++ → PROTON PI+ [1]	
DELTA(1238)- PROTON PI+ PI+	< 100.
DELTA(1238)- → NEUTRON PI- [1]	

[1] FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.

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(TABLE 3)

LABORATORY BEAM MOMENTUM = 4. GEV/C.

REACTION	MILLI-BARNS
PROTON PROTON →	
PROTON PI+ NEUTRON PIO	3.8 +- .3
PROTON PI+ NEUTRON PIO PIO	1.8 .2

43 ELASTIC PROTON-PROTON SCATTERING AT 90 DEG. AND STRUCTURE WITHIN THE PROTON (PHYS. REV. 159, 1138 (1967))

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ABSTRACT THE DIFFERENTIAL CROSS SECTION OF PROTON-PROTON ELASTIC SCATTERING AT 90 DEG. IN THE CENTER-OF-MASS SYSTEM WAS MEASURED AT LABORATORY MOMENTA RANGING FROM 5.0 TO 13.4 GEV/C. FIFTY-ONE MEASUREMENTS WERE MADE AT MOMENTUM INTERVALS OF 100 OR 200 MEV/C. THE EXTRACTED PROTON BEAM OF THE ZGS IMPINGED UPON A CH2 TARGET. THE TWO SCATTERED PROTONS WERE DETECTED BY TWO SPECTROMETERS CONSISTING OF MAGNETS AND SCINTILLATION COUNTER TELESCOPES IN COINCIDENCE. THE INCIDENT BEAM FLUX WAS MEASURED BY RADIOCHEMICAL ANALYSIS OF THE CH2 TARGETS. THE EXPERIMENT SHOWED NO EVIDENCE FOR ANY S=0, T=1 DIBARYON RESONANCES IN THE 3300 - 5200 MEV MASS RANGE. IT ALSO YIELDED SOME INFORMATION ABOUT THE VALIDITY OF THE STATISTICAL MODEL AND THE ANALYTICITY OF THE SCATTERING AMPLITUDE. THE MOST INTERESTING RESULT OF THE EXPERIMENT WAS A SHARP BREAK IN THE FIXED-ANGLE CROSS SECTION. THIS MAY BE EVIDENCE FOR THE EXISTENCE OF TWO INNER REGIONS OF THE PROTON WITH RADII 0.51 +- .02 AND 0.34 +- .02 F.

CITATIONS
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ARTICLE READ BY LEROY PRICE IN 10/67, AND VERIFIED BY ODETTE BENARY.

BEAM IS PROTON ON HYDROGEN COMPOUND FROM 5.0 TO 13.4 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS → PROTON   CROSS SECTION   DIFFERENTIAL CROSS SECTION   MODELS   FORM FACTORS

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- -

ELASTIC DIFFERENTIAL CROSS SECTION (AT FIXED ANGLE OR T) FOR PROTON PROTON. (TABLE 1)

THETA = 90. DEGREES. THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

LABORATORY BEAM MOMENTUM GEV/C [1]		D-SIGMA/D-OMEGA UB/SR [2]	PER CENT
5.000 +-	.005	8.5100 +-	2.9
5.100	.005	7.9000	3.3
5.200	.005	7.0900	3.1
5.300	.005	6.4900	3.6
5.400	.005	5.5300	3.1
5.500	.005	4.9000	3.4
5.600	.005	4.4700	3.1
5.700	.005	3.7200	3.3
5.800	.005	3.3700	3.3
5.900	.005	2.7400	3.5
6.000	.005	2.4400	3.1
6.100	.005	2.1900	3.7
6.200	.005	1.8300	3.7
6.400	.005	1.5000	3.7
6.600	.005	1.0700	4.7
6.800	.005	.7960	4.7
7.000	.005	.6450	4.1
7.200	.005	.5150	4.0
7.400	.005	.3860	4.8
7.600	.005	.3050	5.4
7.800	.005	.2530	4.5
8.000	.005	.2170	4.5
8.100	.005	.1690	3.9
8.200	.005	.1720	4.4
8.300	.005	.1540	3.8
8.400	.005	.1530	4.6
8.600	.005	.1270	4.6
8.800	.005	.1030	4.8
9.000	.005	.0809	4.6
9.200	.005	.0780	4.3
9.400	.005	.0676	5.3
9.600	.005	.0589	4.9
9.800	.005	.0536	4.7
10.000	.005	.0468	4.9
10.200	.005	.0440	4.8
10.400	.005	.0386	4.7
10.600	.005	.0356	4.8
10.800	.005	.0303	4.9
11.000	.005	.0284	5.5
11.200	.005	.0255	5.4
11.400	.005	.0202	5.4
11.600	.005	.0190	5.2
11.800	.005	.0153	5.4
12.000	.005	.0143	5.4
12.200	.005	.0118	5.3
12.400	.005	.0116	5.4
12.600	.005	.0095	6.3
12.800	.005	.0087	5.7
13.000	.005	.0074	5.9
13.200	.005	.0072	7.1
13.400	.005	.0053	5.7

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- .5 PER CENT.
[2] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 2 PER CENT.

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44 NUCLEON-NUCLEON POLARIZATION BETWEEN 300 AND 700 MEV. (PHYS. REV. 163, 1470 (1967))

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ABSTRACT THE POLARIZATION PARAMETER P(THETA *)HAS BEEN MEASURED AT BEAM ENERGIES OF 310, 400, 500, 600, AND 700 MEV OVER THE RANGE IN THE C.M. SCATTERING ANGLES 30 DEG ≤ THETA * ≤150 DEG TO AN ACCURACY OF TYPICALLY +- 0.03 FOR PN SCATTERING, AND +- 0.02 FOR PP SCATTERING. A POLARIZED PROTON BEAM WAS SCATTERED FROM AN UNPOLARIZED TARGET--DEUTERION FOR QUASIFREE PN AND PP MEASUREMENTS, HYDROGEN FOR FREE PP MEASUREMENTS--AND BOTH OF THE OUTGOING NUCLEONS FROM THE (QUASI-) ELASTIC SCATTER WERE DETECTED BY AN ARRAY OF 27 SCINTILLATION COUNTERS IN MULTICHANNEL COINCIDENCES. IT WAS FOUND THAT P(THETA *) FOR PP SCATTERING CAN BE APPROXIMATED BY A SIN THETA * COS THETA *, WHERE A VARIES FROM -0.25 AT 310 MEV TO -0.4 AT 700 MEV IN THIS RANGE. A COMPARISON OF P(THETA *) FOR FREE AND QUASIFREE PP SCATTERING REVEALS GOOD AGREEMENT BETWEEN THE TWO.

CITATIONS
PHYS. REV. 85, 947 (1952), UCRL 11339 (1964), UCRL 121 (1949), PHYS. REV. 117, 485 (1959), PHYS. REV. 137, 862C (1965), AND UCRL 11926 (1965).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM NO. 1 IS PROTON ON PROTON FROM .823 TO 1.343 GEV/C. (BEAM KINETIC ENERGY = .31 TO .70 GEV) (POLARIZED BEAM)
NO. 2 IS PROTON ON DEUTERON FROM .823 TO 1.343 GEV/C. (BEAM KINETIC ENERGY = .31 TO .70 GEV) (POLARIZED BEAM)

THIS EXPERIMENT USES COUNTERS.

GENERAL COMMENTS ON THIS ARTICLE
1 BEAM IS POLARIZED BY SCATTERING ON CARBON.

KEY WORDS - POLARIZATION FITS

COMPOUND KEY WORDS - FITS POLARIZATION

ELASTIC POLARIZATION FOR PROTON PROTON. (TABLE 4)

LABORATORY BEAM ENERGY = .7 GEV.

(USING HYDROGEN TARGET)

THETA DEGREES		POLARIZATION [1]	
30.8 +-	1.7	.555 +-	.019
35.7	1.7	.527	.012
43.2	3.5	.558	.016
52.4	3.1	.529	.022
60.1	3.6	.474	.011
68.7	3.3	.354	.039
77.0	3.6	.255	.015
86.1	3.5	.109	.038

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3 PER CENT.

ELASTIC POLARIZATION FOR PROTON PROTON. (TABLE 4)

LABORATORY BEAM ENERGY = .6 GEV.

(USING HYDROGEN TARGET)

THETA DEGREES		POLARIZATION (1)	
33.6	+- 2.5	.513	+- .010
34.5	1.5	.595	.035
46.1	3.6	.516	.010
49.5	3.2	.484	.010
63.1	3.6	.399	.019
65.6	3.4	.361	.038
80.2	3.6	.168	.010
82.9	3.5	.114	.025

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3 PER CENT.

ELASTIC POLARIZATION FOR PROTON PROTON. (TABLE 4)

LABORATORY BEAM ENERGY = .5 GEV.

(USING HYDROGEN TARGET)

THETA DEGREES		POLARIZATION (1)	
33.7	+- 2.3	.490	+- .011
36.8	1.0	.510	.059
46.9	3.6	.461	.018
48.7	3.1	.452	.014
64.1	3.6	.270	.010
64.6	3.3	.313	.025
81.3	3.6	.107	.015
81.8	3.5	.113	.016

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3 PER CENT.

ELASTIC POLARIZATION FOR PROTON PROTON. (TABLE 4)

LABORATORY BEAM ENERGY = .4 GEV.

(USING HYDROGEN TARGET)

THETA DEGREES		POLARIZATION (1)	
33.8	+- 2.3	.442	+- .014
47.8	3.1	.419	.008
48.0	3.6	.419	.011
63.5	3.3	.275	.008
65.2	3.7	.272	.010
80.6	3.5	.105	.008
82.5	3.7	.084	.009

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3 PER CENT.

ELASTIC POLARIZATION FOR PROTON PROTON. (TABLE 4)

LABORATORY BEAM ENERGY = .31 GEV.

(USING HYDROGEN TARGET)

THETA DEGREES		POLARIZATION (1)	
33.6	+- 2.4	.402	+- .025
47.3	2.8	.374	.007
50.1	2.7	.362	.011
62.4	3.2	.276	.007
66.3	3.7	.217	.008
79.4	3.5	.117	.007
83.7	3.6	.035	.008

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3 PER CENT.

ELASTIC POLARIZATION FOR PROTON NEUTRON. (TABLE 3)

LABORATORY BEAM ENERGY = .7 GEV.

(USING DEUTERIUM TARGET.)
GLAUBER CORRECTION APPLIED

THETA DEGREES		POLARIZATION (1)	
29.5	+- 6.7	.334	+- .027
44.3	6.7	.305	.017
60.4	6.5	.157	.033
77.1	6.0	-.068	.030
93.8	5.7	-.352	.026
110.9	5.4	-.411	.032
127.1	5.3	-.247	.019
143.2	4.9	-.146	.019

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE NEUTRON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3 PER CENT.

ELASTIC POLARIZATICN FCR PROTCN NEUTRCN. (TABLE 3)

LABORATORY BEAM ENERGY = .6 GEV.

(USING DEUTERIUM TARGET)
GLAUBER CORRECTICN APPLIED

THETA DEGREES		POLARIZATION (1)	
33.0 +-	6.0	.364 +-	.040
48.5	5.8	.251	.C41
64.8	5.6	.C84	.C30
81.3	5.7	-.155	.028
97.8	5.6	-.315	.C31
114.7	5.6	-.345	.C30
130.5	5.6	-.241	.023
145.6	5.1	-.090	.C23

THETA IS THE ANGLE THAT THE PROTCN MAKES WITH THE BEAM IN THE GRANC C.M.
THE POLARIZATION IS CF THE NEUTRON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3 PER CENT.

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ELASTIC POLARIZATICN FCR PROTON NEUTRON. (TABLE 3)

LABORATORY BEAM ENERGY = .5 GEV.

(USING DEUTERIUM TARGET)
GLAUBER CORRECTICN APPLIED

THETA DEGREES		POLARIZATION (1)	
33.4 +-	5.8	.297 +-	.C24
48.5	6.1	.255	.C16
64.7	5.9	.090	.C17
81.2	5.9	-.155	.017
97.9	5.9	-.264	.018
115.0	5.9	-.263	.C17
13C.9	5.7	-.147	.017
145.2	4.9	-.111	.C17

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRANC C.M.
THE POLARIZATION IS OF THE NEUTRON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRANC C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3 PER CENT.

- -

ELASTIC POLARIZATICN FOR PROTCN NEUTRON. (TABLE 3)

LABORATORY BEAM ENERGY = .4 GEV.

(USING DEUTERIUM TARGET)
GLAUBER CORRECTICN APPLIED

THETA DEGREES		POLARIZATION (1)	
33.1 +-	6.9	.411 +-	.087
48.3	6.9	.264	.023
66.6	7.2	.089	.032
83.1	7.0	-.152	.026
99.7	6.8	-.309	.025
116.5	6.6	-.272	.022
131.1	5.9	-.158	.018
144.3	5.1	-.104	.056

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE NEUTRON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3 PER CENT.

- -

ELASTIC POLARIZATICN FOR PROTCN NEUTRON. (TABLE 3)

LABORATORY BEAM ENERGY = .31 GEV.

(USING DEUTERIUM TARGET)
GLAUBER CORRECTION APPLIED

THETA DEGREES		POLARIZATION (1)	
33.1 +-	6.7	.421 +-	.C38
47.8	7.2	.287	.026
66.7	8.1	.093	.02C
83.2	8.0	-.114	.024
99.8	7.8	-.239	.C19
116.5	7.6	-.218	.C16
13C.7	6.8	-.174	.018
141.5	7.2	-.133	.C31

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRANC C.M.
THE POLARIZATION IS OF THE NEUTRON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRANC C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3 PER CENT.

45 ISOBAR PRODUCTION MECHANISMS IN PROTON-PROTON COLLISIONS AT 5 GEV/C. (PHYS. REV. 161, 1387 (1967))

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ABSTRACT APPROXIMATELY 7500 FOUR-PRONG PROTON-PROTON COLLISIONS AT 5 GEV/C HAVE BEEN STUDIED USING THE BNL 80-IN. HYDROGEN BUBBLE CHAMBER. THE THREE PRINCIPAL REACTIONS STUDIED WITH THEIR CROSS SECTIONS ARE (A) PP-PP PI+ PI- 2.96 +- 0.12 MB, (B) PP-PP PI+ PI- PIO 1.76 +- 0.07 MB, (C) PP-P N PI+ PI+ PI- 2.19 +- 0.09 MB. IN EACH REACTION BOTH SINGLE AND DOUBLE N* PRODUCTION OCCURS AND THE DECAY ANGULAR DISTRIBUTIONS AND DENSITY MATRIX ELEMENTS HAVE BEEN CALCULATED WHENEVER POSSIBLE. THESE PARAMETERS INDICATE THAT PSEUDOSCALAR (PION) EXCHANGE APPEARS TO BE DOMINANT AT LOW VALUES OF MOMENTUM TRANSFER AND THAT AT HIGHER MOMENTUM TRANSFER ABSORPTIVE EFFECTS BECOME IMPORTANT. WE FIND NO EVIDENCE FOR RHO EXCHANGE IN THE REACTION PP-N*++ N*0. THE FORMATION OF THE ETA AND OMEGA MESON RESONANCES IS OBSERVED IN REACTION (B), BUT IN NONE OF THE REACTIONS STUDIED IS ANY SIGNIFICANT RHO-MESON PRODUCTION FOUND TO OCCUR. IN REACTION (C) WE FIND A DEVIATION FROM PHASE SPACE IN THE REGION OF THE 1580-MEV MASS BUMP IN THE P PI+ PI+ (I=5/2) SYSTEM WHICH WAS OBSERVED BY ALEXANDER ET AL., BUT WE ASCRIBE THIS DEPARTURE FROM PHASE SPACE AT OUR ENERGY AS BEING PRINCIPALLY DUE TO N*++ AND N*- FORMATION IN THIS CHANNEL.

CLOSELY RELATED REFERENCES
SEE ALSO PRINCETON-PENN ACCELERATOR PPAD-60CF (1966).

ADDITIONAL CITATIONS
BNL BC-H-10, CERN DD/63/12 (1963), CERN DD/62/10 (1962), BNL BC-04-3-8 (1965), PHYS. REV. 128, 1836 (1962), PHYS. REV. 129, 2835 (1963), NUOVO CIMENTO 34, 1644 (1965), PHYS. REV. 101, 1570 (1956), NUOVO CIMENTO 30, 240 (1963), PHYS. REV. 144, 1122 (1966), PHYS. REV. 101, 1149 (1956), PHYS. REV. 134, B1062 (1964), PHYS. REV. LETTERS 17, 884 (1966), PHYS. REV. LETTERS 11, 90 (1963), PHYS. REV. 134, B1095 (1964), AND PHYS. REV. LETTERS 15, 207 (1965).

ARTICLE READ BY ODETTE BENARY IN 11/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 4.95 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 80 IN. (H) BUBBLE CHAMBER.

KEY WORDS - CROSS SECTION MASS SPECTRUM ANGULAR DISTRIBUTION MODELS DENSITY MATRIX DELTA(1238) DEUTERON ETA(548) OMEGA(783) RHO(765)

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(TABLE 1)

LABORATORY BEAM MOMENTUM = 4.95 +- .03 GEV/C.

REACTION	MILLI-BARNS	NO. EVENTS
PROTON PROTON -		
PROTON PROTON PI+ PI-	2.96 +- .12	2680
PROTON PROTON PI+ PI- PIO	1.76 .07	1592
PROTON NEUTRON PI+ PI+ PI-	2.19 .09	1985
DEUTERON PI+ PI+ PI-	.02 .01	21
DEUTERON PI+ PI+ PI- PIO	.08 + .01 - .03	73

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(PAGE 1401)

LABORATORY BEAM MOMENTUM = 4.95 +- .03 GEV/C.

REACTION	MILLI-BARNS
PROTON PROTON -	
PROTON PROTON OMEGA(783)	.17 +- .02
PROTON PROTON ETA(548)	.12 .04

46 PROTON-PROTON SCATTERING AT 970 MEV. (PHYS. REV. 133, B1017 (1964))

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ABSTRACT PROTON-PROTON SCATTERING HAS BEEN STUDIED AT 970 MEV USING THE BIRMINGHAM UNIVERSITY 1-BEV SYNCHROTRON AND A 9-IN.-DIAM LIQUID-HYDROGEN BUBBLE CHAMBER: 3945 EVENTS HAVE BEEN ANALYZED AND CROSS SECTIONS DETERMINED FOR THE VARIOUS REACTIONS. THE ELASTIC SCATTERING CROSS SECTION OF 24.8 +- 0.9 MB IS SIGNIFICANTLY HIGHER THAN THE RESULT OF DOWELL ET AL. USING COUNTERS. THE TWO EXPERIMENTS AGREE ON THE SHAPE OF THE ANGULAR DISTRIBUTION, BUT NOT ON ITS NORMALIZATION; POSSIBLE REASONS FOR THIS ARE DISCUSSED. THE ELASTIC SCATTERING ANGULAR DISTRIBUTION IS PEAKED STRONGLY FORWARD, BUT DOES NOT AGREE QUANTITATIVELY WITH PURE DIFFRACTION. POLARIZATION EFFECTS OBSERVED IN THE ELASTIC SCATTERING AGREE WITH PREVIOUS AND MORE ACCURATE COUNTER EXPERIMENTS. INELASTIC SCATTERING IS STRONGLY INFLUENCED BY THE (3/2,3/2) PI+ P RESONANCE AND THE PERIPHERAL MECHANISM. THEORETICAL PREDICTIONS BASED ON THE SINGLE-PION EXCHANGE MODEL ARE COMPARED IN DETAIL WITH THE EXPERIMENTAL RESULTS AND GOOD QUANTITATIVE AGREEMENT IS OBTAINED FOR SMALL MOMENTUM TRANSFERS, PARTICULARLY FOR THE REACTION PP-N P PI+. EVEN FOR SMALL MOMENTUM TRANSFERS, ASYMMETRIES IN THE TREIMAN-YANG TEST AND DEPARTURE FROM THE EXPECTED (1 + 3 (COS)-SQUARED THETA) PI+ P ANGULAR DISTRIBUTION INDICATE THAT OTHER MECHANISMS MAY BE IMPORTANT. THE CROSS SECTION FOR DOUBLE-PION PRODUCTION AT 970 MEV IS LESS THAN 0.2 MB.

CITATIONS
PHYS. REV. 125, 2082 (1962), PHYS. REV. LETTERS 7, 196 (1961), PHYS. REV. 105, 1874 (1957), PHYS. REV. 118, 579 (1960), PHYS. REV. 107, 859 (1957), PROC. OF THE ROYAL SOCIETY OF LONDON A251, 218 (1959), PROC. OF THE ROYAL SOCIETY OF LONDON A251, 233 (1959), PHYS. REV. LETTERS 7, 288 (1961), NUCLEAR INSTRUMENTS AND METHODS 4, 26 (1959), NUCLEAR INSTRUMENTS AND METHODS 13, 118 (1961), NUCLEAR INSTRUMENTS AND METHODS 9, 92 (1960), REVIEW OF SCIENTIFIC INSTRUMENTS 32, 538 (1961), PROC. OF THE ROYAL SOCIETY OF LONDON A70, 165 (1957), NUOVO CIMENTO 23, 690 (1962), NUOVO CIMENTO 18, 818 (1960), UNIV. OF BIRMINGHAM 13 (1962), JETP 12 802 (1961), NUOVO CIMENTO 16, 1132 (1960), ANNUAL REV. OF NUCLEAR SCIENCE 6, 43 (1956), PROC. OF THE ROYAL SOCIETY OF LONDON A244, 491 (1958), PROGRESS OF THEORETICAL PHYSICS 5, 570 (1950), PHYS. REV. 103, 404 (1956), PHYS. REV. 113, 1640 (1959), NUOVO CIMENTO 24, 453 (1962), NUOVO CIMENTO 22, 125 (1961), NUOVO CIMENTO 27, 1450 (1963), PHYS. REV. LETTERS 6, 64 (1961), NUOVO CIMENTO 15, 465 (1960), PHYS. REV. LETTERS 7, 387 (1961), PHYS. REV. 123, 2160 (1961), NUOVO CIMENTO 21, 1028 (1961), PROGRESS OF THEORETICAL PHYSICS 25, 1018 (1961), PHYS. REV. LETTERS 8, 140 (1962), AND PHYS. LETTERS 2, 66 (1962).

ARTICLE READ BY ODETTE BENARY IN 5/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 1.661 GEV/C.

THIS EXPERIMENT USES A HYDROGEN BUBBLE CHAMBER.

GENERAL COMMENTS ON THIS ARTICLE
1 NORMALIZED TO A TOTAL CROSS SECTION OF 47.3 +-1.0 MB.

KEY WORDS - CROSS SECTION DIFFERENTIAL CROSS SECTION POLARIZATION MASS SPECTRUM DALITZ PLOT DELTA(1238) MODELS DEUTERON ANGULAR DISTRIBUTION

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(FIGURE 1)

LABORATORY BEAM ENERGY = .970 +- .C15 GEV.

REACTION	MILLI-BARNS		NO. EVENTS
PROTON PROTON +			
ELASTIC	24.80 +-	.90	2160
DEUTERON PI+	.48	.08	42
PROTON NEUTRON PI+	18.30	.70	1414
PROTCN PROTON PIO	3.70	.30	285

47 NUCLECN ISCBAR PRODUCTION IN PRCTON-PROTON COLLISIONS BETWEEN 3 AND 7 GEV/C. (PHYS. REV. 170, 1223 (1968))

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ABSTRACT A SYSTEMATIC STUDY HAS BEEN MADE CF THE REACTIONS PP+PP AND PP+PN* IN THE ANGULAR RANGE FROM THETA(LAB) = 10 DEG. TO THETA(C.M.) = 90 DEG. AT 3, 4, 5, 6, AND 7 GEV/C. AN ORTHOGONAL DISPERSION MAGNETIC SPECTROMETER DETECTED PROTONS FROM INTERACTIONS IN HYDROGEN WITH MOMENTUM TRANSFER (-T) IN EXCESS OF 0.5 (GEV)SQUARED. WELL-DEFINED PEAKS IN THE MISSING MASS SPECTRA OCCURRED AT AVERAGE N* MASSES OF 1240 +- 6, 1508 +- 2, AND 1683 +- 3 MEV WITH AVERAGE FULL WIDTHS OF 102 +- 4, 92 +- 3, AND 110 +- 4 MEV, RESPECTIVELY. BELOW 2400 MEV NO OTHER SIGNIFICANT ENHANCEMENTS WERE FOUND. THE N* PRODUCTION CROSS SECTIONS D-SIGMA/DT NEAR THETA(C.M.) = 90 DEG. ARE IN QUALITATIVE AGREEMENT WITH THE PREDICTIONS OF THE STATISTICAL MODEL. FOR EACH ISOBAR THE DIFFERENTIAL CROSS SECTION AT FIXED ENERGY VARIES AS EXP(-V/VO), WHERE V IS DEFINED AS [-TU/(T + U)]; VO VARIES SYSTEMATICALLY WITH ENERGY AND TENDS TOWARD THE SAME VALUE (APPROXIMATELY EQUAL TO 0.4(GEV - SQUARED) FOR EACH ISOBAR AT THE UPPER LIMIT OF OUR ENERGY RANGE.

CITATIONS
PHYS. REV. LETTERS 7, 450 (1961), PHYS. REV. 128, 1823 (1962), PHYS. LETTERS 8, 134 (1964), PHYS. LETTERS 18, 167 (1965), NUOVO CIMENTO 35, 1052 (1965), PHYS. REV. LETTERS 16, 855 (1966), PHYS. REV. LETTERS 17, 789 (1966), PHYS. REV. LETTERS 12, 340 (1964), UCRL 17257 (1967), NUOVO CIMENTO 27, 208 (1963), NUOVO CIMENTO 27, 856 (1963), NUOVO CIMENTO 35, 216 (1965), PHYS. REV. LETTERS 12, 112 (1964), PHYS. LETTERS 13, 190 (1964), UCRL 16275 (1966), PHYS. LETTERS 23, 389 (1966), PHYS. LETTERS 25B, 156 (1967), PHYS. REV. LETTERS 17, 1105 (1966), PHYS. REV. 137, B708 (1965), UCRL 16228 (1965), UCRL 9727 (1961), NUOVO CIMENTO 34, 1644 (1964), PHYS. LETTERS 8, 80 (1964), AND PHYS. REV. LETTERS 12, 257 (1964).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LERCY PRICE.

BEAM IS PROTON ON PROTCN FROM 3.0 TC 7.1 GEV/C.

THIS EXPERIMENT USES COUNTERS.

GENERAL COMMENTS ON THIS ARTICLE
1 USES A MISSING MASS TECHNIQUE

KEY WORDS + DIFFERENTIAL CROSS SECTICN FITS MODELS MASS SPECTRUM DELTA(1238) N*(1520)D13 'N*(1688)'

COMPOUND KEY WORDS + FITS DIFFERENTIAL CRCSS SECTION

ELASTIC DIFFERENTIAL CRCSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 2.58 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 (1)	
.27	16.CO +-	4.00
.39	8.9C	.70
.58	3.20	.20
.68	2.10	.20
.79	1.48	.09
.94	1.06	.05
.94	1.C5	.C5
1.34	.63	.03
1.75	.47	.03
1.98	.43	.02

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERRCR CF +- 7 PER CENT.

ELASTIC DIFFERENTIAL CROSS SECTION FCR PROTON PRCTON. (TABLE 1)

LABORATORY BEAM MCMENTUM = 4.00 +- .02 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 (1)	
.48	4.900 +-	.300
.49	4.500	.3C0
.54	3.200	.2C0
.69	1.600	.100
1.18	.320	.1C0
1.61	.188	.007
2.23	.087	.C04
2.85	.C59	.C02

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCCMING PROTON) ANC THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7 PER CENT.

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 5.02 +- .02 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 (1)	
.73	.9500 +-	.0600
.75	1.0500	.0800
.75	1.0700	.0800
.83	.6300	.0400
.84	.7100	.0500
1.03	.3200	.0300
1.04	.3300	.0200
1.52	.1000	.0100
1.76	.0640	.0050
1.80	.0600	.0030
2.80	.0210	.0010
3.08	.0198	.0007
3.23	.0168	.0004
3.59	.0150	.0010
3.64	.0164	.0004
3.64	.0147	.0007
3.80	.0190	.0020

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7 PER CENT.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 6.07 +- .01 GEV/C.

T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 (1)	
1.09	.2000 +-	.0200
1.23	.1230	.0090
1.51	.0570	.0030
1.83	.0290	.0020
2.18	.0170	.0010
2.18	.0170	.0020
2.18	.0170	.0020
2.51	.0121	.0006
2.85	.0093	.0006
3.32	.0062	.0003
3.90	.0045	.0002
4.44	.0031	.0002
4.66	.0031	.0001
4.66	.0030	.0002
4.67	.0032	.0001

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7 PER CENT.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 7.12 +- .05 GEV/C.

T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 (1)	
1.42	.0530 +-	.0060
1.58	.0340	.0040
1.81	.0210	.0020
2.37	.0075	.0010
2.71	.0062	.0007
3.16	.0039	.0005
4.36	.0015	.0002
4.46	.0011	.0003
4.63	.0011	.0003
5.67	.0006	.0001

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7 PER CENT.

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DIFFERENTIAL CROSS SECTION FOR PROTON PROTON - PROTON DELTA(1238)+. (TABLE 3)

LABORATORY BEAM MOMENTUM = 2.98 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 (1)	
.26	1.50 +-	.20
.29	.90	.10
.37	.90	.10
.64	.39	.04
.74	.39	.04
.88	.31	.03
1.26	.10	.02
1.63	.15	.02

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12 PER CENT.

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DIFFERENTIAL CROSS SECTION FOR PROTON PROTON - PROTON DELTA(1238)+. (TABLE 3)

LABORATORY BEAM MOMENTUM = 4.00 +- .02 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 (1)	
.45	.410 +-	.040
.51	.250	.020
.64	.180	.020
1.12	.044	.009
1.52	.024	.003
2.12	.021	.002
2.65	.021	.002

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12 PER CENT.

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → PROTON DELTA(1238)+. (TABLE 3)

LABORATORY BEAM MOMENTUM = 5.02 +- .04 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 (1)	
.70	.0760 +-	.0080
.80	.0430	.0060
.99	.0240	.0030
1.46	.0120	.0030
1.72	.0050	.0010
1.91	.0090	.0010
2.67	.0035	.0005
3.08	.0020	.0010

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12 PER CENT.

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → PROTON DELTA(1238)+. (TABLE 3)

LABORATORY BEAM MOMENTUM = 6.07 +- .01 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 (1)	
1.03	.0110 +-	.0030
1.16	.0110	.0030
1.44	.0090	.0030
1.75	.0066	.0009
2.08	.0050	.0010
2.40	.0030	.0006
2.73	.0021	.0004
3.18	.0009	.0001
3.75	.0005	.0001
4.25	.0004	.0002

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12 PER CENT.

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → PROTON DELTA(1238)+. (TABLE 3)

LABORATORY BEAM MOMENTUM = 7.12 +- .05 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 (1)	
1.33	.0080 +-	.0030
1.50	.0050	.0010
1.72	.0042	.0008
2.27	.0026	.0009
2.60	.0011	.0005
3.05	.0010	.0006
4.22	.0003	.0001

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12 PER CENT.

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → PROTON N*(1520)+. (TABLE 4)

LABORATORY BEAM MOMENTUM = 4.00 +- .02 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 (1)	
.44	.250 +-	.040
.50	.200	.020
.62	.150	.020
1.06	.150	.020
1.43	.120	.009
1.99	.092	.006
2.05	.122	.019

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12 PER CENT.

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → PROTON N*(1520)+. (TABLE 4)

LABORATORY BEAM MOMENTUM = 5.02 +- .04 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 (1)	
.67	.100 +-	.100
.76	.105	.009
.94	.088	.006
1.38	.070	.010
1.61	.052	.006
1.79	.057	.005
2.49	.037	.003
2.83	.030	.010
2.86	.031	.005
3.14	.025	.005

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12 PER CENT.

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → PROTON N*(1520)+. [TABLE 4]

LABORATORY BEAM MOMENTUM = 6.07 +- .01 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 [1]	+-
.98	.0660	.0060
1.10	.0630	.0060
1.36	.0590	.0080
1.65	.0320	.0030
1.97	.0280	.0040
2.27	.0190	.0020
2.58	.0140	.0010
3.00	.0107	.0007
3.52	.0082	.0006
3.89	.0070	.0010
4.02	.0064	.0008

T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING PROTON] AND THE [OUTGOING PROTON].

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12 PER CENT.

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → PROTON N*(1520)+. [TABLE 4]

LABORATORY BEAM MOMENTUM = 7.12 +- .05 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 [1]	+-
1.27	.0350	.0050
1.43	.0290	.0040
1.64	.0200	.0030
2.16	.0070	.0010
2.47	.0070	.0010
2.89	.0032	.0008
4.01	.0023	.0004
5.01	.0013	.0003

T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING PROTON] AND THE [OUTGOING PROTON].

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12 PER CENT.

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → PROTON 'N*(1688)+'. [TABLE 5]

LABORATORY BEAM MOMENTUM = 4.00 +- .02 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 [1]	+-
.47	.660	.090
.52	.340	.030
.64	.450	.040
1.05	.230	.030
1.40	.160	.010
1.93	.129	.009

T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING PROTON] AND THE [OUTGOING PROTON].

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12 PER CENT.

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → PROTON 'N*(1688)+'. [TABLE 5]

LABORATORY BEAM MOMENTUM = 5.02 +- .04 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 [1]	+-
.67	.230	.020
.75	.180	.020
.92	.120	.010
1.33	.090	.010
1.55	.078	.008
1.73	.074	.007
2.39	.051	.006
2.74	.043	.008

T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING PROTON] AND THE [OUTGOING PROTON].

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12 PER CENT.

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → PROTON 'N*(1688)+'. [TABLE 5]

LABORATORY BEAM MOMENTUM = 6.07 +- .01 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 [1]	+-
.95	.0930	.0080
1.07	.0890	.0090
1.32	.0580	.0080
1.59	.0430	.0040
1.90	.0290	.0040
2.18	.0200	.0020
2.47	.0130	.0010
2.88	.0108	.0008
3.38	.0077	.0008
3.85	.0080	.0010

T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING PROTON] AND THE [OUTGOING PROTON].

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12 PER CENT.

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON - PROTON 'N*(1688)+'. (TABLE 5)

LABORATORY BEAM MOMENTUM = 7.12 +- .05 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 [1]	
1.23	.0500 +-	.0070
1.38	.0450	.0060
1.59	.0280	.0040
2.08	.0100	.0020
2.38	.0070	.0010
2.79	.0040	.0010
3.86	.0024	.0004

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12 PER CENT.

48 THE POLARIZATION PARAMETER IN PI+- P AND PP ELASTIC SCATTERING FROM 6 TO 12 GEV/C. (PHYS. LETTERS 24B, 77 (1967))

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ABSTRACT EXPERIMENTAL RESULTS ARE GIVEN FOR THE POLARIZATION PARAMETER P(C) IN PI- P SCATTERING AT 6.0, 8.0, 10.0 AND 12.0 GEV/C, AND IN PI+ P AND PP SCATTERING AT 6.0, 10.0 AND 12.0 GEV/C. THE INVARIANT FOUR-MOMENTUM TRANSFER SQUARED -T VARIES FROM 0.1 TO 0.75 (GEV/C)-SQUARED.

CLOSELY RELATED REFERENCES
CONTINUATION OF PREVIOUS EXPERIMENT IN PHYS. LETTERS 21, 114 (1966).

ADDITIONAL CITATIONS
UCRL 16940 (1960), PHYS. REV. 139, B1336 (1965), PHYS. REV. 148, 1297 (1966), MOSCOW INST. FOR THEOR. AND EXPTL. PHYSICS N-258 (1964), AND JETP 18 874 (1964).

ARTICLE READ BY ODETTE BENARY IN 4/67, AND VERIFIED BY LEROY PRICE.

BEAM NO. 1 IS PROTON ON HYDROGEN COMPOUND FROM 6 TO 12 GEV/C. TARGET IS POLARIZED 70 PER CENT (NORMAL TO THE BEAM DIRECTION).
NO. 2 IS PI- ON HYDROGEN COMPOUND FROM 6 TO 12 GEV/C. TARGET IS POLARIZED 70 PER CENT (NORMAL TO THE BEAM DIRECTION).
NO. 3 IS PI+ ON HYDROGEN COMPOUND FROM 6 TO 12 GEV/C. TARGET IS POLARIZED 70 PER CENT (NORMAL TO THE BEAM DIRECTION).

THIS EXPERIMENT USES COUNTERS.

GENERAL COMMENTS ON THIS ARTICLE
1 THIS ARTICLE ALSO CONTAINS DATA ON POLARIZATION IN PI+P AND PI- P. THIS EXPERIMENT USES UNPOLARIZED BEAMS AND POLARIZED TARGET.

KEY WORDS * POLARIZATION PROTON PI+ PI-

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ELASTIC POLARIZATION FOR PROTON PROTON.

LABORATORY BEAM MOMENTUM = 6. GEV/C.

-T (GEV/C)**2	POLARIZATION [1]	
.109	.124 +-	.069
.136	.041	.034
.166	.122	.025
.198	.138	.016
.233	.101	.014
.271	.117	.014
.312	.095	.015
.355	.141	.017
.400	.117	.018
.448	.083	.019
.499	.108	.023
.551	.063	.029
.606	.125	.041
.665	.062	.080
.723	.092	.164

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5 PER CENT.

- -

ELASTIC POLARIZATION FOR PROTON PROTON.

LABORATORY BEAM MOMENTUM = 10. GEV/C.

-T (GEV/C)**2	POLARIZATION [1]	
.102	.074 +-	.072
.129	.059	.030
.159	.058	.023
.192	.097	.015
.229	.093	.013
.267	.071	.013
.309	.082	.014
.354	.093	.017
.401	.081	.018
.452	.047	.019
.505	.024	.023
.561	.067	.028
.620	.077	.037
.681	.117	.046
.745	.080	.045

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5 PER CENT.

- -

ELASTIC POLARIZATION FOR PROTON PROTON.

LABORATORY BEAM MOMENTUM = 12. GEV/C.

-T (GEV/C)**2	POLARIZATION (1)	
.103	.034 +-	.055
.131	.032	.023
.163	.036	.018
.199	.042	.013
.237	.066	.012
.279	.064	.013
.324	.081	.014
.373	.055	.017
.424	.031	.019
.479	.046	.020
.537	.073	.023
.629	.066	.026
.762	.002	.056

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5 PER CENT.

49 PROTON-PROTON SCATTERING AT 1.48 BEV. (PHYS. REV. 138, B670 (1965))

A.M.EISNER,E.L.HART,R.I.LOUTTIT,T.W.MORRIS (BROOKHAVEN NAT. LAB., UPTON, L.I., N. Y., USA)

ABSTRACT A SAMPLE OF 2657 PROTON-PROTON SCATTERING EVENTS AT 1.48 BEV HAS BEEN ANALYZED. THE ELASTIC CROSS SECTION IS 19.86 MB, AND THE ELASTIC SCATTERING IS CONSISTENT WITH A SIMPLE OPAQUE-DISK OPTICAL MODEL WITH R = 0.91 F AND (1 - A) = 0.864. THE DOMINANT FEATURE OF THE INELASTIC SCATTERING IS THE PRODUCTION OF THE (3/2,3/2) ISOBAR. THE REACTION PP → P N PI+ IS INTERPRETED SATISFACTORILY IN TERMS OF THE ONE-PION-EXCHANGE MODEL.

CITATIONS
PHYS. REV. 125, 701 (1962), PHYS. REV. 128, 1836 (1962), PHYS. REV. 128, 1832 (1962), PHYS. REV. 103, 211 (1956), PHYS. REV. 107, 859 (1957), PHYS. REV. LETTERS 3, 568 (1959), UCRL 9497 (1961), PHYS. REV. LETTERS 5, 333 (1960), PHYS. REV. 123, 2160 (1961), PHYS. REV. LETTERS 5, 571 (1960), PHYS. REV. LETTERS 7, 196 (1961), PHYS. REV. 125, 2082 (1962), PHYS. REV. 125, 2091 (1962), PHYS. REV. 126, 747 (1962), PHYS. REV. 133, B1017 (1964), PHYS. REV. 75, 1352 (1949), PHYS. REV. 105, 1874 (1957), PHYS. REV. 123, 333 (1961), PHYS. REV. LETTERS 6, 64 (1961), CERN 8956/TH428, PHYS. REV. LETTERS 8, 140 (1962), AND PHYS. LETTERS 2, 66 (1962).

ARTICLE READ BY ODETTE BENARY IN 5/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 2.23 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 20 IN. (H) BUBBLE CHAMBER. A TOTAL OF 4000 PICTURES ARE REPORTED ON.

KEY WORDS • CROSS SECTION ANGULAR DISTRIBUTION DIFFERENTIAL CROSS SECTION FITS MASS SPECTRUM MODELS DELTA(1238)

COMPOUND KEY WORDS • FITS DIFFERENTIAL CROSS SECTION

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- -

(TABLE 1)

LABORATORY BEAM MOMENTUM - 2.23 +- .06 GEV/C.

REACTION	MILLI-BARNS		NO. EVENTS
PROTON PROTON →			
ELASTIC	19.86 +	.73	1072
	-	.64	
PROTON NEUTRON PI+	17.22 +	.66	1048
	-	.57	
PROTON PROTON PI0	3.98 +	.27	242
	-	.26	
DEUTERON PI+	.13	.05	8
DEUTERON PI+ PI0	.43	.00	26
PI+ PI+ NEUTRON NEUTRON	.25	.06	15
PROTON PROTON PI0 PI0	.41	.08	25
PROTON PI+ NEUTRON PI0	2.37	.20	144
PROTON PROTON PI+ PI-	1.22	.14	58
PROTON PROTON PI+ PI- PI0	.02	.02	1
PROTON PI+ PI+ PI- NEUTRON	.02	.02	1

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (FIGURE 2)

LABORATORY BEAM MOMENTUM = 2.23 +- .06 GEV/C.

....
. THIS DATA WAS READ FROM A GRAPH .
....

-T (GEV/C)**2	D-SIGMA/D-OMEGA MB/SR	
.0100	1.8 +-	.9
.0196	10.5	2.2
.0324	17.0	2.0
.0484	20.5	3.0
.0676	19.0	3.0
.0900	16.0	2.0
.1156	11.0	1.0
.1444	8.5	1.0
.1764	8.0	1.0
.2116	6.5	1.0
.2500	4.7	1.0
.2500	4.7	1.0
.3400	3.1	.8
.3900	3.5	.5
.4400	2.7	.5
.4900	1.7	.3
.5500	1.0	.3
.6400	1.3	.2
.7100	.9	.2

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

50 P PI+ PI- ENHANCEMENTS IN THE REACTION PP + PP PI+ PI- AT 24.8 GEV/C. [PHYS. REV. LETTERS 21, 1839 (1968)]

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C.BALTAY,J.FEINMAN, P.FRANZINI,P.NEWMAN,N.YEH [COLUMBIA UNIV., NEW YORK, N. Y., USA]

ABSTRACT A STUDY OF THE REACTION PP + PP PI+ PI- AT 24.8 GEV/C, BASED ON 3250 EVENTS, GIVES STRONG SUPPORT FOR THE PRODUCTION OF RESONANT P PI+ PI- STATES AT 1.423 +- 0.027 AND 1.688 +- 0.023 GEV.

CITATIONS
BULL. AM. PHYS. SOC. 13, 704 (1968), PHYS. REV. LETTERS 21, 1368 (1968), BULL. AM. PHYS. SOC. 13, 682 (1968), NUOVO CIMENTO 50A, 1000 (1968), PHYS. REV. LETTERS 17, 884 (1966), UNIV. OF ILLINOIS COO1195-78, PHYS. LETTERS 18, 67 (1965), PHYS. REV. LETTERS 16, 855 (1966), PHYS. REV. LETTERS 19, 397 (1967), BULL. AM. PHYS. SOC. 13, 682 (1968), PHYS. REV. LETTERS 18, 973 (1967), AND PHYS. REV. LETTERS 13, 169 (1964).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 24.8 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 80 IN. (H) BUBBLE CHAMBER.

GENERAL COMMENTS ON THIS ARTICLE
1 THE P PI+ PI- INVARIANT MASS SHOWS ENHANCEMENTS AT 1.42 AND 1.688 GEV. HOWEVER THE RESONANCE PRODUCTION CROSS SECTIONS DEPEND CRITICALLY UPON THE ASSUMED SHAPE OF THE BACKGROUND.

KEY WORDS + CROSS SECTION N*(1470)P11 'N*(1688)' MASS SPECTRUM DELTA(1238)

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CROSS SECTION FOR PROTON PROTON PROTON PROTON PI+ PI-. [PAGE 1839]

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS	NO. EVENTS
24.8	1.5 +- .2	15500

51 THE REAL PART OF THE SPIN-INDEPENDENT FORWARD SCATTERING AMPLITUDE IN ELASTIC NUCLEON-NUCLEON COLLISIONS. [PHYS. LETTERS 25B, 245 (1967)]

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ABSTRACT ELASTIC PP AND PD SCATTERING IN THE COULOMB INTERFERENCE REGION HAVE BEEN STUDIED USING A SONIC SPARK CHAMBER TECHNIQUE. ANALYSES OF THESE DATA YIELD ALPHA(P) = 0.10 +- 0.16 AND ALPHA(N) = -0.50 +- 0.15 AT 1.69 GEV/C IN GOOD AGREEMENT WITH DISPERSION RELATION CALCULATIONS, THE VALUE OF ALPHA(P) = -0.30 +- 0.09 OBTAINED AT 1.54 GEV/C IS HOWEVER NOT CONSISTENT WITH THESE CALCULATIONS.

CLOSELY RELATED REFERENCES
SEE ALSO PHYS. LETTERS 26B, 679 (1968), AND PHYS. REV. LETTERS 19, 1416 (1968).

ADDITIONAL CITATIONS
NUCLEAR INSTRUMENTS AND METHODS 55, 80 (1967), PROC. OF THE PHYSICAL SOCIETY OF LONDON 63A 599 (1950), PROGRESS OF THEORETICAL PHYSICS 31, 1162 (1964), PHYS. LETTERS 12, 252 (1964), PHYS. REV. 135, B358 (1964), PHYS. LETTERS 19, 341 (1965), PHYS. LETTERS 8, 285 (1964), RUTHERFORD HIGH ENERGY LAB. RPP/H/14 (1966), PHYS. REV. 139, B362 (1965), PHYS. REV. 139, B380 (1965), SOVIET JNP 1 620 (1965), JETP 18 810 (1964), KYOTO UNIVERSITY RIFP 46 (1965), PROC. OF THE PHYSICAL SOCIETY OF LONDON 71 781 (1957), PHYS. REV. 119, 381 (1960), JETP 6 28 (1958), SOVIET PHYSICS DOKLADY 1, 361 (1956), PHYS. REV. 118, 579 (1960), JETP 18 412 (1964), SOVIET JNP 1 379 (1965), PHYS. REV. LETTERS 14, 74 (1965), PHYS. LETTERS 14, 54 (1965), PHYS. LETTERS 20, 203 (1966), JETP 19 542 (1964), SOVIET PHYSICS, JETP LETTERS 6, 8 (1966), PHYS. REV. LETTERS 15, 38 (1965), AND NUOVO CIMENTO 40, 167 (1966).

ARTICLE READ BY ODETTE BENARY IN 4/69, AND VERIFIED BY LEROY PRICE.

BEAM NO. 1 IS PROTON ON PROTON FROM 1.54 TO 1.69 GEV/C.
NO. 2 IS PROTON ON DEUTERON FROM 1.54 TO 1.69 GEV/C.

THIS EXPERIMENT USES SPARK CHAMBERS.

KEY WORDS + DIFFERENTIAL CROSS SECTION REAL (AMPLITUDE)/IMAGINARY (AMPLITUDE)

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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON DEUTERON.

LABORATORY BEAM MOMENTUM = 1.69 GEV/C +- .6(PER CENT).

(CORRECTED FOR BEAM DISTRIBUTION AND PLURAL SCATTERING, PRIVATE COMMUNICATION FROM VAN DER RAAY APRIL 1969)

THETA RADIANS		D-SIGMA/D-OMEGA MB/SR	
.0205	+- .0010	598.	+- 39.
.0225	.0010	546.	36.
.0245	.0010	471.	33.
.0265	.0010	494.	32.
.0285	.0010	395.	28.
.0305	.0010	356.	27.
.0325	.0010	332.	25.
.0345	.0010	359.	26.
.0365	.0010	346.	25.
.0385	.0010	317.	23.
.0405	.0010	344.	23.
.0425	.0010	286.	22.
.0445	.0010	304.	22.
.0465	.0010	290.	22.
.0485	.0010	323.	23.

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE LAB.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON.

LABORATORY BEAM MOMENTUM = 1.69 GEV/C +- .6(PER CENT).

(CORRECTED FOR BEAM DISTRIBUTION AND PLURAL SCATTERING, PRIVATE COMMUNICATION FROM VAN DER RAAY APRIL 1969)

THETA RADIANS		D-SIGMA/D-OMEGA MB/SR	
.0195	+- .0010	372.	+- 50.
.0235	.0010	253.	39.
.0275	.0010	154.	32.
.0315	.0010	142.	26.
.0355	.0010	137.	23.
.0395	.0010	121.	20.
.0435	.0010	142.	19.
.0475	.0010	154.	19.
.0515	.0010	133.	17.

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE LAB.

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON.

LABORATORY BEAM MOMENTUM = 1.54 GEV/C +- .6(PER CENT).

(CORRECTED FOR BEAM DISTRIBUTION AND PLURAL SCATTERING, PRIVATE COMMUNICATION FROM VAN DER RAAY APRIL 1969)

THETA RADIANS		D-SIGMA/D-OMEGA MB/SR	
.0185 +-	.0010	533. +-	53.
.0205	.0010	472.	47.
.0225	.0010	431.	41.
.0245	.0010	321.	34.
.0265	.0010	259.	30.
.0285	.0010	215.	27.
.0305	.0010	176.	25.
.0325	.0010	144.	22.
.0345	.0010	176.	22.
.0365	.0010	100.	20.
.0385	.0010	122.	15.
.0405	.0010	114.	15.
.0425	.0010	127.	15.
.0445	.0010	114.	16.
.0465	.0010	129.	17.
.0485	.0010	111.	17.

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE LAB.

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THE RE/IM RATIO FOR THE FORWARD ELASTIC AMPLITUDE FOR PROTON PROTON. [PAGE 245]

(THESE VALUES ASSUME THAT THE SPIN-DEPENDANT AMPLITUDE MAY BE NON-ZERO.)

LABORATORY BEAM MOMENTUM GEV/C	ALPHA	
1.69	.10 +-	.16
1.54	-.30	.09

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THE RE/IM RATIO FOR THE FORWARD ELASTIC AMPLITUDE FOR PROTON PROTON. [PAGE 245]

(THESE VALUES ASSUME THAT THE SPIN-DEPENDANT AMPLITUDE MAY BE NON-ZERO.)

LABORATORY BEAM MOMENTUM GEV/C	ALPHA
1.69	-.50 +- .15

52 SMALL ANGLE PP SCATTERING IN THE MOMENTUM RANGE 1.3 TO 1.5 GEV/C. [PHYS. LETTERS 26B, 679 (1968)]

L.M.C.DUTTON,H.B.VAN DER RAAY [BIRMINGHAM UNIV., BIRMINGHAM, ENGLAND]

ABSTRACT ELASTIC PP SCATTERING IN THE COULOMB INTERFERENCE REGION HAS BEEN STUDIED USING SONIC SPARK CHAMBERS WITH A MAGNETIC SPECTROMETER. MEASUREMENTS WERE MADE AT 1.29, 1.39, AND 1.54 GEV/C AND THE DATA WERE ANALYZED TO DETERMINE THE REAL PART OF THE SPIN INDEPENDENT FORWARD SCATTERING AMPLITUDE. DISAGREEMENT WITH THE PREDICTIONS OF DISPERSION RELATION CALCULATIONS WAS FOUND.

CLOSELY RELATED REFERENCES
SEE ALSO PHYS. REV. LETTERS 19, 1416 (1968).
CONTINUATION OF PREVIOUS EXPERIMENT IN PHYS. LETTERS 25B, 245 (1967).

ADDITIONAL CITATIONS
PHYS. LETTERS 8, 285 (1964), NUCLEAR INSTRUMENTS AND METHODS 55, 80 (1967), PHYS. REV. 146, 980 (1966), JETP 18 412 (1964), PHYS. REV. 119, 381 (1960), AND PHYS. REV. 95, 1350 (1934).

ARTICLE READ BY ODETTE BENARY IN 4/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON FROM 1.29 TO 1.54 GEV/C.

THIS EXPERIMENT USES SPARK CHAMBERS.

KEY WORDS - DIFFERENTIAL CROSS SECTION REAL (AMPLITUDE)/IMAGINARY (AMPLITUDE)

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- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON.

LABORATORY BEAM MOMENTUM = 1.54 GEV/C.

(CORRECTED FOR BEAM DISTRIBUTION AND PLURAL SCATTERING. PRIVATE COMMUNICATION FROM VAN DER RAAY APRIL 1969)

THETA RADIANS	D-SIGMA/D-OMEGA MB/SR	
.0165	1014. +-	243.
.0185	590.	76.
.0205	532.	58.
.0225	337.	36.
.0245	326.	31.
.0265	278.	27.
.0285	228.	24.
.0305	220.	22.
.0325	147.	19.
.0345	183.	22.
.0365	146.	21.
.0385	192.	20.
.0405	136.	18.
.0425	135.	18.
.0445	116.	17.
.0465	135.	16.
.0485	144.	16.
.0505	144.	15.
.0525	101.	14.
.0545	128.	15.
.0565	91.	14.
.0585	126.	14.
.0605	95.	13.
.0625	123.	13.
.0645	106.	13.
.0665	102.	12.
.0685	105.	12.
.0705	96.	11.
.0725	86.	10.

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE LAB.

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON.

LABORATORY BEAM MOMENTUM = 1.39 GEV/C.

(CORRECTED FOR BEAM DISTRIBUTION AND PLURAL SCATTERING. PRIVATE COMMUNICATION FROM VAN DER RAAY APRIL 1969)

THETA RADIANS	D-SIGMA/D-OMEGA MB/SR	
.0175	1039. +-	135.
.0195	535.	73.
.0215	524.	40.
.0235	430.	31.
.0255	384.	28.
.0275	324.	24.
.0295	267.	22.
.0315	212.	20.
.0335	175.	19.
.0355	130.	17.
.0375	146.	16.
.0395	129.	14.
.0415	75.	13.
.0435	106.	13.
.0455	99.	13.
.0475	121.	13.
.0495	94.	12.
.0515	95.	12.
.0535	99.	12.
.0555	94.	11.
.0575	97.	11.
.0595	71.	11.
.0615	81.	11.
.0635	96.	11.
.0655	80.	10.
.0675	73.	9.
.0695	62.	9.
.0715	56.	7.

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE LAB.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON.

LABORATORY BEAM MOMENTUM = 1.29 GEV/C.

(CORRECTED FOR BEAM DISTRIBUTION AND PLURAL SCATTERING. PRIVATE COMMUNICATION FROM VAN DER RAAY APRIL 1969)

THETA RADIANS	D-SIGMA/D-OMEGA MB/SR	
.0205	892. +-	100.
.0225	657.	85.
.0245	608.	73.
.0265	306.	60.
.0285	292.	33.
.0305	263.	30.
.0325	244.	27.
.0345	214.	24.
.0365	162.	22.
.0385	164.	20.
.0405	167.	19.
.0425	154.	18.
.0445	142.	17.
.0465	163.	17.
.0485	136.	16.
.0505	132.	16.
.0525	137.	15.
.0565	132.	20.
.0585	97.	20.
.0605	101.	20.
.0625	94.	20.
.0645	81.	19.
.0665	69.	18.
.0685	78.	16.
.0705	71.	16.
.0725	59.	14.

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE LAB.

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THE RE/IM RATIO FOR THE FORWARD ELASTIC AMPLITUDE FOR PROTON PROTON. (TABLE 1)

(THESE VALUES ASSUME THAT THE SPIN-DEPENDANT PART OF THE AMPLITUDE MAY BE NON-ZERO.)

LABORATORY BEAM MOMENTUM GEV/C	ALPHA	
1.54	-.32 +-	.07
1.39	-.58	.06
1.29	-.76	.13

53 HIGH-ENERGY PROTON-PROTON SCATTERING. (PHYS. REV. LETTERS 9, 111 (1962))

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CLOSELY RELATED REFERENCES
THIS ARTICLE SUPERSEDES PHYS. REV. LETTERS 7, 450 (1961),

ADDITIONAL CITATIONS
PHYS. REV. 127, 950 (1962), PHYS. REV. LETTERS 9, 108 (1962), PHYS. REV. 107, 859 (1957), INT'L. CONF. ON ELEM. PARTICLES, AIX-EN-PROVENCE 2 128 (1961), PHYS. REV. LETTERS 7, 394 (1961), ZURN. EKSP. TEOR. FIZ. 41, 667 (1961), JETP 14 478 (1962), AND PHYS. REV. LETTERS 1, 29 (1962).

ARTICLE READ BY ODETTE BENARY IN 4/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON HYDROGEN COMPOUND FROM 12.99 TO 22.92 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - DIFFERENTIAL CROSS SECTION

- -
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ELASTIC DIFFERENTIAL CROSS SECTION (AT FIXED ANGLE OR T) FOR PROTON PROTON.

THETA = .0565 RADIANS. THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE LAB.

(THIS DATA REPLACES VALUES GIVEN EARLIER IN COCCONI ET AL., PHYS. REV. LETTERS 7, 450 (1961))

LABORATORY BEAM MOMENTUM GEV/C	D-SIGMA/D-OMEGA MB/SR	PER CENT
12.99	45.00 +-	50
15.89	10.00	50
17.30	4.50	50
17.75	5.30	50
18.69	1.50	50
19.56	.53	50
19.75	.90	50
19.91	.54	50
21.88	.28	50
22.74	.29	50
26.02	.10	50

- -

ELASTIC DIFFERENTIAL CROSS SECTION (AT FIXED ANGLE OR T) FOR PROTON PROTON.

THETA = .0605 RADIANS. THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE LAB.

(THIS DATA REPLACES VALUES GIVEN EARLIER IN COCCONI ET AL., PHYS. REV. LETTERS 7, 450 (1961))

LABORATORY BEAM MOMENTUM GEV/C	D-SIGMA/D-OMEGA MB/SR	PER CENT
18.29	.560 +-	50
27.83	.026	50

- -

ELASTIC DIFFERENTIAL CROSS SECTION (AT FIXED ANGLE OR T) FOR PROTON PROTON.

THETA = .11 RADIANS. THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE LAB.

LABORATORY BEAM MOMENTUM GEV/C	D-SIGMA/D-OMEGA MB/SR	PER CENT
8.94	2.7500 +-	50
11.28	.3100	50
13.98	.1200	50
15.96	.0400	50
18.97	.0055	50
21.46	.0011	50

54 SMALL-ANGLE PD SCATTERING IN THE MOMENTUM RANGE 1.3 TO 1.5 GEV/C. (PHYS. REV. LETTERS 21, 1416 (1968))

L.M.C.DUTTON,H.B.VAN DER RAAY (BIRMINGHAM UNIV., BIRMINGHAM, ENGLAND)

ABSTRACT THE ELASTIC AND QUASIELASTIC SCATTERING OF INCIDENT PROTONS BY A DEUTERIUM TARGET, OVER THE ANGULAR RANGE 20-70 MRAD IN THE LABORATORY SYSTEM, HAS BEEN DETERMINED USING A SONIC SPARK-CHAMBER SYSTEM. DATA WERE OBTAINED AT INCIDENT MOMENTA OF 1.29, 1.39, AND 1.54 GEV/C AND ANALYZED TO DETERMINE THE RATIO OF THE REAL TO IMAGINARY PARTS OF THE PN FORWARD SCATTERING AMPLITUDE. SATISFACTORY AGREEMENT WITH THE PREDICTIONS OF DISPERSION-RELATION CALCULATIONS WAS OBTAINED.

CLOSELY RELATED REFERENCES
CONTINUATION OF PREVIOUS EXPERIMENT IN PHYS. LETTERS 25B, 245 (1967).

ADDITIONAL CITATIONS
PHYS. LETTERS 20, 203 (1964), PHYS. REV. 135, B358 (1964), PHYS. LETTERS 26B, 679 (1968), PHYS. REV. 146, 980 (1966), PHYS. LETTERS 19, 341 (1965), PHYS. LETTERS 6, 38 (1965), NUOVO CIMENTO 41A, 167 (1966), PHYS. REV. 139, B362 (1965), PHYS. REV. 139, B380 (1965), AND JETP 19 542 (1964).

ARTICLE READ BY ODETTE BENARY IN 4/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON DEUTERON FROM 1.29 TO 1.54 GEV/C.

THIS EXPERIMENT USES SPARK CHAMBERS.

KEY WORDS • DIFFERENTIAL CROSS SECTION REAL (AMPLITUDE)/IMAGINARY (AMPLITUDE)

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- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON DEUTERON.

LABORATORY BEAM MOMENTUM = 1.54 +- .60 GEV/C.

(CORRECTED FOR BEAM DISTRIBUTION AND PLURAL SCATTERING. PRIVATE COMMUNICATION FROM VAN DER RAAY APRIL 1969)

THETA RADIANS		D-SIGMA/D-OMEGA MB/SR	
.0185 +-	.0010	856. +-	87.
.0205	.0010	536.	64.
.0225	.0010	458.	57.
.0245	.0010	458.	50.
.0265	.0010	495.	47.
.0285	.0010	440.	24.
.0305	.0010	436.	22.
.0325	.0010	401.	21.
.0345	.0010	413.	20.
.0366	.0010	392.	20.
.0385	.0010	347.	18.
.0405	.0010	346.	18.
.0425	.0010	338.	18.
.0445	.0010	311.	17.
.0465	.0010	336.	17.
.0485	.0010	324.	16.
.0505	.0010	356.	16.
.0525	.0010	361.	16.
.0545	.0010	327.	16.
.0565	.0010	306.	16.
.0585	.0010	314.	16.
.0605	.0010	278.	15.
.0625	.0010	277.	15.
.0645	.0010	307.	15.
.0665	.0010	273.	15.
.0685	.0010	253.	14.
.0705	.0010	254.	14.

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE LAB.

ELASTIC DIFFERENTIAL CRCSS SECTICN FCR PROTON DEUTERON.

LABORATORY BEAM MOMENTUM = 1.39 +- .6C GEV/C.

(CORRECTED FOR BEAM DISTRIBUTION AND PLURAL SCATTERING. PRIVATE COMMUNICATION FROM VAN DER RAAY APRIL 1969)

THETA RADIANS		D-SIGMA/D-OMEGA MB/SR	
.0195	+- .0010	791.	+- 63.
.0215	.C010	607.	43.
.0235	.0010	520.	34.
.0255	.C010	511.	32.
.0275	.0010	482.	29.
.0295	.0010	424.	27.
.0315	.C010	395.	25.
.0335	.0010	357.	24.
.0355	.0010	347.	22.
.0375	.0010	312.	21.
.0395	.0010	326.	21.
.0415	.0010	298.	20.
.0435	.0010	297.	19.
.0455	.0010	296.	19.
.0475	.0010	292.	19.
.0495	.0010	302.	19.
.0515	.0010	268.	18.
.0535	.0010	247.	17.
.0555	.0010	289.	18.
.0575	.C010	257.	17.
.0595	.0010	250.	17.
.0615	.0010	252.	17.
.0635	.0010	228.	16.
.0655	.0010	274.	16.
.0675	.C01C	249.	16.

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE LAB.

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ELASTIC DIFFERENTIAL CRCSS SECTICN FCR PROTON DEUTERON.

LABORATORY BEAM MOMENTUM = 1.29 +- .6C GEV/C.

(CORRECTED FOR BEAM DISTRIBUTION AND PLURAL SCATTERING. PRIVATE COMMUNICATION FROM VAN DER RAAY APRIL 1969)

THETA RADIANS		D-SIGMA/D-OMEGA MB/SR	
.0205	+- .0010	1072.	+- 96.
.0225	.0010	756.	82.
.0245	.0010	653.	7C.
.0265	.0010	622.	63.
.0285	.0010	447.	54.
.0305	.0010	392.	52.
.0325	.0010	392.	29.
.0345	.0010	382.	27.
.0365	.C010	363.	26.
.0385	.0010	35C.	25.
.0405	.0010	394.	25.
.0425	.0010	340.	23.
.0445	.C010	334.	23.
.0465	.0010	389.	23.
.0485	.0010	364.	23.
.0505	.0010	348.	22.
.0525	.0010	311.	21.

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE LAB.

- -

THE RE/IM RATIO FOR THE FORWARD ELASTIC AMPLITUDE FOR PROTON NEUTRON. (TABLE 1)

(THESE VALUES ASSUME THAT THE SPIN-DEPENDANT PART OF THE AMPLITUDE MAY BE UNEQUAL TO ZERO.)

LABORATORY BEAM MOMENTUM GEV/C	ALPHA	
1.29	-.68	+- .25
1.39	-.48	.13
1.54	-.36	.18

55 A BUBBLE CHAMBER STUDY OF PROTON-PROTON INTERACTIONS AT 4 GEV/C. PART I - ELASTIC SCATTERING, SINGLE-PION AND DEUTERON PRODUCTION. [NUOVO CIMENTO 49A, 479 (1967)]

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ABSTRACT ELASTIC SCATTERING, SINGLE-PION AND DEUTERON PRODUCTION HAVE BEEN INVESTIGATED. THE CROSS-SECTION FOR ELASTIC SCATTERING IS (13.5 +- 0.3) MB. THE ANGULAR DISTRIBUTION HAS BEEN FITTED TO D-SIGMA/DT = (D-SIGMA/DT (AT T = 0) EXP(-B*T) IN THE REGION OF LOW VALUES OF T. THE BEST FIT GIVES B = (6.7 +- 0.5) (GEV/C)**-2 AND (D-SIGMA/DT (AT T = C)) = (91 +- 5) MB (GEV/C)**-2. THE CROSS SECTIONS FOR PP PIO, PN PI+ REACTIONS ARE RESPECTIVELY (2.6 +- 0.3) MB AND (9.7 +- 0.4) MB. THESE REACTIONS ARE DOMINATED BY THE (3/2,3/2) NUCLEON-PION ISOBAR PRODUCTION AND BY FORWARD BACKWARD COLLIMATION OF THE NUCLEONS. THE PRODUCTION RATES FOR THE ISOBARS N*++(1238), N*+(1238), N*+(1500) HAVE BEEN ESTIMATED, TAKING INTO ACCOUNT THE EXPERIMENTAL PERIPHERAL BEHAVIOUR OF THE INTERACTION. IN THE PN PI+ REACTION THEY ARE (50 +- 2) PER CENT, (10 +- 3) PER CENT, (4 +- 3) PER CENT. IN THE PP PIO REACTION THE PRODUCTION OF N*+(1238) IS ESTIMATED TO BE (45 +- 10) PER CENT. THE D PI+ AND D PI+ PI+ PI- REACTION CROSS SECTIONS ARE RESPECTIVELY (0.03 +- C.01) MB, AND (0.04 +- 0.01) MB.

CLOSELY RELATED REFERENCES
SEE ALSO SIENNA CONFERENCE 1 591 (1963), PHYS. LETTERS 16, 75 (1965), PHYS. LETTERS 16, 196 (1965), AND NUOVO CIMENTO 43, 1210 (1966).

ADDITIONAL CITATIONS
PHYS. REV. 105, 1874 (1957), PHYS. REV. LETTERS 5, 24 (1960), PHYS. REV. 123, 333 (1961), PROGRESS OF THEORETICAL PHYSICS 5, 570 (1950), CERN 59-08 (1959), NUOVO CIMENTO 27, 208 (1963), NUOVO CIMENTO 27, 856 (1963), PHYS. REV. 75, 1352 (1949), ANNUAL REV. OF NUCLEAR SCIENCE 8, 49 (1958), PHYS. REV. 134, B1 (1964), PHYS. REV. 113, 1640 (1959), REV. MOD. PHYS. 33, 458 (1961), PHYS. REV. LETTERS 6, 64 (1960), NUOVO CIMENTO 21, 1028 (1961), PHYS. REV. LETTERS 7, 387 (1961), NUOVO CIMENTO 24, 453 (1962), NUOVO CIMENTO 27, 1450 (1963), NUOVO CIMENTO 30, 240 (1963), NUOVO CIMENTO 34, 735 (1964), PHYS. REV. 139, B646 (1965), REV. MOD. PHYS. 37, 485 (1965), PHYS. REV. 138, B670 (1965), PHYS. REV. 125, 2082 (1962), PHYS. REV. 125, 2091 (1962), PHYS. REV. 123, 1465 (1961), PHYS. REV. 123, 2160 (1961), PHYS. REV. 126, 747 (1962), PHYS. REV. LETTERS 13, 355A (1964), NUOVO CIMENTO 40, 839 (1965), PHYS. REV. LETTERS 15, 207 (1965), PHYS. REV. LETTERS 17, 884 (1966), NUOVO CIMENTO 43, 716 (1966), PHYS. REV. LETTERS 5, 19 (1960), PHYS. LETTERS 7, 222 (1963), PHYS. LETTERS 11, 161 (1964), PHYS. REV. LETTERS 11, 506 (1963), PHYS. REV. 134, B454 (1964), CERN 60-33, CERN DD/1270/P, PHYS. REV. LETTERS 9, 32 (1962), FORTSCHRITTE DER PHYSIK 9, 549 (1961), PHYS. REV. 138, B913 (1965), PHYS. REV. 107, 859 (1957), PHYS. REV. LETTERS 10, 376 (1963), PHYS. REV. LETTERS 9, 108 (1962), PHYS. REV. 126, 2204 (1962), PHYS. REV. LETTERS 11, 499 (1963), PHYS. LETTERS 15, 188 (1962), PHYS. REV. LETTERS 11, 217 (1963), NUOVO CIMENTO 33, 643 (1964), PHYS. LETTERS 13, 190 (1964), PROGRESS OF THEORETICAL PHYSICS 25, 1018 (1961), PHYS. REV. LETTERS 13, 59 (1964), PHYS. REV. 109, 1733 (1958), PHYS. REV. 96, 496 (1954), PHYS. REV. 105, 1582 (1957), AND JETP 7 528 (1958)

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 4 GEV/C.

THIS EXPERIMENT USES THE SACLAY 81 CM (H) BUBBLE CHAMBER. A TOTAL OF 50000 PICTURES ARE REPORTED ON.

KEY WORDS - CROSS SECTION DIFFERENTIAL CROSS SECTION FITS MASS SPECTRUM ANGULAR DISTRIBUTION DENSITY MATRIX DELTA(1238) N*(1520)D13 DEUTERON

COMPOUND KEY WORDS - FITS DIFFERENTIAL CROSS SECTION

[TABLE 1]

LABORATORY BEAM MOMENTUM = 4.C0 +- .04 GEV/C.

REACTION	MILLI-BARNS		NO. EVENTS
PROTON PROTON -			
TOTAL	43.000 +-	1.500	
ELASTIC	13.500	.300	2205
PROTON PROTON PI0	2.600	.300	
PROTON NEUTRON PI+	9.700	.400	
DEUTERON PI+	.027	.010	
DEUTERON PI+ PI+ PI-	.048	.010	
2 PRONGS	34.100	1.100	

[PAGE 492]

LABORATORY BEAM MOMENTUM = 4.00 +- .04 GEV/C.

REACTION	FRACTION PER CENT (1)	
PROTON PROTON -		
DELTA(1238)++ NEUTRON	50. +-	2.
DELTA(1238)++ - PROTON PI+ (2)		
DELTA(1238)+ PROTON	10.	3.
DELTA(1238)+ - NEUTRON PI+ (2)		
N*(1520)+ PROTON	4.	3.
N*(1520)+ - NEUTRON PI+ (2)		

(1) THESE FRACTIONS SHOULD BE MULTIPLIED BY 9.7 +- .4 TO GET CROSS SECTIONS IN MILLIBARNS.
(2) USED SIMPLE MASS CUT.

[PAGE 492]

LABORATORY BEAM MOMENTUM = 4.C0 +- .04 GEV/C.

REACTION	FRACTION PER CENT (1)
PROTON PROTON -	
DELTA(1238)+ PROTON	45. +- 10.
DELTA(1238)+ - PROTON PI0 (2)	
N*(1520)+ PROTON	< 5.
N*(1520)+ - PROTON PI0 (2)	

(1) THESE FRACTIONS SHOULD BE MULTIPLIED BY 2.6 +- .3 TO GET CROSS SECTIONS IN MILLIBARNS.
(2) USED SIMPLE MASS CUT.

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (FIGURE 5)

LABORATORY BEAM MOMENTUM = 4.00 +- .04 GEV/C.

. THIS DATA WAS READ FROM A GRAPH .

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2	+-
.025	80.000	8.000
.040	70.000	8.000
.050	67.000	8.000
.075	50.000	7.000
.100	40.000	8.000
.130	32.000	6.000
.150	28.000	5.000
.210	25.000	5.000
.230	20.000	3.000
.270	15.000	3.000
.380	8.000	1.000
.650	1.300	.400
1.100	.360	.100
1.300	.020	.050
1.600	.080	.003
2.400	.011	.002

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

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FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (PAGE 488)

LABORATORY BEAM MOMENTUM = 4.00 +- .04 GEV/C.

DATA IS FIT OVER -T FROM .02 TO .40 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(B(T))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 91. +- 5.
B = 6.7 +- .5

56 CROSS SECTIONS FOR ELEMENTARY PARTICLE INTERACTIONS (FORTSCHRITTE DER PHYSIK 9, 549 (1961))

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* * THIS IS A COMPILATION * *

ARTICLE READ BY ODETTE BENARY IN 10/69, AND VERIFIED BY LEROY PRICE.

GENERAL COMMENTS ON THIS ARTICLE
1 WE HAVE NOT ENCODED ALL OF THE DATA GIVEN BY BARASHENKOV IN HIS TABLES , BUT RATHER HAVE ARBITRARILY SELECTED OUT SOME REPRESENTATIVE POINTS.

KEY WORDS • CROSS SECTION

- -
- -

PROTON PROTON TOTAL CROSS SECTION. (1) (TABLE 1)

LABORATORY BEAM ENERGY GEV	MILLI-BARNS	+-
.0100	314.0	13.0
.0198	155.0	2.0
.0312	92.0	1.0
.0396	70.0	1.0
.0502	52.8	.6
.0619	42.5	.4
.0695	37.4	2.3
.0785	33.0	2.0
.0950	28.5	1.3
.0980	27.7	1.3
.1180	24.8	.8
.1420	25.2	1.7
.1600	26.1	1.0
.1700	23.2	1.9
.2250	22.4	.9
.2470	22.4	1.8
.2600	22.6	1.3
.3150	24.3	1.0
.3300	23.4	.9
.3450	23.2	.3
.3800	24.4	.4
.4080	24.0	1.0
.4100	26.9	.7

(1) TAKEN FROM A REVIEW ARTICLE.

- -

NEUTRON PROTON TOTAL CROSS SECTION. (1) (TABLE 4)

LABORATORY BEAM ENERGY GEV	MILLI-BARNS	+-
.0199	504.0	10.0
.0390	223.0	7.6
.0630	126.0	3.0
.0900	76.0	1.7
.1011	80.0	7.0
.1530	46.4	1.2
.1600	51.2	2.6
.2200	41.0	4.0
.3500	35.6	.7
.4100	33.7	1.3

(1) TAKEN FROM A REVIEW ARTICLE.

57 PROTON-PROTON INTERACTIONS AT 5.5 GEV/C. (PHYS. REV. 154, 1284 (1967))

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ABSTRACT THIS REPORT IS BASED ON ABOUT 10,500 PP COLLISION EVENTS PRODUCED IN THE 81-CM SACLAY HYDROGEN BUBBLE CHAMBER AT CERN. CROSS-SECTION VALUES FOR THE DIFFERENT IDENTIFIED FINAL STATES AND RESONANCES ARE GIVEN. THE ISOBARS N*(1238), N*(1420), N*(1518), N*(1688), N*(1920), AND N*(2360) WERE IDENTIFIED AND THEIR PRODUCTION CROSS-SECTION VALUES WERE FOUND VIA A BEST-FIT ANALYSIS OF DIFFERENT INVARIANT-MASS HISTOGRAMS. ABOUT 70 PER CENT OF THE ISOBARS ARE CONNECTED WITH THE QUASI-TWO-BODY REACTIONS PP-N*N AND PP-N*N*. THE REACTION PP-NEUTRON N*(1238)++ WITH A CROSS SECTION OF 3.25 +- 0.16 MB WAS ANALYZED IN TERMS OF A PERIPHERAL ABSORPTION MODEL, WHICH WAS FOUND TO BE IN GOOD AGREEMENT WITH THE DATA. VARIOUS DECAY MODES OF THE N*(1518) AND N*(1688) ISOBARS WERE OBSERVED AND THEIR BRANCHING RATIOS DETERMINED. THE BRANCHING RATIO OF N PI+ TO P PI+ PI- WAS FOUND TO BE 0.77 +- 0.45 FOR N*(1518) AND 0.67 +- 0.40 FOR N*(1688). THE BRANCHING RATIO OF N*(1238)++ PI- TO P PI+ PI- OF N*(1688) WAS ESTIMATED TO BE 0.74 +- 0.14. PION PRODUCTION TURNED OUT TO BE MAINLY DUE TO DECAY OF ISOBARS. PRODUCTION OF MESON RESONANCES TURNED OUT TO BE LESS IMPORTANT; THE REACTION PP-PP OMEGA -PP PI+ PI- PI0 WAS IDENTIFIED WITH A CROSS-SECTION VALUE OF 0.11 +- 0.02 MB. FINALLY, THE PRODUCTION OF NEUTRAL STRANGE PARTICLES WITH A CROSS SECTION OF 0.45 +- 0.04 MB IS DISCUSSED. STRONG FORMATION OF Y*(1385) IS OBSERVED.

CLOSELY RELATED REFERENCES
CONTINUATION OF PREVIOUS EXPERIMENT IN PHYS. REV. LETTERS 13, 355A (1964), PHYS. REV. LETTERS 15, 207 (1965), NUOVO CIMENTO 39, 384 (1965), NUOVO CIMENTO 40A, 839 (1965), AND PHYS. REV. 144, 1122 (1966).

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ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 5.52 GEV/C.

THIS EXPERIMENT USES THE SACLAY 81 CM (H) BUBBLE CHAMBER. A TOTAL OF 30000 PICTURES ARE REPORTED ON.

KEY WORDS - CROSS SECTION ANGULAR DISTRIBUTION MASS SPECTRUM DALITZ PLOT DIFFERENTIAL CROSS SECTION FITS DENSITY MATRIX DELTA(1238) N*(1520)D13 'N*(1688)' N*(1470)P11 DELTA(1920) DELTA(2420) RHO(765) ETA(548) OMEGA(783) BRANCHING RATIO STRANGE PARTICLES

COMPOUND KEY WORDS - FITS DIFFERENTIAL CROSS SECTION 'N*(1688)' BRANCHING RATIO

(FROM PAGE 1284 AND TABLE 1)

LABORATORY BEAM MOMENTUM = 5.52 +- .01 GEV/C.

REACTION	MILLI-BARNS		NO. EVENTS
PROTON PROTON -			
TOTAL	41.600 +-	1.400	
ELASTIC	11.990	.250	2512
PROTON NEUTRON PI+	8.030	.190	1682
PROTON PROTON PI0	2.770	.110	581
PROTON PROTON PI+ PI-	2.840	.080	1120
PROTON NEUTRON PI+ PI+ PI-	2.850	.080	1127
PROTON PROTON PI+ PI- PI0	1.840	.070	729
PROTON PROTON PI+ PI+ PI- PI-	.227	.023	91
NEUTRON PROTON PI+ PI+ PI+ PI- PI-	.098	.015	39
PROTON PROTON PI+ PI+ PI- PI- PI0	.088	.014	36

(TABLE 3)

LABORATORY BEAM MOMENTUM = 5.52 +- .01 GEV/C.

REACTION	MILLI-BARNS	
PROTON PROTON -		
DELTA(1238)++ NEUTRON	3.25 +-	.16
DELTA(1238)++ - PROTON PI+ [1]		
DELTA(1238)+ PROTON	.75	.08
DELTA(1238)+ - NEUTRON PI+ [1]		
DELTA(1238)+ PROTON	.72	.05
DELTA(1238)+ - PROTON PI0 [1]		
DELTA(1920)++ NEUTRON	.92	.10
DELTA(1920)++ - PROTON PI+ [1]		
DELTA(2420)++ NEUTRON	.20	.08
DELTA(2420)++ - PROTON PI+ [1]		
N*(1470)+ PROTON	.80	.16
N*(1470)+ - NEUTRON PI+ [1]		
N*(1470)+ PROTON	.36	.06
N*(1470)+ - PROTON PI0 [1]		
N*(1520)+ PROTON	.44	.20
N*(1520)+ - NEUTRON PI+ [1]		
N*(1520)+ PROTON	.00	.04
N*(1520)+ - PROTON PI0 [1]		
'N*(1688)+' PROTON	.32	.16
'N*(1688)+' - NEUTRON PI+ [1]		
'N*(1688)+' PROTON	.22	.06
'N*(1688)+' - PROTON PI0 [1]		

[1] FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.

(TABLE 4)

LABORATORY BEAM MOMENTUM = 5.52 +- .01 GEV/C.

REACTION	MILLI-BARNS
PROTON PROTON -	
N*(1520)+ PROTON	.57 +- .05
N*(1520)+ - PROTON PI+ PI- (1)	
'N*(1688)+' PROTON	.48 .04
'N*(1688)+' - PROTON PI+ PI- (1)	
DELTA(1920)+ PROTON	.42 .06
DELTA(1920)+ - PROTON PI+ PI- (1)	
DELTA(1238)++ PROTON PI-	.28 .04
DELTA(1238)++ - PROTON PI+ (1)	
DELTA(1238)++ DELTA(1238)0	.25 .04
DELTA(1238)++ - PROTON PI+ (1)	
DELTA(1238)0 - PROTON PI- (1)	
DELTA(1238)++ N*(1470)0	.13 .04
DELTA(1238)++ - PROTON PI+ (1)	
N*(1470)0 - PROTON PI- (1)	
DELTA(1238)++ N*(1520)0	.02 .02
DELTA(1238)++ - PROTON PI+ (1)	
N*(1520)0 - PROTON PI- (1)	
DELTA(1238)++ 'N*(1688)0'	.21 .04
DELTA(1238)++ - PROTON PI+ (1)	
'N*(1688)0' - PROTON PI- (1)	
DELTA(1238)0 PROTON PI+	.12 .01
DELTA(1238)0 - PROTON PI- (1)	
N*(1470)0 PROTON PI+	.04 .01
N*(1470)0 - PROTON PI- (1)	
N*(1520)0 PROTON PI+	.08 .02
N*(1520)0 - PROTON PI- (1)	
'N*(1688)0' PROTON PI+	.02 .02
'N*(1688)0' - PROTON PI- (1)	
PROTON PROTON RHO(765)0	.07 .05
RHO(765)0 - PI+ PI- (1)	

(1) FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.

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(TABLE 5)

LABORATORY BEAM MOMENTUM = 5.52 +- .01 GEV/C.

REACTION	MILLI-BARNS
PROTON PROTON -	
DELTA(1238)++ NEUTRON PI+ PI-	1.02 +- .15
DELTA(1238)++ - PROTON PI+ (1)	
DELTA(1238)++ N*(1520)0	.15 .02
DELTA(1238)++ - PROTON PI+ (1)	
N*(1520)0 - NEUTRON PI+ PI- (1)	
DELTA(1238)++ 'N*(1688)0'	.06 .02
DELTA(1238)++ - PROTON PI+ (1)	
'N*(1688)0' - NEUTRON PI+ PI- (1)	
DELTA(1238)++ DELTA(1238)- PI+	.59 .16
DELTA(1238)++ - PROTON PI+ (1)	
DELTA(1238)- - NEUTRON PI- (1)	
DELTA(1238)+ PROTON PI+ PI-	.17 .06
DELTA(1238)+ - NEUTRON PI+ (1)	
N*(1520)0 PROTON PI+	.26 .03
N*(1520)0 - NEUTRON PI+ PI- (1)	
'N*(1688)0' PROTON PI+	.04 .02
'N*(1688)0' - NEUTRON PI+ PI- (1)	
N*(1520)+ NEUTRON PI+	.42 .18
N*(1520)+ - PROTON PI+ PI- (1)	
'N*(1688)+' NEUTRON PI+	.07 .02
'N*(1688)+' - PROTON PI+ PI- (1)	
NEUTRON PROTON PI+ PI+ PI- (2)	.24 .03

(1) FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.
(2) CROSS SECTION IS FOR THE NON-RESONANT PRODUCTION OF THESE PARTICLES ONLY.

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(TABLE 6)

LABORATORY BEAM MOMENTUM = 5.52 +- .01 GEV/C.

REACTION	MILLI-BARNS
PROTON PROTON -	
DELTA(1238)++ PROTON PI- PI0	.20 +- .02
DELTA(1238)++ - PROTON PI+ (1)	
DELTA(1238)++ DELTA(1238)+ PI-	.26 .05
DELTA(1238)++ - PROTON PI+ (1)	
DELTA(1238)+ - PROTON PI0 (1)	
DELTA(1238)++ DELTA(1238)0 PI0	.26 .06
DELTA(1238)++ - PROTON PI+ (1)	
DELTA(1238)0 - PROTON PI- (1)	
DELTA(1238)+ PROTON PI+ PI-	.30 .03
DELTA(1238)+ - PROTON PI0 (1)	
DELTA(1238)0 PROTON PI+ PI0	.01 .01
DELTA(1238)0 - PROTON PI- (1)	
N*(1520)0 PROTON PI+	.11 .04
N*(1520)0 - PROTON PI- PI0 (1)	
'N*(1688)0' PROTON PI+	.02 .02
'N*(1688)0' - PROTON PI- PI0 (1)	
N*(1520)+ PROTON PI0	.44 .09
N*(1520)+ - PROTON PI+ PI- (1)	
'N*(1688)+' PROTON PI0	.17 .13
'N*(1688)+' - PROTON PI+ PI- (1)	
PROTON PROTON PI+ RHO(765)-	.07 .07
RHO(765)- - PI- PI0 (1)	
PROTON PROTON PI- RHO(765)+	.05 .05
RHO(765)+ - PI+ PI0 (1)	
PROTON PROTON ETA(548)	.02 .01
ETA(548) - PI+ PI- PI0 (1)	
PROTON PROTON OMEGA(783)	.11 .02
OMEGA(783) - PI+ PI- PI0 (1)	
PROTON PROTON PI+ PI- PI0 (2)	.16 .02

(1) FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.
(2) CROSS SECTION IS FOR THE NON-RESONANT PRODUCTION OF THESE PARTICLES ONLY.

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(TABLE 7)

LABORATORY BEAM MOMENTUM = 5.52 +- .01 GEV/C.

REACTION	MICRO-BARNS		NO. EVENTS
PROTON PROTON →			
LAMBDA PROTON K+	35.8 +-	9.9	13.0
SIGMA0 PROTON K+	16.0	7.5	4.5
SIGMA+ PROTON K0	4.5	4.5	1.0
LAMBDA NEUTRON K+ PI+	75.4	15.7	23.0
LAMBDA PROTON K0 PI+	78.4	12.6	38.5
LAMBDA PROTON K+ PI0	62.3	12.3	25.5
SIGMA0 PROTON K0 PI+	28.8	11.8	6.5
SIGMA+ NEUTRON K0 PI+	4.1	4.1	1.0
SIGMA+ PROTON K0 PI0	9.4	6.6	2.0
NEUTRON PROTON K0BAR K+	19.4	10.4	3.5
PROTON PROTON K0BAR K0	6.4	4.0	2.5
LAMBDA PROTON K+ PI+ PI-	21.3	8.1	7.0
LAMBDA PROTON K0 PI+ PI0	17.4	12.3	2.0
SIGMA0 PROTON K+ PI+ PI-	2.0	2.0	1.0
SIGMA+ PROTON K0 PI+ PI-	4.1	4.1	1.0
LAMBDA PROTON K0 PI+ PI+ PI-	.9	1.3	.5
LAMBDA NEUTRON K+ PI+ PI+ PI-	1.1	1.6	.5

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (FIGURE 3)

LABORATORY BEAM MOMENTUM = 5.52 +- .01 GEV/C.

. THIS DATA WAS READ FROM A GRAPH .

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2 [1]		NO. EVENTS
.01	.02	25.9 +-	3.5	54.0
.02	.03	57.8	5.3	120.5
.03	.04	61.9	5.5	129.0
.04	.05	54.0	5.1	112.5
.05	.06	62.9	5.5	131.0
.06	.07	60.0	5.4	125.0
.07	.08	43.9	4.6	91.5
.08	.09	44.9	4.6	93.5
.09	.10	38.9	4.3	81.0
.10	.11	36.0	4.2	75.0
.11	.12	29.0	3.7	60.5
.12	.13	32.9	4.0	68.5
.13	.14	26.9	3.6	56.0
.14	.15	27.8	3.7	58.0
.15	.16	25.0	3.5	52.0
.16	.17	14.9	2.7	31.0
.17	.18	19.0	3.0	39.5
.18	.19	18.0	2.9	37.5
.19	.20	19.0	3.0	39.5
.20	.21	18.5	3.0	38.5
.21	.22	18.7	3.0	39.0
.22	.23	10.6	2.3	22.0
.23	.24	11.0	2.3	23.0
.24	.25	14.9	2.7	31.0
.25	.26	10.6	2.3	22.0
.26	.27	10.1	2.2	21.0
.27	.28	14.9	2.7	31.0
.28	.29	7.0	1.6	14.5
.29	.30	6.5	1.8	13.5
.30	.31	12.0	2.4	25.0
.31	.32	7.9	1.9	16.5
.32	.33	9.1	2.1	19.0
.33	.34	9.6	2.1	20.0
.34	.35	[illegible]	1.5	10.5
.35	.36	5.5	1.6	11.5
.36	.37	5.5	1.6	11.5
.37	.38	7.9	1.9	16.5
.38	.39	4.1	1.4	8.5
.39	.40	5.3	1.6	11.0
.40	.41	4.1	1.4	8.5
.41	.42	4.1	1.4	8.5
.42	.43	5.0	1.6	10.5
.43	.44	6.0	1.7	12.5
.44	.45	1.9	1.0	4.0
.45	.46	4.1	1.4	8.5
.46	.47	1.4	.8	3.0
.47	.48	2.9	1.2	6.0
.48	.49	1.9	1.0	4.0
.49	.50	1.9	1.0	4.0
.50	.51	2.9	1.2	6.0
.51	.52	2.9	1.2	6.0
.52	.53	2.9	1.2	6.0
.53	.54	1.4	.8	3.0
.54	.55	2.9	1.2	6.0
.55	.56	1.0	.7	2.0
.56	.57	.0	.5	.0
.57	.58	1.9	1.0	4.0
.58	.59	2.4	1.1	5.0
.59	.60	2.4	1.1	5.0
.60	.61	1.0	.7	2.0
.61	.62	1.4	.8	3.0
.62	.63	1.0	.7	2.0
.63	.64	1.0	.7	2.0
.64	.65	1.0	.7	2.0
.65	.66	.0	.5	.0
.66	.67	.0	.5	.0
.67	.68	.0	.5	.0
.68	.69	.0	.5	.0
.69	.70	1.9	1.0	4.0
.70	.71	1.0	.7	2.0
.71	.72	.0	.5	.0
.72	.73	.0	.5	.0
.73	.74	1.0	.7	2.0
.74	.75	1.9	1.0	4.0

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

[1] COUNTS WERE MULTIPLIED BY .48 TO GET THESE. ERRORS ARE TAKEN AS PROPORTIONAL TO THE SQUARE-ROOT OF THE COUNTS.

FIT TO ELASTIC DIFFERENTIAL CRCSS SECTION FOR PROTON PRCTON. [TABLE 2]

LABORATORY BEAM MCMENTUM = 5.52 +- .01 GEV/C.

DATA IS FIT OVER -T FROM .03 TO .75 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING PROTON] ANC THE [CUTGOING PROTON].
FITTEC FORMULA IS C-SIGMA/D-T = EXP(A+B(T))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 4.39 +- .C4
B = 7.17 +- .18

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FIT TC ELASTIC DIFFERENTIAL CRCSS SECTION FOR PROTON PROTON. [TABLE 2]

LABORATORY BEAM MOMENTUM = 5.52 +- .01 GEV/C.

DATA IS FIT OVER -T FROM .03 TO .75 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING PROTON] AND THE [OUTGOING PROTON].
FITTED FORMULA IS D-SIGMA/D-T = EXP(A+B(T)+C(T**2))

WHERE C-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 4.45 +- .05
B = 7.96 +- .41
C = 1.50 +- .75

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DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → DELTA(1238)++ NEUTRON. [FIGURE 9]
DELTA(1238)++ → PROTON PI+ [1]

LABORATORY BEAM MOMENTUM = 5.52 +- .01 GEV/C.

. THIS DATA WAS READ FROM A GRAPH .

COS(THETA) MAX	COS(THETA) MIN	D-SIGMA/D-OMEGA MB/SR
1.00	.99	7.0
.99	.98	4.4
.98	.97	2.8
.97	.96	1.9
.96	.95	1.0
.95	.94	.8
.94	.93	.7
.93	.92	1.0
.92	.91	.7
.91	.90	.5
.90	.89	.5
.89	.88	.4
.88	.87	.3
.87	.86	.3
.86	.85	.3
.85	.84	.2

THETA IS THE ANGLE THAT THE DELTA(1238)++ MAKES WITH THE BEAM IN THE GRAND C.M.

[1] CCUNTED ALL EVENTS IN MASS BAND.

58 A STUDY OF NUCLEON ISOBAR PRODUCTION IN PROTCN-PROTON COLLISIONS. [NUOVO CIMENTO 63A, 529 (1969)]

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ABSTRACT THE MOMENTUM SPECTRA OF PROTONS SCATTERED INELASTICALLY IN PROTCN-PROTON COLLISIONS WERE OBTAINED IN AN EXTERNAL BEAM AT NIMROD, USING INCIDENT PROTON MOMENTA OF 2.85, 4.55, 6.06 AND 7.88 GEV/C, AND VARIOUS SCATTERING ANGLES IN THE RANGE 22 TO 144 MRAD. THE ISOBARS OF MASS 1236, 1518, AND 1688 MEV ARE CLEARLY SEEN. THERE IS EVIDENCE ALSO IN THE SPECTRA AT SMALL ANGLES FOR THE PRODUCTION OF THE 1410 MEV ISOBAR AT A MASS OF (1410 +- 15) MEV AND WIDTH (125 +- 20) MEV. IT IS SHOWN THAT THE OBSERVED PEAK CANNOT BE EXPLAINED BY THE DECK EFFECT. THE DIFFERENTIAL CROSS-SECTIONS FOR THE PRODUCTION OF THESE ISOBARS ARE PRESENTED IN TERMS OF THE USUAL VARIABLES S AND T, AND ARE COMPARED WITH ABSORPTION AND REGGE-POLE MODEL PREDICTIONS. FITS TO THE DATA WITH VARIOUS EMPIRICAL FUNCTIONS OF THESE VARIABLES ARE ALSO INVESTIGATED. THE BEHAVIOUR OF THE TOTAL CROSS-SECTION FOR THE 1236 MEV ISOBAR IS FOUND TO EXHIBIT ENERGY DEPENDENCE CONSISTENT WITH ONE-PION EXCHANGE, WHEREAS THE 1410 MEV AND 1688 MEV ISOBAR TOTAL CROSS-SECTIONS ARE FOUND TO BE ENERGY-INDEPENDENT. ALSO THE TOTAL CROSS-SECTION FOR THE 1518 MEV ISOBAR IS FOUND TO EXHIBIT ENERGY-DEPENDENCE IN THIS ENERGY RANGE.

CLOSELY RELATED REFERENCES
THIS ARTICLE SUPERSEDES PHYS. REV. LETTERS 17, 789 (1966).

ADDITIONAL CITATIONS
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ARTICLE READ BY ODETTE BENARY IN 10/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON FROM 2.85 TO 7.88 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS → DELTA(1238) N*(1470)P11 N*(1520)D13 'N*(1688)' CROSS SECTION
DIFFERENTIAL CROSS SECTION FITS

COMPOUND KEY WORDS → FITS DIFFERENTIAL CROSS SECTION

- -
- -

CROSS SECTION FOR PROTON PROTON → PROTON DELTA(1238)+. (TABLE 2)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS
2.85	3.80 +- .60
4.55	1.50 .20
6.06	.60 .10
7.88	.41 .06

- -

CROSS SECTION FOR PROTON PROTON → PROTON N*(1470)+. (TABLE 2)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS
4.55	.64 +- .08
6.06	.65 .18
7.88	.45 .09

- -

CROSS SECTION FOR PROTON PROTON → PROTON N*(1520)+. (TABLE 2)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS
4.55	.68 +- .08
6.06	.45 .09
7.88	.31 .05

- -

CROSS SECTION FOR PROTON PROTON → PROTON 'N*(1688)+'. (TABLE 2)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS
4.55	.70 +- .10
6.06	.50 .10
7.88	.46 .09

- -

FIT TO DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → PROTON DELTA(1238)+. (TABLE 3)

LABORATORY BEAM MOMENTUM = 2.85 GEV/C.

DATA IS FIT OVER -T FROM .031 TO .160 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 15.0 +- 1.6
B = 6.9 +- 1.2

- -

FIT TO DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → PROTON DELTA(1238)+. (TABLE 3)

LABORATORY BEAM MOMENTUM = 4.55 GEV/C.

DATA IS FIT OVER -T FROM .034 TO .270 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 6.9 +- .7
B = 8.9 +- .9

- -

FIT TO DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → PROTON DELTA(1238)+. (TABLE 3)

LABORATORY BEAM MOMENTUM = 6.06 GEV/C.

DATA IS FIT OVER -T FROM .056 TO .260 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 2.8 +- .5
B = 10. +- 1.

- -

FIT TO DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → PROTON DELTA(1238)+. (TABLE 3)

LABORATORY BEAM MOMENTUM = 7.88 GEV/C.

DATA IS FIT OVER -T FROM .046 TO .340 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 2.1 +- .3
B = 9.9 +- .6

```
FIT TO DIFFERENTIAL CROSS SECTICN FOR     PROTON PROTON  +  PROTON N*(1470)+.        (TABLE 3)

    LABORATORY BEAM MOMENTUM  =  4.55 GEV/C.

    DATA IS FIT OVER -T FROM .044 TC .220 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) ANC THE
          (CUTGOING PROTON).
    FITTED FORMULA IS         D-SIGMA/D-T  =  A*EXP(B*T)

          WHERE C-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

    FITTED VALUES

          A  =  5.5 +- .8
          B  =  14.C +- 1.3

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

FIT TO DIFFERENTIAL CRCSS SECTICN FOR     PROTON PROTON  +  PROTON N*(1470)+.        (TABLE 3)

    LABORATORY BEAM MOMENTUM  =  6.C6 GEV/C.

    DATA IS FIT OVER -T FROM .061 TC .160 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE
          (CUTGOING PROTON).
    FITTED FORMULA IS         D-SIGMA/D-T  =  A*EXP(B*T)

          WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

    FITTED VALUES

          A  =  8.8 +- 2.9
          B  =  20.7 +- 2.7

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

FIT TO DIFFERENTIAL CRCSS SECTION FOR     PROTON PROTON  +  PROTON N*(1470)+.        (TABLE 3)

    LABORATORY BEAM MOMENTUM  =  7.88 GEV/C.

    DATA IS FIT OVER -T FROM .048 TC .145 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE
          (CUTGOING PROTON).
    FITTED FORMULA IS         D-SIGMA/D-T  =  A*EXP(B*T)

          WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

    FITTED VALUES

          A  =  5.9 +- 2.5
          B  =  22.1 +- 4.1

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

FIT TO DIFFERENTIAL CRCSS SECTICN FCR     PROTON PROTON  +  PROTON N*(1520)+.        (TABLE 3)

    LABORATORY BEAM MOMENTUM  =  4.55 GEV/C.

    DATA IS FIT OVER -T FROM .057 TO .270 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) ANC THE
          (CUTGOING PROTON).
    FITTED FORMULA IS         D-SIGMA/D-T  =  A*EXP(B*T)

          WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

    FITTED VALUES

          A  =  2.2 +- .2
          B  =  5.4 +- .8

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

FIT TO DIFFERENTIAL CRCSS SECTICN FOR     PROTON PROTON  +  PROTON N*(1520)+.        (TABLE 3)

    LABORATORY BEAM MOMENTUM  =  6.C6 GEV/C.

    DATA IS FIT OVER -T FROM .065 TO .290 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE
          (OUTGOING PROTON).
    FITTED FORMULA IS         D-SIGMA/D-T  =  A*EXP(B*T)

          WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

    FITTED VALUES

          A  =  1.8 +- .4
          B  =  7.1 +- 1.1

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

FIT TO DIFFERENTIAL CRCSS SECTICN FOR     PROTON PROTON  +  PROTON N*(1520)+.        (TABLE 3)

    LABORATORY BEAM MOMENTUM  =  7.88 GEV/C.

    DATA IS FIT OVER -T FROM .C92 TO .484 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) ANC THE
          (CUTGOING PROTON).
    FITTED FORMULA IS         D-SIGMA/D-T  =  A*EXP(B*T)

          WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

    FITTEC VALUES

          A  =  .9 +- .1
          B  =  5.2 +- .5

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

FIT TO DIFFERENTIAL CROSS SECTICN FOR     PROTON PROTON  +  PROTON 'N*(1688)+'.        (TABLE 3)

    LABORATORY BEAM MOMENTUM  =  4.55 GEV/C.

    DATA IS FIT OVER -T FROM .C91 TC .270 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE
          (CUTGOING PROTON).
    FITTED FORMULA IS         C-SIGMA/D-T  =  A*EXP(B*T)

          WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

    FITTED VALUES

          A  =  2.1 +- .5
          B  =  4.6 +- 1.3
```

FIT TO DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → PROTON 'N*(1688)+'. (TABLE 3)

LABORATORY BEAM MOMENTUM = 6.06 GEV/C.

DATA IS FIT OVER -T FROM .081 TO .300 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 1.8 +- .5
B = 5.6 +- 1.3

- -

FIT TO DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → PROTON 'N*(1688)+'. (TABLE 3)

LABORATORY BEAM MOMENTUM = 7.88 GEV/C.

DATA IS FIT OVER -T FROM .058 TO .500 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 1.3 +- .2
B = 4.8 +- .4

- -

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → DELTA(1238)+ PROTON. (FIGURE 8A)

LABORATORY BEAM MOMENTUM = 2.85 GEV/C.

(PRIVATE COMMUNICATION FROM A.ASTBURY (DECEMBER 1969))

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 (1)	PER CENT
.031	13.10 +-	3
.034	12.80	3
.039	16.70	3
.048	9.05	3
.049	9.60	3
.052	7.40	3
.058	8.30	3
.065	11.30	3
.072	7.50	3
.078	10.90	3
.085	10.90	3
.092	7.30	3
.102	7.60	3
.110	6.60	3
.119	6.80	3
.128	5.60	3
.138	5.60	3
.148	5.45	3
.160	5.48	3

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10 PER CENT.

- -

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → DELTA(1238)+ PROTON. (FIGURE 8B)

LABORATORY BEAM MOMENTUM = 4.55 GEV/C.

(PRIVATE COMMUNICATION FROM A.ASTBURY (DECEMBER 1969) THERE ARE TWO VALUES BELOW AT -T=.053 .ALSO THE VALUE AT -T=.140 IS GIVEN IN THE ORIGINAL TABLE AS -T=.040)

-T (GEV/C)**2	D-SIGMA/D-T [illegible] (1)	PER CENT
[illegible]	[illegible] +-	3
.035	5.30	3
.042	5.60	3
.043	4.70	3
.053	5.05	3
.053	3.80	3
.064	4.10	3
.075	3.40	3
.089	2.85	3
.096	3.25	3
.109	2.40	3
.140	. 81	3
.160	[illegible]	3
.161	1.57	3
.180	1.81	3
.181	1.17	3
.220	.90	3
.240	.94	3
.270	.60	3

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10 PER CENT.

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → DELTA(1238)+ PROTON. (FIGURE 8C)

LABORATORY BEAM MOMENTUM = 6.06 GEV/C.

(PRIVATE COMMUNICATION FROM A.ASTBURY (DECEMBER 1969))

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 [1]	PER CENT
.056	1.74 +-	3
.070	1.94	3
.107	1.06	3
.128	.67	3
.154	.59	3
.260	.27	3

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10 PER CENT.

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → DELTA(1238)+ PROTON. (FIGURE 8D)

LABORATORY BEAM MOMENTUM = 7.88 GEV/C.

(PRIVATE COMMUNICATION FROM A.ASTBURY (DECEMBER 1969))

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 [1]	PER CENT
.046	1.750 +-	3
.089	.720	3
.093	1.000	3
.114	.580	3
.117	.630	3
.146	.410	3
.181	.350	3
.217	.170	3
.250	.170	3
.260	.190	3
.295	.160	3
.340	.060	3
.390	.120	3
.440	.046	3
.500	.074	3
.526	.029	3

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10 PER CENT.

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → N*(1470)+ PROTON. (FIGURE 9A)

LABORATORY BEAM MOMENTUM = 4.55 GEV/C.

(PRIVATE COMMUNICATION FROM A.ASTBURY (DECEMBER 1969))

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 [1]	PER CENT
.044	2.72 +-	3
.045	3.05	3
.052	3.02	3
.053	2.61	3
.062	2.20	3
.063	2.30	3
.073	2.13	3
.004	1.53	3
.098	1.31	3
.117	1.08	3
.148	.67	3
.166	.55	3
.220	.26	3

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10 PER CENT.

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → N*(1470)+ PROTON. (FIGURE 9B)

LABORATORY BEAM MOMENTUM = 6.06 GEV/C.

(PRIVATE COMMUNICATION FROM A.ASTBURY (DECEMBER 1969))

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 [1]	PER CENT
.061	2.50 +-	3
.074	2.50	3
.110	.70	3
.130	.38	3
.154	.45	3
.260	.13	3

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10 PER CENT.

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → N*(1470)+ PROTON. (FIGURE 9C.

LABORATORY BEAM MOMENTUM = 7.88 GEV/C.

(PRIVATE COMMUNICATION FROM A.ASTBURY (DECEMBER 1969))

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 (1)	PER CENT
.048	2.20 +-	3
.090	.69	3
.094	.79	3
.115	.35	3
.117	.54	3
.145	.26	3
.180	.25	3
.214	.15	3
.250	.16	3
.290	.07	3

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10 PER CENT.

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → N*(1520)+ PROTON. (FIGURE 10A)

LABORATORY BEAM MOMENTUM = 4.55 GEV/C.

(PRIVATE COMMUNICATION FROM A.ASTBURY (DECEMBER 1969) THERE ARE TWO VALUES AT -T=.191 IN THE BELOW TABLE)

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 (1)	PER CENT
.057	1.30 +-	3
.058	1.27	3
.064	2.05	3
.065	1.92	3
.074	1.28	3
.075	1.35	3
.089	1.92	3
.095	1.28	3
.107	1.29	3
.126	1.43	3
.157	1.26	3
.173	.99	3
.175	.67	3
.191	.64	3
.191	.67	3
.230	.49	3
.250	.64	3
.270	.62	3

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10 PER CENT.

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → N*(1520)+ PROTON. (FIGURE 10B)

LABORATORY BEAM MOMENTUM = 6.06 GEV/C.

(PRIVATE COMMUNICATION FROM A.ASTBURY (DECEMBER 1969))

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 (1)	PER CENT
.065	1.15 +-	3
.079	.99	3
.114	.95	3
.134	.79	3
.157	.55	3
.260	.32	3

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10 PER CENT.

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → N*(1520)+ PROTON. (FIGURE 10C)

LABORATORY BEAM MOMENTUM = 7.88 GEV/C.

(PRIVATE COMMUNICATION FROM A.ASTBURY (DECEMBER 1969))

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 (1)	PER CENT
.051	1.120 +-	3
.092	.570	3
.096	.480	3
.116	.440	3
.119	.450	3
.146	.400	3
.180	.320	3
.214	.260	3
.250	.240	3
.255	.270	3
.288	.190	3
.340	.230	3
.380	.120	3
.414	.082	3
.460	.060	3
.484	.068	3
.509	.100	3
.626	.028	3
.670	.051	3
.750	.065	3

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10 PER CENT.

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → 'N*(1688)+' PROTON. (FIGURE 11A)

LABORATORY BEAM MOMENTUM = 4.55 GEV/C.

(PRIVATE COMMUNICATION FROM A.ASTBURY (DECEMBER 1969))

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 [1]	PER CENT
.091	1.45	+- 3
.098	1.85	3
.116	.72	3
.135	.75	3
.157	1.60	3
.171	1.80	3
.186	1.C5	3
.198	.80	3
.204	.62	3
.216	.46	3
.250	.66	3
.270	.77	3

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10 PER CENT.

- -

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → 'N*(1688)+' PROTON. (FIGURE 11B)

LABORATORY BEAM MOMENTUM = 6.C6 GEV/C.

(PRIVATE COMMUNICATION FROM A.ASTBURY (DECEMBER 1969))

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 [1]	PER CENT
.081	1.45	+- 3
.093	.96	3
.127	.58	3
.146	.88	3
.168	.74	3
.26C	.52	3

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10 PER CENT.

- -

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → 'N*(1688)+' PROTON. (FIGURE 11C)

LABORATORY BEAM MOMENTUM = 7.E8 GEV/C.

(PRIVATE COMMUNICATION FROM A.ASTBURY (DECEMBER 1969))

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2 [1]	PER CENT
.059	1.020	+- 3
.098	.900	3
.102	.780	3
.121	.78C	3
.124	.740	3
.150	.620	3
.183	.530	3
.215	.420	3
.25C	.430	3
.255	.360	3
.287	.390	3
.330	.320	3
.370	.190	3
.397	.170	3
.454	.170	3
.476	.096	3
.500	.167	3
.613	.082	3
.64C	.072	3
.735	.100	3

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10 PER CENT.

59 NEUTRON-PROTON ELASTIC SCATTERING FROM 8 TO 30 GEV/C. (PHYS. REV. LETTERS 24, 22 (1970))

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ABSTRACT THE DIFFERENTIAL CROSS SECTION FOR NEUTRON-PROTON ELASTIC SCATTERING WAS MEASURED IN THE DIFFRACTION REGION WITH INCIDENT NEUTRON MOMENTA BETWEEN 8 AND 30 GEV/C. THE EXPERIMENT WAS A SPARK CHAMBER-COUNTER EXPERIMENT, CONDUCTED AT THE A.G.S. RESULTS ARE PRESENTED AND COMPARED TO CURRENTLY AVAILABLE LOWER ENERGY NP DATA AND COMPARABLE ENERGY PP DATA.

CLOSELY RELATED REFERENCES
CONTINUATION OF PREVIOUS EXPERIMENT IN PHYS. REV. LETTERS 16, 1217 (1966).

ADDITIONAL CITATIONS
UCRL 16275 (1966), PHYS. REV. LETTERS 20, 468 (1968), NUCLEAR INSTRUMENTS AND METHODS 39, 335 (1966), PHYS. REV. LETTERS 15, 45 (1965), PHYS. LETTERS 29B, 321 (1969), AND NUOVO CIMENTO 38, 60 (1965).

ARTICLE READ BY ODETTE BENARY IN 12/69, AND VERIFIED BY LEROY PRICE.

BEAM IS NEUTRON ON PROTON FROM 5.4 TO 29.4 GEV/C.

THIS EXPERIMENT USES SPARK CHAMBERS AND COUNTERS.

GENERAL COMMENTS ON THIS ARTICLE
1 THE DATA PRESENTED ARE NORMALIZED TO THE OPTICAL THEOREM POINT, NEGLECTING THE CONTRIBUTION FROM THE REAL PART OF THE FORWARD SCATTERING AMPLITUDE, AND TAKING A CONSTANT VALUE OF 38 MB FOR THE NP TOTAL CROSS SECTION BETWEEN 5 AND 20 GEV/C.

KEY WORDS • DIFFERENTIAL CROSS SECTION FITS MODELS

COMPOUND KEY WORDS • FITS DIFFERENTIAL CROSS SECTION

- -
- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 7.4 +- 2.0 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2	+-
.174	22.000	1.300
.223	15.400	1.000
.274	10.300	.860
.323	8.200	.750
.372	5.700	.660
.423	3.690	.540
.473	2.570	.560
.538	2.600	.460
.649	1.160	.340
.743	.764	.270
.851	.423	.210
.934	.208	.070

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 11.4 +- 2.0 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2	+-
.175	21.000	.930
.224	15.500	.880
.274	10.600	.700
.323	7.180	.570
.374	5.340	.510
.422	3.500	.430
.474	2.590	.290
.545	1.830	.260
.651	.799	.170
.744	.426	.130
.846	.306	.110
.974	.173	.096
1.170	.069	.021
1.476	.034	.012

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 15.4 +- 2.0 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2	+-
.175	20.700	.870
.223	14.100	.770
.273	10.000	.630
.323	7.460	.540
.373	5.130	.450
.423	3.200	.370
.474	2.180	.320
.549	1.540	.230
.649	.555	.140
.745	.294	.100
.846	.128	.067
.969	.056	.022
1.197	.010	.006
1.515	.019	.008

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 19.4 +- 2.0 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2	+-
.223	14.800	.790
.274	9.940	.630
.323	6.620	.510
.374	4.880	.440
.423	3.580	.390
.473	2.380	.320
.550	1.140	.220
.638	.633	.140
.743	.328	.100
.851	.147	.069
.985	.062	.020
1.201	.036	.013
1.638	.002	.003

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 23.4 +- 2.0 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2	+-
.227	11.700	.820
.273	6.560	.470
.324	4.610	.380
.373	3.030	.310
.422	2.160	.270
.474	1.370	.220
.550	.721	.150
.650	.421	.110
.743	.072	.039
.848	.110	.051
.982	.016	.009
1.185	.012	.006

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 27.4 +- 2.0 GEV/C.

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2	
.325	4.8400 +-	.6800
.373	3.0800	.4900
.422	2.1900	.4300
.472	1.3700	.2500
.553	.9510	.2600
.651	.3910	.1600
.738	.0649	.0260
.881	.0124	.0090

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (FIGURE 2)

LABORATORY BEAM MOMENTUM = 7.4 +- 2.0 GEV/C.

DATA IS FIT OVER -T FROM .0 TO .5 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(-A*ABS(T))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 7.01 +- .29

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (FIGURE 2)

LABORATORY BEAM MOMENTUM = 11.4 +- 2.0 GEV/C.

DATA IS FIT OVER -T FROM .0 TO .5 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(-A*ABS(T))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

A = 7.12 +- .22

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (FIGURE 2)

LABORATORY BEAM MOMENTUM = 15.4 +- 2.0 GEV/C.

DATA IS FIT OVER -T FROM .0 TO .5 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(-A*ABS(T))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

A = 7.29 +- .23

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (FIGURE 2)

LABORATORY BEAM MOMENTUM = 19.4 +- 2.0 GEV/C.

DATA IS FIT OVER -T FROM .0 TO .5 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(-A*ABS(T))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

A = 7.31 +- .23

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (FIGURE 2)

LABORATORY BEAM MOMENTUM = 23.4 +- 2.0 GEV/C.

DATA IS FIT OVER -T FROM .0 TO .5 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(-A*ABS(T))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

A = 8.57 +- .33

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (FIGURE 2)

LABORATORY BEAM MOMENTUM = 27.4 +- 2.0 GEV/C.

DATA IS FIT OVER -T FROM .0 TO .5 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(-A*ABS(T))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

A = 8.58 +- .38

60 MEASUREMENT OF PP AND PC TOTAL CROSS SECTIONS AT 3.00 GEV/C. [BNL 14125 (1969)]

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ABSTRACT IN A NEW MEASUREMENT CF PROTCN TOTAL CROSS SECTIONS AT 3.00 GEV/C, THE PD TOTAL CROSS SECTION IS FOUND TO BE LOWER THAN A PREVIOUS MEASUREMENT BY 1.17 +- .09 MB. THIS IMPLIES A CORRESPONDING NEW VALUE FOR THE TOTAL CROSS SECTION FOR I=0 WHICH IS 2.18 +- 0.27 MB LOWER THAN THE PREVIOUS VALUE. POSSIBLE SOURCES OF SYSTEMATIC ERROR ARE DISCUSSED.

CITATIONS
PHYS. REV. 146, 980 (1966), PHYS. REV. 138, B913 (1965), PHYS. REV. LETTERS 16, 1228 (1966), PHYS. REV. LETTERS 17, 102 (1966), BNL 14047, PHYS. REV. LETTERS 18, 1209 (1967), PHYS. REV. LETTERS 19, 259 (1967), PHYS. REV. LETTERS 19, 678 (1967), BNL 14046, PHYS. REV. 144, 1101 (1966), PHYS. REV. LETTERS 19, 330 (1967), PHYS. REV. LETTERS 19, 857 (1967), NUC. PHYS. 79, 609 (1966), PHYS. REV. 168, 1466 (1968), CERN 66-18 (1966), PHYS. REV. LETTERS 5, 263 (1960), PHYS. REV. 112, 2077 (1958), CRYOGENICS 3 16 (1963), INT'L. CONGRESS ON NUCLEAR PHYSICS,PARIS,FRANCE 162 (1964), AND PHYS. REV. LETTERS 20, 468 (1968).

ARTICLE READ BY ODETTE BENARY IN 12/69, AND VERIFIED BY LEROY PRICE.

BEAM NO. 1 IS PROTON ON PROTON AT 3 GEV/C.
NO. 2 IS PROTON CN CEUTERCN AT 3 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - CROSS SECTICN

PROTON PROTCN TOTAL CROSS SECTICN. (PAGE 2)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS (1,2)
3.	44.23 +- .06

(1) ERRORS ARE STASTICAL CNLY.
(2) PLUS POSSIBLE SYSTEMATIC ERROR OF +- .7 PER CENT.

PROTON DEUTERON TOTAL CRCSS SECTIGN. (PAGE 2)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS (1,2)
3.	81.78 +- .07

(1) ERRORS ARE STASTICAL CNLY.
(2) PLUS POSSIBLE SYSTEMATIC ERROR OF +- .8 PER CENT.

I = 0 NUCLEON NUCLEON TOTAL CROSS SECTION. (PAGE 7)

(THIS VALUE HAS BEEN CALCULATED BY RESCALING THE P-P AND P-DEUTERON TOTAL CROSS SECTIONS FROM BUGG ET AL(PHYS.REV.146, 980(1966)) AND TAKING A VALUE OF .0311 MB**(-1) FOR THE INVERSE SQUARE SEPARATION OF THE NUCLEON IN THE DEUTERON.)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS (1)
3.	38.57 +- .23

(1) ERRORS ARE STASTICAL CNLY.

PROTON NEUTRON TOTAL CRCSS SECTION. (PAGE 7)
GLAUBER CORRECTION APPLIED

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS (1)
3.	41.67 +- .09

(1) ERRORS ARE STASTICAL CNLY.

61 THE REACTION PP → PP PI+ PI- AT 7.9 BEV/C. [UNIV. OF ILLINCIS COO1195125 (1968)]

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ABSTRACT THE REACTICN PP → PP PI+ PI- HAS BEEN STUDIED AT AN INCIDENT MOMENTUM OF 7.9 BEV/C USING THE BROOKHAVEN 80 INCH HYDROGEN BUBBLE CHAMBER. APPRCXIMATELY 3600 EVENTS OF THE REACTION WERE IDENTIFIED: THE CROSS SECTION WAS DETERMINED TO BE 2.54 +- .13 MB. THE REACTION IS FOUND TO BE DOMINATED BY PRCDUCTION OF THE QUASI-THREE BODY FINAL STATE N*++ P PI-. A SIMPLE CNE PICN EXCHANGE MODEL IS CCMPARED TO THE DATA AND IS SHOWN TO GIVE GENERALLY GCCD RESULTS FOR INVARIANT MASS DISTRIBUTIONS FOR THE ENTIRE FINAL STATE, AND FOR MASS AND ANGULAR DISTRIBUTIONS FOR THE QUASI-THREE BOCY STATE. DISCREPANCIES BETWEEN THE DATA ANC THE MODEL ARE FOUND TO BE PRIMARILY ASSOCIATEC WITH ENHANCEMENTS IN THE N*++ PI- OR P PI+ PI- MASS DISTRIBUTIONS AT ABOUT 1425 MEV AND 1700 MEV. EXAMINATION OF THE 1425 MEV ENHANCEMENT INCICATES AN APPARENT INTERFERENCE PROCESS RATHER THAN AN INCCHERENT SUM OF ONE PION EXCHANGE BACKGRCUND AND RESCNANCE PROCUCTION: THE ENHANCEMENT COULD NOT BE IDENTIFIED AS THE N*(1470), THE P(11) WAVE RESONANCE OF PI- P PHASE SHIFT ANALYSIS. EXAMINATION OF THE PI+ PI- MASS CISTRIBUTION GIVES SOME INDICATION FOR PRODUCTION OF THE RHO MESON, BUT NO INDICATION OF OTHER PI PI RESONANCES. NO EVIDENCE IS FOUND FOP RESONANCES WITH BARYON NUMBER = 2.

CITATICNS
PHYS. LETTERS 16, 75 (1965), PHYS. REV. 154, 1284 (1967), PHYS. REV. LETTERS 17, 884 (1966), NUOVO CIMENTO 50, 1000 (1967), PHYS. REV. 138, B913 (1965), NUOVO CIMENTO 30, 240 (1963), NUOVG CIMENTC SUPPLEMENT 24 453 (1962), NUOVO CIMENTO 27, 1450 (1963), NUOVO CIMENTO 40, 236 (1965), NUOVO CIMENTO 34, 1644 (1964), REV. MOD. PHYS. 39, 1 (1968), PHYS. LETTERS 26B, 161 (1968), PHYS. REV. LETTERS 13, 169 (1964), PHYS. REV. 120, 1857 (1960), PHYS. REV. LETTERS 19, 546 (1967), PHYS. REV. 165, 1695 (1968), PHYS. REV. LETTERS 12, 340 (1964), PHYS. REV. 165, 1730 (1968), PHYS. REV. 139, B1566 (1965), PHYS. REV. LETTERS 14, 965 (1965), PHYS. REV. 157, 1328 (1967), PHYS. REV. 166, 1731 (1968), PHYS. REV. LETTERS 16, 855 (1966), PHYS. REV. LETTERS 17, 789 (1966), PHYS. REV. LETTERS 19, 397 (1967), PHYS. REV. LETTERS 20, 164 (1968), PHYS. REV. 166, 1395 (1968), PHYS. LETTERS 23, 386 (1966), PHYS. REV. LETTERS 13, 555 (1964), PHYS. REV. LETTERS 14, 1043 (1965), PHYS. REV. LETTERS 20, 133 (1968), CERN 66-18, PHYS. REV. LETTERS 13, 815 (1964), PHYS. LETTERS 26B, 317 (1968), BERKELEY CONFERENCE 103 (1966), HEIDELBERG CCNFERENCE 11 (1968), UCRL 17651 (1968), PHYS. REV. 163, 1559 (1967), NUOVO CIMENTO 1, 1238 (1955), PHYS. REV. 101, 1149 (1956), PHYS. REV. 105, 724 (1957), PHYS. REV. 137, B1115 (1965), PHYS. REV. 134, B1062 (1964), PHYS. REV. 130, 762 (1963), PHYS. REV. 132, 1252 (1963), PHYS. LETTERS 10, 248 (1961), NUC. PHYS. 22, 226 (1961), PHYS. REV. 129, 2300 (1963), PHYS. REV. 134, B1079 (1964), NUOVO CIMENTO 22, 193 (1961), NUOVO CIMENTC 19, 467 (1961), AND ENRICO FERMI INSTITUTE EFINS66-29 (1966).

ARTICLE READ BY OCETTE BENARY IN 10/69, AND VERIFIED BY LERCY PRICE.

BEAM IS PROTON ON PROTCN AT 7.9 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 80 IN. (H) BUBBLE CHAMBER.

KEY WORCS → CROSS SECTICN MASS SPECTRUM MODELS ANGULAR DISTRIBUTICN

CROSS SECTION FOR PROTON PRCTON → PROTON PROTON PI+ PI-. [PAGE 29]

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS	NO. EVENTS
7.875 +- .044	2.54 +- .13	3600

62 EVICENCE FOR DCMINANCE OF POMERON LIKE EXCHANGE IN PP → NN PI AT 19 GEV/C. [PHYS. LETTERS 30B, 369 (1969)]

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ABSTRACT THE REACTICNS PP → NN PI ARE STUDIED AT 19 GEV/C AND ANALYSEC IN TERMS OF THE AMPLITUDES WITH THE LOW MASS NPI SYSTEM IN ISOSPIN STATES 1/2 AND 3/2 RESPECTIVELY. THE I=1/2 CROSS SECTION IS COMPARED WITH THE CORRESPONDING ONE IN PI P → PI PI N AT 8 GEV/C.

CITATIONS
PHYS. REV. LETTERS 15, 49 (1965), CERN TH 1001 (1969), PHYS. REV. 88, 1211 (1952), NUC. PHYS. B8, 45 (1968), CERN TH 1022 (1969), PHYS. REV. LETTERS 19, 330 (1967), PHYS. REV. LETTERS 19, 857 (1967), PHYS. LETTERS 14, 164 (1965), PHYS. REV. 125, 2C82 (1962), PHYS. REV. 123, 2160 (1961), PHYS. REV. 162, 1320 (1967), NUOVO CIMENTO 47A, 470 (1967), PHYS. REV. 154, 1284 (1967), PHYS. REV. 173, 1322 (1968), AND NUOVO CIMENTO 53A, 232 (1968).

ARTICLE REAC BY OCETTE BENARY IN 10/69, ANC VERIFIED BY LEROY PRICE.

BEAM IS PRCTON CN PROTON AT 19 GEV/C.

THIS EXPERIMENT USES THE CERN 2M (H) BUBBLE CHAMBER.

KEY WORCS → CROSS SECTION MASS SPECTRUM MODELS

LABCRATORY BEAM MOMENTUM = 19. GEV/C.

REACTION	MILLI-BARNS
PROTON PRCTON →	
ELASTIC	8.70 +- .50
PROTCN PROTON PI0	1.10 .20
PRCTON NEUTRON PI+	1.90 .20
DELTA(1238)++ NEUTRON	.27 .05
DELTA(1238)++ → PROTON PI+ [1]	

[1] USED SIMPLE MASS CUT.

63 PRCTON-CEUTERON INTERACTICNS AT 970 MEV. (PROC. OF THE ROYAL SOCIETY OF LONDCN 251, 233 (1959))

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ABSTRACT A HIGH-PRESSURE DIFFUSICN CLOUD CHAMBER HAS BEEN USED TO STUDY THE INTERACTICNS OF 970 MEV PROTONS FROM THE BIRMINGHAM SYNCHROTRON WITH DEUTERIUM. ANALYSIS OF THE 569 COLLISICNS OBSERVED INDICATES THAT AT THIS ENERGY THE DEUTERON BEHAVES AS IF IT WERE COMPOSED OF TWO FREE NUCLEONS. THE PROPERTIES OF PROTON-PROTON AND PROTON-NEUTRON SCATTERING HAVE BEEN DETERMINED ON THIS ASSUMPTION. AN ESTIMATE IS MADE CF THE EXTENT OF THE ''SHADOWING'' OF EACH NUCLEON IN THE DEUTERON BY THE OTHER. THE PARTIAL CROSS-SECTIONS FOR PP AND PN ELASTIC SCATTERING HAVE BEEN DETERMINED, AS HAVE ALSO THE VALUES FOR THE FIVE POSSIBLE SINGLE MESON PRODUCTION PROCESSES. THEY HAVE THE FOLLOWING ''BEST'' VALUES

(1) (PP - PP) = 25.9 +- 1.7 MB
(2) (PN - PN) = 16.2 +- 3.5 MB
(3) (PP - PP PIO) = 5.4 +- 1.0 MB
(4) (PP - NP PI+) = 15.6 +- 1.7 MB
(5) (PN - PN PIC) = 14.3 +- 3.5 MB
(6) (PN - PP PI-) = 2.7 +- 0.6 MB
(7) (PN - NN PI+) = 4.3 +- 1.1 MB

DOUBLE MESON PRODUCTION ANC REACTIONS INVOLVING SECONDARY DEUTERONS ARE NOT IMPCRTANT. THE CROSS-SECTIONS (1), (2), (3), (4), AND (5) ARE CONSISTENT WITH VALUES EXTRAPOLATED FROM DATA AT ENERGIES BELOW 660 MEV BY RUSSIAN WORKERS. KNOWLEDGE OF THE OTHER CROSS-SECTIONS (6) AND (7) MAKES POSSIBLE A TEST CF THE VALIDITY OF THE CHARGE INDEPENDENCE OF NUCLEAR FORCES. THE PRESENT RESULTS ARE NOT IN GOOD AGREEMENT WITH THIS. THE RESULTS FOR INELASTIC SCATTERING INDICATE THAT, ASSUMING CHARGE INCEPENDENCE, THE FORMATION OF EXCITED NUCLEONS OF ISOTOPIC SPIN 3/2 DOES NOT DOMINATE THE PROCESS OF PION PRODUCTION. THIS IS ALSO TRUE FOR THE RUSSIAN DATA. TWELVE CASES OF DOUBLE MESON PRODUCTION WERE OBSERVED. THE ANGULAR DISTRIBUTION OF PROTON-NEUTRON ELASTIC SCATTERING HAS THE FORM EXPECTED FRCM LOWER ENERGY DATA.

CITATIONS
NUOVO CIMENTO 9, 547 (1958), PROC. OF THE ROYAL SOCIETY OF LONDON A237, 175 (1956), J. SCI. INSTRUM. 33 302 (1956), J. SCI. INSTRUM. 34 17 (1957), PROC. CF THE ROYAL SOCIETY OF LONDON A251, 218 (1959), PROC. OF THE ROYAL SOCIETY OF LONDON A71, 293 (1958), PHYS. REV. 103, 211 (1956), PHYS. REV. 74, 809 (1948), PHYS. REV. 85, 636 (1952), PHYS. REV. 98, 1369 (1955), PROC. OF THE ROYAL SOCIETY OF LONDON A64, 667 (1951), PHYS. REV. 96, 398 (1954), CERN CCNFERENCE 2 115 (1956), PROGRESS IN THEORETICAL PHYSICS, JAPAN 5, 570 (1950), PHYS. REV. 92, 452 (1953), PHYS. REV. 93, 1434 (1954), PHYS. REV. 75, 1352 (1949), PHYS. REV. 95, 1026 (1954), PHYS. REV. 103, 1479 (1956), PHYS. REV. 100, 242 (1955), PHYS. REV. 89, 1090 (1953), JINR P-157 (1958), PHYS. REV. 104, 784 (1956), PHYS. REV. 101, 397 (1956), PHYS. REV. 94, 1795 (1954), PHYS. REV. 101, 1079 (1956), PROC. OF THE ROYAL SOCIETY OF LONDCN A244, 491 (1958), DOKL. AKAD. NAUK. SSSR 99 955 (1954), PHYS. REV. 103, 1472 (1956), PHYS. REV. 94, 1085 (1954), PHYS. REV. 95, 1580 (1954), JETP 32 750 (1957), PHYS. REV. 96, [illegible] (1954), PHYS. REV. 96, 734 (1954), PHYS. REV. 97, 1186 (1955), PHYS. REV. 97, 783 (1955), PHYS. REV. 105, 1058 (1957), UCRL 2540 (1954), PROGRESS OF THEORETICAL PHYSICS 19, 622 (1958), AND PHYS. REV. 103, 1330 (1955).

ARTICLE READ BY ODETTE BENARY IN 10/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON DEUTERCN AT 1.662 GEV/C. (BEAM KINETIC ENERGY = .97 GEV)

THIS EXPERIMENT USES A CLOUD CHAMBER.

GENERAL CCMMENTS CN THIS ARTICLE
1 THE QUOTED CROSS SECTIONS WERE NORMALIZED TO A TOTAL PD CROSS SECTION OF 77+-2.5 MB.

KEY WORDS - CROSS SECTICN DIFFERENTIAL CROSS SECTION ANGULAR DISTRIBUTION

- -
- -

(TABLE 2)

LABCRATORY BEAM ENERGY = .97 GEV.

REACTION	MILLI-BARNS	
PROTON NEUTRON -		
ELASTIC	16.2 +-	3.5 [1]
PROTON NEUTRON PIO	14.3	3.5
NEUTRON NEUTRON PI+	1.5	1.1
PROTON PROTON PI-	2.7	.6
TOTAL	30.2	3.7

[1] THE WAY THE SCREENING CORRECTION HAS BEEN CALCULATED IS SHOWN IN PAGE 242 CF THE ARTICLE.

64 OMEGA PRODUCTION IN PP - PP PI+ PI- PIO AT 6.6 GEV/C. (UCRL 19330 (1969))

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ABSTRACT WE PRESENT A STUDY OF THE 3 PI SYSTEM IN PP - PP PI+ PI- PIO AT 6.6 GEV/C. BOTH ETA(549) AND OMEGA(783) PRODUCTION ARE OBSERVED. THE DALITZ PLOT IS DISPLAYED FOR THE PP OMEGA EVENTS, IN ADDITION TO SEVERAL OTHER EXPERIMENTAL DISTRIBUTIONS. THERE IS NO EVIDENCE FOR P OMEGA RESONANCES. THE PP OMEGA EVENTS HAVE BEEN ASSIGNED SEPARATELY TO THE SIX POSSIBLE MULTIPERIPHERAL DIAGRAMS ON THE BASIS OF CRITERIA IN THE FOUR-MOMENTUM TRANSFERS ANC C.M. LONGITUDINAL MOMENTA, RESPECTIVELY. IN ADDITION WE DISCUSS THE MEANS OF ACHIEVING AN EFFECTIVE DIAGRAM SEPARATION.

CLOSELY RELATED REFERENCES
SEE ALSO UCLA 1025 (1968), AND UCLA 1036 (1969).

ADDITIONAL CITATIONS
PHYS. REV. LETTERS 21, 1548 (1968), NUOVO CIMENTO 58, 475 (1968), PHYS. REV. 161, 1387 (1967), PHYS. REV. 154, 1284 (1967), NUOVO CIMENTO 55A, 66 (1968), UCRL 17707 (1968), PHYS. REV. 174, 1638 (1968), PHYS. REV. LETTERS 23, 42 (1969), PHYS. REV. 177, 2092 (1969), AND NUOVO CIMENTO 51A, 696 (1967).

ARTICLE READ BY ODETTE BENARY IN 12/69, AND VERIFIED BY LERCY PRICE.

BEAM IS PROTON ON PROTON AT 6.6 GEV/C.

THIS EXPERIMENT USES THE L.R.L. 72 IN. (H) BUBBLE CHAMBER.

KEY WORDS - CROSS SECTION OMEGA(783) ETA(548)

- -
- -

(TABLE 1)

LABORATORY BEAM MOMENTUM = 6.6 GEV/C.

REACTION	MICRO-BARNS		NO. EVENTS
PROTON PRCTON -			
PROTCN PROTON OMEGA(783)	180. +-	23.	671
OMEGA(783) - PI+ PI- PIO [1]			
PROTON PROTON ETA(548)	29.	9.	
ETA(548) - PI+ PI- PIO [1]			

[1] FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.

65 POLE EXTRAPOLATION RESULTS FROM PP → DELTA ++ N AT 6.6 GEV/C. [PHYS. REV. LETTERS 23, 342 (1969)]

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E.COLTON,P.E.SCHLEIN (UNIV. OF CALIF., LOS ANGELES, CALIF., USA)

ABSTRACT WE PRESENT AN EXPERIMENTAL STUDY OF THE LOW-MOMENTUM-TRANSFER DELTA++ N COMPONENT OF 6424 PP → P PI+ N EVENTS AT 6.6 GEV/C. THE PI+ P ELASTIC CROSS SECTIONS IN THE DELTA++ REGION ARE MEASURED BY MEANS OF SEVERAL DIFFERENT POLE-EXTRAPOLATION PROCEDURES. WE FIND THAT THE CONVENTIONAL CHEW-LOW EXTRAPOLATION PROCEDURE YIELDS RESULTS NOT IN SATISFACTORY AGREEMENT WITH THE KNOWN ON-SHELL CROSS SECTIONS. WE SUGGEST A MODIFIED EXTRAPOLATION PROCEDURE WHICH IN OUR CASE YIELDS RESULTS IN GOOD AGREEMENT WITH THE ON-SHELL VALUES.

CITATIONS
PHYS. REV. LETTERS 5, 571 (1960), PHYS. REV. 113, 1640 (1959), NUC. PHYS. B3, 349 (1967), PHYS. REV. LETTERS 21, 1613 (1968), PHYS. REV. LETTERS 19, 925 (1967), UCLA UCLA-1023 (1968), NUOVO CIMENTO 40A, 899 (1965), CERN TH 838 (1967), AND PHYS. LETTERS 6, 62 (1963).

ARTICLE READ BY ODETTE BENARY IN 9/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 6.6 GEV/C.

THIS EXPERIMENT USES THE L.R.L. 72 IN. (H) BUBBLE CHAMBER.

KEY WORDS → CROSS SECTION MASS SPECTRUM DIFFERENTIAL CROSS SECTION MODELS DELTA(1238)++

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CROSS SECTION FOR PROTON PROTON PROTON PI+ NEUTRON. [PAGE 343]

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS
6.6	5.73 +- .35

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DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → NEUTRON DELTA(1238)++. [FIGURE 18]
DELTA(1238)++ → PROTON PI+ [1]

LABORATORY BEAM MOMENTUM = 6.6 GEV/C.

(PRIVATE COMMUNICATION FROM E.COLTON SEPT.1969)

T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2	
.002	.010	11.80 +-	1.12
.010	.020	15.00	1.13
.020	.030	12.40	1.03
.030	.040	12.25	1.02
.040	.060	11.10	.69
.060	.080	7.44	.57
.080	.100	6.80	.54
.100	.120	4.45	.44
.120	.140	3.64	.40
.140	.160	3.94	.41
.160	.180	2.22	.31
.180	.200	2.27	.31
.200	.220	2.27	.31
.220	.240	1.67	.27
.240	.260	1.79	.28
.260	.280	1.41	.25
.280	.300	1.37	.24

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (NEUTRON).

[1] COUNTED ALL EVENTS IN MASS BAND.

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FIT TO DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → NEUTRON DELTA(1238)++. [PAGE 343]
DELTA(1238)++ → PROTON PI+ [1]

LABORATORY BEAM MOMENTUM = 6.6 GEV/C.

DATA IS FIT OVER T FROM .03 TO .30 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (NEUTRON).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(BX+CX**2)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND X=T-TMIN.

FITTED VALUE

A = 21.3 +- 2.3
B = -16.1 +- 1.9
C = 23.0 +- 6.2

[1] COUNTED ALL EVENTS IN MASS BAND.

66 POLARIZATION PARAMETER IN ELASTIC PROTON-PROTON SCATTERING FROM 0.75 TO 2.84 GEV. (PHYS. REV. 161, 1374 (1967))

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ABSTRACT THE POLARIZATION PARAMETER IN ELASTIC PROTON-PROTON SCATTERING HAS BEEN MEASURED AT 0.75, 1.03, 1.32, 1.63, 2.24, AND 2.84 GEV BY EMPLOYING A DOUBLE-SCATTERING TECHNIQUE. AN EXTERNAL PROTON BEAM FROM THE BROOKHAVEN COSMOTRON WAS FOCUSED ON A 3 IN.-LONG LIQUID HYDROGEN TARGET AND THE ELASTIC RECOIL AND SCATTERED PROTONS WERE DETECTED IN COINCIDENCE BY SCINTILLATION COUNTERS. THE POLARIZATION OF THE RECOIL BEAM WAS DETERMINED FROM THE AZIMUTHAL ASYMMETRY EXHIBITED IN ITS SCATTERING FROM A CARBON TARGET. THIS ASYMMETRY WAS MEASURED BY A PAIR OF SCINTILLATION COUNTER TELESCOPES WHICH SYMMETRICALLY VIEWED THE CARBON TARGET. THE ANALYZING POWER OF THIS SYSTEM WAS PREVIOUSLY DETERMINED IN AN INDEPENDENT CALIBRATION EXPERIMENT EMPLOYING A 40 PER CENT POLARIZED PROTON BEAM AT THE CARNEGIE INSTITUTE OF TECHNOLOGY SYNCHROCYCLOTRON. FALSE ASYMMETRIES WERE CANCELLED TO A HIGH ORDER BY PERIODICALLY ROTATING THE ANALYZER 180 DEG. ABOUT THE RECOIL BEAM LINE. SPARK CHAMBERS WERE UTILIZED TO OBTAIN THE SPATIAL DISTRIBUTION OF THE BEAM AS IT ENTERED THE ANALYZER; THIS INFORMATION ALLOWED AN ACCURATE DETERMINATION OF THE CORRECTIONS NECESSARY TO COMPENSATE FOR ANY MISALIGNMENT OF THE AXIS OF THE ANALYZER RELATIVE TO THE INCIDENT-BEAM CENTROID. VALUES OF THE POLARIZATION PARAMETER IS A FUNCTION OF THE CENTER-OF-MASS SCATTERING ANGLE ARE GIVEN FOR EACH INCIDENT BEAM ENERGY. THE PREDICTIONS OF THE REGGE THEORY FOR POLARIZATION IN ELASTIC PROTON-PROTON SCATTERING AND RECENTLY PUBLISHED PHASE-SHIFT SOLUTIONS ARE COMPARED WITH THE EXPERIMENTAL RESULTS. SURPRISINGLY GOOD AGREEMENT WITH THE REGGE PREDICTIONS IS FOUND DESPITE THE LOW ENERGIES INVOLVED.

CLOSELY RELATED REFERENCES
CONTINUATION OF PREVIOUS EXPERIMENT IN PHYS. REV. LETTERS 16, 536 (1966).

ADDITIONAL CITATIONS
PHYS. REV. 148, 1297 (1966), NUOVO CIMENTO 20, 1049 (1961), PROGR. THEORET. PHYS. (KYOTO) 35 261 (1966), PHYS. REV. 85, 947 (1952), PHYS. REV. 99, 996 (1955), PROGR. THEORET. PHYS. (KYOTO) 28 1048 (1962), PHYS. REV. LETTERS 9, 475 (1962), ANNALS OF PHYSICS 7, 404 (1959), PHYS. REV. 120, 2250 (1960), UNIV. OF MICH. TECH. REPORT 03106-23-T (1966), PHYS. REV. 148, 1289 (1966), UCRL 11926 (1965), AND NUOVO CIMENTO 23, 690 (1962).

ARTICLE READ BY ODETTE BENARY IN 10/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON FROM 1.403 TO 3.659 GEV/C.

THIS EXPERIMENT USES COUNTERS AND SPARK CHAMBERS.

GENERAL COMMENTS ON THIS ARTICLE
1 FIRST SCATTERING ON HYDROGEN, SECOND SCATTERING ON CARBON.

KEY WORDS - POLARIZATION MODELS

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ELASTIC POLARIZATION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = .75 GEV +- 2(PER CENT).

THETA DEGREES	POLARIZATION (1)	
43.85	.541 +-	.075
47.19	.513	.044
53.25	.530	.029
63.98	.470	.067
86.29	.097	.078

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5 PER CENT.

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ELASTIC POLARIZATION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = 1.03 GEV +- 2(PER CENT).

THETA DEGREES	POLARIZATION (1)	
39.89	.619 +-	.031
42.47	.464	.040
53.60	.481	.023
57.01	.417	.038
61.62	.325	.033
65.32	.258	.073
68.52	.245	.033
71.37	.265	.037
77.25	.095	.029
88.25	-.021	.034

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5 PER CENT.

- -

ELASTIC POLARIZATION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = 1.32 GEV +- 2(PER CENT).

THETA DEGREES	POLARIZATION (1)	
32.30	.361 +-	.036
34.77	.403	.030
39.06	.343	.045
46.63	.407	.025
49.77	.339	.022
53.13	.266	.020
61.21	.190	.025
68.26	.034	.030
74.76	.062	.032
81.81	.059	.034
88.23	.034	.029

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5 PER CENT.

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ELASTIC POLARIZATION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = 1.63 GEV +- 2(PER CENT).

THETA DEGREES	POLARIZATION [1]	
28.87	.228 +-	.029
32.80	.352	.032
38.55	.335	.025
44.07	.369	.020
49.67	.177	.040
56.03	.151	.053
61.91	.141	.035
67.04	.025	.028
73.93	.025	.030
80.57	.000	.031

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5 PER CENT.

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ELASTIC POLARIZATION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = 2.24 GEV +- 2(PER CENT).

THETA DEGREES	POLARIZATION [1]	
25.32	.227 +-	.031
27.09	.315	.026
30.42	.252	.026
36.08	.292	.030
38.74	.229	.052
40.41	.205	.025
43.45	.178	.027
47.14	.182	.033
50.65	.163	.037
52.25	.134	.036
54.01	.147	.032
57.04	.048	.075
62.22	.020	.041
69.30	.093	.050
85.24	.006	.061

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5 PER CENT.

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ELASTIC POLARIZATION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = 2.84 GEV +- 2(PER CENT).

THETA DEGREES	POLARIZATION [1]	
22.18	.193 +-	.026
23.78	.188	.054
31.65	.237	.039
35.91	.199	.057
41.37	.175	.037
47.15	.142	.071
60.04	.115	.055
72.72	.043	.059

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5 PER CENT.

67 ABSOLUTE DIFFERENTIAL CROSS-SECTION FOR ELASTIC PROTON-PROTON SCATTERING AT 0.97 GEV. (NUOVO CIMENTO 28, 943 (1963))

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ABSTRACT THE ABSOLUTE DIFFERENTIAL CROSS-SECTION FOR ELASTIC PP SCATTERING HAS BEEN MEASURED FOR AN ENERGY OF 0.97 GEV AT 5 DEG, 20 DEG., 25 DEG., 30 DEG., AND 35 DEG. IN THE LABORATORY SYSTEM (LS). THE DATA FIT THE CURVE -- SIGMA(THETA) =[(4.27 +- 0.37) P-ZERO(COS THETA) + (10.13 +- 1.44) P-TWO(COS THETA) + (5.50 +- 1.36) P-FOUR(COS THETA) + (1.50 +- 0.64) P-SIX(COS THETA)]X (1.000 +- 0.016) MB/SR, WHERE SIGMA(THETA) IS THE UNPOLARIZED DIFFERENTIAL CROSS-SECTION AND THETA THE SCATTERING ANGLE IN THE CENTER-OF-MASS SYSTEM (C.M.S). THIS GIVES A TOTAL ELASTIC CROSS-SECTION OF (26.8 +- 2.3) MB AND A FORWARD SCATTERING CROSS-SECTION OF (21.4 +- 0.5) MB/SR, WHICH IS CONSIDERABLY IN EXCESS OF THE OPTICAL THEOREM MINIMUM OF (16.3 +- 0.2) MB/SR.

CITATIONS

PHYS. REV. 97, 1186 (1955), PHILOSOPHICAL MAGAZINE 2 204 (1957), PROC. OF THE ROYAL SOCIETY OF LONDON A251, 218 (1959), PROC. OF THE PHYSICAL SOCIETY OF LONDON 74 625 (1959), NUOVO CIMENTO 18, 818 (1960), NUOVO CIMENTO 23, 690 (1962), NUCLEAR INSTRUMENTS 4, 30 (1959), NUCLEAR INSTRUMENTS 7, 167 (1960), PHYS. REV. 81, 849 (1951), PROC. OF THE ROYAL SOCIETY OF LONDON 71, 770 (1958), PHYS. REV. LETTERS 3, 568 (1959), NUC. PHYS. 9, 600 (1959), PHYS. REV. 103, 211 (1956), PHYS. REV. 118, 579 (1960), JETP 12 802 (1961), NUOVO CIMENTO 20, 1049 (1961), AND PHYS. LETTERS 1, 41 (1961) .

ARTICLE READ BY ODETTE BENARY IN 5/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 1.66 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - CROSS SECTION DIFFERENTIAL CROSS SECTION FITS

COMPOUND KEY WORDS - FITS DIFFERENTIAL CROSS SECTION

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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = .97 GEV.

THETA DEGREES	D-SIGMA/D-OMEGA MB/SR	PER CENT
12.30	19.600 +-	6.5
48.30	3.506	2.4
59.73	2.037	3.4
70.83	1.185	3.4
81.55	.898	2.7

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

PROTON PROTON ELASTIC CROSS SECTION. (PAGE 950)

LABORATORY BEAM ENERGY GEV	MILLI-BARNS
.97	26.8 +- 2.3

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FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (PAGE 943)

LABORATORY BEAM ENERGY = .97 GEV.
FITTED FORMULA IS D-SIGMA/D-OMEGA = A*(B*P0(COS(THETA))+C*P2(COS(THETA))+D*P4(COS(THETA))+E*P6(COS(THETA)))

WHERE D-SIGMA/D-OMEGA IS IN MB/SR. THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

FITTED VALUES

A = 1.000 +- .016
B = 4.27 +- .37
C = 10.13 +- 1.44
D = 5.50 +- 1.36
E = 1.50 +- .64

68 ELASTIC SCATTERING AND SINGLE MESON PRODUCTION IN PROTON-PROTON COLLISIONS AT 2.85 BEV. (PHYS. REV. 123, 2160 (1961))

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ABSTRACT THE BROOKHAVEN NATIONAL LABORATORY TWENTY-INCH LIQUID HYDROGEN BUBBLE CHAMBER WAS EXPOSED TO A MONOENERGETIC BEAM OF 2.85-BEV PROTONS, ELASTICALLY SCATTERED FROM A CARBON TARGET IN THE INTERNAL BEAM OF THE COSMOTRON. ALL TWO-PRONG EVENTS, EXCLUDING STRANGE PARTICLE EVENTS, HAVE BEEN STUDIED BY THE YALE HIGH-ENERGY GROUP. THE REMAINING INTERACTIONS HAVE BEEN STUDIED BY THE BROOKHAVEN BUBBLE CHAMBER GROUP. ELASTIC SCATTERING WAS FOUND TO BE MOSTLY PURE DIFFRACTION SCATTERING AT CENTER-OF-MASS ANGLES UP TO ABOUT THIRTY-FIVE DEGREES. SOME PHASE SHIFT AND/OR TAPERING OF THE PROTON EDGE WAS REQUIRED TO FIT THE DATA AT LARGER ANGLES. NO POLARIZATION EFFECTS IN THE PROTON-CARBON SCATTERING WERE OBSERVED USING HYDROGEN AS AN ANALYZER OF POLARIZED PROTONS. NUCLEONIC ISOBAR FORMATION IN THE T = 3/2, J = 3/2 STATE WAS FOUND TO ACCOUNT FOR A LARGE PART OF SINGLE PION PRODUCTION. HIGH-ORBITAL ANGULAR-MOMENTUM STATES WERE FOUND TO BE GREATLY FAVORED IN SINGLE PION PRODUCTION. THE ISOBAR MODEL OF LINDENBAUM AND STERNHEIMER GAVE GOOD AGREEMENT WITH THE OBSERVED NUCLEON AND PION ENERGY SPECTRA. NO POLARIZATION OR ALIGNMENT EFFECTS WERE OBSERVED FOR THE ISOBAR ASSUMED IN THIS MODEL.

CITATIONS
PHYS. REV. 103, 1448 (1956), PHYS. REV. 107, 859 (1957), PHYS. REV. 103, 211 (1956), PHYS. REV. LETTERS 3, 568 (1959), PHYS. REV. 118, 575 (1960), CERN CONFERENCE 440 (1959), BULL. AM. PHYS. SOC. 2, 11 (1957), BULL. AM. PHYS. SOC. 5, 282 (1960), ROCHESTER CONFERENCE 203 (1960), PHYS. REV. 72, 1114 (1947), PHYS. REV. 75, 1352 (1949), PROGRESS IN THEORETICAL PHYSICS, JAPAN 5, 570 (1954), PHYS. REV. 94, 1085 (1954), PHYS. REV. 95, 1580 (1954), CERN 59-3 (1959), PHYS. REV. 101, 796 (1956), PHYS. REV. LETTERS 4, 242 (1960), PHYS. REV. 105, 1847 (1957), PHYS. REV. 106, 572 (1957), PHYS. REV. 75, 1664 (1949), AND PHYS. REV. LETTERS 5, 571 (1960).

ARTICLE READ BY ODETTE BENARY IN 3/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 3.67 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 20 IN. (H) BUBBLE CHAMBER. A TOTAL OF 9000 PICTURES ARE REPORTED ON.

KEY WORDS - CROSS SECTION DIFFERENTIAL CROSS SECTION ANGULAR DISTRIBUTION MASS SPECTRUM

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(FROM PAGE 2163 AND TABLE 1)

LABORATORY BEAM MOMENTUM = 3.67 GEV/C +- 3(PER CENT).

REACTION	MILLI-BARNS	
PROTON PROTON -		
ELASTIC	15.32 +-	.76 (1)
PROTON NEUTRON PI+	11.44	.65
PROTON PROTON PI0	2.90	.31
DEUTERON PI+	.11	.06

(1) CORRECTED FOR SMALL ANGLE SCANNING LOSSES USING AN OPTICAL MODEL CURVE..

69 ISOBAR PRODUCTION IN PP - PP PI+ PI- AT 6.6 GEV/C. (PHYS. REV. LETTERS 17, 884 (1966))

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ABSTRACT AT 6.6 GEV/C, THE REACTION PP - P PI+ P PI- PROCEEDS DOMINANTLY THROUGH THE N*++ P PI- CHANNEL. WHEN PERIPHERAL N*++'S ARE SELECTED, THE P PI- ANGULAR DISTRIBUTION REPRODUCES THE ANGULAR DISTRIBUTIONS OF FREE PI- P SCATTERING IN THE C.M. ENERGY RANGE FROM THRESHOLD TO 2.0 GEV. THE DIFFRACTION SCATTERING AT THE UPPER END OF THIS ENERGY BAND CAN ACCOUNT FOR THE 1.4-GEV N* DEDUCED IN RECOIL-PROTON SPECTRUM STUDIES.

CLOSELY RELATED REFERENCES
PART OF THIS ARTICLE SUPERSEDED BY UCLA 1025 (1968).

ADDITIONAL CITATIONS
PHYS. REV. 128, 1823 (1962), NUOVO CIMENTO 35, 1052 (1965), PHYS. LETTERS 18, 167 (1965), PHYS. REV. LETTERS 16, 855 (1966), PHYS. REV. LETTERS 12, 340 (1964), PHYS. LETTERS 18, 342 (1965), PHYS. LETTERS 14, 159 (1965), PHYS. REV. 138, B190 (1965), PHYS. REV. LETTERS 15, 468 (1965), PHYS. REV. LETTERS 13, 169 (1964), PHYS. LETTERS 15, 281 (1965), PHYS. REV. LETTERS 15, 731 (1965), PHYS. REV. LETTERS 16, 481 (1966), AND NUOVO CIMENTO 10, 839 (1965).

ARTICLE READ BY ODETTE BENARY IN 4/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 6.6 GEV/C.

THIS EXPERIMENT USES THE L.R.L. 72 IN. (H) BUBBLE CHAMBER.

KEY WORDS - CROSS SECTION DALITZ PLOT MASS SPECTRUM DELTA(1238)++ ANGULAR DISTRIBUTION N*(1470)P11

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CROSS SECTION FOR PROTON PROTON → PROTON PROTON PI+ PI-. (PAGE 887)

(THIS DATA SHOULD NOT BE USED - MORE RECENT VALUES MAY BE FOUND IN COLTON, UCLA 1025 (1968))

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS	NO. EVENTS
6.6	2.6 +- .3	2097

70 DIFFERENTIAL CROSS SECTIONS FOR PP → D PI+ FROM 1 TO 3 BEV. (PHYS. REV. 167, 1232 (1968))

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M.L.PERL (STANFORD UNIV., STANFORD, CALIF., USA)

ABSTRACT THE DIFFERENTIAL AND TOTAL CROSS SECTIONS FOR THE REACTION PP → D PI+ HAVE BEEN MEASURED IN A COUNTER EXPERIMENT FOR INCIDENT PROTON KINETIC ENERGIES OF 1.0, 1.3, 1.5, 1.7, 2.0, 2.5, AND 2.8 BEV. VALUES OF THE DIFFERENTIAL CROSS SECTION ARE GIVEN FOR BARYCENTRIC DEUTERON ANGLES THETA FOR 0 ≥ COS THETA ≥ -0.97 IN SMALL INTERVALS OF COS THETA. FROM 1.3 TO 2.0 BEV, AS COS THETA VARIES FROM -0.5 TO -1.0, THE DIFFERENTIAL CROSS SECTION RISES, PASSES THROUGH A PRONOUNCED MAXIMUM, AND THEN DECREASES RAPIDLY. THIS MAXIMUM PROPAGATES FROM COS THETA = -0.8 AT 1.3 BEV TO COS THETA = -0.94 AT 2.0 BEV, AND EVOLVES INTO A SHARP PEAK AT COS THETA = -1.0 FOR ENERGIES ABOVE 2.0 BEV. THE TOTAL CROSS SECTION DECREASES RAPIDLY AND MONOTONICALLY WITH ENERGY FROM 450 MICROBARNS AT 1.0 BEV TO 30 MICROBARNS AT 2.8 BEV.

CLOSELY RELATED REFERENCES
CONTINUATION OF PREVIOUS EXPERIMENT IN PHYS. REV. LETTERS 13, 59 (1964).

ADDITIONAL CITATIONS
PHYS. REV. 132, 1273 (1963), PHYS. REV. 134, B454 (1964), PHYS. REV. LETTERS 11, 506 (1963), NUOVO CIMENTO 35, 216 (1965), PHYS. REV. LETTERS 11, 474 (1963), PHYS. LETTERS 7, 222 (1963), PHYS. LETTERS 11, 253 (1964), PHYS. REV. LETTERS 11, 161 (1964), BULL. AM. PHYS. SOC. 7, 349 (1962), PHYS. REV. 123, 2160 (1961), PHYS. REV. 136, B779 (1963), PHYS. REV. 142, 918 (1966), PHYS. REV. LETTERS 17, 100 (1966), PHYS. REV. 165, 1442 (1968), PHYS. REV. 133, B1507 (1964), PHYS. REV. 111, 1386 (1958), PHYS. REV. LETTERS 6, 484 (1961), PHYS. REV. 128, 2392 (1962), PHYS. REV. 103, 211 (1956), JETP 7 528 (1958), DOKL. AKAD. NAUK. SSSR 100 673 (1955), DOKL. AKAD. NAUK. SSSR 100 677 (1955), BULL. AM. PHYS. SOC. 10, 19 (1965), PHYS. REV. 143, 1340 (1966), AND PHYS. REV. LETTERS 18, 1218 (1967).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON FROM 1.696 TO 3.618 GEV/C. (BEAM KINETIC ENERGY = 1.0 TO 2.8 GEV)

THIS EXPERIMENT USES COUNTERS.

KEY WORDS → CROSS SECTION DIFFERENTIAL CROSS SECTION MODELS

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CROSS SECTION FOR PROTON PROTON → DEUTERON PI+. (TABLE 2)

LABORATORY BEAM ENERGY GEV	MICRO-BARNS (1)	
1.0	452. +-	21.
1.3	217.	11.
1.5	123.	7.
1.7	84.	5.
2.0	53.	3.
2.5	33.	3.
2.8	30.	3.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10 PER CENT.

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DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → DEUTERON PI+. (TABLE 2)

LABORATORY BEAM ENERGY = 1. GEV.

COS(THETA)	D-SIGMA/D-OMEGA UB/SR (1)	
-.96	50.1 +-	2.5
-.93	49.9	2.7
-.90	52.1	2.0
-.80	51.2	2.4
-.70	43.9	2.2
-.60	42.1	1.5
-.50	33.4	1.7
-.40	31.9	1.6
-.30	24.4	1.2
-.20	23.5	1.1
-.10	21.0	.9
.00	20.3	.9

THETA IS THE ANGLE THAT THE DEUTERON MAKES WITH THE BEAM IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10 PER CENT.

- -

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → DEUTERON PI+. (TABLE 2)

LABORATORY BEAM ENERGY = 1.3 GEV.

COS(THETA)	D-SIGMA/D-OMEGA UB/SR (1)	
-.950	17.5 +-	1.3
-.925	22.7	1.6
-.900	21.0	.8
-.850	24.2	1.1
-.800	25.0	.9
-.700	23.8	.8
-.600	20.1	.7
-.500	17.8	.9
-.400	14.5	.7
-.300	13.6	.7
-.200	12.4	.6
-.100	13.0	.7
.000	12.2	.6

THETA IS THE ANGLE THAT THE DEUTERON MAKES WITH THE BEAM IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10 PER CENT.

- -

DIFFERENTIAL CRCSS SECTICN FCR PROTCN PRCTON → DEUTERON PI+. (TABLE 2)

LABCRATORY BEAM ENERGY = 1.5 GEV.

COS(THETA)	D-SIGMA/D-OMEGA UB/SR [1]	
-.965	9.9 +-	.8
-.950	12.1	.7
-.925	14.6	1.C
-.900	15.9	.6
-.850	16.4	.6
-.800	13.3	.8
-.700	13.1	.7
-.60C	10.2	.5
-.500	9.7	.5
-.400	7.6	.3
-.300	8.6	.5
-.200	6.9	.5
-.100	6.2	.4
.000	6.3	.4

THETA IS THE ANGLE THAT THE DEUTERON MAKES WITH THE BEAM IN THE GRAND C.M.

[1] PLUS POSSIBLE SYSTEMATIC ERRCR OF +- 10 PER CENT.

DIFFERENTIAL CRCSS SECTION FCR PROTON PROTON → DEUTERON PI+. (TABLE 2)

LABORATORY BEAM ENERGY = 1.7 GEV.

COS(THETA)	D-SIGMA/D-OMEGA UB/SR [1]	
-.965	10.6 +-	.9
-.950	12.5	.9
-.925	14.6	.7
-.900	16.1	.8
-.850	12.9	.9
-.800	11.9	.8
-.700	9.4	.5
-.60C	6.0	.4
-.500	5.0	.3
-.400	4.4	.2
-.300	3.8	.2
-.200	3.1	.2
-.100	3.0	.2
.000	2.9	.2

THETA IS THE ANGLE THAT THE DEUTERON MAKES WITH THE BEAM IN THE GRAND C.M.

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10 PER CENT.

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → DEUTERON PI+. (TABLE 2)

LABORATORY BEAM ENERGY = 2. GEV.

COS(THETA)	D-SIGMA/D-OMEGA UB/SR [1]	
-.985	9.5 +-	.7
-.940	8.3	.6
-.920	1C.2	.7
-.900	10.0	.5
-.850	8.4	.5
-.800	7.3	.4
-.700	6.2	.3
-.60C	4.7	.3
.500	2.9	.2
-.400	2.4	.1
-.200	1.3	.1
-.100	1.2	.1
.000	1.1	.1

THETA IS THE ANGLE THAT THE DEUTERON MAKES WITH THE BEAM IN THE GRAND C.M.

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10 PER CENT.

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → DEUTERON PI+. (TABLE 2)

LABORATORY BEAM ENERGY = 2.5 GEV.

COS(THETA)	D-SIGMA/D-OMEGA UB/SR [1]	
-.970	12.3 +-	1.2
-.950	10.6	.8
-.925	6.4	1.C
-.900	5.7	.4
-.800	3.5	.2
-.700	2.7	.3
-.600	1.9	.2
-.500	1.4	.1
-.300	.7	.1
-.100	.8	.1

THETA IS THE ANGLE THAT THE DEUTERON MAKES WITH THE BEAM IN THE GRAND C.M.

[1] PLUS POSSIBLE SYSTEMATIC ERRCR OF +- 10 PER CENT.

DIFFERENTIAL CRCSS SECTION FOR PROTCN PRCTCN • DEUTERON PI+. (TABLE 2)

LABORATORY BEAM ENERGY = 2.8 GEV.

COS(THETA)	C-SIGMA/D-OMEGA UE/SR (1)	
-.97	12.8 +-	2.3
-.95	8.3	.5
-.9C	5.1	.4
-.85	3.7	.3
-.80	3.3	.3
-.70	2.2	.2
-.60	1.7	.2
-.5C	1.2	.1
-.40	1.0	.1

THETA IS THE ANGLE THAT THE DEUTERON MAKES WITH THE BEAM IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 10 PER CENT.

71 PRODUCTION CF STRANGE PARTICLES IN PP COLLISICNS AT 2.85 BEV. (PHYS. REV. 123, 1465 (1961))

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R.M.LEA (CITY COLLEGE OF NEW YORK, NEW YORK, N. Y., USA)

ABSTRACT FROM A SAMPLE OF 98 HYPERON PRODUCTION EVENTS OBSERVED IN A LIQUID HYDROGEN BUBBLE CHAMBER THE PARTIAL CROSS SECTIONS FOR VARIOUS FINAL STATES ARE FCUND TO BE -- SIGMA+ K+ N - 0.047, SIGMA+ KO P - 0.030, SIGMA-C K+ P - 0.013, LAMBDA-O K+ P - 0.051, SIGMA- K+ P PI+ - 0.003, SIGMA+ K N PI - 0.004, (LAMBDA-O,SIGMA-O) K+ P PIO - 0.011, (LAMBDA-O,SIGMA-O) KO P PI+ - 0.014, (LAMBDA-O,SIGMA-O) K+ N PI+ - 0.002, ALL IN MILLIBARNS. FOR THE FIRST FOUR PROCESSES THE VALUES ARE IN GENERAL AGREEMENT WITH THOSE CALCULATED BY FERRARI USING A ONE-PION-EXCHANGE MODEL. ONLY ONE EXAMPLE OF K PAIR PRODUCTION WAS CBSERVED, INDICATING A CROSS SECTION LESS THAN 0.01 MB.

CITATIONS
PHYS. REV. 108, 1048 (1957), PHYS. REV. 108, 1322 (1957), PHYS. REV. 112, 614 (1958), PHYS. REV. 112, 614 (1958), PHYS. REV. 109, 546 (1958), NUOVC CIMENTO 15, 652 (1960), PHYS. REV. 120, 988 (1960), BULL. AM. PHYS. SOC. 5, 508 (1960), PHYS. REV. 108, 1046 (1957), JETP 4 661 (1957), PHYS. REV. 119, 432 (1960), UCRL 9098, PHYS. REV. LETTERS 5, 520 (1960), UCRL 9097, ANC RCCHESTER CCNFERENCE V-6 (1957).

ARTICLE READ BY ODETTE BENARY IN 3/67, AND VERIFIEC BY LERCY PRICE.

BEAM IS PROTON ON PROTON AT 3.67 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 20 IN. (H) BUBBLE CHAMBER. A TOTAL OF 90000 PICTURES ARE REPORTED ON.

KEY WORDS • CROSS SECTION ANGULAR DISTRIBUTION MASS SPECTRUM SIGMA LAMBDA

- -

(TABLE 2)

LABCRATORY BEAM MOMENTUM = 3.67 GEV/C +- 1(PER CENT).

REACTION	MILLI-BARNS		NC. EVENTS
PROTON PRCTON •			
SIGMA+ K+ NEUTRON	.047 +-	.013	74.3
SIGMA+ KO PROTON	.030	.01C	46.7
SIGMAO K+ PROTCN	.013	.007	20.3
LAMBDA K+ PROTCN	.051	.012	80.2
SIGMA- K+ PROTON PI+	.003	.002	5.0
SIGMA+ KAON NUCLEON PION	.004	.003	2.0

72 SMALL-ANGLE ELASTIC SCATTERING CF PROTONS AND PIONS, 7-20 BEV/C. (PHYS. REV. LETTERS 11, 425 (1963))

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CLOSELY RELATED REFERENCES
SEE ALSO PHYS. REV. LETTERS 10, 376 (1963).

ADDITIONAL CITATICNS
PHYS. REV. LETTERS 10, 543 (1963), PHYS. REV. LETTERS 7, 185 (1961), PHYS. REV. LETTERS 7, 362 (1961), PHYS. REV. LETTERS 8, 173 (1962), PHYS. REV. LETTERS 10, 413 (1963), PHYS. REV. LETTERS 9, 108 (1962), ZURN. EKSP. TEOR. FIZ. 41 , 1748 (1961), JETP 14 1243 (1962), PHYS. REV. 107, 859 (1957), PHYS. LETTERS 1, 226 (1962), ZURN. EKSP. TEOR. FIZ. 38, 426 (1960), JETP 11 313 (1960), PHYS. REV. 130, 1182 (1963), AND PHYS. REV. 118, 579 (1960).

ARTICLE READ BY ODETTE BENARY IN 5/63, AND VERIFIEC BY LEROY PRICE.

BEAM IS PROTON ON PROTCN FROM 6.8 TC 19.6 GEV/C.

THIS EXPERIMENT USES COUNTERS.

GENERAL COMMENTS CN THIS ARTICLE
1 SAME EXPERIMENT GIVES TOTAL AND DIFFERENTIAL CROSS SECTIONS FOR PI-P AND PI+P ELASTIC SCATTERING.

KEY WORDS • CROSS SECTICN CIFFERENTIAL CROSS SECTION

- -

PROTON PROTON ELASTIC CROSS SECTION. (TABLE 1)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS (1)	
6.8	11.79 +-	.22
8.8	11.71	.22
10.8	11.04	.22
12.8	10.89	.30
14.8	10.48	.32
16.7	9.74	.37
19.6	9.64	.44

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 6 PER CENT.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 6.8 GEV/C.

-T (GEV/C)**2	PER CENT	D-SIGMA/D-T MB/(GEV/C)**2 (1)	
.000(2)		105.50	+- 2.40
.023	8	86.80	3.40
.034	8	76.70	3.00
.046	8	69.30	2.50
.063	8	57.10	2.10
.082	8	46.80	1.80
.101	8	41.60	1.80
.248	8	10.88	.44
.317	8	6.65	.31
.395	8	3.83	.21
.476	8	2.23	.14
.564	8	1.22	.09
.658	8	.72	.07
.758	8	.42	.05
.863	8	.23	.03

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 6 PER CENT.
(2) EXTRAPOLATED POINT.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 8.8 GEV/C.

-T (GEV/C)**2	PER CENT	D-SIGMA/D-T MB/(GEV/C)**2 (1)	
.000(2)		106.40	+- 2.70
.039	8	74.70	2.50
.057	8	60.30	2.10
.078	8	49.90	1.10
.105	8	38.50	1.20
.137	8	32.20	1.20
.168	8	22.51	.92
.263	8	9.50	.38
.337	8	5.32	.25
.419	8	2.84	.16
.504	8	1.55	.10
.597	8	.80	.06
.697	8	.40	.04
.803	8	.19	.03
.916	8	.11	.02

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 6 PER CENT.
(2) EXTRAPOLATED POINT.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 10.8 GEV/C.

-T (GEV/C)**2	PER CENT	D-SIGMA/D-T MB/(GEV/C)**2 (1)	
.000(2)		102.80	+- 3.10
.050	8	59.40	1.70
.084	8	44.80	1.40
.116	8	32.70	1.10
.157	8	23.73	.76
.204	8	16.56	.61
.250	8	10.26	.45
.268	8	8.10	.32
.343	8	4.53	.21
.427	8	2.38	.13
.515	8	1.15	.08
.612	8	.55	.04
.713	8	.29	.03
.824	8	.14	.02

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 6 PER CENT.
(2) EXTRAPOLATED POINT.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 12.8 GEV/C.

-T (GEV/C)**2	PER CENT	D-SIGMA/D-T MB/(GEV/C)**2 (1)	+-
.000(2)		104.00	4.20
.049	8	66.20	4.60
.073	8	46.70	1.70
.120	8	33.90	1.40
.166	8	22.90	1.10
.224	8	13.93	.78
.278	8	6.88	.28
.283	8	7.84	.54
.356	8	3.64	.17
.443	8	1.92	.11
.534	8	.90	.06
.634	8	.42	.04
.741	8	.23	.03
.856	8	.09	.02

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 6 PER CENT.
(2) EXTRAPOLATED POINT.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 14.8 GEV/C.

-T (GEV/C)**2	PER CENT	D-SIGMA/D-T MB/(GEV/C)**2 (1)	+-
.000(2)		103.20	4.80
.066	8	49.40	1.90
.120	8	34.20	1.30
.160	8	20.82	.96
.221	8	10.98	.68
.294	8	5.78	.25
.298	8	5.83	.47
.376	8	2.93	.15
.386	8	2.40	.28
.468	8	1.49	.09
.564	8	.66	.05
.668	8	.32	.03
.781	8	.13	.02

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 6 PER CENT.
(2) EXTRAPOLATED POINT.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 16.7 GEV/C.

-T (GEV/C)**2	PER CENT	D-SIGMA/D-T MB/(GEV/C)**2 (1)	+-
.000(2)		92.200	5.500
.042	8	56.000	4.300
.084	8	42.400	2.900
.141	8	24.420	.980
.204	8	13.240	.680
.281	8	7.030	.430
.308	8	5.060	.220
.380	8	2.810	.260
.393	8	2.430	.130
.488	8	1.114	.072
.491	8	1.090	.170
.589	8	.471	.038
.698	8	.214	.023

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 6 PER CENT.
(2) EXTRAPOLATED POINT.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 19.6 GEV/C.

-T (GEV/C)**2	PER CENT	D-SIGMA/D-T MB/(GEV/C)**2 (1)	+-
.000(2)		96.500	7.000
.115	8	29.400	1.200
.192	8	14.080	.410
.278	8	6.390	.260
.302	8	5.010	.240
.384	8	2.260	.130
.388	8	2.400	.130
.483	8	1.089	.076
.517	8	.710	.073
.583	8	.465	.043
.692	8	.156	.023
.811	8	.113	.018

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 6 PER CENT.
(2) EXTRAPOLATED POINT.

73 STRANGE-PARTICLE PRODUCTION IN 10 GEV/C PROTON-PROTON REACTIONS. [NUOVO CIMENTO 51A, 305 (1967)]

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ABSTRACT STRANGE-PARTICLE PRODUCTION IN 10 GEV/C PROTON-PROTON COLLISIONS HAS BEEN STUDIED. THE FOLLOWING CROSS SECTIONS WERE OBTAINED -- (SIGMA+ KO) = (239 +- 40) MICROBARNS; (SIGMA- KO) = (44 +- 12) MICROBARNS; (LAMBDA O/SIGMA-O KO) = (334 +- 44) MICROBARNS AND (KO KO) = (204 +- 42) MICROBARNS. IN THE FINAL STATES Y N K PI AND Y N K PI PI THERE IS EVIDENCE FOR PRODUCTION OF THE FOLLOWING RESONANCES -- DELTA(1236), (37 +- 9) PER CENT, N*(APPROXIMATELY 1650), (18 +- 9) PER CENT, SIGMA(1383), (28 +- 7) PER CENT AND SIGMA(1650), (16 +- 6) PER CENT (PERCENTAGES OF (339 +- 42) MICROBARNS). NO EVIDENCE WAS FOUND FOR THE PRODUCTION OF TWO-BODY INTERMEDIATE STATES CORRESPONDING TO PARTICLES WITH DEFINED MASS AND QUANTUM NUMBERS.

CITATIONS
NUC. PHYS. 60, 209 (1964), CERN CONFERENCE 247 (1962), CERN D502, NUOVO CIMENTO 40, A844 (1965), CERN TC 66.12, BULL. AM. PHYS. SOC. 11, 360 (1966), BULL. AM. PHYS. SOC. 11, 360 (1966), AND NUOVO CIMENTO 29, 8 (1963).

ARTICLE READ BY ODETTE BENARY IN 11/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 10 GEV/C.

THIS EXPERIMENT USES THE SACLAY 81 CM (H) BUBBLE CHAMBER. A TOTAL OF 83000 PICTURES ARE REPORTED ON.

KEY WORDS • CROSS SECTION ANGULAR DISTRIBUTION MASS SPECTRUM DELTA(1238) 'N*(1688)' Y*(1385) Y*(1660) STRANGE PARTICLES

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[FROM TABLE 1 AND PAGE 309]

LABORATORY BEAM MOMENTUM = 10. GEV/C.

REACTION	MICRO-BARNS		NO. EVENTS
PROTON PROTON •			
SIGMA+ PROTON KO	60.	+- 20.	9.0
SIGMA+ PROTON KO PIO	31.	13.	5.5
SIGMA+ NEUTRON KO PI+	49.	16.	9.5
SIGMA+ PROTON KO PI+ PI-	35.	13.	7.0
SIGMA+ NEUTRON KO PI+ PI+ PI-	5.	4.	2.0
SIGMA- PROTON KO PI+ PI+	18.	7.	6.0
SIGMA- PROTON KO PI+ PI+ PIO	13.	6.	5.0
SIGMA- NEUTRON KO PI+ PI+ PI+	7.	4.	3.0
LAMBDA PROTON KO PI+	106.	29.	13.3
LAMBDA PROTON KO PI+ PIO	58.	14.	16.2
LAMBDA NEUTRON KO PI+ PI+	42.	14.	8.7
LAMBDA PROTON KO PI+ PI+ PI-	23.	12.	5.0
LAMBDA PROTON KO PI+ PI+ PI- PIO	34.	11.	9.0
LAMBDA NEUTRON KO PI+ PI+ PI+ PI-	13.	8.	2.5
PROTON PROTON KOBAR KO	33.	16.	4.0
PROTON PROTON KO KOBAR PIO	21.	11.	3.5
PROTON PI+ KOBAR KO NEUTRON	53.	20.	7.3
PROTON PROTON KOBAR KO PI+ PI-	9.	9.	1.0
PROTON PROTON KOBAR KO PI+ PI- PIO	5.	5.	.5
PROTON NEUTRON KOBAR KO PI+ PI+ PI-	36.	18.	4.0
SIGMA+ PROTON KO PI+ PI- PIO	0.		
PROTON K+ K+ XI-	7.	5.	2.0

74 A DESCRIPTION OF FINAL STATES WITH THREE, FOUR, AND FIVE PARTICLES IN PP INTERACTIONS AT 28.5 GEV/C. [BNL 13671 (1969)]

W.E.ELLIS,T.W.MORRIS,R.S.PANVINI,A.M.THORNDIKE [BROOKHAVEN NAT. LAB., UPTON, L.I., N. Y., USA]

CLOSELY RELATED REFERENCES
SEE ALSO BNL 12673 (1968), AND PHYS. REV. LETTERS 21, 697 (1968).
THIS ARTICLE SUPERSEDES PART OF BNL 11980 (1967).

ADDITIONAL CITATIONS
PHYS. REV. LETTERS 16, 855 (1966), PHYS. LETTERS 18, 167 (1965), PHYS. REV. LETTERS 17, 789 (1966), PHYS. REV. 120, 1857 (1960), PHYS. REV. 154, 1284 (1967), NUOVO CIMENTO 55A, 66 (1965), PHYS. REV. 173, 173 (1968), NUC. PHYS. B5, 169 (1968), DESY DESY 68/17 (1968), AND PHYS. REV. LETTERS 15, 45 (1965).

ARTICLE READ BY ODETTE BENARY IN 9/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 28.5 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 80 IN. (H) BUBBLE CHAMBER. A TOTAL OF 83000 PICTURES ARE REPORTED ON.

GENERAL COMMENTS ON THIS ARTICLE
1 EXCEPT FOR THE ONE REACTION GIVEN BELOW THE 28.5 GEV/C RESULTS GIVEN IN FIGURE 1 ARE JUST REPEATS OF DATA GIVEN IN BNL 11908 (1967).

KEY WORDS • CROSS SECTION MASS SPECTRUM ANGULAR DISTRIBUTION DIFFERENTIAL CROSS SECTION

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CROSS SECTION FOR PROTON PROTON • DELTA(1238)++ NEUTRON. [PAGE 5]
DELTA(1238)++ • PROTON PI+ [1]

[THIS DATA REPLACES VALUES GIVEN EARLIER IN CONNOLLY ET AL., BNL 11980 (1967)]

LABORATORY BEAM MOMENTUM GEV/C	MICRO-BARNS
28.5	115. +- 15.

[1] USED SIMPLE MASS CUT.

75 PP INTERACTIONS AT 2 BEV. I. SINGLE-PION PRODUCTION. (PHYS. REV. 125, 2082 (1962))

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ABSTRACT 3600 TWO-PRONGED EVENTS, OBTAINED IN PP INTERACTIONS AT 2 BEV IN THE BNL 20-IN. HYDROGEN BUBBLE CHAMBER, HAVE BEEN ANALYZED. CROSS SECTIONS HAVE BEEN MEASURED FOR ELASTIC SCATTERING, FOR THE TWO MODES OF SINGLE-PION PRODUCTION, PP + P N PI+, PP + P P PIO, AND FOR STRANGE-PARTICLE PRODUCTION. THE BRANCHING RATIO FOR THE TWO ONE-PION PRODUCTION REACTIONS IS SIGMA(P N PI+) / SIGMA(P P PIO) = 4.17 +- 0.25. MOMENTUM DISTRIBUTIONS AND Q VALUES INDICATE THAT SINGLE-PION PRODUCTION PROCEEDS ALMOST ENTIRELY THROUGH THE (3/2,3/2) RESONANT STATE. THE DATA HAVE BEEN CONSIDERED IN TERMS OF THE EXTENDED ISOBAR MODEL AND ALSO A ONE-PION EXCHANGE MODEL FOR PRODUCTION. THE BRANCHING RATIO AND MOMENTUM DISTRIBUTIONS CAN BE EXPLAINED BY INCLUDING A SMALL EFFECT FROM THE I = 1/2 RESONANT STATE IN ADDITION TO THE DOMINANT I = 3/2 RESONANCE. THE C.M. ANGULAR DISTRIBUTION OF THE NUCLEONS IN SINGLE-PION PRODUCTION SHOWS VERY MARKED BACKWARD-FORWARD PEAKING INDICATING A ONE-PION EXCHANGE MECHANISM. ABSOLUTE DIFFERENTIAL CROSS SECTIONS AS A FUNCTION OF LABORATORY KINETIC ENERGY HAVE BEEN CALCULATED FROM SELLERI'S EQUATION FOR THE P N PI+ REACTION. THERE IS GOOD AGREEMENT WITH THE DATA FOR LOW FOUR-MOMENTUM TRANSFERS (Q-SQUARED < 0.15(BEV/C)-SQUARED), BUT FOR HIGHER MOMENTUM TRANSFERS THE THEORETICAL CROSS SECTIONS ARE LARGER THAN THE EXPERIMENTAL CROSS SECTIONS.

CITATIONS
PHYS. REV. 97, 1186 (1955), PHYS. REV. 100, 1802 (1955), PHYS. REV. 103, 211 (1956), PHYS. REV. 107, 859 (1957), PHYS. REV. LETTERS 3, 568 (1959), PHYS. REV. 103, 1484 (1956), PROC. OF THE ROYAL SOCIETY OF LONDON A251, 218 (1959), PHYS. REV. 123, 1465 (1961), PHYS. REV. 123, 2160 (1961), PHYS. REV. 125, 2091 (1962), PHYS. REV. 123, 333 (1961), PHYS. REV. LETTERS 6, 64 (1960), UCRL 9097 (1960), PROC. OF THE ROYAL SOCIETY OF LONDON A251, 218 (1959), PHYS. REV. 75, 1352 (1949), PHYS. REV. 94, 1085 (1954), CERN CONFERENCE 195 (1956), AND PHYS. REV. LETTERS 7, 196 (1961).

ARTICLE READ BY ODETTE BENARY IN 6/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 2.807 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 20 IN. (H) BUBBLE CHAMBER. A TOTAL OF 45000 PICTURES ARE REPORTED ON.

KEY WORDS + CROSS SECTION DIFFERENTIAL CROSS SECTION MASS SPECTRUM ANGULAR DISTRIBUTION DELTA(1238)

(TABLE 1)

LABORATORY BEAM MOMENTUM = 2.807 +- .005 GEV/C.

REACTION	MILLI-BARNS		NO. EVENTS
PROTON PROTON +			
ELASTIC	19.210 +-	.480 (1)	1493
PROTON PROTON PIO	3.850	.220	318
PROTON NEUTRON PI+	16.060	.440	1326
LAMBDA K+ PROTON	.018	.005	11
DEUTERON PI+ + DEUTERON PI+ PIO	.170	.045	14

(1) CORRECTED FOR SMALL ANGLE SCANNING LOSSES.

76 MULTIPLE MESON PRODUCTION IN PROTON-PROTON COLLISIONS AT 2.85 BEV. (PHYS. REV. 126, 747 (1962))

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ABSTRACT MEASUREMENTS HAVE BEEN MADE ON 753 FOUR-PRONG EVENTS OBTAINED BY EXPOSING THE BROOKHAVEN NATIONAL LABORATORY 20-IN. LIQUID HYDROGEN BUBBLE CHAMBER TO 2.85-BEV PROTONS. THE PARTIAL CROSS SECTIONS OBSERVED FOR MULTIPLE MESON PRODUCTION REACTIONS ARE -- PP+-(PP + PP PI+ PI-), 2.67 +- 0.13; PN++-, 1.15 +- 0.09; PP+-0, 0.74 +- 0.07; D++-, 0.06 +- 0.02; FOUR OR MORE MESON PRODUCTION, 0.04 +- 0.02, ALL IN MB. PRODUCTION OF TWO MESONS APPEARS TO OCCUR MAINLY IN PERIPHERAL COLLISIONS WITH RELATIVELY LITTLE MOMENTUM TRANSFER. IN CASES OF THREE-MESON PRODUCTION, HOWEVER, THE PROTONS ARE TYPICALLY DEFLECTED AT LARGE ANGLES AND ARE MORE STRONGLY DEGRADED IN ENERGY. THE 3/2, 3/2 PION-NUCLEON RESONANCE DOMINATES THE INTERACTION; THERE IS SOME INDICATION THAT ONE OR BOTH OF THE T = 1/2, PION-NUCLEON RESONANCES ALSO PLAY A PART. THE RECENTLY DISCOVERED RESONANCE IN A T = 0, THREE-PION STATE APPEARS TO BE PRESENT IN THE PP+-0 REACTION. RESULTS ARE COMPARED WITH THE PREDICTIONS OF THE ISOBARIC NUCLEON MODEL OF STERNHEIMER AND LINDENBAUM, AND WITH THE STATISTICAL MODEL OF CERULUS AND HAGEDORN. THE CROSS SECTION FOR THE REACTION PIO P + PI+ PI- P IS DERIVED USING AN EXPRESSION FROM THE ONE-PION EXCHANGE MODEL OF DRELL.

CLOSELY RELATED REFERENCES
SEE ALSO PHYS. REV. 123, 1465 (1961), AND PHYS. REV. 123, 2160 (1961).

ADDITIONAL CITATIONS
PHYS. REV. 103, 211 (1956), PHYS. REV. 107, 859 (1957), PHYS. REV. LETTERS 3, 568 (1959), UCRL 9497, PHYS. REV. LETTERS 5, 333 (1960), PHYS. REV. 103, 1479 (1956), PHYS. REV. 103, 1484 (1956), PHYS. REV. 103, 1443 (1999), PHYS. REV. 118, 579 (1960), BULL. AM. PHYS. SOC. 6, 302 (1961), PHYS. REV. 125, 2091 (1962), PHYS. REV. 125, 2082 (1962), PHYS. REV. 123, 333 (1961), PHYS. REV. LETTERS 5, 24 (1960), ROCHESTER CONFERENCE 205 (1960), PHYS. REV. 94, 1085 (1954), PHYS. REV. 95, 1580 (1954), PHYS. REV. 105, 1874 (1957), CERN 5908/TH.13 (1959), PROGRESS IN THEORETICAL PHYSICS, JAPAN 5, 570 (1950), PHYS. REV. 92, 452 (1953), PHYS. REV. 93, 1434 (1954), PHYS. REV. LETTERS 5, 342 (1960), PHYS. REV. 113, 1640 (1959), REVIEW OF SCIENTIFIC INSTRUMENTS 32, 1116 (1961), UCRL 9097, BERKELEY CONFERENCE 117 (1960), PHYS. REV. 101, 796 (1956), PHYS. REV. LETTERS 6, 628 (1961), PHYS. REV. LETTERS 7, 192 (1961), PHYS. REV. LETTERS 6, 624 (1961), PHYS. REV. LETTERS 7, 178 (1961), AND PHYS. REV. LETTERS 7, 327 (1961).

ARTICLE READ BY ODETTE BENARY IN 6/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 3.67 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 20 IN. (H) BUBBLE CHAMBER. A TOTAL OF 8669 PICTURES ARE REPORTED ON.

KEY WORDS + CROSS SECTION MASS SPECTRUM ANGULAR DISTRIBUTION DELTA(1238) MODELS

(FROM PAGE 750 AND TABLE 1)

LABORATORY BEAM MOMENTUM = 3.67 GEV/C +- 1.6(PER CENT).

REACTION	MILLI-BARNS		NO. EVENTS
PROTON PROTON +			
TOTAL	42.100 +-	1.200	
PROTON PROTON PI+ PI-	2.670	.130 (1)	414
PROTON NEUTRON PI+ PI+ PI-	1.150	.090 (1)	178
PROTON PROTON PI+ PI- PIO	.740	.070 (1)	115
DEUTERON PI+ PI+ PI-	.064	.020 (1)	10

(1) ERRORS ARE STASTICAL ONLY.

77 PROTON-PROTON INTERACTIONS AT 1.5 BEV. (PHYS. REV. 103, 1479 (1956))

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ABSTRACT 152 INTERACTIONS OF 1.5-BEV PROTONS HAVE BEEN OBSERVED IN A HYDROGEN-FILLED DIFFUSION CLOUD CHAMBER. THE DATA INDICATE AN ELASTIC CROSS SECTION OF 20 MILLIBARNS, WITH ABOUT 22 MILLIBARNS CROSS SECTION FOR SINGLE PION PRODUCTION AND 5 MILLIBARNS FOR DOUBLE PION PRODUCTION. MOST SINGLE PION PRODUCTION CASES ARE PP - P N PI+. NO DEFINITE CASES OF - D PI+ OR - P P PIO WERE OBSERVED. THE MEDIAN ELASTIC SCATTERING ANGLE IS 24 DEG. IN THE C.M. SYSTEM. INELASTIC EVENTS HAVE PIONS EMITTED ISOTROPICALLY WITH LOW MOMENTA, NUCLEONS EMITTED NEAR 0 DEG. AND 180 DEG. WITH HIGH MOMENTA. THE AVERAGE RELATIVE ENERGY (Q VALUE) FOR THE P, PI+ PAIR IS 154 MEV.

CITATIONS
PHYS. REV. 103, 1472 (1956), PHYS. REV. 103, 1484 (1956), PHYS. REV. 103, 1489 (1956), REVIEW OF SCIENTIFIC INSTRUMENTS 25, 996 (1955), PHYS. REV. 97, 797 (1955), PHYS. REV. 95, 663 (1954), PHYS. REV. 103, 212 (1956), PHYS. REV. 92, 452 (1953), PHYS. REV. 93, 1434 (1954), PHYS. REV. 94, 1085 (1954), AND PHYS. REV. 95, 1580 (1954).

ARTICLE READ BY ODETTE BENARY IN 3/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 2.25 GEV/C.

THIS EXPERIMENT USES A CLOUD CHAMBER. A TOTAL OF 15600 PICTURES ARE REPORTED ON.

KEY WORDS - CROSS SECTION DIFFERENTIAL CROSS SECTION ANGULAR DISTRIBUTION

- -

(FROM PAGE 1480 AND PAGE 1481)

LABORATORY BEAM MOMENTUM = 2.25 +- .30 GEV/C.

REACTION	MILLI-BARNS	NO. EVENTS
PROTON PROTON -		
TOTAL	35. + 8. - 5.	152
ELASTIC	20. (1)	55
TOTAL INELASTIC	27. (1)	91

(1) VALUE IS APPROXIMATE ONLY.

78 EXPERIMENTAL INVESTIGATIONS OF THE NUCLEON-NUCLEON INTERACTION AT 600-650 MEV. (REV. MOD. PHYS. 39, 509 (1967))

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ABSTRACT THE UPPER BOUNDARY OF THE UNAMBIGUOUS PHASE-SHIFT ANALYSIS AS IS KNOWN, IS AT 310 MEV. ABOVE THE MESON PRODUCTION THRESHOLD THIS UNAMBIGUITY IS ABSENT. IN THE RANGE FROM 600-650 MEV WHERE THE PHYSICISTS OF OUR LABORATORY HAVE WORKED DURING RECENT YEARS THE SCATTERING AMPLITUDE HAS BEEN DETERMINED AMBIGUOUSLY AND NOT VERY RELIABLY. IN THIS CONNECTION ALL THE EXPERIMENTS FOR STUDYING NUCLEON-NUCLEON SCATTERING BEING CARRIED OUT AT OUR LABORATORY HAVE TWO PURPOSES -- FIRST, THE MORE ACCURATE DETERMINATION AND IMPROVEMENT OF THE PHASE-SHIFT ANALYSIS AND SECOND, THE DISCRIMINATION OF THE OBTAINED PHASE-SHIFT SETS FOR THE DETERMINATION OF THE MOST PROBABLE SET OF THEM. MY REPORT IS A SHORT SURVEY OF SOME OF EXPERIMENTS PERFORMED WITH THE ABOVE PURPOSE AT DUBNA IN RECENT YEARS.

CITATIONS
PHYS. REV. 105, 288 (1957), NUOVO CIMENTO 43A, 709 (1966), SOVIET JNP 2 636 (1966), UCRL 11440 (1964), ANNALS OF PHYSICS 7, 65 (1959), NUOVO CIMENTO 8, 265 (1958), AND JETP 19 542 (1964).

ARTICLE READ BY ODETTE BENARY IN 1/65, AND VERIFIED BY LEROY PRICE.

BEAM NO. 1 IS PROTON ON HYDROGEN COMPOUND AT 1.263 GEV/C. (BEAM KINETIC ENERGY = .635 GEV) (BEAM IS POLARIZED 42 PER CENT (NORMAL TO THE BEAM DIRECTION).
NO. 2 IS PROTON ON DEUTERIUM COMPOUND AT 1.225 GEV/C. (BEAM KINETIC ENERGY = .605 GEV) (BEAM IS POLARIZED 34 PER CENT (NORMAL TO THE BEAM DIRECTION).

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - POLARIZATION

- -

ELASTIC POLARIZATION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = .635 GEV.

THETA DEGREES		POLARIZATION	
27.60 +-	1.25	.475 +-	.024
32.20	1.25	.499	.021
34.40	1.25	.496	.024
36.70	1.25	.522	.019
38.90	1.25	.522	.019
41.20	1.25	.518	.014
43.40	1.25	.511	.014
44.50	1.25	.513	.016
45.60	1.25	.508	.014
46.70	1.25	.501	.014
47.80	1.25	.485	.009
49.00	1.25	.482	.016
50.10	1.25	.492	.014
51.20	1.25	.452	.014
52.30	1.25	.482	.014
54.50	1.25	.445	.014
56.60	1.25	.419	.014
58.80	1.25	.455	.016
60.80	1.25	.395	.014
63.10	1.25	.405	.021
71.80	1.25	.296	.014
79.90	1.25	.181	.016
89.70	1.25	.012	.009

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

- -

ELASTIC POLARIZATICN FCR PROTCN NEUTRON. (TABLE 2)

LABORATORY BEAM ENERGY = .605 GEV.

THETA DEGREES	POLARIZATION	
70.	-.C5 +-	.18
90.	-.07	.C6
125.	-.44	.16

THETA IS THE ANGLE THAT THE TARGET MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE NEUTRON ALCNG THE NORMAL TO THE PRODUCTION PLANE IN THE GRANC C.M.

79 EXPERIMENTAL RESULTS ON PROTON-PROTON INTERACTIONS AT 10 GEV/C WITH SIX CHARGEC PARTICLES IN THE FINAL STATE. (NUOVO CIMENTO 57A, 20 (1968))

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ABSTRACT HIGH-MULTIPLICITY PROTCN-PROTON REACTIONS AT 10 GEV/C HAVE BEEN STUDIEC. IN THE ANALYSIS OF 1937 EVENTS THE FOLLOWING RESULTS WERE OBTAINED -- REACTION (1) PP + PP PI+ PI+ PI- PI-, SIGMA = (0.46 +- 0.04) MB, (2) PP + PP PI+ PI+ PI- PI- PIO, SIGMA = (C.69 +- 0.05) MB, (3) PP+ PN PI+ PI+ PI+ PI- PI-, SIGMA = (0.54 +- 0.C4) MB, (4) PP + > 1 NEUTRAL PARTICLE, SIGMA = (0.76 +- 0.05) MB. THE FRACTION OF DELTA++ + P PI+ IS 0.64 +- 0.16 IN CHANNEL (1), 0.60 +- 0.12 IN (2) AND 0.48 +- 0.09 IN (3). THERE IS EVICENCE FOR PRODUCTION OF DELTA++(1920) + P PI+ IN REACTION (3) AND DELTA+(1920) + P PIO IN REACTION (2). NO SIGNIFICANT EVIDENCE FOR OTHER BARYON RESONANCES, MESON RESONANCES OR DOUBLE ISOBAR PRODUCTION WAS FOUNC.

CITATIONS
PHYS. REV. 125, 2091 (1962), PHYS. REV. 126, 747 (1962), PHYS. LETTERS 21, 351 (1966), PHYS. REV. 138, B913 (1965), PHYS. LETTERS 19, 311 (1965), PHYS. LETTERS 14, 164 (1965), CERN TH.708, REV. MOD. PHYS. 39, 1 (1967), PHYS. REV. LETTERS 18, 89 (1967), CERN TC 67-1, AND PHYS. REV. 120, 300 (1960).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIEC BY LEROY PRICE.

BEAM IS PROTON ON PROTCN AT 10 GEV/C.

THIS EXPERIMENT USES THE SACLAY 81 CM (H) BUBBLE CHAMBER. A TOTAL OF 82000 PICTURES ARE REPORTED ON.

KEY WORDS + CROSS SECTICN ANGULAR DISTRIBUTION MASS SPECTRUM DELTA(1238) DELTA(1920) STRANGE PARTICLES

- -

(TABLE 2)

LABCRATORY BEAM MOMENTUM = 10. GEV/C.

REACTION	MILLI-BARNS		NC. EVENTS
PROTON PRCTON +			
PROTON PROTON PI+ PI- PI+ PI-	.457 +-	.037	251
PRCTCN PROTON PI+ PI- PIO PI+ PI-	.695	.049	382
PROTCN NEUTRON PI+ PI+ PI- PI+ PI-	.537	.041	295

80 PP INTERACTIONS AT 2 BEV. II. MULTIPLE-PION PRODUCTION. (PHYS. REV. 125, 2091 (1962))

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ABSTRACT ANALYSES HAVE BEEN MADE FOR 871 FOUR-PRONG EVENTS AND 463 TWO-PRONG EVENTS CORRESPONDING TO MULTIPLE PION PRODUCTION, RESULTING FRCM PP INTERACTIONS AT 2 BEV IN THE BNL 20-IN. HYDROGEN BUBBLE CHAMBER. CROSS SECTIONS HAVE BEEN OBTAINED FOR ALL THE CBSERVABLE COUBLE AND TRIPLE PION PRODUCTION PROCESSES; THE BRANCHING RATIOS PREDICTEC BY THE EXTENDED ISOBAR MODEL ARE SHCWN TO BE IN FAIR AGREEMENT WITH THE DATA, BUT THERE ARE SIGNIFICANT DIFFERENCES. THE C.M. MOMENTUM DISTRIBUTIONS ARE ALSC IN FAIR AGREEMENT WITH THE PREDICTICNS OF THE MODEL, ALTHOUGH THERE ARE AMBIGUITIES IN THE INTERPRETATION. THE PION-NUCLEON Q VALUES GIVE CLEAR EVIDENCE FOR THE IMPORTANCE OF THE (3/2,3/2) RESONANT STATE IN MULTIPLE PION PRODUCTION, BUT CONSIDERATION OF THIS STATE ALONE DOES NOT PROVIDE AN EXPLANATION OF THE FEATURES OF DOUBLE PION PRODUCTION. SOME CONTRIBUTICN FROM ANOTHER STATE, POSSIBLY THE I = 1/2 NUCLEON ISOBAR, IS NECESSARY. IN DOUBLE PROCUCTION, THE C.M. ANGULAR DISTRIBUTIONS OF THE NUCLEONS SHOW BACKWARD-FORWARD PEAKING SUGGESTIVE OF A ONE-PION EXCHANGE PROCESS. THE ANGULAR DISTRIBUTIONS OF THE NUCLEONS FROM TRIPLE PRODUCTION ARE ALMOST ISOTRCPIC.

CLOSELY RELATED REFERENCES
CONTINUATION OF PREVIOUS EXPERIMENT IN PHYS. REV. 125, 2082 (1962).

ADDITIONAL CITATICNS
PHYS. REV. 103, 1484 (1956), UCRL 9097, PHYS. REV. 123, 333 (1961), PHYS. REV. LETTERS 5, 342 (1960), PHYS. REV. LETTERS 5, 377 (1960), PHYS. REV. LETTERS 7, 192 (1961), PHYS. REV. LETTERS 7, 178 (1961), NUOVO CIMENTO 16, 388 (1960 ANC PHYS. REV. LETTERS 7, 421 (1961).

ARTICLE READ BY ODETTE BENARY IN 6/67, ANC VERIFIED BY LEROY PRICE.

BEAM IS PRCTON CN PRCTON AT 2.807 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 20 IN. (H) BUBBLE CHAMBER.

KEY WORDS + CROSS SECTION ANGULAR DISTRIBUTION MASS SPECTRUM DELTA(1238)

- -

(TABLE 1)

LABORATORY BEAM MOMENTUM = 2.807 +- .005 GEV/C.

REACTION	MILLI-BARNS		NO. EVENTS
PROTON PRCTON +			
PRCTCN PROTON PI+ PI-	2.5100 +-	.1400	681
PROTON PROTON PIO PIO + PRCTON PROTON PIO PIO PIO	.9200	.1000	76
PROTON NEUTRON PI+ PIO + PROTON NEUTRON PI+ PIO PIO	4.0700	.2100	336
NEUTRON NEUTRON PI+ PI+ + NEUTRON NEUTRON PI+ PI+ PIO	.6200	.C830	51
PROTON PROTON PI+ PI- PIO	.2170	.0290	59
PROTON NEUTRON PI+ PI+ PI-	.4050	.0400	110
PROTON NEUTRON PI+ PI+ PI- PIO	< .0007		
PROTON PROTON PI+ PI- PIO PIO	< .0050		2
DEUTERON PI+ PI+ PI- + DEUTERON PI+ PI+ PI- PIO	.0550	.0140	15

81 ANALYSIS OF 4 GEV/C PROTON PROTON INTERACTIONS. II. THREE PION PRODUCTION IN (PP) INTERACTIONS. (SIENNA CONFERENCE I 348 (1963))

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CLOSELY RELATED REFERENCES
SEE ALSO PHYS. LETTERS 16, 75 (1965).
DATA SUPERSEDED BY NUOVO CIMENTO 58A, 175 (1968).

ADDITIONAL CITATIONS
PHYS. REV. 125, 2091 (1962), PHYS. REV. LETTERS 9, 133 (1962), AND PHYS. REV. 126, 747 (1962).

ARTICLE READ BY ODETTE BENARY IN 4/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 4 GEV/C.

THIS EXPERIMENT USES THE SACLAY 81 CM (H) BUBBLE CHAMBER.

KEY WORDS - CROSS SECTION MASS SPECTRUM DELTA(1238) OMEGA(783)

(TABLE 1)

LABORATORY BEAM MOMENTUM = 4. GEV/C.

(THIS DATA SHOULD NOT BE USED - MORE RECENT VALUES MAY BE FOUND IN BODINI ET AL., NUOVO CIMENTO 58A, 175 (1968))

REACTION	MILLI-BARNS (1)		NO. EVENTS
PROTON PROTON -			
PROTON PROTON PI+ PI-	2.89 +- .15		259
PROTON NEUTRON PI+ PI- PI+	1.33	.08	120
PROTON PROTON PI+ PI- PI0	.83	.05	74

(1) ERRORS ARE STASTICAL ONLY.

CROSS SECTION FOR PROTON PROTON - PROTON PROTON OMEGA(783). (PAGE 340)

(AUTHORS QUOTE AN ERROR OF +-.06 ON LOWER LIMIT)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS	NO. EVENTS
4.	> .14	20

82 PP - PP PI+ PI- INTERACTIONS AT 8.1 GEV/C. (NUC. PHYS. B5, 169 (1968))

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ABSTRACT AT 8 GEV/C, THE CROSS SECTION FOR THE REACTION PP - PP PI+ PI- IS (2.46 +- 0.1) MB. WE DESCRIBE THE PRODUCTION OF WELL KNOWN RESONANCES -- DELTA++(1236), DELTA 0(1236), N*(1525), N*(1688). THE PRESENCE OF THE P11(1470) RESONANCE IS ALSO DISCUSSED.

CITATIONS
PHYS. LETTERS 18, 167 (1965), PHYS. REV. LETTERS 17, 789 (1966), PHYS. REV. LETTERS 16, 855 (1966), NUOVO CIMENTO 48A, 909 (1967), PHYS. REV. LETTERS 17, 884 (1966), PHYS. REV. LETTERS 13, 169 (1964), NUOVO CIMENTO 50A, 1000 (1967), REV. MOD. PHYS. 39, 1 (1967), AND DUBNA CONFERENCE 1 127 (1964).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 8.11 GEV/C.

THIS EXPERIMENT USES THE CERN 2M (H) BUBBLE CHAMBER. A TOTAL OF 60000 PICTURES ARE REPORTED ON.

KEY WORDS - CROSS SECTION MASS SPECTRUM MODELS DIFFERENTIAL CROSS SECTION FITS DENSITY MATRIX
DELTA(1238) N*(1520)D13 'N*(1688)' N*(1470)P11

COMPOUND KEY WORDS - FITS DIFFERENTIAL CROSS SECTION

(FROM PAGE 172 AND PAGE 171)

LABORATORY BEAM MOMENTUM = 8.11 +- .08 GEV/C.

REACTION	MILLI-BARNS
PROTON PROTON -	
PROTON PROTON PI+ PI-	2.46 +- .10
PROTON PROTON RHO(765)	< .10
RHO(765) - PI+ PI- (1)	

(1) FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.

(TABLE 1)

LABORATORY BEAM MOMENTUM = 8.11 +- .08 GEV/C.

REACTION	MILLI-BARNS (1)	
PROTON PROTON -		
DELTA(1238)++ DELTA(1238)0	.22 +-	.05
DELTA(1238)++ - PROTON PI+ (2)		
DELTA(1238)0 - PROTON PI- (2)		
DELTA(1238)++ N*(1520)0	.13	.04
DELTA(1238)++ - PROTON PI+ (2)		
N*(1520)0 - PROTON PI- (2)		
DELTA(1238)++ 'N*(1688)0'	.14	.04
DELTA(1238)++ - PROTON PI+ (2)		
'N*(1688)0' - PROTON PI- (2)		
PROTON 'N*(1688)+'	.16	.03
'N*(1688)+' - DELTA(1238) PION + PROTON PI+ PI- (2)		

(1) PLUS POSSIBLE SYSTEMATIC ERRO.
(2) FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.

83 TWO AND THREE PION PRODUCTION IN PP COLLISIONS AT 6.92 GEV/C. (WEIZMANN INST REPORT (1969))

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ABSTRACT CROSS SECTIONS ARE GIVEN FOR THE MAIN PROCESSES CONTRIBUTING TO THE FINAL STATES PP PI+ PI-, PP PI+ PI- PIO AND P N PI+ PI+ PI-. IN ALL REACTIONS N*(1238) IS OBSERVED TO BE STRONGLY PRODUCED. FOR THESE THREE REACTIONS THE BARYONS ARE STRONGLY FORWARD/BACKWARD PEAKED IN THE CENTER OF MASS. THE REACTION PP + N*(1238)++ P PI- HAS BEEN EXAMINED IN SOME DETAIL, AND COMPARED WITH THE PREDICTIONS OF VARIOUS PERIPHERAL MODELS. AS IS ALREADY WELL KNOWN, THE FERRARI-SELLERI MODEL IS INADEQUATE, BUT WHEN SOME OF THE EFFECTS OF ABSORPTION ARE INCLUDED, THE AGREEMENT WITH THE DATA IS CONSIDERABLY IMPROVED. THE ALTERNATIVE OF REPLACING THE PROPAGATOR CORRESPONDING TO ELEMENTARY PION EXCHANGE BY THAT FOR A REGGE EXCHANGE ALSO GIVES GOOD AGREEMENT WITH EXPERIMENT. FINALLY WE HAVE TESTED A DOUBLE REGGE EXCHANGE MODEL, AND FOUND THAT ITS PREDICTION FOR ONE OF THE TREIMAN-YANG ANGLES IS UNSATISFACTORY. A DISCUSSION IS ALSO GIVEN OF A CLASSIFICATION IN WHICH EVENTS ARE DIVIDED INTO CATEGORIES DEPENDING ON WHICH PARTICLES ARE EMITTED IN THE SAME HEIMSPHERE. THE TWO GROUPINGS P(P PI+ PI-) AND (P PI+) (P PI-) EACH ACCOUNTS FOR APPROXIMATELY HALF OF THE PP PI+ PI- FINAL STATE. THE FINAL STATES PP OMEGA, PP ETA AND POSSIBLY PP RHOO ARE OBSERVED, AND CROSS SECTIONS ARE COMPARED WITH VALUES OBTAINED AT OTHER MOMENTA.

CLOSELY RELATED REFERENCES
SEE ALSO NUOVO CIMENTO 53, 455 (1968), AND PHYS. REV. 173, 1322 (1968).

ADDITIONAL CITATIONS
PHYS. REV. 161, 1387 (1967), PHYS. REV. 154, 1284 (1967), NUOVO CIMENTO 55, 66 (1968), PHYS. REV. LETTERS 20, 964 (1968), PHYS. REV. 174, 1638 (1968), NUC. PHYS. B10, 221 (1969), PHYS. LETTERS 27B, 376 (1968), NUOVO CIMENTO 24, 453 (1962), ANNALS OF PHYSICS 41, 456 (1967), NUC. PHYS. 88, 686 (1968), PHYS. REV. 168, 1773 (1968), PHYS. REV. LETTERS 21, 701 (1968), CERN TH-850 (1967), AND NUOVO CIMENTO 51B, 404 (1967).

ARTICLE READ BY ODETTE BENARY IN 10/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 6.9 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 80 IN. (H) BUBBLE CHAMBER.

KEY WORDS + CROSS SECTION ANGULAR DISTRIBUTION MASS SPECTRUM MODELS DELTA(1238) N*(1520)D13 'N*(1688)' RHO(765) OMEGA(783) ETA(548)

- -

(TABLE 2)

LABORATORY BEAM MOMENTUM = 6.9 GEV/C.

REACTION	MILLI-BARNS	
PROTON PROTON +		
PROTON PROTON PI+ PI-	3.00 +-	.30
PROTON NEUTRON PI+ PI+ PI-	2.60	.30
PROTON PROTON PI+ PI- PIO	2.60	.30
DELTA(1238)++ PROTON PI-	2.30	.30
DELTA(1238)++ + PROTON PI+ (1)		
DELTA(1238)++ DELTA(1238)0	.42	.10
DELTA(1238)++ + PROTON PI+ (1)		
DELTA(1238)0 + PROTON PI- (1)		
DELTA(1238)++ N*(1520)0	.23	.07
DELTA(1238)++ + PROTON PI+ (1)		
N*(1520)0 + PROTON PI- (1)		
DELTA(1238)++ 'N*(1688)0'	.23	.07
DELTA(1238)++ + PROTON PI+ (1)		
'N*(1688)0' + PROTON PI- (1)		
DELTA(1238)++ NEUTRON PI+ PI-	1.56	.15
DELTA(1238)++ + PROTON PI+ (1)		
DELTA(1238)- PROTON PI+ PI+	.84	.10
DELTA(1238)- + NEUTRON PI- (1)		
DELTA(1238)++ PROTON PI- PIO	1.56	.16
DELTA(1238)++ + PROTON PI+ (1)		
PROTON PROTON ETA(548)	.04	.01
ETA(548) + PI+ PI- PIO (1)		
PROTON PROTON OMEGA(783)	.14	.04
OMEGA(783) + PI+ PI- PIO (1)		

(1) FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.

84 ELASTIC SCATTERING OF LAMBDA HYPERONS WITH AVERAGE MOMENTUM 2.7 BEV/C BY PROTONS. (SOVIET JNP 3 511 (1966))

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ABSTRACT WE HAVE EXPERIMENTALLY DETERMINED THE TOTAL CROSS SECTION FOR ELASTIC SCATTERING OF LAMBDA HYPERONS WITH AVERAGE MOMENTUM = 2.7 +- 1.2 BEV/C BY PROTONS, WHICH TURNS OUT TO BE 15 +- 4 MB. THIS VALUE IS COMPARED WITH THE THEORETICAL AND EXPERIMENTAL DATA KNOWN PREVIOUSLY.

CITATIONS
PHYS. REV. LETTERS 2, 174 (1959), PHYS. REV. LETTERS 7, 348 (1961), JETP 42 979 (1962), JETP 15 676 (1962), PHYS. REV. 129, 1372 (1963), PHYS. REV. LETTERS 12, 625 (1964), PHYS. REV. LETTERS 13, 282 (1964), PHYS. REV. LETTERS 13, 484 (1964), PHYS. LETTERS 12, 350 (1964), PRIBORI I TECH TECH. EXP. 1 41 (1959), JINR R-1959 (1965), JINR R-2215 (1965), JINR R-1352 (1963), JINR R-1468 (1963), AND NUOVO CIMENTO 36, 189 (1965).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS NEUTRON ON HEAVY LIQUID FROM 2.786 TO 10.900 GEV/C. (BEAM KINETIC ENERGY = 2 TO 10 GEV)

THIS EXPERIMENT USES A HEAVY LIQUID BUBBLE CHAMBER. A TOTAL OF 116000 PICTURES ARE REPORTED ON.

KEY WORDS + LAMBDA CROSS SECTION ANGULAR DISTRIBUTION

COMPOUND KEY WORDS + LAMBDA CROSS SECTION

- -

LAMBDA PROTON ELASTIC CROSS SECTION. (PAGE 514)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS	NO. EVENTS
2.7 +- 1.2	15. +- 4.	12

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR LAMBDA PROTON. (FIGURE 3)

LABORATORY BEAM MOMENTUM = 2.7 GEV/C (MEAN VALUE).

. THIS DATA WAS READ FROM A GRAPH .

COS(THETA) MIN	COS(THETA) MAX	NO. EVENTS
-1.0	-.5	3.5
-.5	.0	3.2
.0	.5	3.5
.5	1.0	9.0

THETA IS THE ANGLE THAT THE LAMBDA MAKES WITH THE BEAM IN THE GRAND C.M.

- -

FORWARD TO BACKWARD RATIO FOR LAMBDA PROTON ELASTIC SCATTERING. (1)

LABORATORY BEAM MOMENTUM GEV/C	(F-B)/(F+B)
2.7 +- 1.2	.30 +- .22

(1) CALCULATED BY US FROM DATA IN THIS ARTICLE.

- -

POLAR TO EQUATORIAL RATIO FOR LAMBDA PROTON ELASTIC SCATTERING. (1)

LABORATORY BEAM MOMENTUM GEV/C	(P-E)/(P+E)
2.7 +- 1.2	.30 +- .22

(1) CALCULATED BY US FROM DATA IN THIS ARTICLE.

85 NEUTRON-PROTON CHARGE-EXCHANGE SCATTERING IN THE BEV/C REGION. (PHYS. REV. LETTERS 15, 38 (1965))

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CLOSELY RELATED REFERENCES
THIS ARTICLE SUPERSEDES PHYS. REV. LETTERS 9, 509 (1962).

ADDITIONAL CITATIONS
PHYS. LETTERS 4, 19 (1963), PHYS. REV. LETTERS 11, 88 (1963), PHYS. REV. LETTERS 11, 444 (1963), PHYS. REV. 134, B633 (1964), PHYS. REV. 136, B1783 (1964), PHYS. LETTERS 12, 62 (1964), PHYS. REV. 137, B1530 (1965), NUOVO CIMENTO 18, 1039 (1960), REV. MOD. PHYS. 36, 649 (1964), PHYS. REV. LETTERS 11, 217 (1963), PHYS. REV. LETTERS 10, 357 (1963), PHYS. REV. 127, 1836 (1962), PHYS. LETTERS 12, 112 (1964), AND PHYS. REV. 137, B708 (1965).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS NEUTRON ON PROTON AT 3 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - CROSS SECTION DIFFERENTIAL CROSS SECTION MODELS

- -
- -

NEUTRON PROTON ELASTIC CROSS SECTION. (PAGE 41)

DATA IS INTEGRATED OVER COS(THETA) FROM -1. TO 0.. THETA IS THE ANGLE THAT THE NEUTRON MAKES WITH THE BEAM IN THE GRAND C.M.

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS
3.	1.10 +- .25

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. [FIGURE 2]

LABORATORY BEAM MOMENTUM = 3. GEV/C.

(QUOTED VALUES ARE NEW DATA PLUS DATA FROM PRL 9,509(1962))

. THIS DATA WAS READ FROM A GRAPH .

THETA DEGREES	D-SIGMA/D-OMEGA MB/SR
.00	31.6 + 5.C - 5.0
1.25	27.8 + 2.9 - 2.9
2.50	15.8 + 2.5 - 2.5
3.00	16.4 + .9 - .9
3.75	10.9 + 1.3 - 1.3
5.0C	11.2 + 1.C - 1.0
5.00	10.3 + .7 - .7
5.00	8.2 + 1.6 - 1.6
7.00	6.7 + .3 - .7
7.00	5.7 + .3 - .7
7.5C	6.2 + .9 - .9
9.00	4.6 + .5 - .5
11.00	4.0 + .3 - .3
15.00	1.0 + .2 - .2

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE LAB.

86 SINGLE-ISOBAR PRODUCTION IN PROTON-PROTON INTERACTIONS AT 28.5 GEV/C. [PHYS. REV. LETTERS 21, 697 (1968)]

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ABSTRACT TWO AND FOUR PRONG FINAL STATES IN A 28.5-GEV/C PP BUBBLE-CHAMBER EXPERIMENT WERE EXAMINED FOR SINGLE-ISOBAR PRODUCTION IN VARIOUS DECAY CHANNELS. RESULTS ARE COMPARED WITH MISSING-MASS-SPECTROMETER DATA. THE 1400 ENHANCEMENT WAS FOUND TO BE AN N PI SYSTEM WITH THE RATIO N PI+/P PIO ABOUT 2, WHICH ESTABLISHES THE ISOSPIN ASSIGNMENT I = 1/2. THE FINAL STATE DELTA++(1238) N WAS MEASURED AND COMPARED WITH LOW-ENERGY DATA TO SHOW THAT THE CROSS SECTION DECREASES ACCORDING TO P(LAB)**-(1.91 +- 0.08), CONSISTENT WITH SINGLE-PION EXCHANGE.

CLOSELY RELATED REFERENCES
DATA SUPERSEDED BY BNL 13671 (1969).

ADDITIONAL CITATIONS
PHYS. REV. LETTERS 16, 855 (1966), PHYS. LETTERS 18, 167 (1965), PHYS. REV. LETTERS 17, 789 (1966), PHYS. REV. LETTERS 19, 397 (1967), PHYS. REV. LETTERS 20, 964 (1968), PHYS. REV. LETTERS 20, 1078 (1968), PHYS. REV. 165, 1659 (1968), AND REV. MOD. PHYS. 38, 476 (1966).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 28.5 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 80 IN. (H) BUBBLE CHAMBER. A TOTAL OF 83000 PICTURES ARE REPORTED ON.

GENERAL COMMENTS ON THIS ARTICLE
1 NO DATA PUNCHED FOR THIS ARTICLE. SAME DATA REPORTED AT LUND CONFERENCE -- BNL 13671 (1969).

KEY WORDS + CROSS SECTION MASS SPECTRUM MODELS N*(1470)P11

* NO DATA PUNCHED FOR THIS ARTICLE *

87 NEUTRON-PROTON AND NEUTRON-DEUTERON TOTAL CROSS SECTIONS AT 4.0 AND 5.7 GEV/C. [PHYS. LETTERS 31B, 246 (1970)]

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ABSTRACT THE NP AND ND TOTAL CROSS SECTIONS HAVE BEEN MEASURED DIRECTLY WITH A NEUTRON BEAM WITH MOMENTA OF 4.0 +- 0.6 AND 5.7 +- 0.6 GEV/C. THE DATA ARE COMPARED WITH THE PREVIOUS NUCLEON-NUCLEON AND NUCLEON-DEUTERON RESULTS, AND THE DEUTERON SCREENING TERM WAS ALSO EVALUATED. THE MEASURED TOTAL CROSS SECTIONS ARE 43.1 +- 0.6 AND 80.3 +- 1.9 MB AT 4.0 GEV/C AND 42.5 +- 1.3 MB AT 5.7 GEV/C.

CITATIONS
PHYS. REV. LETTERS 20, 468 (1968), SLAC 66 (1966), J. AM. CHEM. SOC. 74 824 (1952), JETP 2 349 (1956), PROC. OF THE PHYSICAL SOCIETY OF LONDON 71 293 (1958), INT'L. CONGRESS ON NUCLEAR PHYSICS,PARIS,FRANCE 2 162 (1964), PHYS. REV. 94 , 174 (1954), PROC. OF THE PHYSICAL SOCIETY OF LONDON A70 745 (1957), PHYS. LETTERS 7, 80 (1963), PHYS. LETTERS 27B, 599 (1968), PHYS. REV. 138, 913 (1965), PHYS. REV. LETTERS 19, 857 (1967), PHYS. REV. 146, 980 (1966), AND PHYS. REV. 100, 242 (1955).

ARTICLE READ BY ODETTE BENARY IN 1/70, AND VERIFIED BY LEROY PRICE.

BEAM NO. 1 IS NEUTRON ON PROTON FROM 4.0 TO 5.7 GEV/C.
NO. 2 IS NEUTRON ON DEUTERON FROM 4.0 TO 5.7 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS + CROSS SECTION MODELS

NEUTRON PROTON TOTAL CROSS SECTION. [TABLE 1]

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS
4.0 +- .6	43.1 +- .6
5.7 .6	42.5 .6

- -

NEUTRON DEUTERON TOTAL CROSS SECTION. (TABLE 1)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS
4.0 +- .6	80.3 +- 1.9
5.7 .6	77.8 1.3

- -

NEUTRON NEUTRON TOTAL CROSS SECTION.

(EVALUATED USING THE GALLBRAITH ET.AL.(PHYS.REV.138,913(1965)) EXPERIMENTAL VALUE FOR THE GLAUBER SCREENING TERM (I.E.. 042+-.003 MB**-1) THESE VALUES ARE TAKEN FROM PARKER ET AL. MICHIGAN 03028-3-T(1969))
GLAUBER CORRECTION APPLIED

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS
4.	43.5 +- 2.4
6.	41.2 1.7

88 NEUTRON-PROTON ELASTIC SCATTERING IN THE FORWARD DIRECTION BETWEEN 4 AND 16 GEV. (PHYS. LETTERS 29B, 321 (1969))

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ABSTRACT THE DIFFERENTIAL CROSS-SECTION FOR THE ELASTIC NEUTRON-PROTON-SCATTERING HAS BEEN MEASURED FOR NEUTRON ENERGIES BETWEEN 4 AND 16 GEV AND ABS(T) FROM 0.3 TO 1.3 (GEV/C)-SQUARED. THE RESULTS CAN BE FITTED BY EXP(A + BT),WHERE B INCREASES SLIGHTLY WITH ENERGY INDICATING SHRINKAGE. THE VALUES OF B FOR N-P SCATTERING ARE IN GOOD AGREEMENT WITH THE CORRESPONDING DATA FOR P-P SCATTERING

CITATIONS
PHYS. REV. LETTERS 16, 1217 (1966), SLAC SLAC-66 (1966), PHYS. REV. LETTERS 21, 645 (1966), PHYS. LETTERS 27B, 599 (1968), PHYS. LETTERS 28B, 64 (1968), COMPTES RENDUS. ACAD. SCI. 265, 1350 (1967), UCRL 17275 (1966), NUOVO CIMENTO 38, 60 (1965), AND PHYS. REV. LETTERS 15, 45 (1965).

ARTICLE READ BY ODETTE BENARY IN 9/69, AND VERIFIED BY LEROY PRICE.

BEAM IS NEUTRON ON PROTON FROM 4.850 TO 16.914 GEV/C. (BEAM KINETIC ENERGY = 4 TO 16 GEV)

THIS EXPERIMENT USES SPARK CHAMBERS.

KEY WORDS - DIFFERENTIAL CROSS SECTION FITS

COMPOUND KEY WORDS - FITS DIFFERENTIAL CROSS SECTION

- -
- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (FIGURE 2)

DATA IS AVERAGED OVER LABORATORY BEAM ENERGY FROM 8. TO 10. GEV.

(THE CROSS SECTION AT T=O IS NORMALIZED TO THE OPTICAL THEOREM POINT)

. THIS DATA WAS READ FROM A GRAPH .

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2	
.35	6.600 +-	.400
.45	3.100	.200
.55	1.700	.200
.65	.710	.090
.75	.350	.080
.85	.190	.050
.95	.090	.040
1.05	.062	.030
1.15	.026	.026
1.25	.018	.018

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 1)

DATA IS FIT OVER LABORATORY BEAM ENERGY FROM 4. TO 6. GEV.
FITTED FORMULA IS D-SIGMA/D-T = EXP(A+BT)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

FITTED VALUES

B = 6.22 +- .31

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 1)

DATA IS FIT OVER LABORATORY BEAM ENERGY FROM 6. TO 8. GEV.
FITTED FORMULA IS D-SIGMA/D-T = EXP(A+BT)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

FITTED VALUE

B = 6.43 +- .48

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. [TABLE 1]

DATA IS FIT OVER LABORATORY BEAM ENERGY FROM 8. TO 10. GEV.
FITTED FORMULA IS D-SIGMA/D-T = EXP[A+BT]

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING NEUTRON] AND THE [OUTGOING NEUTRON].

FITTED VALUE

B = 7.14 +- .38

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. [TABLE 1]

DATA IS FIT OVER LABORATORY BEAM ENERGY FROM 10. TO 12. GEV.
FITTED FORMULA IS D-SIGMA/D-T = EXP[A+BT]

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING NEUTRON] AND THE [OUTGOING NEUTRON].

FITTED VALUE

B = 7.04 +- .46

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. [TABLE 1]

DATA IS FIT OVER LABORATORY BEAM ENERGY FROM 12. TO 14. GEV.
FITTED FORMULA IS D-SIGMA/D-T = EXP[A+BT]

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING NEUTRON] AND THE [OUTGOING NEUTRON].

FITTED VALUE

B = 7.64 +- .61

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. [TABLE 1]

DATA IS FIT OVER LABORATORY BEAM ENERGY FROM 14. TO 16. GEV.
FITTED FORMULA IS D-SIGMA/D-T = EXP[A+BT]

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING NEUTRON] AND THE [OUTGOING NEUTRON].

FITTED VALUE

B = 8.06 +- .88

89 NEUTRON-PROTON ELASTIC SCATTERING FROM 2 TO 7 GEV/C. [SLAC PUB-622 (1969)]

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ABSTRACT DIRECT MEASUREMENTS WERE MADE OF NEUTRON-PROTON ELASTIC SCATTERING DIFFERENTIAL CROSS SECTIONS AT HIGH ENERGIES. A NEUTRON BEAM WITH A CONTINUOUS MOMENTUM SPECTRUM BETWEEN 1.2 AND 6.7 GEV/C WAS SCATTERED OFF A LIQUID HYDROGEN TARGET, AND SPARK CHAMBERS WERE USED TO DETERMINE THE NEUTRON SCATTERING ANGLE AND, IN A PROTON SPECTROMETER, TO MEASURE THE MOMENTUM AND SCATTERING ANGLE OF THE RECOIL PROTON. DIFFERENTIAL CROSS SECTIONS ARE PRESENTED OVER THE INCIDENT NEUTRON MOMENTUM RANGE IN INTERVALS OF THE ORDER OF 1/2 GEV/C WIDE. THE CROSS SECTIONS HAVE AN EXPONENTIAL PEAK IN THE FORWARD DIRECTION AND THEN FLATTEN AND BECOME ISOTROPIC ABOUT THE 90 DEG. C.M. SCATTERING ANGLE. AT LARGER ANGLES THE CROSS SECTIONS AGAIN RISE TOWARDS THE EXPECTED CHARGE EXCHANGE PEAK WHICH WAS NOT WITHIN THE RANGE OF THIS EXPERIMENT. THERE IS LITTLE EVIDENCE OF ANY OTHER STRUCTURE IN THE CROSS SECTION. VALUES ARE PRESENTED FOR THE SLOPE OF THE DIFFRACTION PEAK, AND COMPARISONS ARE MADE BETWEEN THESE SLOPES, AND THE 90 DEG. C.M. CROSS SECTIONS, FOR PP AND NP ELASTIC SCATTERING. THE RESULTS PRESENTED HERE DIFFER FROM THOSE PREVIOUSLY REPORTED DUE TO AN ERROR IN A MONTE CARLO CALCULATION AND IN THE AVAILABILITY OF IMPROVED DATA ON THE REAL PART OF THE NP ELASTIC SCATTERING AMPLITUDE. AT 5 GEV A DIRECT COMPARISON OF PP AND NP DATA ALLOWS THE I = 0 DIFFERENTIAL CROSS SECTION TO BE EXTRACTED. THE NP DATA HAVE BEEN FITTED IN POWERS OF COSINE THETA (C.M.) FOR /COSINE THETA(C.M.)/ < 0.8 FOR EACH ENERGY RANGE.

CLOSELY RELATED REFERENCES
CONTINUATION OF PREVIOUS EXPERIMENT IN PHYS. REV. LETTERS 16, 1217 (1966), AND PHYS. REV. LETTERS 21, 641 (1968).

ADDITIONAL CITATIONS
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ARTICLE READ BY ODETTE BENARY IN 10/69, AND VERIFIED BY LEROY PRICE.

BEAM IS NEUTRON ON PROTON FROM 2 TO 7 GEV/C.

THIS EXPERIMENT USES SPARK CHAMBERS.

GENERAL COMMENTS ON THIS ARTICLE
1 NORMALIZED TO TOTAL CROSS SECTIONS BY USING THE OPTICAL THEOREM PLUS THE ASSUMPTION THAT THE RE/IM RATIO FOR N P ELASTIC SCATTERING = -0.45.
2 AUTHORS DO NOT CLEARLY STATE WHAT SYSTEMATIC ERRORS MIGHT BE IN D-SIGMA/D-T . WE ASSUME FROM THEIR DISCUSSION THAT THEY ARE ABOUT 5 PER CENT.

KEY WORDS - DIFFERENTIAL CROSS SECTION FITS MODELS

COMPOUND KEY WORDS - FITS DIFFERENTIAL CROSS SECTION

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ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 1)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM 1.70 TO 2.25 GEV/C.

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2 (1)	+-	NO. EVENTS
.10	.20	46.008	5.237	153
.20	.30	23.556	3.038	89
.30	.40	15.326	1.744	149
.40	.50	8.090	1.037	100
.50	.60	7.501	.518	127
.60	.70	3.336	.442	85
.70	.80	2.722	.457	56
.80	.90	1.957	.297	64
.90	1.00	1.536	.260	59
1.00	1.25	1.034	.176	106
1.25	1.55	1.077	.224	144

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5 PER CENT.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 1)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM 2.25 TO 2.79 GEV/C.

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2 (1)	+-	NO. EVENTS
.10	.20	49.533	5.295	189
.20	.30	19.447	2.073	137
.30	.40	13.582	1.681	104
.40	.50	7.128	.761	132
.50	.60	3.745	.468	81
.60	.70	2.397	.382	44
.70	.80	1.706	.223	72
.80	.90	1.090	.154	59
.90	1.00	1.051	.153	54
1.00	1.20	.636	.084	79
1.20	1.40	.506	.064	100
1.40	1.60	.353	.049	74
1.60	1.80	.270	.041	67
1.80	2.00	.299	.049	71
2.00	2.49	.391	.080	157

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5 PER CENT.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 1)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM 2.79 TO 3.31 GEV/C.

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2 (1)	+-	NO. EVENTS
.10	.20	44.437	4.030	202
.20	.30	18.111	1.553	195
.30	.40	8.262	1.003	79
.40	.50	6.267	.782	91
.50	.60	3.663	.391	102
.60	.70	1.927	.260	57
.70	.80	1.939	.239	30
.80	.90	[illegible]	.171	60
.90	1.00	.666	.103	47
1.00	1.20	.714	.083	104
1.20	1.40	.597	.075	86
1.40	1.60	.397	.040	90
1.60	1.80	.277	.035	77
1.80	2.20	.171	.020	109
2.20	2.60	.115	.015	94
2.60	3.00	.140	.025	80
3.00	3.43	.122	.031	44

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5 PER CENT.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 1)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM 3.31 TO 3.83 GEV/C.

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2 (1)	+-	NO. EVENTS
.10	.20	43.885	3.679	226
.20	.30	15.932	1.214	220
.30	.40	8.703	.860	117
.40	.50	5.564	.729	73
.50	.60	3.327	.356	99
.60	.70	1.432	.188	63
.70	.80	.808	.143	34
.80	.90	.687	.142	25
.90	1.00	.654	.096	52
1.00	1.20	.442	.050	96
1.20	1.40	.232	.035	49
1.40	1.60	.218	.033	50
1.60	1.80	.164	.022	61
1.80	2.00	.130	.019	53
2.00	2.50	.084	.012	65
2.50	3.00	.081	.009	113
3.00	3.50	.045	.007	56
3.50	4.37	.059	.012	62

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5 PER CENT.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 1)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM 3.83 TO 4.34 GEV/C.

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2 (1)	+-	NO. EVENTS
.1	.2	36.458	2.676	251
.2	.3	18.225	1.196	295
.3	.4	8.090	.708	150
.4	.5	4.257	.559	63
.5	.6	2.473	.337	73
.6	.7	1.559	.192	75
.7	.8	1.007	.141	57
.8	.9	.413	.090	22
.9	1.0	.612	.119	28
1.0	1.2	.256	.034	61
1.2	1.4	.227	.030	62
1.4	1.6	.171	.028	41
1.6	1.8	.109	.018	40
1.8	2.0	.072	.013	35
2.0	2.5	.050	.007	62
2.5	3.0	.037	.007	33
3.0	3.5	.026	.004	39
3.5	4.0	.023	.004	35
4.0	4.5	.019	.004	33
4.5	5.3	.055	.013	37

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5 PER CENT.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 1)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM 4.34 TO 4.85 GEV/C.

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2 (1)	+-	NO. EVENTS
.10	.20	34.847	2.177	357
.20	.30	11.930	.770	319
.30	.40	6.294	.490	205
.40	.50	3.037	.354	84
.50	.60	1.484	.217	62
.60	.70	.973	.121	73
.70	.80	.573	.080	56
.80	.90	.414	.068	39
.90	1.00	.248	.055	21
1.00	1.20	.210	.031	60
1.20	1.40	.117	.016	57
1.40	1.60	.078	.013	37
1.60	1.80	.055	.012	22
1.80	2.00	.025	.006	21
2.00	2.50	.021	.003	47
2.50	3.00	.014	.003	23
3.00	3.50	.011	.003	17
3.50	4.00	.009	.002	15
4.00	4.50	.012	.002	31
4.50	5.00	.012	.002	35
5.00	5.50	.005	.002	6
5.50	6.25	.020	.006	21

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5 PER CENT.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 1)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM 4.85 TO 5.36 GEV/C.

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2 (1)	+-	NO. EVENTS
.11	.20	33.477	2.080	346
.20	.30	16.948	1.000	420
.30	.40	7.206	.523	254
.40	.50	3.464	.369	106
.50	.60	1.903	.264	66
.60	.70	1.036	.134	69
.70	.80	.545	.075	56
.80	.90	.568	.079	55
.90	1.00	.281	.055	27
1.00	1.20	.197	.035	34
1.20	1.40	.090	.014	43
1.40	1.60	.060	.011	32
1.60	1.80	.044	.010	21
1.80	2.00	.028	.009	11
2.00	2.50	.014	.002	33
2.50	3.00	.016	.003	32
3.00	3.50	.010	.002	16
3.50	4.18	.004	.001	10
4.33	5.00	.006	.002	16
5.00	5.50	.006	.002	19
5.50	6.00	.010	.003	15
6.00	6.50	.012	.003	13
6.50	7.10	.017	.005	14

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5 PER CENT.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 1)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM 5.36 TO 5.87 GEV/C.

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2 (1)		NO. EVENTS
.11	.20	39.129 +-	2.611	386
.20	.30	17.365	1.161	420
.30	.40	8.532	.583	332
.40	.50	4.792	.413	170
.50	.60	2.231	.302	59
.60	.70	1.480	.150	110
.70	.80	.791	.091	81
.80	.90	.455	.066	51
.90	1.00	.305	.056	31
1.00	1.20	.167	.030	32
1.20	1.40	.158	.024	56
1.40	1.60	.055	.010	35
1.60	1.80	.030	.007	18
1.80	2.00	.027	.008	12
2.00	2.50	.022	.004	36
2.50	3.00	.013	.002	33
3.00	3.50	.004	.002	7
3.50	4.48	.004	.001	13
4.99	6.00	.004	.001	21
6.00	6.50	.005	.002	9
6.50	7.00	.006	.002	9
7.00	7.50	.013	.004	15
7.50	7.97	.012	.005	7

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5 PER CENT.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 1)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM 5.87 TO 6.37 GEV/C.

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2 (1)		NO. EVENTS
.13	.20	30.350 +-	2.318	298
.20	.30	15.191	.970	471
.30	.40	6.116	.421	318
.40	.50	3.240	.283	158
.50	.60	2.269	.267	79
.60	.70	1.196	.118	114
.70	.80	.631	.078	72
.80	.90	.361	.050	55
.90	1.00	.168	.034	25
1.00	1.20	.111	.022	27
1.20	1.40	.063	.016	17
1.40	1.60	.030	.007	22
1.60	1.80	.022	.005	18
1.80	2.00	.021	.006	13
2.00	2.50	.012	.003	18
2.50	3.00	.006	.001	22
3.00	3.50	.005	.001	14
3.50	4.00	.006	.002	12
4.00	4.79	.001	.001	5
5.65	7.00	.002	.001	14
7.00	8.00	.005	.001	19
8.00	8.73	.012	.003	18

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5 PER CENT.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 1)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM 6.37 TO 7.18 GEV/C.

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2 (1)		NO. EVENTS
.17	.20	32.876 +-	3.598	108
.20	.30	15.413	1.066	371
.30	.40	8.736	.578	348
.40	.50	3.901	.327	172
.50	.60	2.050	.252	75
.60	.70	1.177	.149	82
.70	.80	.709	.089	69
.80	.90	.362	.057	49
.90	1.00	.282	.049	35
1.00	1.20	.146	.026	34
1.20	1.40	.059	.017	13
1.40	1.60	.027	.011	7
1.60	1.80	.041	.009	23
1.80	2.00	.018	.005	12
2.00	2.50	.018	.004	23
2.50	3.00	.006	.002	10
3.00	3.50	.004	.001	9
3.50	4.00	.005	.002	10
4.00	5.09	.001	.001	5
6.36	7.25	.003	.001	8
7.35	8.50	.001	.001	5
8.50	9.63	.006	.002	14

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5 PER CENT.

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FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON.        (TABLE 2)
     DATA IS FIT OVER LABORATORY BEAM MOMENTUM FROM 1.7 TO 2.3 GEV/C.
     DATA IS FIT OVER -T FROM .1 TO .5 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE
          (OUTGOING NEUTRON).
     FITTED FORMULA IS          D-SIGMA/D-T  =  A*EXP(-B*T)
            WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.
     FITTED VALUE
            B  =  -5.66 +- .54
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON.        (TABLE 2)
     DATA IS FIT OVER LABORATORY BEAM MOMENTUM FROM 2.3 TO 2.8 GEV/C.
     DATA IS FIT OVER -T FROM .1 TO .5 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE
          (OUTGOING NEUTRON).
     FITTED FORMULA IS          D-SIGMA/D-T  =  A*EXP(-B*T)
            WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.
     FITTED VALUE
            B  =  -6.22 +- .48
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON.        (TABLE 2)
     DATA IS FIT OVER LABORATORY BEAM MOMENTUM FROM 2.8 TO 3.3 GEV/C.
     DATA IS FIT OVER -T FROM .1 TO .5 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE
          (OUTGOING NEUTRON).
     FITTED FORMULA IS          D-SIGMA/D-T  =  A*EXP(-B*T)
            WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.
     FITTED VALUE
            B  =  -6.86 +- .48
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON.        (TABLE 2)
     DATA IS FIT OVER LABORATORY BEAM MOMENTUM FROM 3.3 TO 3.8 GEV/C.
     DATA IS FIT OVER -T FROM .1 TO .5 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE
          (OUTGOING NEUTRON).
     FITTED FORMULA IS          D-SIGMA/D-T  =  A*EXP(-B*T)
            WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.
     FITTED VALUE
            B  =  -7.14 +- .46
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON.        (TABLE 2)
     DATA IS FIT OVER LABORATORY BEAM MOMENTUM FROM 3.8 TO 4.3 GEV/C.
     DATA IS FIT OVER -T FROM .1 TO .5 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE
          (OUTGOING NEUTRON).
     FITTED FORMULA IS          D-SIGMA/D-T  =  A*EXP(-B*T)
            WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.
     FITTED VALUE
            B  =  -7.33 +- .43
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON.        (TABLE 2)
     DATA IS FIT OVER LABORATORY BEAM MOMENTUM FROM 4.3 TO 4.8 GEV/C.
     DATA IS FIT OVER -T FROM .1 TO .5 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE
          (OUTGOING NEUTRON).
     FITTED FORMULA IS          D-SIGMA/D-T  =  A*EXP(-B*T)
            WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.
     FITTED VALUE
            B  =  -8.25 +- .38
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON.        (TABLE 2)
     DATA IS FIT OVER LABORATORY BEAM MOMENTUM FROM 4.8 TO 5.4 GEV/C.
     DATA IS FIT OVER -T FROM .1 TO .5 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE
          (OUTGOING NEUTRON).
     FITTED FORMULA IS          D-SIGMA/D-T  =  A*EXP(-B*T)
            WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.
     FITTED VALUE
            B  =  -7.65 +- .36
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
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FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 2)

DATA IS FIT OVER LABORATORY BEAM MOMENTUM FROM 5.4 TO 5.9 GEV/C.

DATA IS FIT OVER -T FROM .1 TO .5 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(-B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

B = -7.11 +- .33

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FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 2)

DATA IS FIT OVER LABORATORY BEAM MOMENTUM FROM 5.9 TO 6.4 GEV/C.

DATA IS FIT OVER -T FROM .1 TO .5 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(-B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

B = -7.94 +- .37

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FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 2)

DATA IS FIT OVER LABORATORY BEAM MOMENTUM FROM 6.4 TO 7.2 GEV/C.

DATA IS FIT OVER -T FROM .1 TO .5 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(-B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

B = -7.31 +- .44

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 2)

DATA IS FIT OVER LABORATORY BEAM MOMENTUM FROM 1.7 TO 2.3 GEV/C.

DATA IS FIT OVER -T FROM .1 TO .4 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(-B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

B = -5.5 +- .8

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 2)

DATA IS FIT OVER LABORATORY BEAM MOMENTUM FROM 2.3 TO 2.8 GEV/C.

DATA IS FIT OVER -T FROM .1 TO .4 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(-B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

B = -6.67 +- .81

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 2)

DATA IS FIT OVER LABORATORY BEAM MOMENTUM FROM 2.8 TO 3.3 GEV/C.

DATA IS FIT OVER -T FROM .1 TO .4 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(-B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

B = -8.48 +- .74

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 2)

DATA IS FIT OVER LABORATORY BEAM MOMENTUM FROM 3.3 TO 3.8 GEV/C.

DATA IS FIT OVER -T FROM .1 TO .4 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(-B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

B = -8.23 +- .64

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 2)

DATA IS FIT OVER LABORATORY BEAM MOMENTUM FROM 3.8 TO 4.3 GEV/C.

DATA IS FIT OVER -T FROM .1 TO .4 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(-B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

B = -7.48 +- .57

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 2)

DATA IS FIT OVER LABORATORY BEAM MOMENTUM FROM 4.3 TO 4.8 GEV/C.

DATA IS FIT OVER -T FROM .1 TO .4 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(-B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

B = -8.73 +- .49

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 2)

DATA IS FIT OVER LABORATORY BEAM MOMENTUM FROM 4.8 TO 5.4 GEV/C.

DATA IS FIT OVER -T FROM .1 TO .4 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(-B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

B = -7.63 +- .48

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 2)

DATA IS FIT OVER LABORATORY BEAM MOMENTUM FROM 5.4 TO 5.9 GEV/C.

DATA IS FIT OVER -T FROM .1 TO .4 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(-B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

B = -7.62 +- .48

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 2)

DATA IS FIT OVER LABORATORY BEAM MOMENTUM FROM 5.9 TO 6.4 GEV/C.

DATA IS FIT OVER -T FROM .1 TO .4 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(-B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

B = -8.47 +- .54

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 2)

DATA IS FIT OVER LABORATORY BEAM MOMENTUM FROM 6.4 TO 7.2 GEV/C.

DATA IS FIT OVER -T FROM .1 TO .4 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(-B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

B = -7.12 +- .68

90 OBSERVATION OF THE P PI PI DECAY MODE OF THE N*1/2(1400) RESONANCE IN PP INTERACTIONS AT 22 GEV/C. [PHYS. REV. LETTERS 21, 1368 (1968)]

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ABSTRACT APPROXIMATELY 12,000 FOUR-PRONGED INTERACTIONS OF 22-GEV/C PROTONS IN A HYDROGEN BUBBLE CHAMBER HAVE BEEN MEASURED. IN A SAMPLE OF 1234 PP PI+ PI- EVENTS THE FINAL STATE IS DOMINATED BY DELTA++(1236) PRODUCTION. APPROXIMATELY 120 OF THESE EVENTS ARE ATTRIBUTED TO THE P PI+ PI- DECAY OF A RESONANT STATE WITH MASS 1443 +- 15 MEV AND WIDTH 100 +- 25 MEV IDENTIFIED WITH THE N*1/2(1400) RESONANCE. THERE IS ALSO STRONG EVIDENCE FOR P PI PI ENHANCEMENT WITH A CENTRAL MASS VALUE OF 1693 MEV.

CITATIONS
PHYS. REV. LETTERS 12, 340 (1964), PHYS. LETTERS 18, 342 (1965), PHYS. REV. 165, 1730 (1968), PHYS. LETTERS 18, 167 (1965), NUOVO CIMENTO 35, 1052 (1965), PHYS. REV. LETTERS 16, 855 (1966), PHYS. REV. LETTERS 17, 789 (1966), PHYS. REV. LETTERS 19, 397 (1967), PHYS. REV. LETTERS 13, 555 (1964), PHYS. REV. LETTERS 14, 1043 (1965), PHYS. LETTERS 23, 386 (1966), PHYS. REV. LETTERS 20, 164 (1968), BULL. AM. PHYS. SOC. 13, 682 (1968), PHYS. REV. LETTERS 17, 884 (1966), UCLA UCLA-1023, PHYS. REV. LETTERS 20, 964 (1968), NUOVO CIMENTO 50A, 1000 (1967), UNIV. OF ILLINOIS COO1195-78 (1967), PHYS. REV. LETTERS 13, 169 (1964), PHYS. REV. LETTERS 19, 546 (1967), NUOVO CIMENTO 24, 453 (1962), NUOVO CIMENTO 40A, 899 (1965), PHYS. REV. LETTERS 19, 925 (1967), SLAC 43 (1965), AND PHYS. REV. 139, B1023 (1965).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 21.8 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 80 IN. (H) BUBBLE CHAMBER. A TOTAL OF 70000 PICTURES ARE REPORTED ON.

KEY WORDS - CROSS SECTION MASS SPECTRUM DIFFERENTIAL CROSS SECTION FITS N*(1470)P11 DELTA(1238)
BARYON RESONANCE WITH Y = 1 AT 1700 MEV

COMPOUND KEY WORDS - FITS DIFFERENTIAL CROSS SECTION

- -

CROSS SECTION FOR PROTON PROTON - PROTON PROTON PI+ PI-. [PAGE 1368]

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS	NO. EVENTS
21.8	1.36 +- .16	1234

- -

CROSS SECTION FOR PROTON PROTON - PROTON N*(1470)+. [PAGE 1369]
N*(1470)+ - PROTON PI+ PI- [1]

LABORATORY BEAM MOMENTUM GEV/C	MICRO-BARNS
21.8	155. +- 30.

[1] FITTED FOR MASS AND/OR WIDTH (MASS = 1.443 GEV; WIDTH = .100 GEV), AND THEN TOOK ONLY EVENTS ABOVE (FITTED) BACKGROUND.

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FIT TO DIFFERENTIAL CROSS SECTION FOR PROTON PROTON - N*(1470)+ PROTON. [PAGE 1370]

LABORATORY BEAM MOMENTUM = 21.8 GEV/C.

T (GEV/C)**2 < .250. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (N*(1470)+).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(B(T))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND T IS IN (GEV/C)**2.

FITTED VALUE

B = 18.0 +- 2.3

91 NEUTRON-PROTON AND NEUTRON-DEUTERON TOTAL CROSS SECTIONS FROM 14 TO 27 GEV/C. [PHYS. REV. LETTERS 20, 468 (1968)]

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ABSTRACT THE FIRST DIRECT MEASUREMENTS OF NEUTRON-PROTON AND NEUTRON-DEUTERON TOTAL CROSS SECTIONS IN THE MOMENTUM RANGE 14 TO 27 GEV/C ARE PRESENTED. THE NP TOTAL CROSS SECTION APPARENTLY BECOMES LESS THAN THE PP TOTAL CROSS SECTION IN THIS MOMENTUM REGION. OUR RESULTS SHOW NO EVIDENCE FOR A RAPID VANISHING OF THE GLAUBER SCREENING CORRECTION AS PREDICTED BY ABERS ET AL. ON THE BASIS OF REGGE THEORY.

CITATIONS
PHYS. REV. 138, B913 (1965), PHYS. LETTERS 19, 341 (1965), PHYS. LETTERS 14, 164 (1965), PHYS. REV. 100, 242 (1955), PHYS. REV. LETTERS 19, 857 (1967), BERKELEY CONFERENCE 253 (1967), PHYS. LETTERS 21, 339 (1966), NUOVO CIMENTO 42A, 365 (1966), PHYS. REV. 146, 980 (1966), INT'L. CONGRESS ON NUCLEAR PHYSICS,PARIS,FRANCE 162 (1964), AND JETP 18 1239 (1963).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM NO. 1 IS NEUTRON ON PROTON FROM 14.6 TO 27.0 GEV/C.
NO. 2 IS NEUTRON ON DEUTERON FROM 14.6 TO 27.0 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - CROSS SECTION

- -

NEUTRON PROTON TOTAL CROSS SECTION. [TABLE 1]

LABORATORY BEAM MOMENTUM GEV/C [1]	MILLI-BARNS
14.6	37.1 +- 1.2
17.8	37.5 1.2
21.6	37.7 .8
27.0	38.9 .6

[1] MEAN VALUES.

NEUTRON DEUTERON TOTAL CROSS SECTION. (TABLE 1)

LABORATORY BEAM MOMENTUM GEV/C (1)	MILLI-BARNS
14.6	72.2 +- 1.5
27.0	69.7 .7

(1) MEAN VALUES.

92 TOTAL CROSS SECTION FOR INTERACTION BETWEEN PROTONS AND 8.3 BEV NEUTRONS. (JETP 15 272 (1962))

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ABSTRACT THE TOTAL NEUTRON-PROTON INTERACTION CROSS SECTION WAS MEASURED FOR A MEAN EFFECTIVE NEUTRON ENERGY 8.2 -1.3 +1.2 BEV (IN THE L.S.) UNDER GOOD GEOMETRY (THETA/2 = 0.228 DEG.). THE TOTAL CROSS SECTION WAS FOUND TO EQUAL 41.2 +- 2.6 MB.

CITATIONS
PHYS. REV. 98, 1369 (1955), PHYS. REV. 103, 212 (1956), NUC. PHYS. 9, 600 (1959), PROC. OF THE ROYAL SOCIETY OF LONDON A251, 233 (1959), BULL. AM. PHYS. SOC. 4, 253 (1959), AND PHYS. REV. LETTERS 5, 576 (1960).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS NEUTRON ON HYDROGEN COMPOUND AT 9.192 GEV/C. (BEAM KINETIC ENERGY = 8.3 GEV)

THIS EXPERIMENT USES COUNTERS.

KEY WORDS → CROSS SECTION

- -

NEUTRON PROTON TOTAL CROSS SECTION. (PAGE 272)

LABORATORY BEAM ENERGY GEV	MILLI-BARNS
8.3 + 1.2 - 1.3	41.2 +- 2.6

93 STUDY OF PP INTERACTIONS AT 28.5 BEV/C IN TWO- AND FOUR-PRONG FINAL STATES. (BNL 11980 (1967))

P.L.CONNOLLY,W.E.ELLIS,P.V.C.HOUGH,D.J.MILLER,T.W.MORRIS,C.OUANNES, R.S.PANVINI,A.M.THORNDIKE (BROOKHAVEN NAT. LAB., UPTON, L.I., N. Y., USA)

CITATIONS
BNL 11681, PHYS. REV. 120, 1857 (1960), PHYS. REV. LETTERS 19, 546 (1967), USAEC REPORT UC-34 (1967), PHYS. REV. LETTERS 16, 855 (1966), PHYS. LETTERS 18, 167 (1965), PHYS. REV. LETTERS 17, 789 (1966), PHYS. REV. 154, 1284 (1967), PRINCETON-PENN ACCELERATOR PPAD 600F (1966), AND PHYS. REV. 137, 1566 (1964).

ARTICLE READ BY ODETTE BENARY IN 9/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 28.5 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 80 IN. (H) BUBBLE CHAMBER. A TOTAL OF 83000 PICTURES ARE REPORTED ON.

KEY WORDS → CROSS SECTION DIFFERENTIAL CROSS SECTION FITS MASS SPECTRUM ANGULAR DISTRIBUTION

COMPOUND KEY WORDS → FITS DIFFERENTIAL CROSS SECTION

- -

(FROM TABLE 1A AND TABLE 1B)

LABORATORY BEAM MOMENTUM = 28.5 GEV/C.

REACTION	MILLI-BARNS	
PROTON PROTON →		
PROTON N*(1470)+	.50	+ .20 - .10
PROTON N*(1470)+	.40	+ .20 - .10
N*(1470)+ → NUCLEON PION (1)		
PROTON NEUTRON PI+	1.50	.10
NEUTRON DELTA(1238)++	.16	.02 (2)
DELTA(1238)++ → PROTON PI+ (1)		
DELTA(1238)++ DELTA(1238)0	.03	.02
DELTA(1238)++ → PROTON PI+ (1)		
DELTA(1238)0 → NEUTRON PI0 (1)		
DELTA(1238)0 PROTON PI+	.16	+ .10 - .05
DELTA(1238)0 → NEUTRON PI0 (1)		
PROTON PROTON PI+ PI-	1.10	.20
DELTA(1238)++ PROTON PI-	.60	.10
DELTA(1238)++ → PROTON PI+ (1)		
DELTA(1238)0 PROTON PI+	.06	.02
DELTA(1238)0 → PROTON PI- (1)		
'N*(1688)' PROTON PI+	.03	.01
'N*(1688)' → PROTON PI- (1)		
DELTA(1238)++ DELTA(1238)0	.02	.01
DELTA(1238)++ → PROTON PI+ (1)		
DELTA(1238)0 → PROTON PI- (1)		
PROTON PROTON OMEGA(783)	.05	.01
PROTON NEUTRON PI+ PI+ PI-	1.60	.30
DELTA(1238)++ NEUTRON PI+ PI-	.45	.03
DELTA(1238)++ → PROTON PI+ (1)		
DELTA(1238)++ DELTA(1238)- PI+	.05	.01
DELTA(1238)++ → PROTON PI+ (1)		
DELTA(1238)- → NEUTRON PI- (1)		
DELTA(1238)- PROTON PI+ PI+	> .08	
DELTA(1238)- → NEUTRON PI- (1)		
PROTON 'N*(1688)+'	.32	+ .13 - .07

(1) USED SIMPLE MASS CUT.
(2) THIS DATA SHOULD NOT BE USED - MORE RECENT VALUES MAY BE FOUND IN ELLIS ET AL., BNL 13671 (1969).

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (FIGURE 1)

LABORATORY BEAM MOMENTUM = 28.5 GEV/C.

(NORMALIZED TO COUNTER EXPERIMENTS)

. THIS DATA WAS READ FROM A GRAPH .

-T (GEV/C)**2 MIN	MAX	NO. EVENTS
.0	.2	37
.2	.4	460
.4	.6	740
.6	.8	680
.8	1.0	610
1.0	1.2	520
1.2	1.4	380
1.4	1.6	290
1.6	1.8	280
1.8	2.0	230
2.0	2.2	205
2.2	2.4	150
2.4	2.6	104
2.6	2.8	114
2.8	3.0	107
3.0	3.2	92
3.2	3.4	68
3.4	3.6	62
3.6	3.8	53
3.8	4.0	62
4.0	4.2	42
4.2	4.4	25
4.4	4.6	25
4.6	4.8	18
4.8	5.0	15

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (FIGURE 1)

LABORATORY BEAM MOMENTUM = 28.5 GEV/C.
FITTED FORMULA IS D-SIGMA/D-T = EXP(A-B*T+C*T**2)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

FITTED VALUE

A = 7.34 +- .11
B = -10.91 +- 1.05
C = 4.18 +- 2.11

94 NEUTRON-PROTON CHARGE-EXCHANGE SCATTERING BETWEEN 600 MEV/C AND 2000 MEV/C. (PPAR 10 (1969))

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ABSTRACT N-P ELASTIC DIFFERENTIAL CROSS SECTIONS IN THE CHARGE-EXCHANGE REGION HAVE BEEN MEASURED FOR INCIDENT NEUTRON MOMENTA BETWEEN 600 MEV/C AND 2000 MEV/C. A SECONDARY NEUTRON BEAM FROM THE BOMBARDMENT OF A 1 1/2 IN. PLATINUM TARGET BY THE 3 GEV INTERNAL PROTON BEAM AT THE PRINCETON- PENNSYLVANIA ACCELERATOR WAS SCATTERED FROM A LIQUID-HYDROGEN TARGET. THE INCIDENT NEUTRON ENERGY WAS DETERMINED BY A MEASUREMENT OF FLIGHT TIME OVER A 108 FT. FLIGHT PATH. THE MOMENTUM AND SCATTERING ANGLE OF THE RECOIL PROTON WERE MEASURED BY A WIRE-SPARK-CHAMBER MAGNETIC SPECTROMETER WITH MAGNETOSTRICTIVE READOUT. APPROXIMATELY 450,000 ELASTIC EVENTS WERE DETECTED FOR PROTON LABORATORY ANGLES BETWEEN [illegible] AND [illegible]. DIFFERENTIAL CROSS SECTIONS ARE PRESENTED AT FIFTEEN ENERGIES. AN ABSOLUTE NORMALIZATION OF THE CROSS SECTIONS WAS ACHIEVED BY MEASURING THE INCIDENT NEUTRON FLUX WITH A DETECTOR WHOSE EFFICIENCY WAS DETERMINED EXPERIMENTALLY.

CITATIONS
MIDWEST CONF. THEORET. PHYS.,PURDUE UNIV. 50 (1960), PHYS. REV. 169, 1128 (1968), PHYS. REV. 169, 1149 (1968), PHYS. REV. 173, 1272 (1968), PHYS. REV. 165, 1579 (1968), REV. MOD. PHYS. 39, 560 (1967), PHYS. REV. LETTERS 15, 38 (1965), NUOVO CIMENTO 41A, 167 (1966), ANNALS OF PHYSICS 32, 193 (1965), NUC. PHYS. 36, 258 (1962), PHYS. REV. 142, 584 (1966), JETP 16 24 (1963), PHYS. REV. 79, 96 (1950), PHYS. REV. 99, 1447 (1955), PHYS. REV. 95, 185 (1954), PHYS. REV. 95, 591 (1954), JETP 4 161 (1957), JETP 10 1125 (1960), NUOVO CIMENTO 18, 1039 (1960), PROGR. THEORET. PHYS. (KYOTO) SUP.3 32 (1956), PROGR. THEORET. PHYS. (KYOTO) 16 455 (1956), PHYS. REV. 112, 1380 (1958), REV. MOD. PHYS. 39, 611 (1967), PHYS. REV. 138, B145 (1965), PHYS. REV. 142, 1000 (1966), PHYS. REV. 75, 1352 (1949), PHYS. LETTERS 4, 19 (1963), PHYS. REV. LETTERS 11, 444 (1963), PHYS. LETTERS 12, 62 (1964), PHYS. REV. 136, B1783 (1964), PHYS. REV. 137, B1530 (1965), PHYS. REV. LETTERS 11, 442 (1963), PHYS. REV. 134, B633 (1964), PHYS. REV. LETTERS 11, 88 (1963), PHYS. REV. LETTERS 17, 113 (1966), PHYS. REV. 155, 1773 (1967), NUC. PHYS. 82, 394 (1967), PHYS. REV. 163, 1603 (1967), UCRL 10677, PHYS. REV. 134, B630 (1964), ANNALS OF PHYSICS 7, 404 (1959), JETP 17 720 (1963), PHYS. REV. 166, 1599 (1968), PHYS. REV. 142, 576 (1966), PHYS. REV. 156, 1703 (1967), PRINCETON-PENN ACCELERATOR A-101 (1964), PRINCETON-PENN ACCELERATOR A-215 (1965), PRINCETON-PENN ACCELERATOR A-242 (1966), PRINCETON-PENN ACCELERATOR A-243 (1966), PHYS. REV. 169, 1045 (1968), NUCLEAR INSTRUMENTS AND METHODS 46, 197 (1967), NUCLEAR INSTRUMENTS AND METHODS 33, 141 (1965), PRINCETON-PENN ACCELERATOR PPAD 605-E (1966), PRINCETON-PENN ACCELERATOR PPAR-3 (1968), PRINCETON-PENN ACCELERATOR PPAD 633F (1967), UCRL 9727 (1961), UCRL 2301 (1964), AND PRINCETON-PENN ACCELERATOR PPAR-11 (1969).

ARTICLE READ BY ODETTE BENARY IN 10/69, AND VERIFIED BY LEROY PRICE.

BEAM IS NEUTRON ON PROTON FROM 6 TO 2 GEV/C.

THIS EXPERIMENT USES SPARK CHAMBERS.

GENERAL COMMENTS ON THIS ARTICLE
1 THIS IS SHEPARD'S THESIS. IT CONTAINS A NICE DISCUSSION OF THE HISTORY AND THEORY OF NP CHARGE EXCHANGE SCATTERING.

KEY WORDS • DIFFERENTIAL CROSS SECTION CHARGE EXCHANGE FITS

COMPOUND KEY WORDS • FITS CHARGE EXCHANGE DIFFERENTIAL CROSS SECTION

ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 5)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM .600 TO .625 GEV/C.

-U (GEV/C)**2	D-SIGMA/D-U MB/(GEV/C)**2 [1]	
.0000	355.80 +-	15.00
.0003	358.70	13.30
.0007	339.70	9.90
.0014	331.40	10.30
.0023	317.30	11.40
.0034	282.30	10.90
.0055	244.00	7.30
.0091	235.10	7.60
.0475	140.05	4.60
.0563	126.44	4.40
.0657	116.53	4.20
.0796	104.88	2.47
.0860	96.17	2.40
.0968	87.82	2.28

U IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 8 PER CENT.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 6)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM .625 TO .650 GEV/C.

-U (GEV/C)**2	D-SIGMA/D-U MB/(GEV/C)**2 [1]	
.0001	396.70 +-	22.60
.0003	374.20	13.00
.0008	346.20	10.00
.0015	317.00	10.20
.0025	278.40	10.70
.0037	271.70	10.80
.0060	231.40	7.20
.0099	231.70	7.40
.0427	133.89	4.60
.0514	130.28	4.50
.0608	120.36	4.30
.0711	108.55	4.10
.0818	95.21	2.40
.0931	86.71	2.28
.1047	85.00	2.31
.1167	71.20	2.80

U IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5.5 PER CENT.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 7)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM .650 TO .675 GEV/C.

-U (GEV/C)**2	D-SIGMA/D-U MB/(GEV/C)**2 [1]	
.0001	383.10 +-	22.80
.0003	337.30	11.90
.0009	337.80	9.80
.0016	312.30	10.00
.0027	294.80	11.00
.0040	260.70	10.50
.0065	230.70	7.10
.0107	213.90	7.10
.0459	132.57	4.50
.0555	123.86	4.30
.0657	114.65	4.20
.0769	102.84	3.90
.0882	86.73	2.28
.1002	79.15	2.16
.1128	76.19	2.11
.1257	62.80	2.50

U IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3.6 PER CENT.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 8)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM .675 TO .700 GEV/C.

-U (GEV/C)**2	D-SIGMA/D-U MB/(GEV/C)**2 [1]	
.0001	354.30 +-	21.20
.0004	318.40	11.40
.0009	300.90	8.90
.0018	275.60	9.50
.0029	276.90	10.40
.0043	236.40	9.80
.0070	218.00	6.80
.0115	180.80	6.30
.0494	114.83	4.11
.0595	110.89	4.11
.0708	107.15	4.01
.0824	85.48	3.61
.0947	73.29	2.02
.1077	68.58	1.97
.1211	65.18	1.94
.1350	54.70	2.30

U IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3.2 PER CENT.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 9)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM .700 TO .725 GEV/C.

-U (GEV/C)**2	D-SIGMA/D-U MB/(GEV/C)**2 (1)	
.0001	288.60	+- 17.60
.0004	300.00	10.90
.0010	276.10	8.40
.0019	249.70	8.90
.0031	242.30	9.60
.0047	204.10	9.00
.0076	196.60	6.40
.0124	164.00	5.90
.0182	154.10	6.00
.0429	111.81	4.02
.0532	96.18	3.72
.0640	98.25	3.72
.0759	81.44	3.41
.0884	77.39	3.31
.1016	69.06	1.92
.1155	62.65	1.90
.1299	58.83	1.85
.1445	51.80	2.20

U IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3.1 PER CENT.

ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 10)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM .725 TO .760 GEV/C.

-U (GEV/C)**2	D-SIGMA/D-U MB/(GEV/C)**2 (1)	
.0001	323.30	+- 14.90
.0004	271.90	9.20
.0011	257.80	7.00
.0021	221.20	7.20
.0034	194.30	7.20
.0051	182.10	7.20
.0081	158.40	4.80
.0135	144.20	4.60
.0200	132.00	4.60
.0464	96.74	3.22
.0574	88.32	3.02
.0693	81.73	2.92
.0823	66.08	2.62
.0957	65.14	2.61
.1100	59.83	1.59
.1248	54.69	1.51
.1407	49.42	1.37
.1564	43.30	1.60
.1732	39.50	1.60

U IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3 PER CENT.

ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 11)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM .81 TO .85 GEV/C.

-U (GEV/C)**2	D-SIGMA/D-U MB/(GEV/C)**2 (1)	
.0001	238.00	+- 11.80
.0005	234.30	7.30
.0013	218.70	6.10
.0026	195.10	6.20
.0043	149.90	5.90
.0063	131.80	5.70
.0102	125.00	3.90
.0168	118.80	3.90
.0350	103.00	3.70
.0582	73.89	2.64
.0717	58.47	2.37
.0860	55.47	2.31
.1018	48.44	2.09
.1189	46.05	2.08
.1367	41.67	1.21
.1555	37.34	1.14
.1743	33.42	1.10
.1937	29.40	1.20
.2137	28.50	1.30

U IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 2.4 PER CENT.

ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 12)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM .85 TO .90 GEV/C.

-U (GEV/C)**2	D-SIGMA/D-U MB/(GEV/C)**2 (1)	
.0001	227.00 +-	10.60
.0006	208.80	6.40
.0015	193.00	5.10
.0029	180.10	5.60
.0047	144.60	5.40
.0070	122.40	4.90
.0113	104.20	3.30
.0187	95.60	3.20
.0274	82.80	3.00
.0505	66.03	2.34
.0643	60.39	2.21
.0793	54.36	2.09
.0953	47.43	1.85
.1134	40.13	1.73
.1311	36.94	1.61
.1514	36.04	.96
.1716	29.00	1.10
.1928	25.90	1.00
.2136	23.70	1.00
.2366	22.80	1.00
.2593	23.20	1.10

U IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 2.1 PER CENT.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 13)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM .90 TO .95 GEV/C.

-U (GEV/C)**2	D-SIGMA/D-U MB/(GEV/C)**2 (1)	
.0001	207.70 +-	10.20
.0007	204.00	6.40
.0017	177.70	4.80
.0032	152.20	5.30
.0053	140.60	5.50
.0078	111.00	4.70
.0127	104.50	3.30
.0208	76.00	2.90
.0562	61.19	2.30
.0718	53.53	2.14
.0883	48.40	1.99
.1069	45.31	1.95
.1262	39.18	1.80
.1469	33.42	1.65
.1687	29.94	.94
.1912	24.40	1.00
.2144	21.50	1.00
.2385	21.40	1.00
.2624	19.90	1.00
.2887	20.10	1.00
.4125	24.48	1.23
.4365	26.88	1.32
.4597	29.09	1.32
.4824	30.60	1.41
.5048	31.42	1.51

U IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 2 PER CENT.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 14)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM .95 TO 1.00 GEV/C.

-U (GEV/C)**2	D-SIGMA/D-U MB/(GEV/C)**2 (1)	
.0001	195.60 +-	10.00
.0007	182.60	6.00
.0018	165.60	4.60
.0036	143.70	4.80
.0058	120.10	4.80
.0087	107.30	4.70
.0140	91.30	3.10
.0228	75.00	2.90
.0476	59.88	2.31
.0625	56.15	2.15
.0794	45.66	1.88
.0984	40.57	1.85
.1185	33.52	1.70
.1400	30.97	1.55
.1625	25.53	1.41
.1868	22.93	.81
.2115	20.70	.90
.2372	17.00	.90
.2646	15.20	.80
.2909	16.00	.90
.3179	15.90	.90
.4282	18.97	1.03
.4539	22.32	1.13
.4787	23.01	1.22
.5044	27.37	1.32
.5310	28.47	1.41
.5533	28.09	1.41
.5773	33.66	1.61

U IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 2 PER CENT.

ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. [TABLE 15]

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM 1.0 TO 1.1 GEV/C.

-U (GEV/C)**2	D-SIGMA/D-U MB/(GEV/C)**2	(1)
.0002	159.90 +-	6.70
.0008	154.90	4.20
.0021	137.90	3.50
.0041	120.30	3.40
.0068	100.50	3.40
.0100	93.60	3.30
.0161	74.60	2.10
.0267	64.40	2.00
.0393	54.80	1.80
.0549	49.12	1.69
.0721	44.76	1.51
.0912	38.98	1.48
.1122	31.89	1.30
.1357	26.74	1.13
.1603	24.42	1.10
.1862	18.95	.94
.2135	17.24	.50
.2422	15.90	.60
.2707	12.60	.50
.3023	12.20	.50
.3316	11.30	.50
.3634	12.40	.60
.4850	16.79	.74
.5153	17.50	.73
.5443	20.21	.83
.5744	21.98	.92
.6036	23.76	.92
.6285	25.65	1.01
.6553	29.78	1.11
.6705	32.01	1.31

U IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 2.4 PER CENT.

ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. [TABLE 16]

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM 1.1 TO 1.2 GEV/C.

-U (GEV/C)**2	D-SIGMA/D-U MB/(GEV/C)**2	(1)
.0002	136.70 +-	6.20
.0010	115.10	3.60
.0025	110.40	3.60
.0049	95.50	3.00
.0081	80.70	3.00
.0121	64.90	2.80
.0192	55.90	1.80
.0319	43.50	1.60
.0472	41.20	1.50
.0651	33.28	.99
.0853	28.45	1.23
.1095	23.51	1.05
.1342	16.82	.89
.1613	16.72	.87
.1960	13.18	.89
.2222	12.73	.82
.2542	11.93	.42
.2886	10.13	.42
.3228	8.40	.40
.3556	7.70	.40
.3910	7.10	.40
.4308	7.20	.40
.4671	7.80	.50
.5732	10.81	.64
.6065	12.34	.63
.6431	13.22	.73
.6757	15.67	.82
.7087	17.89	.82
.7381	19.91	.91
.7656	23.15	1.01
.7985	25.78	1.21
.8235	28.33	1.51
.8489	31.70	1.81

U IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 3.1 PER CENT.

ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 17)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM 1.2 TO 1.4 GEV/C.

-U (GEV/C)**2	D-SIGMA/D-U MB/(GEV/C)**2 [1]	
.0003	87.80 +-	3.70
.0012	81.60	2.40
.0032	65.30	2.20
.0063	57.60	1.70
.0102	54.10	1.90
.0152	42.60	1.60
.0244	34.80	1.00
.0397	30.90	1.00
.0591	25.74	.65
.0815	20.72	.57
.1074	15.54	.66
.1362	10.75	.52
.1669	9.18	.52
.2023	7.39	.38
.2378	6.14	.38
.2751	5.91	.37
.3134	5.61	.23
.3585	5.25	.25
.3986	4.90	.30
.4390	4.90	.30
.4863	4.00	.20
.5268	4.20	.30
.6558	7.32	.42
.6961	8.07	.42
.7346	10.06	.52
.7737	11.52	.62
.8236	14.19	.71
.8608	17.36	.81
.8949	18.80	.81
.9301	24.18	1.11
.9633	29.55	1.51
.9971	34.11	2.11

U IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 4.3 PER CENT.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 18)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM 1.4 TO 1.6 GEV/C.

-U (GEV/C)**2	D-SIGMA/D-U MB/(GEV/C)**2 [1]	
.0003	57.00 +-	3.30
.0016	50.40	2.30
.0043	44.70	2.00
.0084	40.20	1.60
.0137	35.20	1.60
.0203	30.10	1.50
.0325	21.20	.90
.0536	17.40	.80
.0788	14.10	.49
.1088	11.08	.43
.1433	9.39	.54
.1805	6.90	.53
.2232	5.77	.39
.2648	3.75	.39
.3131	3.95	.38
.3726	3.13	.38
.4196	2.59	.37
.4705	3.20	.20
.5219	3.70	.20
.5836	2.50	.20
.6362	2.20	.20
.6791	2.20	.20
.7435	2.20	.20
.7986	1.74	.22
.8560	2.36	.21
.9049	2.65	.21
.9551	3.14	.31
1.0090	4.76	.31
1.0480	4.21	.31
1.0900	6.50	.51
1.1470	7.80	.61
1.1790	10.40	.71
1.2300	12.78	1.01
1.2600	16.17	1.61

U IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5.8 PER CENT.

ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 19)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM 1.6 TO 2.0 GEV/C.

-U (GEV/C)**2	D-SIGMA/D-U MB/(GEV/C)**2 (1)	
.0004	36.80 +-	2.50
.0023	38.10	2.00
.0059	32.10	1.40
.0114	25.40	1.10
.0186	23.90	1.20
.0278	17.90	1.00
.0441	14.20	.70
.0722	10.70	.60
.1070	8.16	.32
.1472	6.00	.32
.1922	5.39	.41
.2402	3.90	.21
.2985	3.11	.27
.3582	2.54	.27
.4318	1.98	.26
.4826	1.56	.26
.5587	1.41	.26
.6143	1.90	.20
.6938	1.50	.10
.7698	1.40	.10
.8308	1.10	.10
.8916	1.00	.10
1.0470	.89	.11
1.0980	1.10	.11
1.1630	1.51	.22
1.2540	1.06	.11
1.2930	1.57	.21
1.3630	2.59	.31
1.4000	3.60	.31
1.4870	3.67	.31
1.5170	5.68	.51
1.5500	6.56	.81
1.6240	8.45	1.01

U IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7.7 PER CENT.

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 20)

LABORATORY BEAM ENERGY = .182 GEV (MEAN VALUE).

(THE FIT IS PERFORMED DEMANDING (ALPHA+GAMMA) NORMALIZED TO UNITY)
FITTED FORMULA IS D-SIGMA/D-U = ALPHA*(EXP(BETA*U))+GAMMA*(EXP(DELTA*U))

WHERE D-SIGMA/D-U IS IN MB/(GEV/C)**2 AND U IS IN (GEV/C)**2. U IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).

FITTED VALUES

ALPHA = .40 +- .03
BETA = 208. +- 44.
GAMMA = .60 +- .03
DELTA = 9.7 +- .7

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 20)

LABORATORY BEAM ENERGY = .195 GEV (MEAN VALUE).

(THE FIT IS PERFORMED DEMANDING (ALPHA+GAMMA) NORMALIZED TO UNITY)
FITTED FORMULA IS D-SIGMA/D-U = ALPHA*(EXP(BETA*U))+GAMMA*(EXP(DELTA*U))

WHERE D-SIGMA/D-U IS IN MB/(GEV/C)**2 AND U IS IN (GEV/C)**2. U IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).

FITTED VALUES

ALPHA = .44 +- .02
BETA = 238. +- 52.
GAMMA = .56 +- .02
DELTA = 9.2 +- .5

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 20)

LABORATORY BEAM ENERGY = .21 GEV (MEAN VALUE).

(THE FIT IS PERFORMED DEMANDING (ALPHA+GAMMA) NORMALIZED TO UNITY)
FITTED FORMULA IS D-SIGMA/D-U = ALPHA*(EXP(BETA*U))+GAMMA*(EXP(DELTA*U))

WHERE D-SIGMA/D-U IS IN MB/(GEV/C)**2 AND U IS IN (GEV/C)**2. U IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).

FITTED VALUES

ALPHA = .42 +- .02
BETA = 203. +- 34.
GAMMA = .58 +- .02
DELTA = 9.4 +- .5

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 20)

LABORATORY BEAM ENERGY = .224 GEV (MEAN VALUE).

(THE FIT IS PERFORMED DEMANDING (ALPHA+GAMMA) NORMALIZED TO UNITY)
FITTED FORMULA IS D-SIGMA/D-U = ALPHA*(EXP(BETA*U))+GAMMA*(EXP(DELTA*U))

WHERE D-SIGMA/D-U IS IN MB/(GEV/C)**2 AND U IS IN (GEV/C)**2. U IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).

FITTED VALUES

ALPHA = .44 +- .02
BETA = 177. +- 21.
GAMMA = .56 +- .02
DELTA = 8.9 +- .4

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 20)

LABORATORY BEAM ENERGY = .239 GEV (MEAN VALUE).

(THE FIT IS PERFORMED DEMANDING (ALPHA+GAMMA) NORMALIZED TO UNITY)
FITTED FORMULA IS D-SIGMA/D-U = ALPHA*[EXP(BETA*U)]+GAMMA*[EXP(DELTA*U)]

WHERE D-SIGMA/D-U IS IN MB/(GEV/C)**2 AND U IS IN (GEV/C)**2. U IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).

FITTED VALUES

ALPHA = .48 +- .02
BETA = 135. +- 20.
GAMMA = .52 +- .02
DELTA = 7.5 +- .4

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FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 20)

LABORATORY BEAM ENERGY = .257 GEV (MEAN VALUE).

(THE FIT IS PERFORMED DEMANDING (ALPHA+GAMMA) NORMALIZED TO UNITY)
FITTED FORMULA IS D-SIGMA/D-U = ALPHA*[EXP(BETA*U)]+GAMMA*[EXP(DELTA*U)]

WHERE D-SIGMA/D-U IS IN MB/(GEV/C)**2 AND U IS IN (GEV/C)**2. U IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).

FITTED VALUES

ALPHA = .510 +- .015
BETA = 222. +- 29.
GAMMA = .490 +- .015
DELTA = 7.6 +- .3

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FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 20)

LABORATORY BEAM ENERGY = .313 GEV (MEAN VALUE).

(THE FIT IS PERFORMED DEMANDING (ALPHA+GAMMA) NORMALIZED TO UNITY)
FITTED FORMULA IS D-SIGMA/D-U = ALPHA*[EXP(BETA*U)]+GAMMA*[EXP(DELTA*U)]

WHERE D-SIGMA/D-U IS IN MB/(GEV/C)**2 AND U IS IN (GEV/C)**2. U IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).

FITTED VALUES

ALPHA = .540 +- .015
BETA = 204. +- 25.
GAMMA = .460 +- .015
DELTA = 7.2 +- .2

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FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 20)

LABORATORY BEAM ENERGY = .343 GEV (MEAN VALUE).

(THE FIT IS PERFORMED DEMANDING (ALPHA+GAMMA) NORMALIZED TO UNITY)
FITTED FORMULA IS D-SIGMA/D-U = ALPHA*[EXP(BETA*U)]+GAMMA*[EXP(DELTA*U)]

WHERE D-SIGMA/D-U IS IN MB/(GEV/C)**2 AND U IS IN (GEV/C)**2. U IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).

FITTED VALUES

ALPHA = .580 +- .013
BETA = 175. +- 15.
GAMMA = .420 +- .013
DELTA = 6.8 +- .2

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FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 20)

LABORATORY BEAM ENERGY = .378 GEV (MEAN VALUE).

(THE FIT IS PERFORMED DEMANDING (ALPHA+GAMMA) NORMALIZED TO UNITY)
FITTED FORMULA IS D-SIGMA/D-U = ALPHA*[EXP(BETA*U)]+GAMMA*[EXP(DELTA*U)]

WHERE D-SIGMA/D-U IS IN MB/(GEV/C)**2 AND U IS IN (GEV/C)**2. U IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).

FITTED VALUES

ALPHA = .580 +- .015
BETA = 160. +- 15.
GAMMA = .420 +- .015
DELTA = 6.4 +- .3

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FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 20)

LABORATORY BEAM ENERGY = .414 GEV (MEAN VALUE).

(THE FIT IS PERFORMED DEMANDING (ALPHA+GAMMA) NORMALIZED TO UNITY)
FITTED FORMULA IS D-SIGMA/D-U = ALPHA*[EXP(BETA*U)]+GAMMA*[EXP(DELTA*U)]

WHERE D-SIGMA/D-U IS IN MB/(GEV/C)**2 AND U IS IN (GEV/C)**2. U IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).

FITTED VALUES

ALPHA = .570 +- .016
BETA = 157. +- 16.
GAMMA = .430 +- .016
DELTA = 7.2 +- .3

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 20)

LABORATORY BEAM ENERGY = .466 GEV (MEAN VALUE).

(THE FIT IS PERFORMED DEMANDING (ALPHA+GAMMA) NORMALIZED TO UNITY)
FITTED FORMULA IS D-SIGMA/D-U = ALPHA*[EXP(BETA*U)]+GAMMA*[EXP(DELTA*U)]

WHERE D-SIGMA/D-U IS IN MB/(GEV/C)**2 AND U IS IN (GEV/C)**2. U IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING NEUTRON] AND THE [PROTON].

FITTED VALUES

ALPHA = .540 +- .014
BETA = 146. +- 14.
GAMMA = .460 +- .014
DELTA = 7.3 +- .3

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 20)

LABORATORY BEAM ENERGY = .542 GEV (MEAN VALUE).

(THE FIT IS PERFORMED DEMANDING (ALPHA+GAMMA) NORMALIZED TO UNITY)
FITTED FORMULA IS D-SIGMA/D-U = ALPHA*[EXP(BETA*U)]+GAMMA*[EXP(DELTA*U)]

WHERE D-SIGMA/D-U IS IN MB/(GEV/C)**2 AND U IS IN (GEV/C)**2. U IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING NEUTRON] AND THE [PROTON].

FITTED VALUES

ALPHA = .570 +- .016
BETA = 122. +- 11.
GAMMA = .430 +- .016
DELTA = 7.8 +- .4

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 20)

LABORATORY BEAM ENERGY = .649 GEV (MEAN VALUE).

(THE FIT IS PERFORMED DEMANDING (ALPHA+GAMMA) NORMALIZED TO UNITY)
FITTED FORMULA IS D-SIGMA/D-U = ALPHA*[EXP(BETA*U)]+GAMMA*[EXP(DELTA*U)]

WHERE D-SIGMA/D-U IS IN MB/(GEV/C)**2 AND U IS IN (GEV/C)**2. U IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING NEUTRON] AND THE [PROTON].

FITTED VALUES

ALPHA = .49 +- .02
BETA = 162. +- 18.
GAMMA = .51 +- .02
DELTA = 9.9 +- .3

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 20)

LABORATORY BEAM ENERGY = .817 GEV (MEAN VALUE).

(THE FIT IS PERFORMED DEMANDING (ALPHA+GAMMA) NORMALIZED TO UNITY)
FITTED FORMULA IS D-SIGMA/D-U = ALPHA*[EXP(BETA*U)]+GAMMA*[EXP(DELTA*U)]

WHERE D-SIGMA/D-U IS IN MB/(GEV/C)**2 AND U IS IN (GEV/C)**2. U IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING NEUTRON] AND THE [PROTON].

FITTED VALUES

ALPHA = .58 +- .03
BETA = 65. +- 7.
GAMMA = .42 +- .03
DELTA = 6.5 +- .7

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 20)

LABORATORY BEAM ENERGY = 1.028 GEV (MEAN VALUE).

(THE FIT IS PERFORMED DEMANDING (ALPHA+GAMMA) NORMALIZED TO UNITY)
FITTED FORMULA IS D-SIGMA/D-U = ALPHA*[EXP(BETA*U)]+GAMMA*[EXP(DELTA*U)]

WHERE D-SIGMA/D-U IS IN MB/(GEV/C)**2 AND U IS IN (GEV/C)**2. U IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING NEUTRON] AND THE [PROTON].

FITTED VALUES

ALPHA = .60 +- .05
BETA = 56. +- 11.
GAMMA = .40 +- .05
DELTA = 6.2 +- 1.2

95 ELASTIC NP CHARGE-EXCHANGE SCATTERING AT 8 GEV/C. [NUOVO CIMENTO 41A, 167 (1966)]

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ABSTRACT THE DIFFERENTIAL CROSS SECTION FOR ELASTIC CHARGE-EXCHANGE SCATTERING OF NEUTRONS ON PROTONS HAS BEEN MEASURED AT 8 GEV/C OVER FORWARD LABORATORY SCATTERING ANGLES (0-90)MRAD (SQUARE OF FOUR-MOMENTUM TRANSFER 0 < -T < 0.5(GEV/C)-SQUARED). THE METHOD UTILIZED ACOUSTIC SPARK CHAMBERS AND ABOUT 1900 ELASTIC-SCATTERING EVENTS WERE ANALYZED. A VALUE OF [D-SIGMA/D-OMEGA(LAB)] = (20 +- 6)MB/SR(D-SIGMA/D-T = (0.93 +- 0.28)MB/(GEV/C-SQUARED) WAS OBTAINED FOR THE FORWARD DIFFERENTIAL CROSS-SECTION AND AN ESTIMATED (0.06 +- 0.03) MB FOR THE ELASTIC CHARGE EXCHANGE CROSS SECTION. BOTH CROSS SECTIONS SHOW THE DECREASED VALUES EXPECTED FROM POMERANCHUK'S SECOND THEOREM WHEN COMPARED WITH RESULTS AT LOWER ENERGIES. FURTHER COMPARISON SHOWS THAT THE NARROW FORWARD PEAK IN THE DISTRIBUTION OF D-SIGMA/D-T PREVIOUSLY OBSERVED FOR -T < 0.05, IS STILL PRESENT AT 8 GEV/C, VARYING IN SHAPE ONLY SLOWLY, IF AT ALL, WITH ENERGY. FOR -T > 0.1 HOWEVER, ENERGY DEPENDENCE IS APPARENT. THE RESULTS ALSO SUGGEST THAT THE INTERACTION IS SPIN-DEPENDENT AND/OR THAT THE REAL PARTS OF THE SCATTERING AMPLITUDES IN THE ISOSPIN STATES 0 AND 1 ARE DIFFERENT. COMPARISONS WITH THE THEORETICAL PREDICTIONS SHOW GOOD AGREEMENT WITH THE VALUE OF FORWARD CROSS SECTION GIVEN BY THE REGGE POLE APPROACH OF AHMADZADEH. THE MODEL OF RINGLAND AND PHILLIPS FOR SINGLE-PION EXCHANGE WITH ABSORPTION AGREES WITH OUR RESULTS FOR -T < 0.01 BUT A PREDICTED SECONDARY PEAK AT -T APPROXIMATELY 0.08 IS NOT OBSERVED.

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ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS NEUTRON ON PROTON AT 8 GEV/C.

THIS EXPERIMENT USES SPARK CHAMBERS.

KEY WORDS • CROSS SECTION DIFFERENTIAL CROSS SECTION MODELS

- -
- -

NEUTRON PROTON ELASTIC CROSS SECTION. [PAGE 167]

DATA IS INTEGRATED OVER COS(THETA) FROM -1. TO 0.. THETA IS THE ANGLE THAT THE NEUTRON MAKES WITH THE BEAM IN THE GRAND C.M.

LABORATORY BEAM MOMENTUM GEV/C PER CENT	MILLI-BARNS
8. +- .5	.06 +- .03

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. [TABLE 1]

LABORATORY BEAM MOMENTUM = 8. GEV/C +- .5(PER CENT).

(LAST 9 POINTS HAVE AN ADDITIONAL SYSTEMATIC ERROR OF 15 PERCENT)

-U (GEV/C)**2	D-SIGMA/D-U MB/(GEV/C)**2 [1]		THETA RADIANS	D-SIGMA/D-OMEGA MB/SR [1]	
.0001	.95 +-	.09	.0010	20.4 +-	1.9
.0006	.84	.06	.0030	18.1	1.2
.0016	.96	.06	.0050	20.8	1.3
.0031	.71	.06	.0070	15.3	1.2
.0052	.67	.00	.0090	14.4	.0
.0077	.48	.05	.0110	10.4	1.1
.0108	.52	.00	.0130	11.1	.0
.0144	.47	.00	.0150	10.0	.0
.0185	.35	.00	.0170	7.5	.0
.0231	.39	.00	.0190	8.4	.0
.0282	.29	.00	.0210	6.4	.0
.0338	.31	.00	.0230	6.6	.0
.0399	.34	.00	.0250	7.3	.0
.0465	.27	.04	.0270	5.9	.9
.0536	.23	.00	.0290	5.0	.0
.0613	.17	.00	.0310	3.7	.0
.0694	.23	.00	.0330	4.9	.0
.0780	.22	.00	.0350	4.6	.0
.0871	.18	.00	.0370	3.7	.0
.0967	.21	.00	.0390	4.4	.0
.1070	.18	.00	.0410	3.7	.0
.1170	.17	.03	.0430	3.5	.7
.1290	.10	.03	.0450	2.2	.6
.1430	.13	.02	.0475	2.7	.3
.1740	.10	.00	.0525	2.2	.0
.2090	.08	.00	.0575	1.6	.0
.2460	.06	.00	.0625	1.2	.0
.2860	.05	.01	.0675	1.0	.2
.3290	.04	.01	.0725	.8	.2
.3750	.04	.00	.0775	.8	.0
.4240	.02	.00	.0825	.4	.0
.4750	.03	.01	.0875	.5	.2

U IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING NEUTRON] AND THE [PROTON].
THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 30 PER CENT.

96 PROTON-PROTON REACTIONS AT 19 GEV/C WITH PRODUCTION OF TWO AND THREE PIONS (SUBMITTED TO THE VIENNA CONF., 1968 (1968))

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ARTICLE READ BY ODETTE BENARY IN 10/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 19 GEV/C.

THIS EXPERIMENT USES THE CERN 2M (H) BUBBLE CHAMBER.

GENERAL COMMENTS ON THIS ARTICLE
1 THE RESULTS ARE PRELIMINARY

KEY WORDS - CROSS SECTION MASS SPECTRUM MODELS DALITZ PLOT ANGULAR DISTRIBUTION

(TABLE 1)

LABORATORY BEAM MOMENTUM = 19. GEV/C.

REACTION	MILLI-BARNS		NO. EVENTS
PROTON PROTON -			
PROTON PROTON PI+ PI-	1.50 +-	.20	2107
DELTA(1238)++ PROTON PI-	.83	.15	
DELTA(1238)++ - PROTON PI+ [1]			
DELTA(1238)++ DELTA(1238)0	.02	.01	
DELTA(1238)++ - PROTON PI+ [1]			
DELTA(1238)0 - PROTON PI- [1]			
DELTA(1238)++ N*(1520)0	.02	.01	
DELTA(1238)++ - PROTON PI+ [1]			
N*(1520)0 - PROTON PI- [1]			
PROTON PROTON F(1260)	.02	.01	
F(1260) - PI+ PI- [1]			
DELTA(1238)0 PROTON PI+	.18	.03	
DELTA(1238)0 - PROTON PI- [1]			
N*(1470)+ PROTON	.08	.02	
N*(1470)+ - PROTON PI+ PI- [1]			
'N*(1688)+' PROTON	.11	.03	
'N*(1688)+' - PROTON PI+ PI- [1]			
N*(1520)0 PROTON PI+	.14	.03	
N*(1520)0 - PROTON PI- [1]			
NEUTRON PROTON PI+ PI+ PI-	1.70	.30	1977
DELTA(1238)++ NEUTRON PI+ PI-	.45	.15 [2]	
DELTA(1238)++ - PROTON PI+ [1]			
DELTA(1238)++ DELTA(1238)- PI+	.08	.02	
DELTA(1238)++ - PROTON PI+ [1]			
DELTA(1238)- - NEUTRON PI- [1]			
DELTA(1238)++ N*(1470)0	.02	.01	
DELTA(1238)++ - PROTON PI+ [1]			
N*(1470)0 - NEUTRON PI+ PI- [1]			
DELTA(1238)++ 'N*(1688)0'	.03	.01	
DELTA(1238)++ - PROTON PI+ [1]			
'N*(1688)0' - NEUTRON PI+ PI- [1]			
DELTA(1238)++ DELTA(1920)0	.02	.01	
DELTA(1238)++ - PROTON PI+ [1]			
DELTA(1920)0 - NEUTRON PI+ PI- [1]			
DELTA(1238)++ RHO(765)0 NEUTRON	.19	.03 [2]	
DELTA(1238)++ - PROTON PI+ [1]			
RHO(765)0 - PI+ PI- [1]			
DELTA(1238)++ NEUTRON F(1260)	.03	.01	
DELTA(1238)++ - PROTON PI+ [1]			
F(1260) - PI+ PI- [1]			
DELTA(1238)+ PROTON PI+ PI-	.03	.01 [2]	
DELTA(1238)+ - NEUTRON PI+ [1]			
DELTA(1238)- PROTON PI+ PI+	.30	.10	
DELTA(1238)- - NEUTRON PI- [1]			
'N*(1688)0' PROTON PI+	.08	.02	
'N*(1688)0' - NEUTRON PI+ PI- [1]			
DELTA(1238)+ RHO(765)0 PROTON	.02	.01 [2]	
DELTA(1238)+ - NEUTRON PI+ [1]			
RHO(765)0 - PI+ PI- [1]			
PROTON PROTON PI+ PI- PI0	1.70	.30	2049
DELTA(1238)++ PROTON PI- PI0	.44	.15 [2]	
DELTA(1238)++ - PROTON PI+ [1]			
DELTA(1238)++ DELTA(1238)+ PI-	.05	.03	
DELTA(1238)++ - PROTON PI+ [1]			
DELTA(1238)+ - PROTON PI0 [1]			
DELTA(1238)0 RHO(765)+ PROTON	.07	.03 [2]	
DELTA(1238)0 - PROTON PI- [1]			
RHO(765)+ - PI+ PI0 [1]			
DELTA(1238)+ PROTON PI+ PI-	.17	.10 [2]	
DELTA(1238)+ - PROTON PI0 [1]			
DELTA(1238)0 PROTON PI0 PI+	.00	.05 [2]	
DELTA(1238)0 - PROTON PI- [1]			
PROTON PROTON OMEGA(783)	.08	.02 [3]	
OMEGA(783) - PI+ PI- PI0 [1]			
DELTA(1238)++ RHO(765)- PROTON	.12	.03 [2]	
DELTA(1238)++ - PROTON PI+ [1]			
RHO(765)- - PI- PI0 [1]			
DELTA(1238)+ RHO(765)0 PROTON	.03	.01 [2]	
DELTA(1238)+ - PROTON PI0 [1]			
RHO(765)0 - PI+ PI- [1]			

[1] USED SIMPLE MASS CUT.
[2] .45 .15 PRIVATE COMMUNICATION FROM G. EKSPONG, OCTOBER, 1969.
[3] THIS DATA IS NOT TO BE USED. SAME DATA REPORTED AT LUND CONFERENCE..

97 THE ANALYSIS OF 28.5 GEV/C PP INTERACTIONS PRODUCING 6 OR MORE CHARGED PARTICLES. (BNL 13694 (1969))

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CLOSELY RELATED REFERENCES
SEE ALSO BNL 13671 (1969), AND BNL 11980 (1967).

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ARTICLE READ BY ODETTE BENARY IN 7/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 28.5 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 80 IN. (H) BUBBLE CHAMBER. A TOTAL OF 150000 PICTURES ARE REPORTED ON.

KEY WORDS • CROSS SECTION MODELS MASS SPECTRUM ANGULAR DISTRIBUTION DELTA(1238) RHO(765) 'N*(1688)' N*(1520)D13

- -

(TABLE 1)

LABORATORY BEAM MOMENTUM = 28.5 GEV/C.

REACTION	MILLI-BARNS (1)
PROTON PROTON •	
PROTON PROTON PI+ PI+ PI- PI-	.380
6 PRONGS	5.500
8 PRONGS	2.400
10 PRONGS	.450
PROTON PROTON PI+ PI+ PI+ PI- PI- PI-	.115
PROTON PROTON PI+ PI+ PI+ PI+ PI- PI- PI- PI-	.020
12 PRONGS	.050
PROTON PROTON PI+ PI+ PI+ PI+ PI+ PI- PI- PI- PI- PI-	.002

(1) VALUES ARE APPROXIMATE ONLY.

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(PAGE 7)

LABORATORY BEAM MOMENTUM = 28.5 GEV/C.

REACTION	MICRO-BARNS
PROTON PROTON •	
N*(1520)D13 N*(1520)D13	< 40.
'N*(1688)' 'N*(1688)'	< 110.

98 PI+- P AND PP ELASTIC SCATTERING AT 8.5, 12.4 AND 18.4 GEV/C. (NUOVO CIMENTO 38, 60 (1965))

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ABSTRACT APPROXIMATELY 60,000 EVENTS HAVE BEEN COLLECTED IN A SPARK CHAMBER EXPERIMENT AT THE CERN PROTON SYNCHROTRON WHICH STUDIED ELASTIC DIFFRACTION SCATTERING OF PI- P AND P-P AT INCIDENT MOMENTA OF 8.5 AND 12.4 GEV/C.MAGNETIC ANALYSIS OF THE INCOMING AND DIFFRACTION SCATTERED PARTICLE, TOGETHER WITH MEASUREMENT OF ALL ANGLES, PERMITTED EACH EVENT TO BE DETERMINED AS ELASTIC SUBJECT TO THREE CONSTRAINTS, SO THAT THE INELASTIC BACKGROUND WAS REJECTED WITH HIGH EFFICIENCY, EVEN AT THE LARGER MOMENTUM TRANSFERS. MUCH OF THE DATA HAVE BEEN PROCESSED BY THE CERN AUTOMATIC FLYING SPOT DIGITIZER (FPD). A DETAILED DESCRIPTION OF THE EXPERIMENTAL TECHNIQUE AND OF THE METHODS OF ANALYSIS IS GIVEN. THE RESULTS, TOGETHER WITH DATA FROM LOWER ENERGIES, CONFIRM THE REMARKABLE ENERGY-INDEPENDENCE OF THE SHAPE OF THE PION-PROTON DIFFRACTION SCATTERING PEAK UP TO /T/ = 1.5 (GEV/C)-SQUARED, WHERE T IS THE SQUARE OF THE FOUR-MOMENTUM TRANSFER, OVER A RANGE OF PION ENERGIES FROM 2 TO 18 GEV. PROTON-PROTON SCATTERING DOES HOWEVER APPEAR TO SHOW A SHRINKING DIFFRACTION PEAK. IN GENERAL, THE DATA AGREE WITH OTHER EXPERIMENTS USING BOTH COUNTER AND BUBBLE CHAMBER TECHNIQUES, BUT SOME DIFFERENCES DO APPEAR. DURING THE EXPERIMENT, DATA WERE TAKEN WHICH SET AN UPPER LIMIT OF 2*10**-2 MICROBARNS/(GEV/C)-SQUARED ON THE DIFFERENTIAL ELASTIC CROSS-SECTION D-SIGMA/D-T OVER A RANGE OF /T/ FROM 20.9 TO 23.4 (GEV/C)-SQUARED AT 13.4 GEV/C INCIDENT PION MOMENTUM

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ARTICLE READ BY ODETTE BENARY IN 3/69, AND VERIFIED BY LEROY PRICE.

BEAM NO. 1 IS PI- ON PROTON FROM 8.5 TO 18.4 GEV/C.
NO. 2 IS PROTON ON PROTON FROM 8.5 TO 18.4 GEV/C.
NO. 3 IS PI+ ON PROTON FROM 8.5 TO 12.4 GEV/C.

THIS EXPERIMENT USES SPARK CHAMBERS.

KEY WORDS • DIFFERENTIAL CROSS SECTION FITS CROSS SECTION MODELS

COMPOUND KEY WORDS • FITS DIFFERENTIAL CROSS SECTION

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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 4)

LABORATORY BEAM MOMENTUM = 8.5 GEV/C +- 2.5(PER CENT).

-T (GEV/C)**2 [1]	D-SIGMA/D-T MB/(GEV/C)**2 [2]	
.13	24.500 +-	.660
.15	20.650	.610
.17	17.780	.570
.19	14.950	.520
.22	11.800	.330
.26	8.740	.280
.30	7.210	.250
.34	4.770	.200
.38	3.350	.170
.42	2.490	.150
.46	1.790	.120
.50	1.370	.110
.54	1.139	.098
.58	.800	.085
.65	.485	.041
.75	.278	.032
.85	.123	.021
.95	.059	.016
1.05	.058	.016

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 1 PER CENT.
[2] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7 PER CENT.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 4)

LABORATORY BEAM MOMENTUM = 12.4 GEV/C +- 2.5(PER CENT).

-T (GEV/C)**2 [1]	D-SIGMA/D-T MB/(GEV/C)**2 [2]	
.13	23.430 +-	.770
.15	18.400	.650
.17	16.220	.610
.19	12.440	.450
.22	10.430	.320
.26	7.150	.260
.30	5.360	.220
.34	3.600	.150
.38	2.960	.160
.42	2.100	.140
.46	1.430	.110
.50	1.280	.110
.54	.815	.091
.58	.506	.069
.65	.370	.038
.75	.178	.026
.85	.087	.020
.95	.034	.011
1.10	.020	.006
1.30	.012	.005
1.50	.012	.005
2.00	.006	.003

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 1 PER CENT.
[2] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7 PER CENT.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 4)

LABORATORY BEAM MOMENTUM = 18.4 GEV/C +- 2.5(PER CENT).

-T (GEV/C)**2 [1]	D-SIGMA/D-T MB/(GEV/C)**2 [2]	
.19	12.510 +-	.860
.22	10.260	.600
.26	7.350	.470
.30	4.800	.280
.34	3.570	.220
.38	2.360	.170
.42	1.710	.120
.46	1.200	.100
.50	1.064	.095
.54	.602	.071
.58	.387	.057
.65	.277	.030
.75	.092	.018
.85	.041	.011
.95	.050	.014
1.10	.013	.005
1.30	.005	.003
1.50	.002	.002
2.00	.000	.000
3.60	.000	.000

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 1 PER CENT.
[2] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7 PER CENT.

- -

PROTON PROTON ELASTIC CROSS SECTION. (TABLE 9)

(THE TOTAL ELASTIC CROSS SECTION IS OBTAINED BY EXTRAPOLATING THE MEASURED CROSS SECTION TO A POINT 6 PERCENT ABOVE THE OPTICAL POINT AT T=0)

LABORATORY BEAM MOMENTUM GEV/C	PER CENT	MILLI-BARNS [1]	
8.5 +-	2.5	9.68 +-	.62
12.4	2.5	8.50	.61
18.4	2.5	8.80	.72

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7 PER CENT.

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 6)

LABORATORY BEAM MOMENTUM = 8.5 GEV/C +- 2.5(PER CENT).

DATA IS FIT OVER -T FROM .13 TO .50 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(A+BT)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 4.198 +- .028
B = 7.75 +- .11

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 6)

LABORATORY BEAM MOMENTUM = 12.4 GEV/C +- 2.5(PER CENT).

DATA IS FIT OVER -T FROM .13 TO .50 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(A+BT)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 4.150 +- .033
B = 8.19 +- .13

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 6)

LABORATORY BEAM MOMENTUM = 18.4 GEV/C +- 2.5(PER CENT).

DATA IS FIT OVER -T FROM .19 TO .50 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(A+BT)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 4.178 +- .080
B = 8.58 +- .24

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 7)

LABORATORY BEAM MOMENTUM = 8.5 GEV/C +- 2.5(PER CENT).

DATA IS FIT OVER -T FROM .13 TO .95 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(A+BT+CT**2)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 4.241 +- .044
B = 8.16 +- .28
C = .84 +- .36

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 7)

LABORATORY BEAM MOMENTUM = 12.4 GEV/C +- 2.5(PER CENT).

DATA IS FIT OVER -T FROM .13 TO .95 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(A+BT+CT**2)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 4.259 +- .053
B = 9.05 +- .34
C = 1.41 +- .44

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 7)

LABORATORY BEAM MOMENTUM = 18.4 GEV/C +- 2.5(PER CENT).

DATA IS FIT OVER -T FROM .19 TO .95 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(A+BT+CT**2)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 4.391 +- .131
B = 9.79 +- .63
C = 1.53 +- .69

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 8)

LABORATORY BEAM MOMENTUM = 8.5 GEV/C +- 2.5(PER CENT).

DATA IS FIT OVER -T FROM .13 TO 1.05 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(A+BT+CT**2)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 4.266 +- .042
B = 8.35 +- .25
C = 1.14 +- .31

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 8)

LABORATORY BEAM MOMENTUM = 12.4 GEV/C +- 2.5(PER CENT).

DATA IS FIT OVER -T FROM .13 TO 2.00 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(A+BT+CT**2)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 4.352 +- .034
B = 9.71 +- .16
C = 2.33 +- .14

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 8)

LABORATORY BEAM MOMENTUM = 18.4 GEV/C +- 2.5(PER CENT).

DATA IS FIT OVER -T FROM .19 TO 3.60 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(A+BT+CT**2)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 4.418 +- .066
B = 9.96 +- .21
C = 1.76 +- .10

99 PION EXCHANGE DOMINANCE IN THE REACTION PP • N DELTA++ (1236) AT HIGH ENERGIES. (PHYS. REV. LETTERS 24, 1031 (1970))

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ABSTRACT THE CHARGE-EXCHANGE REACTION PP • N DELTA++ (1236) WAS BEEN ANALYZED UP TO 24.2 GEV/C TO TEST THE CONCEPT OF DOMINANCE IN THE T-CHANNEL BY HIGH-LYING REGGE TRAJECTORIES AT VERY HIGH ENERGIES. THE RESULTS PROVIDE CLEAR EVIDENCE FOR NO MORE THAN PION EXCHANGE UP TO THE HIGHEST MOMENTUM STUDIED.

CITATIONS
PHYS. LETTERS 18, 176 (1965), PHYS. REV. LETTERS 16, 855 (1966), PHYS. REV. LETTERS 17, 789 (1966), PHYS. REV. LETTERS 19, 937 (1967), PHYS. REV. 113, 1640 (1959), NUOVO CIMENTO 34, 735 (1964), NUOVO CIMENTO 40A, 039 (1965), PHYS. REV. LETTERS 19, 925 (1967), PHYS. REV. LETTERS 23, 342 (1969), NUOVO CIMENTO 56A, 269 (1968), PHYS. REV. 182, 1538 (1969), PHYS. REV. 182, 1579 (1969), PHYS. REV. 154, 1284 (1967), PHYS. REV. 138, B670 (1965), PHYS. REV. 125, 2082 (1962), PHYS. REV. 123, 2160 (1961), NUOVO CIMENTO 49A, 479 (1967), PHYS. REV. 173, 1322 (1969), NUOVO CIMENTO 53A, 232 (1968), PHYS. REV. 174, 1638 (1968), AND PHYS. REV. LETTERS 21, 697 (1968).

ARTICLE READ BY ODETTE BENARY IN 12/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON FROM 13.0 TO 24.2 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 80 IN. (H) BUBBLE CHAMBER.

KEY WORDS • CROSS SECTION DELTA(1238)++ MODELS

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CROSS SECTION FOR PROTON PROTON • NEUTRON DELTA(1238)++. (PAGE 4)
DELTA(1238)++ • PROTON PI+ (1)

(THE QUOTED ERRORS INCLUDE POSSIBLE SYSTEMATIC UNCERTAINTIES)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS	
13.0	.550 +-	.099
18.1	.301	.052
21.1	.217	.053
24.2	.205	.047

(1) COUNTED ONLY EVENTS ABOVE BACKGROUND.

100 RECENT EXPERIMENTAL RESULTS ON NP SCATTERING FROM 6 TO 30 GEV/C. (CERN HADRON CONFERENCE 2 523 (1968))

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CLOSELY RELATED REFERENCES
PART OF THIS ARTICLE SUPERSEDED BY PHYS. REV. LETTERS 20, 468 (1968).

ADDITIONAL CITATIONS
PHYS. REV. 138, B913 (1965), PHYS. LETTERS 19, 341 (1965), PHYS. LETTERS 14, 164 (1965), PHYS. REV. LETTERS 19, 857 (1967), PHYS. LETTERS 21, 339 (1966), NUOVO CIMENTO 42A, 365 (1966), PHYS. REV. 100, 242 (1955), PHYS. REV. 146, 980 (1966), INT'L. CONGRESS ON NUCLEAR PHYSICS,PARIS,FRANCE 162 (1964), JETP 18 1239 (1963), NUC. PHYS. 79, 699 (1966), PHYS. REV. LETTERS 16, 1217 (1966), SLAC 66 (1966), AND NUOVO CIMENTO 38, 60 (1965).

ARTICLE READ BY LEROY PRICE IN 4/70, AND VERIFIED BY ODETTE BENARY.

BEAM IS NEUTRON ON PROTON FROM 14 TO 30 GEV/C.

THIS EXPERIMENT USES COUNTERS AND SPARK CHAMBERS.

KEY WORDS • CROSS SECTION

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* NO DATA PUNCHED FOR THIS ARTICLE *
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101 STUDY OF INELASTIC PROTON-PROTON SCATTERING AT 12.5 GEV/C. (PHYS. REV. LETTERS 21, 1097 (1968))

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ABSTRACT WE HAVE TESTED EXPERIMENTALLY THE MODEL THAT THE THREE REGIONS SEEN IN PP ELASTIC SCATTERING ARE THE DIFFRACTION SCATTERING DUE TO PI, K, AND PBAR PRODUCTION. THE INELASTIC PP CROSS SECTION WAS MEASURED ON CIRCLES OF CONSTANT P(C.M.). ONE CONTAINED A PURE SAMPLE OF INELASTIC PI EVENTS; THE OTHER, BOTH PI AND K EVENTS. THE CROSS SECTION HAS A BREAK ON BOTH CIRCLES SHOWING THAT THE BREAK IS NOT DUE TO K MESONS AND THAT THE MODEL IS WRONG.

CITATIONS
PHYS. REV. LETTERS 10, 376 (1963), PHYS. REV. LETTERS 10, 543 (1963), PHYS. REV. LETTERS 11, 425 (1963), PHYS. REV. LETTERS 11, 503 (1963), PHYS. REV. LETTERS 14, 862 (1965), PHYS. REV. LETTERS 15, 45 (1965), UCRL 16275 (1966), PHYS. REV. LETTERS 11, 499 (1963), PHYS. REV. 138, B165 (1965), PHYS. REV. LETTERS 17, 1105 (1966), PHYS. REV. 159, 1138 (1967), PHYS. LETTERS 23, 389 (1966), PHYS. LETTERS 25B, 156 (1967), PHYS. LETTERS 27B, 49 (1968), PHYS. REV. LETTERS 19, 1149 (1967), PHYS. REV. LETTERS 18, 1147 (1967), PHYS. REV. 135, B1456 (1964), PHYS. LETTERS 25B, 228 (1968), PHYS. REV. 166, 1353 (1968), PHYS. REV. LETTERS 19, 198 (1967), AND PHYS. REV. LETTERS 21, 830 (1968).

ARTICLE READ BY LEROY PRICE IN 4/70, AND VERIFIED BY ODETTE BENARY.

BEAM IS PROTON ON PROTON AT 12.5 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS • CROSS SECTION

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* NO DATA PUNCHED FOR THIS ARTICLE *
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102 PION, KAON, AND ANTIPROTON PRODUCTION IN THE CENTER OF MASS IN HIGH ENERGY PROTON PROTON COLLISIONS. (CERN HADRON CONFERENCE 2 262 (1968))

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CLOSELY RELATED REFERENCES
DATA SUPERSEDED BY PHYS. REV. 166, 1353 (1968).
CONTINUATION OF PREVIOUS EXPERIMENT IN PHYS. REV. LETTERS 18, 1218 (1967).

ADDITIONAL CITATIONS
PHYS. REV. LETTERS 7, 1C1 (1961), NUOVO CIMENTO 31, 961 (1964), PHYS. REV. 137, B962 (1965), PHYS. REV. LETTERS 14, 504 (1965), PHYS. REV. LETTERS 16, 855 (1966), PHYS. REV. LETTERS 19, 198 (1967), UCRL 10022 (1961), PHYS. REV. LETTERS 17, 1105 (1966), PHYS. REV. LETTERS 159, 1138 (1967), PHYS. REV. 135, B1456 (1964), PHYS. LETTERS 25B, 156 (1967), NUOVO CIMENTO 27, 203 (1963), AND NUOVO CIMENTO 27, 856 (1963).

ARTICLE READ BY LEROY PRICE IN 4/70, AND VERIFIED BY ODETTE BENARY.

BEAM IS PROTON ON PROTON AT 12.5 GEV/C.

THIS EXPERIMENT USES COUNTERS.

GENERAL COMMENTS ON THIS ARTICLE
1 THIS ARTICLE IS ESSENTIALLY IDENTICAL TO RATNER, ET AL., PHYS. REV. 166, 1353(1968)

KEY WORDS • ANGULAR DISTRIBUTION FITS

COMPOUND KEY WORDS • FITS ANGULAR DISTRIBUTION

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* NO DATA PUNCHED FOR THIS ARTICLE *
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103 PION, KAON, AND ANTIPROTON PRODUCTION IN THE CENTER-OF-MASS IN HIGH-ENERGY PROTON-PROTON COLLISIONS. (PHYS. REV. 166, 1353 (1968))

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C.W.AKERLOF,D.G.CRABB,J.L.DAY,A.D.KRISCH, M.T.LIN (UNIV. OF MICHIGAN, ANN ARBOR, MICH., USA)

ABSTRACT THE DIFFERENTIAL PRODUCTION CROSS SECTION (D**2-SIGMA/D-OMEGA DP) HAS BEEN MEASURED FOR PIONS, KAONS, AND ANTIPROTONS PRODUCED IN 12.5-GEV/C PROTON-PROTON COLLISIONS. IN THIS EXPERIMENT WE STUDIED THE DEPENDENCE OF(D**2-SIGMA/D-OMEGA DP) ON THE LONGITUDINAL AND TRANSVERSE COMPONENTS OF THE C.M. MOMENTA OF THE PRODUCED PARTICLES, P-LONGITUDINAL AND P-PERPENDICULAR, WHILE HOLDING ALL OTHER VARIABLES FIXED IN THE CENTER-OF-MASS SYSTEM. THE RANGES OF THE COMPONENTS MEASURED WERE P-LONGITUDINAL = 0.0 - 1.0 GEV/C AND P-PERPENDICULAR**2 = 0.1 - 1.5 (GEV/C)**2. THE 12.5-GEV/C EXTRACTED PROTON BEAM OF THE ARGONNE ZGS IMPINGED UPON A LIQUID-HYDROGEN TARGET. THE PRODUCED PARTICLES WERE DETECTED BY A SPECTROMETER CONTAINING TWO BENDING MAGNETS AND CERENKOV COUNTERS AND SCINTILLATION COUNTERS IN COINCIDENCE. THE INCIDENT PROTON FLUX WAS DETERMINED BY MONITOR SCINTILLATORS CALIBRATED DURING GOLD-FOIL IRRADIATIONS. THE CROSS SECTIONS FOR THE PRODUCTION OF PI+- AND K+- WERE ALL FOUND TO HAVE AN UNAMBIGUOUS GAUSSIAN DEPENDENCE ON P-PERPENDICULAR OVER THE ENTIRE RANGE. IN THE FORMULA (D**2-SIGMA/D-OMEGA DP) = B EXP (-AP-PERPENDICULAR**2), WE FOUND A APPROXIMATELY = 3.5 (GEV/C)**-2 FOR PI+- AND K-. HOWEVER, FOR K+ WE FOUND A APPROXIMATELY = 2.7 (GEV/C)**-2. IN STUDYING THE DEPENDENCE OF (D**2-SIGMA/D-OMEGA DP) ON P-LONGITUDINAL, WE FOUND THAT THE CROSS SECTION WAS VERY STRONGLY PEAKED ABOUT P-LONGITUDINAL APPROXIMATELY EQUAL TO 0.5 GEV/C, WITH VERY FEW PARTICLES PRODUCED NEAR P-LONGITUDINAL = 0. THIS SHOWS THAT THERE IS NO TENDENCY FOR PARTICLES TO BE PRODUCED AT REST IN THE CENTER-OF-MASS SYSTEM. (SUCH PRODUCTION IS PREDICTED BY THE STATISTICAL MODEL.) INSTEAD, PARTICLES COME OUT IN TWO CLOUDS OR 'FIREBALLS' FOLLOWING THE TWO DEPARTING BARYONS. THESE FIREBALLS HAVE A MASS OF ABOUT 2100 MEV.

CLOSELY RELATED REFERENCES
SEE ALSO PHYS. REV. LETTERS 21, 830 (1968).
THIS ARTICLE SUPERSEDES CERN HADRON CONFERENCE 2 262 (1968).
CONTINUATION OF PREVIOUS EXPERIMENT IN PHYS. REV. LETTERS 18, 1218 (1967).

ADDITIONAL CITATIONS
NUOVO CIMENTO 31, 961 (1964), PHYS. REV. 137, B962 (1965), PHYS. REV. LETTERS 14, 504 (1965), PHYS. REV. LETTERS 16, 855 (1966), PHYS. REV. LETTERS 19, 198 (1967), UCRL 10022 (1961), CERN MPS/EP66-4 (1966), UCRL 16830, PHYS. REV. LETTERS 17, 1105 (1966), PHYS. REV. 159, 1138 (1967), PHYS. LETTERS 25B, 156 (1967), PHYS. REV. 135, B1456 (1964), PHYS. LETTERS 25B, 228 (1967), PHYS. REV. 128, 2392 (1962), ANNUAL REV. OF NUCLEAR SCIENCE 13, 261 (1963), ANL PAD RJL-2, ANL PAD RJL-3, ANL PAD RJL-5, ANL PAD RJL-6, CERN NP/INT66-2 (1966), CERN MPS/63-23 (1964), CERN NP 62-17 (1962), NUOVO CIMENTO 27, 203 (1963), NUOVO CIMENTO 27, 856 (1963), AND PHYS. REV. 7, 101 (1961).

ARTICLE READ BY LEROY PRICE IN 4/70, AND VERIFIED BY ODETTE BENARY.

BEAM IS PROTON ON PROTON AT 12.5 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - ANGULAR DISTRIBUTION FITS

COMPOUND KEY WORDS - FITS ANGULAR DISTRIBUTION

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* NO DATA PUNCHED FOR THIS ARTICLE *
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104 PARTICLE PRODUCTION AT HIGH TRANSVERSE MOMENTUM. (PHYS. REV. LETTERS 21, 830 (1968))

D.G.CRABB,J.L.DAY,A.D.KRISCH,M.T.LIN,M.L.MARSHAK (UNIV. OF MICHIGAN, ANN ARBOR, MICH., USA)
J.G.ASBURY,L.G.RATNER (ARGONNE NAT. LAB., ARGONNE, ILL., USA)
A.L.READ (NATIONAL ACCELERATOR LAB., BATAVIA, ILLINOIS)

ABSTRACT WE HAVE MEASURED (D**2-SIGMA/D-OMEGA DP), THE DIFFERENTIAL CROSS SECTION FOR THE PRODUCTION OF PI+- MESONS, AT HIGH P-PERPENDICULAR, IN 12.5-GEV/C PROTON-PROTON COLLISIONS. WE COVERED THE RANGE P-PERPENDICULAR-SQUARED = 1.0 - 6.0 (GEV/C)**2 AND THE CROSS SECTION APPEARS TO BREAK AT ABOUT 1.5 (GEV/C)**2. THUS, (D**2-SIGMA/D-OMEGA DP) APPEARS TO BE THE SUM OF TWO GAUSSIANS IN P-PERPENDICULAR.

CLOSELY RELATED REFERENCES
CONTINUATION OF PREVIOUS EXPERIMENT IN PHYS. REV. 166, 1353 (1968).

ADDITIONAL CITATIONS
PHYS. REV. LETTERS 17, 1105 (1966), PHYS. REV. 159, 1138 (1967), PHYS. LETTERS 25B, 156 (1967), PHYS. LETTERS 27B, 49 (1968), AND PHYS. REV. LETTERS 19, 1149 (1967).

ARTICLE READ BY LEROY PRICE IN 4/70, AND VERIFIED BY ODETTE BENARY.

BEAM IS PROTON ON PROTON AT 12.5 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - ANGULAR DISTRIBUTION FITS

COMPOUND KEY WORDS - FITS ANGULAR DISTRIBUTION

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* NO DATA PUNCHED FOR THIS ARTICLE *
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105 PRODUCTION OF K+ MESONS IN 2.85-AND 2.40-BEV PP COLLISIONS. (PHYS. REV. 168, 1495 (1968))

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E.J.SACHARIDIS, S.J.LINDENBAUM,S.OZAKI,L.C.L.YUAN (BROOKHAVEN NAT. LAB., UPTON, L.I., N. Y., USA)

ABSTRACT WE REPORT AN EXPERIMENTAL MEASUREMENT OF K+ MESON PRODUCTION IN PP COLLISIONS AT 2.85 AND 2.40 BEV. THE MOMENTUM SPECTRA OF THE K+ MESONS ARE GIVEN AT THE THREE LABORATORY ANGLES OF ZERO DEG. 17 DEG. AND 32 DEG. THE K+ MESONS WERE IDENTIFIED BY MOMENTUM AND VELOCITY USING DIFFERENTIAL CERENKOV COUNTERS WITH A COMBINED REJECTION OF THE ORDER OF 10**-6. IT IS SHOWN THAT THE PRODUCTION SPECTRA CAN BE ACCOUNTED FOR BY A ONE-MESON-EXCHANGE MECHANISM WITH THE INTRODUCTION OF APPROPRIATE CUTOFFS. AT THE HIGH-ENERGY LIMIT OF THE ZERO DEG. SPECTRUM, A CLEAR PEAK IS OBSERVED, WHICH IS ATTRIBUTED TO THE LOW-ENERGY LAMBDA-P INTERACTION IN THE K-LAMBDA-P FINAL STATE. NO OTHER ENHANCEMENTS OR PRONOUNCED EFFECTS DUE TO RESONANCES EITHER IN THE YP OR KY SYSTEM ARE OBSERVED.

CLOSELY RELATED REFERENCES
SEE ALSO PHYS. REV. 142, 918 (1966).
THIS ARTICLE SUPERSEDES PHYS. REV. LETTERS 14, 604 (1965).
CONTINUATION OF PREVIOUS EXPERIMENT IN PHYS. REV. 93, 1431 (1954), PHYS. REV. 103, 404 (1956), PHYS. REV. 105, 1931 (1957), AND PHYS. REV. 128, 2373 (1962).

ADDITIONAL CITATIONS
PHYS. REV. 123, 1465 (1961), PHYS. REV. 147, 922 (1966), PHYS. REV. 154, 1284 (1967), NUOVO CIMENTO SUPPLEMENT 24 453 (1962), NUCLEAR INSTRUMENTS AND METHODS 35, 301 (1965), BNL 711(T248), FORTSCHRITTE DER PHYSIK 9, 549 (1961), REVIEW OF SCIENTIFIC INSTRUMENTS 25, 1070 (1954), PHYS. REV. 107, 859 (1957), PHYS. REV. 128, 2392 (1962), PHYS. REV. 137, B962 (1965), PHYS. REV. 148, 1315 (1966), PHYS. REV. 101, 796 (1956), PHYS. LETTERS 21, 229 (1966), BERKELEY CONFERENCE ABS.9.A.6 (1967), BULL. AM. PHYS. SOC. 10, 717 (1965), UNIV. OF MARYLAND 469 (1965), PHYS. REV. 82, 738 (1951), ANNALS OF PHYSICS 19, 458 (1962), PHYS. REV. 131, 2239 (1963), PHYS. REV. LETTERS 11, 164 (1964), PHYS. REV. LETTERS 13, 484 (1964), PHYS. REV. LETTERS 13, 668 (1964), BULL. AM. PHYS. SOC. 12, 104 (1967), AND PHYS. REV. LETTERS 13, 282 (1964).

ARTICLE READ BY LEROY PRICE IN 4/70, AND VERIFIED BY ODETTE BENARY.

BEAM IS PROTON ON PROTON FROM 3.203 TO 3.670 GEV/C. (BEAM KINETIC ENERGY = 2.40 TO 2.85 GEV)

THIS EXPERIMENT USES COUNTERS.

KEY WORDS • ANGULAR DISTRIBUTION CROSS SECTION STRANGE PARTICLES

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* NO DATA PUNCHED FOR THIS ARTICLE *
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106 PROTON-NEUTRON TRIPLE SCATTERING AT 425 MEV. (PHYS. REV. 175, 1704 (1968))

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L.PONDROM,S.OLSEN,R.HANDLER (UNIV. OF WISCONSIN, MADISON, WISC., USA)

ABSTRACT THE PROTON-NEUTRON TRIPLE SCATTERING PARAMETERS P, D, R, AND A HAVE BEEN MEASURED AT LAB ANGLES OF 20 DEG, 30 DEG, AND 42 DEG, AT 425 MEV INCIDENT PROTON ENERGY. POLARIZED PROTONS WERE SCATTERED FROM NEUTRONS IN DEUTERIUM, AND THE FINAL PROTON POLARIZATION WAS MEASURED WITH A CARBON PLATE WIRE-SPARK-CHAMBER SYSTEM. THE RECOIL NEUTRONS WERE DETECTED. PP QUASIELASTIC SCATTERING FROM DEUTERIUM WAS ALSO STUDIED AT 30 DEG. AND 42 DEG. AS A CHECK ON THE IMPULSE APPROXIMATION.

CLOSELY RELATED REFERENCES
SEE ALSO PHYS. REV. 169, 1026 (1968), AND PHYS. REV. 140, 1533 (1965).

ADDITIONAL CITATIONS
UCRL 50426, PHYS. REV. 173, 1272 (1968), AND REV. MOD. PHYS. 39, 513 (1967).

ARTICLE READ BY LEROY PRICE IN 4/70, AND VERIFIED BY ODETTE BENARY.

BEAM IS PROTON ON DEUTERON AT .989 GEV/C. (BEAM KINETIC ENERGY = .425 GEV) (BEAM IS POLARIZED 54 PER CENT (NORMAL TO THE BEAM DIRECTION).

THIS EXPERIMENT USES SPARK CHAMBERS.

KEY WORDS • POLARIZATION

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* NO DATA PUNCHED FOR THIS ARTICLE *
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107 NP INELASTIC INTERACTIONS AT ENERGIES FROM 2 TO 10 GEV. III. STUDY OF N PI PI-COMBINATIONS IN THE REACTION NP+NP PI+ PI+ PI- PI- (M PIO) (JINR E1-3940 (1968))

V.I.MOROZ,A.V.NIKITIN,YU.A.TROYAN (JOINT INST. FOR NUCL. RESEARCH, DUBNA, USSR)

ABSTRACT 730 EVENTS OF THE TYPE NP+NP PI+ PI+ PI- PI- (M PIO) ORIGINATING IN A PROPANE BUBBLE CHAMBER IN AN EXPOSURE TO NEUTRONS WITH ENERGIES FROM 2 TO 10 GEV HAVE BEEN SELECTED. IT IS SEEN THAT THE EFFECTIVE MASS DISTRIBUTIONS OF P PI+ PI+,P PI+ PI- AND P PI- PI- COMBINATIONS ARE SATISFACTORILY EXPLAINED BY N*++(1236) AND N*-(1236) PRODUCTIONS.

CITATIONS
JINR P1-3145 (1967), NUC. PHYS. 47, 33 (1963), NUOVO CIMENTO 34, 1644 (1964), NUOVO CIMENTO 55, A66 (1968), PHYS. REV. 154, 287 (1967), AND PHYS. REV. 161, 1387 (1967).

ARTICLE READ BY LEROY PRICE IN 4/70, AND VERIFIED BY ODETTE BENARY.

BEAM IS NEUTRON ON HYDROGEN COMPOUND FROM 2.786 TO 10.900 GEV/C. (BEAM KINETIC ENERGY = 2 TO 10 GEV)

THIS EXPERIMENT USES THE DUBNA 24 LITER (HLBC) BUBBLE CHAMBER. A TOTAL OF 22000 PICTURES ARE REPORTED ON.

KEY WORDS • MASS SPECTRUM FITS

COMPOUND KEY WORDS • FITS MASS SPECTRUM

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* NO DATA PUNCHED FOR THIS ARTICLE *
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108 POLARIZATION AND DIFFERENTIAL CROSS SECTIONS IN PROTON-PROTON AND PROTON-NUCLEUS SCATTERINGS AT 725 MEV. (PHYS. REV. 137, 862C (1965))

P.G.MC MANIGAL,R.D.EANDI,S.N.KAPLAN,B.J.MOYER [U.C. LAWRENCE RAD. LAB., BERKELEY, CALIF., USA, AND UNIV. OF CALIFORNIA, BERKELEY, CALIF., USA]

ABSTRACT THE POLARIZATION AND ANGULAR DISTRIBUTION OF PROTONS SCATTERED FROM PROTONS, HELIUM, BERYLLIUM, CARBON, ALUMINUM, CALCIUM, IRON, AND TANTALUM WERE MEASURED AS FUNCTIONS OF ANGLE AT 725 MEV. A VARIATION OF THE USUAL DOUBLE-ELASTIC SCATTERING METHOD WAS USED, IN THAT THE SENSE OF THE FIRST SCATTERING ANGLE WAS REVERSED IN FINDING ASYMMETRIES, RATHER THAN THE SECOND ANGLE. ENERGY ANALYSIS OF THE SCATTERED BEAM WAS ACCOMPLISHED BY MEANS OF A 102-DEGREE MAGNETIC SPECTROMETER ALLOWING A TOTAL RESOLUTION OF +- 10 MEV. THE DATA WERE FITTED WITH AN OPTICAL MODEL. IN THE PROTON-NUCLEUS SCATTERING THE POLARIZATION REACHES A MAXIMUM VALUE OF ABOUT 40 PER CENT AT ANGLES LESS THAN THE DIFFRACTION MINIMUM. RESULTS IN PROTON-PROTON SCATTERINGS ARE MORE INTERESTING: HOWEVER, BECAUSE OF AN UNCERTAINTY IN THE ANALYZING POWER OF CARBON, A DEFINITE STATEMENT CANNOT BE MADE. ONE CAN SAY, HOWEVER, THAT EITHER THE POLARIZATION IN PROTON-PROTON SCATTERINGS IS ABOVE 50 PER CENT AT THIS ENERGY OR THE ANALYZING POWER OF CARBON AT 6 DEG AND 600 MEV IS MORE THAN 40 PER CENT, WHICH IS CONSIDERABLY GREATER THAN THE 30 PER CENT MEASURED AT 725 MEV.

CLOSELY RELATED REFERENCES
DATA SUPERSEDED BY PHYS. REV. 148, 128C (1966).

ADDITIONAL CITATIONS
PHYS. REV. 75, 1352 (1949), NUOVO CIMENTO 11, 407 (1954), PROGR. NUCL. PHYS. 8 47 (1960), PHYS. REV. 102, 1659 (1956), NUC. PHYS. 23, 562 (1961), UCRL 10637 (1963), JETP 4 337 (1957), NUC. PHYS. 3, 185 (1957), PHYS. REV. 104, 449 (1956), PHYS. REV. 106, 1271 (1957), JETP 35 64 (1959), NUC. PHYS. 43, 213 (1963), NUC. PHYS. 25, 642 (1961), PHYS. REV. 124, 890 (1961), PHYS. REV. 105, 288 (1957), PHYS. REV. 95, 1694 (1954), NUOVO CIMENTO 23, 690 (1962), PHYS. REV. 102, 1157 (1956), ANNUAL REV. OF NUCLEAR SCIENCE 7, 231 (1957), ANNUAL REV. OF NUCLEAR SCIENCE 8, 49 (1958), SOVIET PHYSICS DOKLADY 1, 607 (1956), JETP 2 349 (1956), AND NUOVO CIMENTO 6, 235 (1957).

ARTICLE READ BY LEROY PRICE IN 4/70, AND VERIFIED BY ODETTE BENARY.

BEAM IS PROTON ON PROTON AT 7.25 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS • POLARIZATION

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* NO DATA PUNCHED FOR THIS ARTICLE *

109 EXCHANGE MECHANISM FOR THE REACTION PN•DELTA++ DELTA-. (PHYS. LETTERS 26B, 598 (1968))

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ABSTRACT IN THE REACTION PN • PN PI+ PI- WE HAVE OBSERVED COPIOUS DELTA++ AND DELTA- PRODUCTION AT FOUR-MOMENTUM TRANSFERS GREATER THAN 100 PION MASS-SQUARED EVEN WHEN RESTRICTION WAS MADE TO THE DOUBLE ISOBAR OVERLAP REGION. SUCH BEHAVIOR IS NOT OBSERVED IN THE ANALOGUE PP AND PBAR P REACTIONS AND STRONGLY SUGGESTS THE IMPORTANCE OF A MECHANISM IN ADDITION TO ONE PION EXCHANGE.

CITATIONS
PHYS. REV. 136, B843 (1964), PHYS. REV. 138, B1528 (1965), PHYS. REV. 154, 1264 (1967), PHYS. REV. LETTERS 19, 397 (1967), PHYS. REV. 17, 884 (1966), PHYS. REV. 161, 1387 (1967), UCRL 16170, AND BULL. AM. PHYS. SOC. 11, 841 (1966).

ARTICLE READ BY LEROY PRICE IN 4/70, AND VERIFIED BY ODETTE BENARY.

BEAM IS PROTON ON PROTON AT 2.7 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 20 IN. (H) BUBBLE CHAMBER. A TOTAL OF 30000 PICTURES ARE REPORTED ON.

KEY WORDS • CROSS SECTION DELTA(1238) MASS SPECTRUM MOMENTUM TRANSFER

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* NO DATA PUNCHED FOR THIS ARTICLE *

110 DOUBLE-REGGE-POLE MODEL ANALYSIS OF PP • DELTA++ P PI- AT 6.6 GEV/C. (PHYS. REV. LETTERS 20, 964 (1968))

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E.GELLERT,G.A.SMITH [U.C. LAWRENCE RAD. LAB., BERKELEY, CALIF., USA, AND UNIV. OF CALIFORNIA, BERKELEY, CALIF., USA]
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ABSTRACT REASONABLE FITS TO INVARIANT-MASS, MOMENTUM-TRANSFER, AND TREIMAN-YANG ANGLE DISTRIBUTIONS FOR THE REACTION PP • DELTA++ P PI- AT 6.6 GEV/C ARE OBTAINED FROM A DOUBLE-REGGE POLE MODEL WITH PION EXCHANGE.

CLOSELY RELATED REFERENCES
SEE ALSO UCLA 1025 (1968).
THIS ARTICLE SUPERSEDES PHYS. REV. LETTERS 17, 884 (1966).

ADDITIONAL CITATIONS
PHYS. REV. LETTERS 19, 614 (1967), PHYS. REV. 163, 1572 (1967), NUOVO CIMENTO 49A, 157 (1967), NUOVO CIMENTO 51A, 696 (1967), PHYS. REV. 160, 1322 (1967), PHYS. REV. 160, 1326 (1967), PHYS. REV. 166, 1525 (1968), PHYS. REV. 138, B190 (1965), PHYS. REV. LETTERS 15, 468 (1965), PHYS. REV. 163, 1603 (1967), PHYS. REV. 166, 1768 (1968), AND PHYS. REV. LETTERS 20, 628 (1968).

ARTICLE READ BY LEROY PRICE IN 4/70, AND VERIFIED BY ODETTE BENARY.

BEAM IS PROTON ON PROTON AT 6.6 GEV/C.

THIS EXPERIMENT USES THE L.R.L. 72 IN. (H) BUBBLE CHAMBER.

KEY WORDS • ANGULAR DISTRIBUTION FITS MASS SPECTRUM DELTA(1238) MODELS

COMPOUND KEY WORDS • FITS ANGULAR DISTRIBUTION

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* NO DATA PUNCHED FOR THIS ARTICLE *

111 FORWARD DIFFERENTIAL CROSS SECTIONS FOR THE REACTION PP → D PI+ IN THE RANGE 3.4 TO 12.3 GEV/C. (PHYS. REV. LETTERS 21, 853 (1968))

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C.K.HARGROVE,E.P.HINCKS (NATIONAL RESEARCH COUNCIL, OTTAWA, CANADA)
S.FUKUI (NAGOYA UNIVERSITY, NAGOYA, JAPAN)

ABSTRACT A SPARK-CHAMBER MISSING-MASS SPECTROMETER WAS USED TO MEASURE THE DIFFERENTIAL CROSS SECTION FOR THE REACTION PP → D PI+ AT CLOSELY SPACED INTERVALS OF INCIDENT MOMENTUM BETWEEN 3.4 AND 12.3 GEV/C AND AT SMALL C.M. ANGLE. THE DATA CONFIRM THE EXISTENCE OF A PROMINENT PEAK IN THE FORWARD CROSS SECTION AT E(C.M.) APPROXIMATELY = 2.9 GEV AND SHOW A HITHERTO UNREPORTED SHOULDER AT E(C.M.) = 3.6 GEV. THE RESULTS MAKE EVIDENT THE INADEQUACIES OF PRESENT ONE-PION-EXCHANGE AND ONE-NUCLEON-EXCHANGE MODELS.

CITATIONS
DOKL. AKAD. NAUK. SSSR 100 673 (1955), DOKL. AKAD. NAUK. SSSR 100 677 (1955), ZURN. EKSP. TEOR. FIZ. 34, 767 (1958), PHYS. REV. LETTERS 11, 474 (1963), PHYS. LETTERS 7, 222 (1963), PHYS. REV. LETTERS 13, 59 (1964), PHYS. REV. 167, 1232 (1968), PHYS. LETTERS 11, 161 (1964), PHYS. LETTERS 22, 708 (1966), PHYS. REV. LETTERS 17, 100 (1966), PHYS. REV. 142, 918 (1966), REVIEW OF SCIENTIFIC INSTRUMENTS 35, 492 (1964), INT.CONF. ON NUCLEAR STRUCTURE,STANFORD UNIV. 63 (1966), PHYS. REV. LETTERS 18, 89 (1967), NUC. PHYS. 76, 123 (1966), PROC. OF THE ROYAL SOCIETY OF LONDON A244, 491 (1958), PHYS. REV. 130, 2407 (1963), PHYS. REV. 134, B454 (1964), PHYS. REV. LETTERS 20, 607 (1968), PHYS. REV. LETTERS 16, 709 (1966), AND NUOVO CIMENTO 55A, 346 (1968).

ARTICLE READ BY LEROY PRICE IN 4/70, AND VERIFIED BY ODETTE BENARY.

BEAM IS PROTON ON PROTON FROM 3.4 TO 12.3 GEV/C.

THIS EXPERIMENT USES SPARK CHAMBERS.

KEY WORDS • DIFFERENTIAL CROSS SECTION

DIFFERENTIAL CROSS SECTION (AT FIXED ANGLE OR T) FOR PROTON PROTON → DEUTERON PI+. (FIGURE 3)

DATA IS AVERAGED OVER COS(THETA) FROM .99 TO 1.00. THETA IS THE ANGLE THAT THE DEUTERON MAKES WITH THE BEAM IN THE GRAND C.M.

. THIS DATA WAS READ FROM A GRAPH .

LABORATORY BEAM MOMENTUM GEV/C	D-SIGMA/D-OMEGA UB/SR (1)
3.2	11.0 +- .1
3.3	15.0 .1
3.5	14.0 .1
3.8	11.0 .1
4.0	10.5 .1
4.3	7.0 .1
4.6	4.8 .1
4.8	4.0 .1
5.0	3.5 .1
5.1	3.0 .1
5.3	2.8 .1
5.5	2.6 .1
5.8	2.5 .1
6.0	2.6 .1
6.1	2.5 .1
6.2	2.6 .1
6.3	2.3 .1
6.8	2.0 .1
7.1	1.7 .1
7.3	1.8 .1
7.6	1.6 .1
7.9	1.4 .1
8.4	1.1 .1
9.0	.9 .1
9.5	.8 .1
10.5	.6 .1
11.0	.5 .1
11.5	.5 .1
12.3	.4 .1

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5 PER CENT.

112 MEASUREMENT OF PP → PI+ D AT 90 DEG. AND 5 GEV/C. (PHYS. REV. 165, 1442 (1968))

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L.G.RATNER (ARGONNE NAT. LAB., ARGONNE, ILL., USA)
K.W.EDWARDS (UNIV. OF IOWA, IOWA CITY, IOWA, USA)
C.W.AKERLOF,R.H.HIEBER, A.C.KRISCH (UNIV. OF MICHIGAN, ANN ARBOR, MICH., USA)

ABSTRACT THE DIFFERENTIAL CROSS SECTION FOR THE PROCESS PP → PI+ D WAS MEASURED AT 5.0 GEV/C FOR A CENTER-OF-MASS ANGLE OF 90 DEG. THE EXPERIMENT WAS DONE ON THE ARGONNE ZGS WITH THE SAME APPARATUS AS WAS USED IN A RECENT 90 DEG. PROTON-PROTON ELASTIC SCATTERING EXPERIMENT. THE EXTRACTED PROTON BEAM OF THE ZGS WAS MADE TO IMPINGE UPON A CH(2) TARGET. THE PION AND DEUTERON WERE DETECTED BY TWO SPECTROMETERS, EACH CONTAINING MAGNETS AND A SCINTILLATION-COUNTER TELESCOPE, IN COINCIDENCE. THE INCIDENT BEAM FLUX WAS MEASURED BY A RADIOCHEMICAL ANALYSIS OF THE CH(2) TARGET. THE 90 DEG. CROSS SECTION AT 5.0 GEV/C WAS FOUND TO BE 35 +- 9 NB/SR.

CITATIONS
PHYS. REV. 159, 1138 (1967), PHYS. LETTERS 7, 222 (1963), PHYS. REV. LETTERS 11, 474 (1963), DOKL. AKAD. NAUK. SSSR 100 673 (1955), PHYS. REV. LETTERS 13, 59 (1964), PHYS. REV. 136, B779 (1964), PHYS. REV. LETTERS 18, 1218 (1967), PHYS. REV. 128, 2392 (1962), ANNUAL REV. OF NUCLEAR SCIENCE 13, 261 (1963), PHYS. REV. LETTERS 11, 217 (1963), PHYS. REV. 135, B1456 (1964), AND PHYS. REV. LETTERS 17, 1105 (1966).

ARTICLE READ BY LEROY PRICE IN 4/70, AND VERIFIED BY ODETTE BENARY.

BEAM IS PROTON ON PROTON AT 5 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS • DIFFERENTIAL CROSS SECTION

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → DEUTERON PI+. (PAGE 1444)

LABORATORY BEAM MOMENTUM = 5.000 +- .005 GEV/C.

THETA DEGREES	D-SIGMA/D-OMEGA NANOBARNS/SR
90.	35. +- 9.

THETA IS THE ANGLE THAT THE DEUTERON MAKES WITH THE BEAM IN THE GRAND C.M.

113 SMALL-ANGLE DP ELASTIC SCATTERING AT 1.69 GEV/C. [NUC. PHYS. B9, 594 (1969)]

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ABSTRACT THE DIFFERENTIAL CROSS SECTION FOR ELASTIC DP SCATTERING WAS MEASURED OVER THE ANGULAR RANGE 18-70 MRAD. THESE DATA WHEN ANALYSED GAVE A VALUE OF 0.05 +- 0.20 FOR THE RATIO OF THE REAL TO IMAGINARY PARTS OF THE SPIN INDEPENDENT NP SCATTERING AMPLITUDE AT 0.845 GEV/C, IN GOOD AGREEMENT WITH THE PREDICTIONS OF FORWARD NN DISPERSION RELATIONS.

CLOSELY RELATED REFERENCES
SEE ALSO NUCLEAR INSTRUMENTS 55, 80 (1967), PHYS. REV. LETTERS 21, 1416 (1968), AND PHYS. LETTERS 25B, 245 (1967).

ADDITIONAL CITATIONS
PHYS. REV. 135, B358 (1964), NUC. PHYS. 7, 113 (1958), REV. MOD. PHYS. 30, 368 (1958), PHYS. REV. 95, 1350 (1954), PHYS. REV. 139, B362 (1965), PHYS. LETTERS 8, 285 (1964), PROC. OF THE ROYAL SOCIETY OF LONDON 63A, 595 (1950), PHYS. LETTERS 20, 203 (1966), JETP 19 542 (1964), NUOVO CIMENTO 40, 167 (1966), PHYS. LETTERS 19, 341 (1965), AND PHYS. REV. 102, 473 (1956).

ARTICLE READ BY LEROY PRICE IN 4/70, AND VERIFIED BY ODETTE BENARY.

BEAM IS DEUTERON ON PROTON AT 1.69 GEV/C.

THIS EXPERIMENT USES SPARK CHAMBERS.

KEY WORDS - REAL (AMPLITUDE)/IMAGINARY (AMPLITUDE) ANGULAR DISTRIBUTION

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ELASTIC DIFFERENTIAL CROSS SECTION FOR DEUTERON PROTON. [TABLE 1]

LABORATORY BEAM MOMENTUM = 1.69 +- .05 GEV/C.

THETA MR	D-SIGMA/D-OMEGA MB/SR	
18.5	349. +-	68.
20.5	431.	58.
22.5	444.	56.
24.5	275.	44.
26.5	207.	37.
28.5	197.	34.
30.5	104.	29.
32.5	163.	28.
34.5	164.	26.
36.5	177.	24.
38.5	139.	23.
40.5	106.	24.
42.5	150.	22.
44.5	142.	21.
46.5	142.	20.
48.5	160.	20.
50.5	140.	19.
52.5	140.	19.
54.5	141.	18.
56.5	131.	18.
58.5	146.	19.
60.5	125.	17.
62.5	111.	17.
64.5	121.	16.
66.5	89.	15.
68.5	107.	15.
70.5	127.	15.

THETA IS THE ANGLE THAT THE DEUTERON MAKES WITH THE BEAM IN THE GRAND C.M.

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THE RE/IM RATIO FOR THE FORWARD ELASTIC AMPLITUDE FOR NEUTRON PROTON. [PAGE 600]

(THIS IS THE VALUE OBTAINED FOR THE BEST FIT WITH BETA (SPIN DEPENDANT PART) NOT IDENTICALLY EQUAL TO ZERO.)

LABORATORY BEAM MOMENTUM GEV/C	ALPHA
.85	.05 +- .20

114 ISOTOPIC SPIN DEPENDENCE OF NUCLEON-NUCLEON CROSS-SECTIONS BETWEEN 600 AND 1000 MEV. [NUOVO CIMENTO 21, 581 (1961)]

G.MARTELLI,H.B.VAN DER RAAY,R.RUBINSTEIN,K.R.CHAPMAN,J.D.DOWELL,W.R.FRISKEN, B.MUSGRAVE,D.H.READING [BIRMINGHAM UNIV., BIRMINGHAM, ENGLAND]

ABSTRACT THE RATIO OF THE DIFFERENTIAL CROSS-SECTION FOR PP AND PN SCATTERING AT 90 DEG. IN THE C.M.S HAS BEEN MEASURED AT THREE DIFFERENT ENERGIES, BETWEEN 600 MEV AND 1000 MEV, USING FAST SCINTILLATION COUNTERS IN CONJUNCTION WITH MAGNETIC MOMENTUM ANALYSIS. THE VALUE OF THIS RATIO DECREASES MARKEDLY WITH INCREASING ENERGY, FROM 3.04 +- 0.56 AT 595 MEV, TO 1.00 +- 0.18 AT 775 MEV AND TO 0.683 +- 0.097 AT 1010 MEV, SHOWING AN ENHANCEMENT OF THE SCATTERING AMPLITUDE IN THE T=0 STATE ABOVE 600 MEV. IT IS SHOWN HOW THIS BEHAVIOUR MAY BE RELATED TO THE SECOND RESONANCE IN PI P SCATTERING.

CITATIONS
REV. MOD. PHYS. 30, 560 (1958), ZURN. EKSP. TEOR. FIZ. 37, 1307 (1959), NUCLEAR INSTRUMENTS AND METHODS 7, 225 (1960), PHYS. REV. 97, 1186 (1955), NUOVO CIMENTO 18, 818 (1960), ZURN. EKSP. TEOR. FIZ. 31, 169 (1956), ZURN. EKSP. TEOR. FIZ. 32, 440 (1957), CERN CONFERENCE 2 115 (1956), PROC. OF THE ROYAL SOCIETY OF LONDON A251, 233 (1959), PHYS. REV. 118, 325 (1960), AND CERN CONFERENCE 2 195 (1956).

ARTICLE READ BY LEROY PRICE IN 4/70, AND VERIFIED BY ODETTE BENARY.

BEAM IS PROTON ON HYDROGEN COMPOUND FROM 1.219 TO 1.696 GEV/C. (BEAM KINETIC ENERGY = .6 TO 1.0 GEV)

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - ANGULAR DISTRIBUTION

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* NO DATA PUNCHED FOR THIS ARTICLE *
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115 DIFFRACTION-LIKE STRUCTURE IN ELASTIC PROTON-PROTON SCATTERING AT LARGE MOMENTUM TRANSFERS. (PHYS. LETTERS 27B, 49 (1968))

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ABSTRACT MEASUREMENTS OF WIDE ANGLE ELASTIC PP SCATTERING BETWEEN 7 AND 12 GEV/C ARE REPORTED. STRUCTURE FOUND IN THE ANGULAR DISTRIBUTIONS IS SUGGESTIVE OF DIFFRACTION.

CLOSELY RELATED REFERENCES
SEE ALSO CERN HADRON CONFERENCE 1 580 (1968).
CONTINUATION OF PREVIOUS EXPERIMENT IN PHYS. LETTERS 25B, 156 (1967).

ADDITIONAL CITATIONS
PHYS. REV. LETTERS 17, 1105 (1966), PHYS. REV. 159, 1138 (1967), ANNUAL REV. OF NUCLEAR SCIENCE 13, 261 (1963), BNL 11360 (1967), UCRL 16275 (1966), UCRL 17257 (1966), PHYS. REV. LETTERS 11, 425 (1963), PHYS. REV. LETTERS 15, 45 (1965), NUOVO CIMENTO 38, 60 (1965), PHYS. REV. LETTERS 9, 111 (1962), PHYS. REV. 138, B165 (1965), PHYS. REV. 152, 1162 (1966), PHYS. LETTERS 13, 190 (1964), PHYS. REV. LETTERS 19, 1149 (1967), PHYS. REV. LETTERS 10, 357 (1963), REV. MOD. PHYS. 36, 649 (1964), PHYS. REV. LETTERS 20, 637 (1968), PHYS. REV. 137, B708 (1965), AND PHYS. LETTERS 25B, 228 (1967).

ARTICLE READ BY LEROY PRICE IN 4/70, AND VERIFIED BY ODETTE BENARY.

BEAM IS PROTON ON PROTON FROM 8.1 TO 12.1 GEV/C.

THIS EXPERIMENT USES COUNTERS.

GENERAL COMMENTS ON THIS ARTICLE
1 DATA IN THIS ARTICLE IS IN GRAPHICAL FORM ONLY. FOR TABULAR DATA SEE ALLABY ET AL., CERN HADRON CONFERENCE, VOL 1, P 580 (1968).

KEY WORDS * DIFFERENTIAL CROSS SECTION

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* NO DATA PUNCHED FOR THIS ARTICLE *
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116 SEARCH FOR THE RESONANCE 'SMALL DELTA'+, OF MASS 960 MEV IN THE REACTION PP * D DELTA+. (PHYS. LETTERS 25B, 569 (1967))

M.BANNER,J.CHEZE,J.L.HAMEL,G.MAREL,J.TEIGER,J.ZSEMBERY (CNTR. D'ETUDES NUC. SACLAY, GIF-SUR-YVETTE, FRANCE)
P.CHAVANON, M.CROZON,L.K.RANGAN (COLLEGE DE FRANCE, PARIS, FRANCE)

ABSTRACT A MISSING MASS EXPERIMENT OF THE REACTION PP * D DELTA+ SHOWS NO EVIDENCE FOR THE EXISTENCE OF A BOSON AROUND 960 MEV.

CITATIONS
PHYS. REV. LETTERS 17, 890 (1966), PHYS. LETTERS 22, 708 (1966), PHYS. LETTERS 25B, 300 (1967), AND PHYS. LETTERS 11, 161 (1964).

ARTICLE READ BY LEROY PRICE IN 4/70, AND VERIFIED BY ODETTE BENARY.

BEAM IS PROTON ON PROTON AT 3.8 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS * MASS SPECTRUM

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* NO DATA PUNCHED FOR THIS ARTICLE *
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117 THE STUDY OF 28.6 GEV/C PP INTERACTIONS WITH 6 CHARGED PARTICLES IN THE FINAL STATES. (CERN HADRON CONFERENCE 2 208 (1968))

P.L.CONNOLLY,I.R.KENYON,T.W.MORRIS,A.M.THORNDIKE (BROOKHAVEN NAT. LAB., UPTON, L.I., N. Y., USA)

ABSTRACT RESULTS FROM A STUDY OF HIGH-MULTIPLICITY HIGH-ENERGY PP INTERACTIONS AT 28.6 GEV/C IN A HYDROGEN BUBBLE CHAMBER ARE DESCRIBED. THE MEASUREMENTS OF 29500 PICTURES YIELDED 5230 WELL-RECONSTRUCTED EVENTS. MASS DISTRIBUTIONS ARE SHOWN FROM WHICH THE DOMINANCE OF DELTA(1236) IS NOTED. ALSO CONSIDERABLE ENHANCEMENT APPEARS FROM 1440 TO 1760 GEV WHICH IS NOT INCONSISTENT WITH THE KNOWN LARGE DECAY RATES OF THE N(1525) AND N(1670). THE 1-CONSTRAINT FITS SHOW THE PRESENCE OF OMEGA PRODUCTION IN THE REACTION PP * 2P 2PI+ 2PI- PIO. IT IS OBSERVED THAT THE REACTION PP * 2P 2PI+ 2PI- SHOWS SEVERAL SIMPLE FEATURES WHICH ARE CONSISTENT WITH DOMINANCE OF THE REACTION BY DIFFRACTION DISSOCIATION OF THE PROTONS. BUT THIS DOMINANCE IS NOT ESTABLISHED BY THESE FEATURES.

CLOSELY RELATED REFERENCES
SEE ALSO BNL 11993 (1967).

ADDITIONAL CITATIONS
PHYS. REV. LETTERS 16, 855 (1966), PHYS. LETTERS 12, 57 (1964), USAEC REPORT UC34ID4500 (1967), PHYS. REV. 120, 1857 (1960), AND PHYS. REV. LETTERS 7, 199 (1961).

ARTICLE READ BY LEROY PRICE IN 4/70, AND VERIFIED BY ODETTE BENARY.

BEAM IS PROTON ON PROTON AT 28.6 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 80 IN. (H) BUBBLE CHAMBER.

GENERAL COMMENTS ON THIS ARTICLE
1 THIS IS THE SAME AS BNL-11993.

KEY WORDS * CROSS SECTION MASS SPECTRUM N*(1236)

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* NO DATA PUNCHED FOR THIS ARTICLE *
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118 ELASTIC PP SCATTERING AT 1.45 BEV. (SOVIET JNP 1 225 (1965))

S.P.KRUCHININ,K.N.MUKHIN,A.S.ROMANISEVA,I.A.SVETLOLOBOV,M.M.SULKOVSKAYA, S.A.CHUEVA,R.S.SHLYAPNIKOV (JOINT INST. FOR NUCL. RESEARCH, DUBNA, USSR)

ABSTRACT ELASTIC PP SCATTERING AT 1.45 BEV HAS BEEN INVESTIGATED WITH THE HELP OF A PROPANE BUBBLE CHAMBER WITH A PULSED MAGNETIC FIELD. THE DIFFERENTIAL CROSS SECTION HAS BEEN OBTAINED OVER THE ENTIRE ANGULAR REGION ZERO DEG. TO 90 DEG. (C.M.S). THE RESULTS ARE COMPARED WITH OPTICAL-MODEL PREDICTIONS AND OPTIMAL VALUES OF THE PARAMETERS ARE OBTAINED. IT IS SHOWN THAT THE EXPERIMENTAL DEPENDENCE OF D-SIGMA/D-OMEGA ON P-PERPENDICULAR OBTAINED FOR LARGE P-PERPENDICULAR IS WELL APPROXIMATED BY THE EXPONENTIAL DEPENDENCE SUGGESTED BY OREAR D-SIGMA/D-OMEGA APPROXIMATELY EXP (-P-PERPENDICULAR/PO). IT IS NOTED THAT THE BEST AGREEMENT WITH THE EXPONENTIAL APPROXIMATION IS OBTAINED FOR C.M.S SCATTERING ANGLES OF CHI = 90 DEG. WHEN P-PERPENDICULAR = P C.M.S. IN THIS CASE (CHI = 90 DEG.) WE HAVE D-SIGMA/D-OMEGA = A EXP(-P C.M.S/PO). A = 115 MB/SR, PO = 143 MEV/C, AND THE EXTRAPOLATION IS CORRECT FOR ALL KNOWN DATA ON ELASTIC PP SCATTERING IN THE ENERGY REGION 0.38 - 30.9 BEV.

CITATIONS
PHYS. REV. 103, 1484 (1956), PHYS. REV. 128, 1836 (1962), CERN CONFERENCE 514 (1959), PRIBORI I TECH TECH. EXP. 6 48 (1963), PHYS. REV. 87, 425 (1952), PHYS. REV. 130, 762 (1963), PHYS. REV. 104, 221 (1956), PHYS. REV. 125, 701 (1962) JINR E-1802 (1964), PHYS. REV. 75, 1352 (1949), PHYS. REV. 107, 859 (1957), PHYS. REV. 125, 2082 (1962), PHYS. REV. 123, 2160 (1961), PHYS. REV. LETTERS 12, 112 (1964), REV. MOD. PHYS. 30, 368 (1958), AND PHYS. REV. LETTERS 11, 499 (1963).

ARTICLE READ BY LEROY PRICE IN 4/70, AND VERIFIED BY ODETTE BENARY.

BEAM NO. 1 IS PI+ ON HYDROGEN COMPOUND AT 2.2 GEV/C.
NO. 2 IS PROTON ON HYDROGEN COMPOUND AT 2.2 GEV/C.

THIS EXPERIMENT USES THE DUBNA 1/2 METER BUBBLE CHAMBER. A TOTAL OF 17000 PICTURES ARE REPORTED ON.

KEY WORDS • ANGULAR DISTRIBUTION FITS

COMPOUND KEY WORDS • FITS ANGULAR DISTRIBUTION

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* NO DATA PUNCHED FOR THIS ARTICLE *

119 THE FINAL STATE P D PI+ PI- IN PD INTERACTIONS AT ABOUT 2 GEV/C. (PHYS. LETTERS 26B, 317 (1968))

D.C.BRUNT,M.J.CLAYTON,B.A.WESTWOOD (CAVENDISH LAB., CAMB. UNIV., CAMBRIDGE, ENGLAND)

ABSTRACT RESULTS ARE PRESENTED ON 265 EXAMPLES OF THE FINAL STATE P D PI+ PI-. IT IS SHOWN THAT A LARGE NUMBER OF THE EVENTS INVOLVE BARYON EXCHANGE. EVIDENCE IS ALSO PRESENTED FOR A D PI RESONANCE OF MASS 2130 MEV AND WIDTH 50 MEV.

CLOSELY RELATED REFERENCES
DATA SUPERSEDED BY PHYS. REV. 187, 1856 (1969).

ADDITIONAL CITATIONS
JETP 7 528 (1958), PHYS. REV. LETTERS 11, 474 (1963), PHYS. REV. LETTERS 15, 125 (1965), PHYS. LETTERS 19, 68 (1965), AND PHYS. LETTERS 19, 526 (1965).

ARTICLE READ BY LEROY PRICE IN 4/70, AND VERIFIED BY ODETTE BENARY.

BEAM IS PROTON ON DEUTERON FROM 1.825 TO 2.110 GEV/C.

THIS EXPERIMENT USES THE SACLAY 180 LITER BUBBLE CHAMBER. A TOTAL OF 65000 PICTURES ARE REPORTED ON.

KEY WORDS • CROSS SECTION NON-STRANGE DIBARYON AT 2130 MEV. MASS SPECTRUM

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CROSS SECTION FOR PROTON DEUTERON • PROTON DEUTERON PI+ PI-. (TABLE 1)

(THIS DATA SHOULD NOT BE USED - A MORE RECENT VALUE MAY BE FOUND IN BRUNT ET AL., PHYS. REV. 187, 1856 (1969))

LABORATORY BEAM MOMENTUM GEV/C	MICRO-BARNS	NO. EVENTS
1.825 +- .045	125. +- 30.	75
2.110 .045	170. 30.	100

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CROSS SECTION FOR PROTON DEUTERON • PROTON DEUTERON PI+ PI- PI0 + NEUTRON DEUTERON PI+ PI+ PI-. (TABLE 1)

LABORATORY BEAM MOMENTUM GEV/C	MICRO-BARNS	NO. EVENTS
1.825 +- .045	3. +- 2.	2
2.110 .045	25. 5.	14

120 PROTON-PROTON INTERACTIONS AT 6 GEV/C. (NUOVO CIMENTO 55A, 66 (1968))

C.CASO,F.CONTE,G.TOMASINI (UNIV. DI GENOVA, GENOVA, ITALY)
L.CASE,L.MOSCA,S.RATTI,L.TALLONE-LOMBARDI (UNIV. DI MILANO, MILANO, ITALY)
I.BLOODWORTH,L.LYONS,A.NORTON (OXFORD UNIV., OXFORD, ENGLAND)

ABSTRACT ABOUT 5500 EVENTS WITH FOUR CHARGED SECONDARIES AND 900 EVENTS WITH TWO CHARGED SECONDARIES PLUS NEUTRAL STRANGE PARTICLES HAVE BEEN ANALYSED IN THE 1.5M HYDROGEN BUBBLE CHAMBER, EXPOSED TO A PROTON BEAM OF 6 GEV/C INCIDENT MOMENTUM. CROSS-SECTIONS FOR THE VARIOUS CHANNELS ARE REPORTED AND COMPARED WITH SIMILAR RESULTS OF OTHER ENERGIES. THE CONTRIBUTION OF THE VARIOUS (N PI) AND (N PI PI) ISOBARS TO THE MULTIPION FINAL STATES HAS BEEN ESTIMATED, TAKING INTO ACCOUNT THE PERIPHERAL CHARACTER OF THE INTERACTION TO EVALUATE THE BACKGROUND. ALL REACTIONS ARE STRONGLY DOMINATED BY THE PRODUCTION OF THE N*(1236) ISOBAR, WITH A TOTAL CROSS-SECTION (6.6 +- 0.6) MB. IN THE PP PI+ PI- CHANNEL, THE N*++(1236) IS PRODUCED IN 40 PER CENT OF THE CASES IN ASSOCIATION WITH ONE OF THE N*0(1236), N*0(1512), OR N*0(1688) ISOBARS, YIELDING FOR THIS CHANNEL A TOTAL CROSS-SECTION FOR DOUBLE ISOBAR PRODUCTION (1.1 +- 0.2) MB. DOUBLE ISOBAR PRODUCTION DOES NOT SEEM TO BE IMPORTANT IN THE 5-BODY CHANNELS. AMONG BOSON RESONANCES, THERE IS EVIDENCE FOR OMEGA (WITH A TOTAL CROSS SECTION OF(0.18 +- 0.05) MB) AND ETA (WITH A TOTAL CROSS SECTION OF (0.07 +- 0.05) MB) PRODUCTION, AND AN UPPER LIMIT OF 250 MICROBARNS HAS BEEN SET FOR RHO PRODUCTION. THERE IS NO SIGNIFICANT EVIDENCE FOR THE I = 5/2 P PI+ PI+ ISOBAR. STRONG PERIPHERALITY OF THE INTERACTION, AND ABUNDANT PRODUCTION OF Y(1385) IS REPORTED IN THE STRANGE PARTICLE EVENTS.

CLOSELY RELATED REFERENCES
ANALYSIS OF THIS DATA IN NUC. PHYS. B8, 686 (1968).

ADDITIONAL CITATIONS
NUOVO CIMENTO 27, 1450 (1963), PHYS. REV. 137, B1530 (1965), NUOVO CIMENTO 33, 906 (1964), PHYS. REV. 123, 333 (1961) , NUOVO CIMENTO 24, 453 (1962), PHYS. REV. 125, 1703 (1962), PHYS. REV. 139, B646 (1965), PHYS. REV. 139, B428 (1965), NUOVO CIMENTO 31, 360 (1964), NUOVO CIMENTO 15, 652 (1960), PHYS. REV. 120, 988 (1960), PHYS. REV. 125, 1048 (1962), PHYS. REV. 146, 1031 (1966), PHYS. REV. 131, 2239 (1963), NUOVO CIMENTO 34, 1167 (1964), PHYS. REV. LETTERS 15, 207 (1965), PHYS. LETTERS 11, 164 (1964), PHYS. LETTERS 16, 75 (1965), PHYS. REV. 142, 918 (1966), PHYS. REV. LETTERS 17, 100 (1966), CERN TC/02/63-3, NUOVO CIMENTO 49A, 479 (1967), CERN 60-33, CERN 61-29, PHYS. REV. 138, B670 (1965), PHYS. REV. 125, 2091 (1962), PHYS. REV. 126, 747 (1962), PHYS. REV. 147, 922 (1966), PHYS. REV. 154, 1284 (1967), BULL. AM. PHYS. SOC. 12, 10 (1967), BULL. AM. PHYS. SOC. 11, 360 (1966), BULL. AM. PHYS. SOC. 12, 45 (1967), NUOVO CIMENTO 50A, 1000 (1967), PHYS. REV. LETTERS 16, 855 (1966), PHYS. LETTERS 22, 226 (1966), PHYS. LETTERS 22, 528 (1966), NUOVO CIMENTO 47A, 232 (1967), PHYS. REV. LETTERS 17, 884 (1966), NUOVO CIMENTO 43A, 1210 (1966), CERN 66-18, CERN 1320/5-TH (1965), NUOVO CIMENTO 46B, 438 (1966), REV. MOD. PHYS. 39, 1 (1967), PHYS. LETTERS 21, 581 (1966), NUOVO CIMENTO 42A, 606 (1966), PHYS. REV. 148, 1444 (1966), NUOVO CIMENTO 34, 1644 (1964), AND UCRL 17619.

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 5.97 GEV/C.

THIS EXPERIMENT USES THE BRITISH NATIONAL 150 CM. BUBBLE CHAMBER. A TOTAL OF 75000 PICTURES ARE REPORTED ON.

KEY WORDS - CROSS SECTION ANGULAR DISTRIBUTION MASS SPECTRUM DALITZ PLOT MODELS STRANGE PARTICLES Y*(1385) N*(1520)D13 'N*(1688)' OMEGA(783) ETA(548) RHO(765)

(TABLE 2)

LABORATORY BEAM MOMENTUM = 5.97 +- .05 GEV/C.

REACTION	MILLI-BARNS		NO. EVENTS
PROTON PROTON +			
PROTON PROTON PI+ PI-	2.800 +-	.100	1111
PROTON PROTON PI+ PI- PI0	2.200	.200	850
PROTON NEUTRON PI+ PI+ PI-	2.300	.200	1038
PROTON K+ LAMBDA	.059	.011	74
PROTON K+ SIGMA0	.012	.005	16
PROTON K+ LAMBDA PI0 + PROTON K+ SIGMA0 PI0	.036	.009	48
PROTON K0 LAMBDA PI+	.071	.010	106
NEUTRON K+ LAMBDA PI+ + NEUTRON K+ SIGMA0 PI+	.052	.009	71
PROTON K0 SIGMA0 PI+	.016	.005	8
PROTON PROTON K0 K0BAR	.005	.003	6
PROTON NEUTRON K+ K0BAR	.013	.007	4

(TABLE 3)

LABORATORY BEAM MOMENTUM = 5.97 +- .05 GEV/C.

REACTION	MILLI-BARNS	
PROTON PROTON +		
DELTA(1238)++ PROTON PI-	1.18 +-	.20
DELTA(1238)++ - PROTON PI+ (1)		
DELTA(1238)++ DELTA(1238)0	.72	.15
DELTA(1238)++ - PROTON PI+ (1)		
DELTA(1238)0 - PROTON PI- (1)		
DELTA(1238)++ N*(1520)0	.23	.12
DELTA(1238)++ - PROTON PI+ (1)		
N*(1520)0 - PROTON PI- (1)		
DELTA(1238)++ 'N*(1688)0'	.18	.10
DELTA(1238)++ - PROTON PI+ (1)		
'N*(1688)0' - PROTON PI- (1)		
DELTA(1238)0 PROTON PI+	.05	(2)
DELTA(1238)0 - PROTON PI- (1)		
N*(1520)0 PROTON PI+	.13	(2)
N*(1520)0 - PROTON PI- (1)		
'N*(1688)0' PROTON PI+	.05	(2)
'N*(1688)0' - PROTON PI- (1)		
PROTON PROTON PI+ PI- (3)	.00	(2)

(1) FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.
(2) VALUE IS APPROXIMATE ONLY.
(3) CROSS SECTION IS FOR THE NON-RESONANT PRODUCTION OF THESE PARTICLES ONLY.

(TABLE 4A)

LABORATORY BEAM MOMENTUM = 5.97 +- .05 GEV/C.

REACTION	MILLI-BARNS	
PROTON PROTON →		
DELTA(1238)++ DELTA(1238)- PI+	.00 +-	.30
DELTA(1238)++ → PROTON PI+ (1)		
DELTA(1238)- → NEUTRON PI- (1)		
DELTA(1238)++ NEUTRON PI+ PI-	1.10	.30
DELTA(1238)++ → PROTON PI+ (1)		
DELTA(1238)- PROTON PI+ PI+	.85	.20
DELTA(1238)- → NEUTRON PI- (1)		
PROTON NEUTRON PI+ PI+ PI- (2)	.35	.10

(1) FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.
(2) CROSS SECTION IS FOR THE NON-RESONANT PRODUCTION OF THESE PARTICLES ONLY.

(TABLE 4B)

LABORATORY BEAM MOMENTUM = 5.97 +- .05 GEV/C.

REACTION	MILLI-BARNS	
PROTON PROTON →		
DELTA(1238)++ PROTON PI- PI0	1.20 +-	.30
DELTA(1238)++ → PROTON PI+ (1)		
DELTA(1238)0 PROTON PI+ PI0	.60	.20
DELTA(1238)0 → PROTON PI- (1)		
DELTA(1238)+ PROTON PI+ PI-	.25	.10
DELTA(1238)+ → PROTON PI0 (1)		
DELTA(1238)++ DELTA(1238)0 PI0	.00	.10
DELTA(1238)++ → PROTON PI+ (1)		
DELTA(1238)0 → PROTON PI- (1)		
DELTA(1238)++ DELTA(1238)+ PI-	.00	.10
DELTA(1238)++ → PROTON PI+ (1)		
DELTA(1238)+ → PROTON PI0 (1)		
PROTON PROTON PI+ PI- PI0 (2)	.00	.10
PROTON PROTON OMEGA(783)	.18	.05
OMEGA(783) → PI+ PI- PI0 (3)		
PROTON PROTON ETA(548)	.07	.05
ETA(548) → PI+ PI- PI0 (1)		

(1) FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.
(2) CROSS SECTION IS FOR THE NON-RESONANT PRODUCTION OF THESE PARTICLES ONLY.
(3) FITTED FOR MASS AND/OR WIDTH (MASS = .786 GEV; WIDTH = .025 GEV), AND THEN TOOK ONLY EVENTS ABOVE (FITTED) BACKGROUND.

121 TOTAL CROSS SECTIONS FOR P, P-BAR, CHARGED K, AND CHARGED PI ON HYDROGEN BETWEEN 3 AND 10 GEV/C. (PHYS. REV. LETTERS 5, 333 (1960))

G.VONDARDEL,D.H.FRISCH,R.MERMOD,R.H.MILBURN,P.A.PIROUE,M.VIVARGENT,G.WEBER, K.WINTER (EUROPEAN ORG. FOR NUC. RES., GENEVA, SWITZERLAND)

CITATIONS
JETP 34 495 (1958), PHYS. REV. LETTERS 4, 63 (1960), REVIEW OF SCIENTIFIC INSTRUMENTS 25, 1010 (1954), PHYS. REV. LETTERS 3, 568 (1959), JETP 37 872 (1960), PHYS. REV. 119, 2C68 (1960), PHYS. REV. LETTERS 2, 117 (1959), PHYS. REV. 118, 563 (1960), UCRL 3630 (1957), AND UCRL 906E.

ARTICLE READ BY NAOMI BARASH-SCHMIDT IN 6/68, AND VERIFIED BY LEROY PRICE.

BEAM NO. 1 IS K+ ON PROTON FROM 3 TO 10 GEV/C.
NO. 2 IS PROTON ON PROTON FROM 3 TO 10 GEV/C.
NO. 3 IS ANTI-PROTON ON PROTON FROM 3 TO 10 GEV/C.
NO. 4 IS K- ON PROTON FROM 3 TO 10 GEV/C.
NO. 5 IS PI+ ON PROTON FROM 3 TO 10 GEV/C.
NO. 6 IS PI- ON PROTON FROM 3 TO 10 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS → CROSS SECTION

K+ PROTON TOTAL CROSS SECTION.

. THIS DATA WAS READ FROM A GRAPH .

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS	
3.0	24.5 +-	2.5
3.5	23.5	2.5
5.0	20.0	1.5
8.0	19.5	1.0

PROTON PROTON TOTAL CROSS SECTION. (FIGURE 3)

. THIS DATA WAS READ FROM A GRAPH .

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS	
5.0	44.0 +-	1.0
6.0	44.0	1.0
7.0	43.0	1.0
10.0	42.0	.5
10.7	41.0	.5

K- PROTON TOTAL CRCSS SECTICN.

(- NO DATA PUNCHEC FOR THIS PARAMETER.)

- -

PI+ PROTON TOTAL CROSS SECTION.

(- NO DATA PUNCHED FCR THIS PARAMETER.)

- -

PI- PROTCN TOTAL CRCSS SECTION.

(- NO DATA PUNCHEC FOR THIS PARAMETER.)

- -

PBAP PPCTON TOTAL CROSS SECTICN.

(- NO DATA PUNCHED FOR THIS PARAMETER.)

122 FOUR-BOCY STRANGE-PARTICLE PRODUCTION IN PP COLLISIONS AT 6 BEV/C. (UCRL 18306 (1968))

S.L.KLEIN (U.C. LAWRENCE RAD. LAB., BERKELEY, CALIF., USA)

ABSTRACT AN EXPOSURE CF THE LRL 72-IN. LIQUID-HYDROGEN BUBBLE CHAMBER TO 6 BEV/C PROTONS HAS YIELDED SCME 3000 EXAMPLES OF PRODUCTION OF STRANGE PARTICLES IN FOUR-BODY FINAL STATES. CROSS SECTIONS FOR THE REACTIONS PP - LAMBDA KO P PI+, PP - LAMBDA K+ P PIO, AND PP - LAMBDA K+ N PI+ ARE 64 +- 6 MICROBARNS, 39 +- 6 MICROBARNS, AND 43 +- 4 MICROBARNS, RESPECTIVELY. THE RESONANCES K*(890), N*(1236), AND Y*(1385) ARE PRODUCED WITH CROSS SECTIONS

SIGMA(P LAMBDA K*+) = 9 +- 3 MICROBARNS
SIGMA(LAMBCA KO N*++) = 23 +- 3 MICROBARNS
SIGMA(LAMBDA K+ N*+) = 4 +- 2 MICROBARNS
SIGMA(P KO Y*+) = 11 +- 2 MICROBARNS
SIGMA(P K+ Y*0) = 7 +- 1 MICRCBARNS
SIGMA(N K+ Y*+) = 15 +- 2 MICROBARNS.

IN ADDITION, THE QUASI-TWO-BOCY REACTION PP - N N*(1950), N* - Y* K IS OBSERVED. EXCEPT FOR THE LOW K PI EFFECTIVE MASS REGION, THE DATA ARE FCUND TO BE IN GOOD AGREEMENT WITH A PION EXCHANGE MODEL.

CLOSELY RELATEC REFERENCES
THIS ARTICLE SUPERSEDES PART CF PHYS. REV. 171, 1421 (1968).

ADDITICNAL CITATIONS
PHYS. REV. LETTERS 19, 397 (1967), PHYS. REV. LETTERS 17, 789 (1966), PHYS. REV. LETTERS 16, 855 (1966), NUOVO CIMENTO 35, 1052 (1965), PHYS. LETTERS 8, 134 (1964), PHYS. REV. 133, B1017 (1964), PHYS. REV. 128, 1823 (1962), PHYS. REV. LETTERS 7, 450 (1961), PHYS. REV. LETTERS 4, 611 (1960), PHYS. REV. 161, 1387 (1967), PHYS. REV. 154, 1284 (1967), NUOVO CIMENTO 49A, 475 (1967), PHYS. REV. 138, B670 (1965), NUOVO CIMENTO 40A, 839 (1965), PHYS. REV. 126, 747 (1962), PHYS. REV. 125, 2082 (1962), PHYS. REV. 125, 2091 (1962), PHYS. REV. 123, 2160 (1961), UCRL 17707, PHYS. REV. LETTERS 19, 925 (1967), NUCVO CIMENTO 53A, 455 (1968), PHYS. REV. 165, 1466 (1968), PHYS. REV. 147, 922 (1966), UCLA UCLA-1031, PHYS. REV. 125, 1048 (1962), UCRL 16275, PHYS. REV. LETTERS 15, 214 (1965), PHYS. REV. 140, B914 (1965), PHYS. REV. LETTERS 10, 192 (1963), PHYS. LETTERS 26B, 161 (1968), PHYS. REV. 165, 1730 (1968), REV. MOD. PHYS. 41, 109 (1969), PHYS. REV. 121, 1541 (1961), PHYS. REV. LETTERS 8, 332 (1962), PHYS. REV. 133, B457 (1964), UCRL 10838, PHYS. REV. 108, 1353 (1957), PHYS. REV. 163, 1430 (1967), PHYS. REV. 163, 1377 (1967), NUOVO CIMENTO 43, A1010 (1966) , PHYS. REV. 161, 1384 (1967), PHYS. REV. 134B, 383 (1964), AND PHYS. REV. 139B, 1097 (1965).

ARTICLE READ BY OCETTE BENARY IN 1/69, AND VERIFIED BY LERCY PRICE.

BEAM IS PROTON ON PROTON AT 6 GEV/C.

THIS EXPERIMENT USES THE L.R.L. 72 IN. (H) BUBBLE CHAMBER. A TOTAL OF 5500CO PICTURES ARE REPORTED ON.

KEY WCRDS - CROSS SECTION ANGULAR DISTRIBUTION MASS SPECTRUM MODELS STRANGE PARTICLES DELTA(1238) K*(890) Y*(1385) CELTA(1920)

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(TABLE 1)

LABORATORY BEAM MOMENTUM = 6. GEV/C +- .12(PER CENT).

REACTION	MICRO-BARNS	NO. EVENTS
PROTCN PRCTON -		
LAMBDA PROTON KO PI+	64. +- 6. (1)	959
SIGMAO PROTON KO PI+	11. 2.	160
LAMBDA PRCTON K+ PIO	39. 6. (1)	492
LAMBDA NEUTRON K+ PI+	43. 4. (1)	554

(1) THIS DATA REPLACES VALUES GIVEN EARLIER IN CHINOWSKY ET AL., PHYS. REV. 171, 1421 (1968).

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(TABLE 2)

LABORATORY BEAM MOMENTUM = 6. GEV/C +- .12(PER CENT).

REACTION	MICRO-BARNS
PROTON PROTON -	
Y*(1385)+ PRCTCN KO	11. +- 2.
Y*(1385)+ - LAMBDA PI+ (1)	
DELTA(1238)++ LAMBDA KO	23. 3.
DELTA(1238)++ - PRCTCN PI+ (1)	
K*(890)+ LAMBDA PROTON	6. 2.
K*(890)+ - KO PI+ (1)	
LAMBDA PROTON KO PI+ (2)	23. 3.
Y*(1385)O K+ PROTON	7. 1.
Y*(1385)O - LAMBDA PIO (1)	
DELTA(1238)+ LAMBDA K+	4. 2.
DELTA(1238)+ - PROTON PIO (1)	
K*(890)+ LAMBDA PRCTCN	2. 1.
K*(890)+ - K+ PIO (1)	
LAMBDA PROTCN K+ PIO (2)	26. 4.
Y*(1385)+ NEUTRON K+	15. 2.
Y*(1385)+ - LAMBDA PI+ (1)	
DELTA(1238)+ LAMBDA K+	0. 1.
DELTA(1238)+ - NEUTRON PI+ (1)	
LAMBDA NEUTRON K+ PI+ (2)	29. 3.

(1) FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.
(2) CROSS SECTION IS FOR THE NON-RESONANT PRODUCTION OF THESE PARTICLES CNLY.

123 LARGE-ANGLE ELASTIC PROTON-PROTCN SCATTERING FROM 1.5 TO 3.5 GEV/C. (PHYS. REV. LETTERS 23, 1306 (1969))

B.B.BRABSCN,R.R.CRITTENCEN,R.M.HEINZ,R.C.KAMMERUD,H.A.NEAL,H.W.PAIK, R.A.SICWELL,K.F.SUEN (UNIV. OF INDIANA, BLOOMINGTON, IND., USA)

ABSTRACT WE PRESENT PP ELASTIC CIFFERENTIAL CROSS SECTION RESULTS AT NINE MOMENTA IN THE RANGE 1.5 TO 3.5 GEV/C FOR 40 DEG. ≤ THETA(C.M.) ≤ 90 DEG. NO STRONG EVICENCE OF SECONDARY DIFFRACTION-LIKE BEHAVIOR IN THIS MOMENTUM REGION IS OBSERVED. RAPID CHANGES IN THE SLCPE CF THE 90 CEG.

CITATIONS
PHYS. REV. 161, 1374 (1967), PHYS. REV. LETTERS 21, 651 (1968), PHYS. REV. 174, 915 (1968), PHYS. REV. 159, 1138 (1967), PHYS. LETTEPS 27B, 49 (1968), PHYS. LETTERS 28B, 67 (1968), UCRL 16275 (1966), PHYS. REV. 170, 1223 (1968), NUCLEAR INSTRUMENTS AND METHODS 54, 1 (1967), NUOVO CIMENTO SUPPLEMENT 3 147 (1965), PHYS. REV. 146, 1075 (1966), NUOVO CIMENTO 62A, 275 (1969), ANNALS OF PHYSICS 54, 62 (1969), PHYS. LETTERS 25B, 228 (1967), CERN TH-801 (1967), PHYS. LETTERS 29B, 348 (1969), AND PHYS. LETTEPS 13, 190 (1964).

ARTICLE READ BY ODETTE BENARY IN 12/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTCN FROM 1.5 TC 3.5 GEV/C.

THIS EXPERIMENT USES SPARK CHAMPERS.

GENERAL COMMENTS CN THIS ARTICLE
1 TABLE OF VALUES FOR FIGURE 3 REQUESTED FROM AUTHORS 29 JANUARY 1970. CROSS SECTIONS ARE REPORTED NEAR -T = 0.7 AND 3 (GEV/C)SQUAREC.

KEY WORDS - DIFFERENTIAL CROSS SECTICN FITS

COMPOUND KEY WORDS - FITS DIFFERENTIAL CROSS SECTION

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* NO DATA PUNCHED FOR THIS ARTICLE *
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124 MEASUREMENTS OF THE POLARIZATION PARAMETERS P AND C(N,N) IN PP ELASTIC SCATTERING BETWEEN 500 AND 1200 MEV. (PHYS. REV. 164, 1672 (1967))

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J.DEREGEL,J.M.FONTAINE (LAB. CE PHYS. CORPUSCULAIRE, CAEN, FRANCE)

ABSTRACT THE POLARIZATION PARAMETER P AND THE SPIN CORRELATION PARAMETER C(N,N) IN PROTON-PROTON ELASTIC SCATTERING HAVE BEEN MEASURED IN AN EXPERIMENT WITH A POLARIZED-PROTON TARGET IN THE BEAM EXTRACTED FROM THE SYNCHROTRON SATURNE. THE ANGULAR DISTRIBUTICN OF P WAS MEASUREC AT 7 ENERGIES BETWEEN 0.5 AND 1.2 GEV. THE VALUE OF P SHOWS A MAXIMUM OF +0.6 AT ABOUT 7CO MEV FOR A SCATTERING ANGLE OF 45 DEG. IN THE CENTER-OF-MASS SYSTEM. AT 1.2 GEV THE VALUE OF P IS CONSISTENT WITH 0 FOR SCATTERING ANGLES ≥ 70 DEG. (MOMENTUM TRANSFERS -T≥0.8 (GEV/C)-SQUARED). THE SPIN CORRELATION COEFFICIENT C(N,N) WAS MEASURED AT THREE ENERGIES, 0.735, 0.978, AND 1.19 GEV, BY SCATTERING A POLARIZED-PROTON BEAM ON THE POLARIZED TARGET. THE VALUE OF C(N,N) AT 90 DEG. C.M. DECREASES FROM 0.7 TO 0.4 AS THE ENERGY INCREASES FROM 0.735 TO 1.19 GEV.

CLOSELY RELATED REFERENCES
THIS ARTICLE SUPERSECES REV. MOC. PHYS. 39, 531 (1967).

ACCITIONAL CITATIONS
PROGR. THEORET. PHYS. (KYOTO) 31 1162 (1964), RES. INST. FOR FUNDAMENTAL PHYSICS, KYCTO RIFP-47 (1965), DUBNA E-2726 (1966), BULL. AM. PHYS. SOC. 10, 717 (1965), PHYS. REV. 137, B620 (1965), UCRL 11926 (1965), UCRL 11565 (1964), PHYS. REV. 148, 1289 (1966), PHYS. REV. 148, 1297 (1966), NUOVO CIMENTO 43, 708 (1966), PHYS. LETTERS 18, 203 (1965), UCRL 11877 (1965), PHYS. REV. 153, 1394 (1967), JETP 17 98 (1963), PHYS. REV. 96, 1654 (1954), PHYS. REV. 120, 2250 (1960), PROC. OF THE ROYAL SOCIETY CF LCNDON A244, 491 (1958), NUOVO CIMENTO 27, 1450 (1963), NUOVO CIMENTO 47A, 85 (1967), AND PHYS. REV. LETTERS 16, 576 (1966)

ARTICLE READ BY ODETTE BENARY IN 1/68, AND VERIFIEC BY LEROY PRICE.

BEAM IS PROTON ON HYDRCGEN CCMPOUNC FROM 1.09 TO 1.91 GEV/C. TARGET IS POLARIZED 65 PER CENT (NORMAL TO THE BEAM DIRECTION).

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - POLARIZATION

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ELASTIC POLARIZATION FCR PROTCN PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = .5 GEV.

THETA DEGREES	POLARIZATION	+-
34.6	.490	.C35
39.6	.440	.C54
43.2	.430	.C22
43.8	.490	.034
47.6	.420	.032
48.2	.454	.030
51.7	.375	.C22
52.4	.435	.040
56.0	.345	.C22
57.2	.340	.C32
60.0	.330	.C20
61.0	.300	.020
63.8	.295	.C20
64.8	.260	.C20
68.6	.230	.C2C
72.4	.190	.C20
73.4	.141	.C17
76.0	.125	.013
77.0	.C87	.C19
79.8	.095	.C09
80.6	.094	.C05
83.7	.06C	.C18
87.2	.015	.016
90.4	-.C31	.C13
93.6	-.070	.CC5

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS CF THE PROTCN ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

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ELASTIC POLARIZATION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = .609 GEV.

THETA DEGREES	POLARIZATION	+-
30.3	.440	.080
30.8	.360	.091
35.2	.415	.043
37.8	.440	.026
39.8	.415	.029
42.6	.480	.027
44.1	.450	.026
47.0	.476	.029
48.7	.450	.019
50.0	.500	.023
51.1	.410	.045
53.1	.455	.024
54.2	.500	.024
57.3	.410	.025
58.4	.465	.025
62.2	.400	.036
66.4	.380	.018
67.4	.345	.020
70.3	.320	.019
71.4	.265	.020
74.0	.290	.070
75.1	.210	.020
78.9	.160	.015
82.6	.122	.010
86.1	.029	.015
89.6	-.006	.020

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

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ELASTIC POLARIZATION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = .735 GEV.

(FIRST TWO VALUES (SMALL ANGLES) OBTAINED USING UNPOLARIZED TARGET (DOUBLE SCATTERING TECHNIQUE).)

THETA DEGREES	+-	POLARIZATION	+-
6.7	2.0	.118	.160
18.3	2.0	.367	.032
25.4	.0	.490	.030
29.8	.0	.520	.040
34.2	.0	.530	.040
39.0	.0	.570	.030
43.6	.0	.550	.030
48.0	.0	.500	.030
54.2	.0	.486	.030
58.2	.0	.460	.020
62.4	.0	.404	.030
66.2	.0	.364	.030
70.4	.0	.296	.050
74.4	.0	.268	.015

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

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ELASTIC POLARIZATION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = .82 GEV.

THETA DEGREES	POLARIZATION	+-
23.2	.435	.035
28.0	.465	.035
30.0	.443	.029
32.6	.470	.025
34.6	.443	.016
37.2	.484	.025
39.4	.455	.012
42.0	.476	.030
43.8	.475	.016
44.8	.450	.017
46.3	.410	.040
48.2	.435	.022
49.3	.455	.015
52.8	.465	.016
53.6	.445	.016
58.4	.410	.017
62.4	.392	.012
63.6	.330	.017
66.4	.355	.017
67.4	.335	.025
70.4	.315	.035
71.2	.300	.011
75.4	.225	.017
79.2	.155	.016
82.9	.100	.036
86.6	.056	.005

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

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ELASTIC POLARIZATION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = .924 GEV.

THETA DEGREES	POLARIZATION	+-
23.4	.340	.018
28.0	.400	.017
32.8	.435	.021
37.4	.445	.024
42.4	.385	.024
47.0	.385	.024
51.4	.370	.018

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

ELASTIC POLARIZATION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = 1.029 GEV.

THETA DEGREES	POLARIZATION	
25.9	.345 +-	.040
30.9	.355	.020
35.6	.370	.030
40.0	.305	.030
42.0	.405	.027
45.4	.370	.020
46.6	.360	.025
50.0	.345	.021
51.2	.330	.020
55.4	.330	.020
60.0	.285	.020
64.6	.265	.030
67.2	.287	.050
68.7	.210	.060
71.6	.210	.020
75.6	.080	.035
79.4	.092	.013
83.2	.090	.020
87.0	-.017	.046

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

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ELASTIC POLARIZATION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = 1.194 GEV.

(FIRST TWO VALUES (SMALL ANGLES) OBTAINED USING UNPOLARIZED TARGET (DOUBLE SCATTERING TECHNIQUE).)

THETA DEGREES		POLARIZATION	
13.8 +-	2.0	.124 +-	.033
21.7	2.0	.224	.030
23.9	.0	.350	.090
28.8	.0	.355	.034
29.0	.0	.390	.025
34.0	.0	.370	.044
34.2	.0	.405	.016
39.0	.0	.392	.060
39.2	.0	.375	.015
43.9	.0	.385	.037
44.2	.0	.385	.017
45.7	.0	.310	.036
49.0	.0	.337	.040
49.0	.0	.330	.019
50.6	.0	.305	.024
53.8	.0	.320	.025
54.0	.0	.245	.020
55.2	.0	.275	.024
59.8	.0	.190	.020
64.4	.0	.105	.019
65.3	.0	.085	.024
68.5	.0	.085	.030
69.6	.0	.080	.028
73.7	.0	.020	.035
77.8	.0	.035	.017
81.6	.0	-.083	.025
85.4	.0	-.016	.070

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

125 INELASTIC REACTIONS IN PROTON-DEUTERON SCATTERING AT 1.825 AND 2.11 GEV/C. (PHYS. REV. 187, 1856 (1969))

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ABSTRACT THE FINAL STATES P(SPECTATOR) P P PI-, P(SPECTATOR) P P PI- PI0, P(SPECTATOR) P N PI+ PI-, AND N(SPECTATOR) P P PI+ PI- HAVE BEEN OBSERVED IN PD COLLISIONS AT 1.825 AND 2.11 GEV/C. THE SPECTATOR-NUCLEON MOMENTUM AND ANGULAR DISTRIBUTIONS ARE SHOWN TO REQUIRE THE ADDITION OF DOUBLE-SCATTERING EVENTS TO THE USUAL IMPULSE-MODEL PREDICTIONS, IN PROPORTIONS VARYING BETWEEN 15 AND 40 PER CENT. RESULTS FOR THE REACTION P N*P P PI- ARE IN GOOD AGREEMENT WITH THE ONE-PION-EXCHANGE MODEL. THE CROSS SECTION FOR THE T = 0 PART OF THE REACTION P N-P N PI+ PI- RISES BY 0.97 +- 0.22 MB BETWEEN 1.825 AND 2.11 GEV/C, COMPARED WITH A RISE OF 3 MB IN THE TOTAL T = 0 NUCLEON-NUCLEON CROSS SECTION IN THE SAME ENERGY REGION; BUT NO EVIDENCE HAS BEEN FOUND FOR THE REACTION P N-N N*(1470).

CLOSELY RELATED REFERENCES
CONTINUATION OF PREVIOUS EXPERIMENT IN PHYS. LETTERS 26B, 317 (1968).

ADDITIONAL CITATIONS
NUOVO CIMENTO 33, 1509 (1964), PHYS. REV. 146, 980 (1966), BULL. AM. PHYS. SOC. 12, 470 (1967), PHYS. LETTERS 26B, 598 (1968), PHYS. REV. LETTERS 21, 1835 (1968), PHYS. REV. 125, 2091 (1962), PHYS. REV. 126, 747 (1962), PHYS. REV. 133, B1017 (1964), PHYS. REV. 138, B670 (1965), PHYS. REV. 80, 196 (1950), PHYS. REV. 84, 710 (1951), PHYS. REV. 85, 636 (1952), PHYS. REV. 142, 1195 (1966), PHYS. REV. 100, 242 (1955), PHYS. REV. 135, B358 (1964), PHYS. REV. 137, AB3E (1965), HANDBUCH DER PHYSIK 39 1 (1957), PHYS. REV. 123, 1393 (1961), CERN TH 68-15 (1968), NUC. PHYS. 53, 650 (1964), NUC. PHYS. 38, 281 (1962), PHYS. REV. 139, B362 (1965), PHYS. REV. 139, B380 (1965), NUOVO CIMENTO 30, 240 (1963), NUOVO CIMENTO 34, 1644 (1964), FORTSCHRITTE DER PHYSIK 9, 549 (1961), NUOVO CIMENTO SUPPLEMENT 24 453 (1962), AND NUOVO CIMENTO SUPPLEMENT 27 1450 (1963).

ARTICLE READ BY ODETTE BENARY IN 3/70, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON DEUTERON FROM 1.825 TO 2.110 GEV/C.

THIS EXPERIMENT USES THE SACLAY 81 CM (H) BUBBLE CHAMBER. A TOTAL OF 56000 PICTURES ARE REPORTED ON.

GENERAL COMMENTS ON THIS ARTICLE
1 IN THE ABSENCE OF ANY INFORMATION ON THE DISTRIBUTION OF THE TOTAL SHADOWING EFFECT CONTRIBUTION BETWEEN THE VARIOUS REACTION CHANNELS, THE AUTHORS HAVE ASSUMED THAT THE N AND P SHADOWING ARE EQUAL, AND THAT THE SHADOWING EFFECT FOR EACH ABSORPTIVE REACTION IS PROPORTIONAL TO ITS SHARE OF THE TOTAL-ABSORPTION CROSS SECTION.

KEY WORDS + CROSS SECTION ANGULAR DISTRIBUTION MASS SPECTRUM MODELS DALITZ PLOT

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CROSS SECTION FOR PROTON NEUTRON → PROTON PROTON PI-. (TABLE 5)
GLAUBER CORRECTION APPLIED

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS	NO. EVENTS
1.825 +- .045	2.57 +- .14	1379
2.110 .045	2.68 .19	1362

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CROSS SECTION FOR PROTON NEUTRON → PROTON PROTON PI- PIO. (TABLE 5)
GLAUBER CORRECTION APPLIED

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS	NO. EVENTS
1.825 +- .045	.16 +- .03	48
2.110 .045	.35 .04	97

- -

CROSS SECTION FOR PROTON NEUTRON → PROTON NEUTRON PI+ PI-. (TABLE 5)
GLAUBER CORRECTION APPLIED

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS	NO. EVENTS
1.825 +- .045	.77 +- .07	300
2.110 .045	1.75 .20	564

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CROSS SECTION FOR NEUTRON PROTON → DEUTERON PI+ PI-. (TABLE 5)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS
1.825 +- .045	.13 +- .03
2.110 .045	.17 .03

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CROSS SECTION FOR PROTON DEUTERON → PROTON DEUTERON PI+ PI-. (TABLE 5)

(THIS DATA REPLACES VALUES GIVEN EARLIER IN BRUNT ET AL., PHYS. LETTERS 26B, 317 (1968))

(ONLY EVENTS IN WHICH THE D DOES NOT BREAK)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS	NO. EVENTS
1.825	.18 +- .02	136
2.110	.17 .02	129

126 ZERO STRANGENESS RESONANCE PRODUCTION IN 6 GEV/C PROTON-PROTON COLLISIONS. (UCRL 17707 (1968))

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ABSTRACT APPROXIMATELY 33,000 FOUR-PRONGED PROTON-PROTON INTERACTIONS AT 6 GEV/C HAVE BEEN EXAMINED FOR THE PRODUCTION OF NONSTRANGE MESON AND BARYON RESONANCES. THESE EVENTS WERE FOUND BY SCANNING APPROXIMATELY 112,000 PICTURES TAKEN IN THE LRL 72-IN. HYDROGEN BUBBLE CHAMBER. THE REACTIONS STUDIED IN DETAIL AND THEIR CROSS SECTIONS ARE
(1) PP → PP PI+ PI- 3.2 +- 0.3 MB
(2) PP → PN PI+ PI+ PI- 2.9 +- 0.4 MB
(3) PP → PP PI+ PI- PI0 2.4 +- 0.2 MB .
PROTON-PROTON INTERACTIONS HAVE BEEN STUDIED BY OTHERS IN THIS ENERGY REGION AND THIS EXPERIMENT AGREES WITH THESE STUDIES IN THE GENERAL FEATURES OF REACTION (1). REACTION (1) IS DOMINATED BY THE PSEUDO-TWO-BODY FINAL STATES NN* AND N*N* PRODUCED IN A PERIPHERAL MANNER. FITS TO THE VARIOUS POSSIBLE FINAL STATES HAVE BEEN MADE AND ARE REPORTED. DATA FROM THIS REACTION HAVE ALSO BEEN COMPARED TO THE PERIPHERAL ONE-PION EXCHANGE (OPE) MODEL AND THE RESULTS ARE GIVEN. IN REACTIONS (2) AND (3), AN INTERESTING FEATURE IS THE PRODUCTION OF AN I = 3/2 BARYON RESONANCE WHICH IS OBSERVED TO DECAY INTO A NUCLEON AND THREE PIONS AND WHICH PRODUCES A PEAK IN THE APPROPRIATE MASS SPECTRUM AT 2080 MEV/C-SQUARED. IN ADDITION, THE RHO MESON HAS BEEN DETECTED FOR THE FIRST TIME IN A BUBBLE CHAMBER PROTON-PROTON PRODUCTION EXPERIMENT IN ADDITION TO THE ETA AND OMEGA MESONS ALREADY REPORTED. DUE TO THE COMPLICATED NATURE OF THE FINAL STATES IN REACTIONS (2) AND (3) FITS TO THE NUMEROUS POSSIBLE FINAL STATES ARE NOT ATTEMPTED. HOWEVER AN ATTEMPT HAS BEEN MADE TO DETERMINE THE PRODUCTION CROSS SECTIONS FOR VARIOUS NEW OR INTERESTING RESONANCES.

CLOSELY RELATED REFERENCES
PART OF THIS ARTICLE SUPERSEDED BY PHYS. REV. 171, 1421 (1968).

ADDITIONAL CITATIONS
CERN TC 66-20, PHYS. LETTERS 19, 925 (1967), PHYS. LETTERS 12, 356 (1964), UCRL 17003 (1966), PHYS. REV. 154, 1284 (1967), NUCLEAR INSTRUMENTS AND METHODS 20, 393 (1963), UCRL 16508 (1965), REVIEW OF SCIENTIFIC INSTRUMENTS 34, 484 (1963), LRL INTERDEPARTMENTAL REPORT UCID 1930 (1963), LRL INTERDEPARTMENTAL REPORT UCID 1931 (1963), PHYS. REV. LETTERS 15, 214 (1965), PHYS. REV. 138, B670 (1965), PHYS. REV. 125, 2091 (1962), PHYS. REV. 126, 747 (1962), PHYS. LETTERS 16, 75 (1965), PRINCETON-PENN ACCELERATOR PPAD 600F (1966), NUOVO CIMENTO 33, 309 (1964), LRL INTERDEPARTMENTAL REPORT P-156 (1966), PHYS. REV. 113, 1640 (1959), NUOVO CIMENTO 24, 453 (1962), NUOVO CIMENTO 30, 240 (1963), NUOVO CIMENTO 33, 906 (1964), NUOVO CIMENTO 34, 1841 (1964), UCRL 17651 (1968), NUOVO CIMENTO 35, 1644 (1964), AND PHYS. REV. LETTERS 10, 192 (1963).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 6 GEV/C.

THIS EXPERIMENT USES THE L.R.L. 72 IN. (H) BUBBLE CHAMBER. A TOTAL OF 112000 PICTURES ARE REPORTED ON.

KEY WORDS → CROSS SECTION MASS SPECTRUM MODELS ANGULAR DISTRIBUTION DELTA(1238) ETA(548) RHO(765) OMEGA(783) DELTA(1920)

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LABORATORY BEAM MOMENTUM = 6.00 +- .02 GEV/C.

REACTION	MILLI-BARNS	NO. EVENTS
PROTON PROTON →		
PROTON PROTON PI+ PI-	3.20 +- .30 [1]	3445
NEUTRON PROTON PI+ PI+ PI-	2.90 .40 [1]	3182
PROTON PROTON PI+ PI- PI0	2.40 .20 [1]	2634
DEUTERON PI+ PI+ PI-	.04 .01	50
DEUTERON PI+ PI+ PI- PI0	.16 .03	178

[1] THIS DATA SHOULD NOT BE USED - MORE RECENT VALUES MAY BE FOUND IN CHINOWSKY ET AL., PHYS. REV. 171, 1421 (1968).

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(TABLE 3)

LABORATORY BEAM MOMENTUM = 6.00 +- .02 GEV/C.

REACTION	MILLI-BARNS
PROTON PROTON →	
DELTA(1238)++ DELTA(1238)0	.66 +- .07
DELTA(1238)++ → PROTON PI+ [1]	
DELTA(1238)0 → PROTON PI- [1]	
DELTA(1238)++ N*(1520)0	.44 .05
DELTA(1238)++ → PROTON PI+ [1]	
N*(1520)0 → PROTON PI- [1]	
DELTA(1238)++ 'N*(1688)0'	.25 .04
DELTA(1238)++ → PROTON PI+ [1]	
'N*(1688)0' → PROTON PI- [1]	
PROTON N*(1470)+	.68 .09
N*(1470)+ → PROTON PI+ PI- [1]	
PROTON DELTA(1920)+	.19 .04
DELTA(1920)+ → PROTON PI+ PI- [1]	
PROTON PROTON PI+ PI- [2]	.07 .12

[1] FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.
[2] CROSS SECTION IS FOR THE NON-RESONANT PRODUCTION OF THESE PARTICLES ONLY.

- -

(TABLE 4)

LABORATORY BEAM MOMENTUM = 6.00 +- .02 GEV/C.

REACTION	MICRO-BARNS
PROTON PROTON →	
PROTON DELTA(1238)++ RHO(765)-	153. +- 31.
DELTA(1238)++ → PROTON PI+ [1]	
RHO(765)- → PI- PI0 [1]	
PROTON DELTA(1238)+ RHO(765)0	45. 12.
DELTA(1238)+ → PROTON PI0 [1]	
RHO(765)0 → PI+ PI- [1]	
PROTON DELTA(1238)0 RHO(765)+	65. 18.
DELTA(1238)0 → PROTON PI- [1]	
RHO(765)+ → PI+ PI0 [1]	
NEUTRON DELTA(1238)++ RHO(765)0	228. 46.
DELTA(1238)++ → PROTON PI+ [1]	
RHO(765)0 → PI+ PI- [1]	

[1] FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.

127 PERIPHERAL PROCESSES IN PROTON-PROTON INTERACTIONS AT 29 GEV/C. (BNL 13918 (1969))

W.E.ELLIS,T.W.MORRIS,R.S.PANVINI,F.TURKOT (BROOKHAVEN NAT. LAB., UPTON, L.I., N. Y., USA)

ABSTRACT BUBBLE CHAMBER AND MISSING-MASS-SPECTROMETER DATA ARE COMBINED TO STUDY DETAILS OF PERIPHERAL, QUASI-TWO-BODY PP INTERACTIONS P+P→P+M. DISTRIBUTIONS AS A FUNCTION OF MOMENTUM TRANSFER T TO THE RECOIL PROTON AND OF THE MASS M ARE MEASURED FOR THE TOTAL INTERACTION AND FOR SPECIFIC PARTICLE COMPOSITIONS OF M. T-DISTRIBUTIONS ARE FOUND TO BE EXPONENTIAL, WITH A CHANGE IN SLOPE AT APPROXIMATELY T = 0.2 GEV**-2. AT LOW T, THE SLOPE IS A STRONG FUNCTION OF MASS M, BUT IS NEARLY CONSTANT WITH MASS AT LARGE T. ENHANCEMENTS IN THE MASS DISTRIBUTIONS AT 1.4 AND 1.7 GEV ARE ANALYZED.

CLOSELY RELATED REFERENCES
ANALYSIS OF DATA FROM PHYS. REV. LETTERS 16, 855 (1966), AND PHYS. REV. LETTERS 21, 697 (1968).

ADDITIONAL CITATIONS
PHYS. LETTERS 18, 167 (1965), PHYS. REV. LETTERS 17, 789 (1966), PHYS. REV. 179, 1567 (1969), AND PHYS. REV. LETTERS 15, 45 (1965).

ARTICLE READ BY LEROY PRICE IN 4/70, AND VERIFIED BY ODETTE BENARY.

KEY WORDS • MASS SPECTRUM ANGULAR DISTRIBUTION

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* NO DATA PUNCHED FOR THIS ARTICLE *
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128 THE REACTICN PP-N*P PI- AT 6 GEV/C.   [NUC. PHYS. 88, 686 (1968)]

L.LYONS (OXFORD UNIV., OXFORD, ENGLAND)

ABSTRACT   SOME ASPECTS OF THE REACTICN PP-N*(1238)P PI- AT 6 GEV/C ARE COMPARED WITH THE PREDICTIONS OF A ONE-PION-EXCHANGE PROCESS IN WHICH SOME OF THE EFFECTS OF ABSORPTICN HAVE BEEN TAKEN INTO ACCOUNT. THE AGREEMENT BETWEEN THEORY AND EXPERIMENT IS ENCOURAGING.

CLOSELY RELATED REFERENCES
ANALYSIS OF DATA FROM NUOVO CIMENTO 55, 66 (1968).

ADDITIONAL CITATIONS
NUOVO CIMENTO SUPPLEMENT 24 453 (1962), NUOVO CIMENTO 31, 360 (1966), ANNALS OF PHYSICS 41, 456 (1967), REV. MOD. PHYS. 37, 484 (1965), AND UCLA 1023 (1968).

ARTICLE READ BY LEROY PRICE IN 4/70, AND VERIFIED BY ODETTE BENARY.

KEY WORDS - FITS   ANGULAR DISTRIBUTION   DELTA(1238)   MODELS

COMPOUND KEY WORDS -   FITS ANGULAR DISTRIBUTION

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* NO DATA PUNCHED FOR THIS ARTICLE *
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129 PROTON-NEUTRON QUASI-ELASTIC SCATTERING AT 991 MEV.   [NUOVO CIMENTO 49A, 261 (1967)]

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ABSTRACT   THE PROTON-PROTON AND PROTON-NEUTRON ELASTIC-SCATTERING ANGULAR DISTRIBUTIONS HAVE BEEN MEASURED AT 1.69 GEV/C (= 991 MEV) FROM 14.5 DEG. TO 150 DEG. C.M.S USING FAST SCINTILLATION COUNTERS IN CONJUNCTION WITH MAGNETIC MOMENTUM ANALYSIS. IN BOTH CASES, THE FORWARD ELASTIC CROSS-SECTIONS ARE CONSIDERABLY IN EXCESS OF THEIR RESPECTIVE OPTICAL-THEOREM MINIMA, THE RESULTS BEING CONSISTENT WITH THE EXISTENCE OF A REAL PART IN THE T = 0 SCATTERING AMPLITUDE TOGETHER WITH SPIN DEPENDENCE IN BOTH INTERACTIONS. THE PROTON-NEUTRON ANGULAR DISTRIBUTION IS MORE STRONGLY ASYMMETRIC ABOUT 90 DEG. C.M.S THAN IT IS AT LOWER ENERGIES, INDICATING THE ONSET OF DIFFRACTION SCATTERING AND INCREASED INTERFERENCE BETWEEN THE SCATTERING AMPLITUDES IN THE T = 0 AND T = 1 I-SPIN STATES. AT THE LARGER CENTER OF MASS ANGLES, THE DATA SUGGESTED THAT SUBSTANTIAL CORRECTIONS WERE NECESSARY BECAUSE OF THE INAPPLICABILITY OF THE IMPULSE APPROXIMATION AS A RESULT OF MULTIPLE NUCLEAR SCATTERING IN THE DEUTERON, NECESSITATING A MEASUREMENT OF THE RATIO OF QUASI-ELASTIC TO ELASTIC PROTON-PROTON SCATTERING FROM 100 DEG. TO 150 DEG. C.M.S.

CITATIONS
PROGRESS OF THEORETICAL PHYSICS 31, 615 (1964), PROGRESS OF THEORETICAL PHYSICS 31, 1162 (1964), JETP 19 542 (1964), PHYS. REV. 139, B362 (1965), PHYS. REV. 139, B38C (1965), NUOVO CIMENTO 28, 943 (1963), NUCLEAR INSTRUMENTS AND METHODS 36, 277 (1965), PHYS. REV. 80, 196 (1950), PHYS. REV. 85, 636 (1952), PHYS. REV. 85, 686 (1952), PHYS. REV. 87, 778 (1952), PHYS. REV. 126, 831 (1962), NUC. PHYS. 66, 673 (1965), JETP 5 371 (1957), SOVIET PHYSICS, JETP LETTERS 3, 8 (1966), PHYS. REV. LETTERS 16, 761 (1966), PHYS. REV. LETTERS 17, 827 (1966), PHYS. LETTERS 9, 72 (1964), PHYS. REV. 100, 242 (1955), NUOVO CIMENTO 42, 365 (1966), PHYS. LETTERS 21, 339 (1966), PHYS. REV. 146, 980 (1966), PHYS. LETTERS 12, 252 (1964), NUOVO CIMENTO 23, 690 (1962), PHYS. LETTERS 20, 203 (1966), CERN CONFERENCE 2 115 (1956), JETP 36 516 (1959), PROC. OF THE ROYAL SOCIETY OF LONDON A213, 392 (1952), PROC. OF THE ROYAL SOCIETY OF LONDON A229, 492 (1955), PHYS. REV. 95, 185 (1954), CERN CONFERENCE 2 124 (1956), PHYS. REV. 75, 1664 (1949), JETP 16 24 (1963), NUOVO CIMENTO 18, 1039 (1960), PHYS. REV. LETTERS 9, 509 (1962), PHYS. REV. LETTERS 15, 38 (1965), NUOVO CIMENTO 167, 41 (1966), JETP 7 499 (1958), PHYS. REV. 134, B633 (1964), PHYS. LETTERS 22, 90 (1966), AND PHYS. REV. LETTERS 16, 1217 (1966).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM NO. 1 IS PROTON ON HYDROGEN COMPOUND AT 1.69 GEV/C.
NO. 2 IS PROTON ON DEUTERIUM COMPOUND AT 1.69 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - CROSS SECTION   DIFFERENTIAL CROSS SECTION   FITS

COMPOUND KEY WORDS -   FITS DIFFERENTIAL CROSS SECTION

- -

PROTON PROTON ELASTIC CROSS SECTION.   (PAGE 267)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS
1.69	28.2 +- 2.1

- -

PROTON NEUTRON ELASTIC CROSS SECTION.   (PAGE 267)
GLAUBER CORRECTION APPLIED

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS
1.69	19.5 +- 2.5

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON NEUTRON. (FIGURE 4)

LABORATORY BEAM MOMENTUM = 1.69 GEV/C.

. THIS DATA WAS READ FROM A GRAPH .

THETA DEGREES	D-SIGMA/D-OMEGA MB/SR	
0.(1)	15.9 +-	1.2
15.	12.6	.8
20.	10.5	.4
25.	7.7	.2
30.	5.6	.2
40.	2.4	.2
50.	1.6	.2
60.	1.3	.1
70.	.6	.1
80.	.5	.1
90.	.3	.1
100.	.2	.1
110.	.2	.1
120.	.2	.1
130.	.3	.1
140.	.4	.2
150.	1.0	.2
180.(1)	3.7	1.0

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

(1) EXTRAPOLATED POINT.

130 BACKWARD NP SCATTERING WITH A POLARIZED TARGET. (PHYS. LETTERS 31B, 617 (1970))

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(U.C. LAWRENCE RAD. LAB., BERKELEY, CALIF., USA)
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ABSTRACT WE MEASURED THE POLARIZATION PARAMETER P IN NEUTRON-PROTON ELASTIC SCATTERING NEAR THE BACKWARD DIRECTION, USING A POLARIZED PROTON TARGET. MEASUREMENTS COVERED THE RANGE OF INCIDENT NEUTRON MOMENTA FROM 1.0 TO 5.5 GEV/C AND OF FOUR-MOMENTUM TRANSFER SQUARED U FROM -0.005 TO -0.5 (GEV/C)SQUARED.

CITATIONS
PHYS. REV. LETTERS 23, 542 (1969), NUOVO CIMENTO 41A, 167 (1966), PHYS. REV. LETTERS 15, 38 (1965), PHYS. REV. 164, 1726 (1967), PHYS. REV. 163, 1603 (1967), PHYS. REV. 182, 1579 (1969), PHYS. LETTERS 29B, 372 (1969), PHYS. REV. 156, 1703 (1967), PHYS. LETTERS 4, 19 (1963), PHYS. REV. 130, 1571 (1963), AND PHYS. REV. 177, 2318 (1969).

ARTICLE READ BY ODETTE BENARY IN 6/70, AND VERIFIED BY LEROY PRICE.

BEAM IS NEUTRON ON HYDROGEN COMPOUND FROM 1.0 TO 5.5 GEV/C. TARGET IS POLARIZED 50 PER CENT (NORMAL TO THE BEAM DIRECTION).

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - POLARIZATION

ELASTIC POLARIZATION FOR NEUTRON PROTON. (FIGURE 2)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM 1. TO 2. GEV/C.

(PRIVATE COMMUNICATION FROM P.R.ROBRISH, JUNE, 1970)

(THESE ARE PRELIMINARY RESULTS)

-T (GEV/C)**2 MIN	MAX	POLARIZATION (1)	
.01	.03	-.10 +-	.08
.03	.06	-.06	.04
.06	.10	-.04	.03
.10	.20	-.14	.04
.20	.30	-.47	.15

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5 PER CENT.

ELASTIC POLARIZATION FOR NEUTRON PROTON. (FIGURE 2)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM 2. TO 3. GEV/C.

(PRIVATE COMMUNICATION FROM P.R.ROBRISH, JUNE, 1970)

(THESE ARE PRELIMINARY RESULTS)

-T (GEV/C)**2 MIN	MAX	POLARIZATION (1)	
.00	.01	-.03 +-	.12
.01	.03	-.03	.06
.03	.06	-.17	.05
.06	.10	-.17	.04
.10	.20	-.17	.04
.20	.30	-.28	.06
.30	.40	-.36	.11
.40	.60	-.61	.24

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (PROTON).
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5 PER CENT.

ELASTIC POLARIZATICN FCR NEUTRCN PRCTCN. (FIGURE 2)

DATA IS AVERAGED CVER LABCRATORY BEAM MCMENTUM FRCM 3. TO 4. GEV/C.

[PRIVATE COMMUNICATION FRCM P.R.ROBRISH, JUNE, 1970]

(THESE ARE PRELIMINARY RESULTS)

-T (GEV/C)**2 MIN	MAX	POLARIZATICN [1]	
.0C	.01	.04 +-	.12
.01	.03	-.17	.C7
.03	.C6	-.15	.05
.06	.10	-.27	.C5
.10	.20	-.21	.04
.2C	.30	-.31	.C6
.30	.40	-.22	.09
.4C	.60	-.26	.09

T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING NEUTRON] AND THE [PROTON].
THE POLARIZATION IS OF THE PROTCN ALONG THE NORMAL TC THE PRODUCTION PLANE IN THE GRAND C.M.

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5 PER CENT.

- -

ELASTIC POLARIZATICN FCR NEUTRCN PRCTCN. (FIGURE 2)

DATA IS AVERAGED OVER LABCRATORY BEAM MOMENTUM FROM 4. TO 5. GEV/C.

[PRIVATE COMMUNICATION FRCM P.R.ROBRISH, JUNE, 197C]

(THESE ARE PRELIMINARY RESULTS)

-T (GEV/C)**2 MIN	MAX	POLARIZATION [1]	
.00	.01	-.11 +-	.10
.01	.03	.C4	.C6
.03	.06	-.09	.05
.06	.10	-.11	.05
.10	.20	-.14	.C4
.20	.30	-.22	.05
.30	.40	-.34	.C7
.40	.60	-.49	.C7

T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING NEUTRON] AND THE [PROTON].
THE POLARIZATION IS OF THE PROTCN ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5 PER CENT.

- -

ELASTIC POLARIZATICN FCR NEUTRON PROTON. (FIGURE 2)

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM 5.0 TO 5.5 GEV/C.

' PRIVATE COMMUNICATION FRCM P.R.ROBRISH, JUNE, 1970]

(THESE ARE PRELIMINARY RESULTS)

-T (GEV/C)**2 MIN	MAX	POLARIZATION [1]	
.00	.01	-.20 +-	.12
.01	.03	-.C9	.C7
.03	.06	-.26	.C6
.06	.10	-.20	.06
.10	.20	-.28	.C5
.20	.30	-.37	.07
.3C	.40	-.17	.C9
.40	.60	-.42	.C9

T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING NEUTRON] AND THE [PROTON].
THE POLARIZATION IS OF THE PROTCN ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5 PER CENT.

131 TWO-PRONG EVENTS IN PROTON-PROTCN INTERACTIONS AT 8.1 GEV/C. (NUC. PHYS. B13, 283 (1969))

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ABSTRACT ABOUT 10000 TWO-PRCNG EVENTS CF 8.1 GEV/C PROTON-PROTON INTERACTIONS IN THE CERN 2 M. BUBBLE CHAMBER HAVE BEEN ANALYZED. WE STUDY ELASTIC SCATTERING AND SINGLE-PION PRODUCTION REACTIONS. WE GIVE CROSS SECTIONS FOR ISOBAR PRODUCTION. WE ATTEMPT TO INTERPRET THE GENERAL FEATURES OF THE PP-P N PI+ REACTION BY THE DECK MECHANISM. WE COMPARE THE PRODUCTION AND THE DECAY OF DELTA++(1236) WITH ABSORPTION OR PI REGGE TRAJECTCRY EXCHANGE MODELS.

CLCSELY RELATED REFERENCES
CONTINUATION OF PREVIOUS EXPERIMENT IN NUC. PHYS. B5, 169 (1968).

ADDITICNAL CITATIONS
PHYS. REV. LETTERS 17, 789 (1966), RUTHERFORD HIGH ENERGY LAB. RPP/H/53, PHYS. REV. LETTERS 19, 397 (1967), PHYS. REV. 170, 1223 (1968), PHYS. REV. 173, 1322 (1968), NUOVO CIMENTO 49A, 479 (1967), PHYS. REV. 154, 1284 (1967), NUOVO CIMENTC 38, 60 (1965), NUOVO CIMENTO 53A, 232 (1968), PHYS. REV. 174, 1638 (1968), NUOVC CIMENTC 50A, 1000 (1967), PHYS. LETTERS 28B, 195 (1968), PHYS. REV. LETTERS 13, 169 (1964), NUOVO CIMENTO 48, 676 (1967), NUOVO CIMENTO 45, 1010 (1966), PHYS. REV. 168, 1773 (1968), PHYS. REV. 144, 1122 (1966), PHYS. REV. 160, 141C (1967), AND NUOVO CIMENTO 55, 667 (1968).

ARTICLE READ BY ODETTE BENARY IN 3/7C, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 8.1 GEV/C.

THIS EXPERIMENT USES THE CERN 2M (H) BUBBLE CHAMBER. A TOTAL OF 60000 PICTURES ARE REPORTED ON.

KEY WORDS - CROSS SECTION ANGULAR DISTRIBUTION DIFFERENTIAL CROSS SECTION FITS MODELS DENSITY MATRIX MASS SPECTRUM DELTA(1238) N*(1470)P11 'N*(1688)' DELTA(1920)

CCMPOUND KEY WORDS - FITS DIFFERENTIAL CROSS SECTION

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- -

(TABLE 1)

LABORATORY BEAM MOMENTUM = 8.1 +- .1 GEV/C.

REACTION	MILLI-BARNS		NO. EVENTS
PROTON PROTON →			
ELASTIC	10.80 +-	.40	3360
PROTON PROTON PI0	1.75	.20	
PROTON NEUTRON PI+	4.50	.40	
PROTON PROTON MM≥2PI0	1.60	.40	
PROTON NEUTRON PI+ MM≥1PI0	6.50	.50	
PI+ PI+ NEUTRON NEUTRON MM≥0PI0	> .60		
2 PRONGS	26.10	1.40	
TOTAL	40.10	.20	

- -

(TABLE 3)

LABORATORY BEAM MOMENTUM = 8.1 +- .1 GEV/C.

REACTION	MILLI-BARNS	
PROTON PROTON →		
NEUTRON DELTA(1238)++	1.35 +-	.30
DELTA(1238)++ → PROTON PI+ (1)		
PROTON DELTA(1238)+	.40	.10
DELTA(1238)+ → NEUTRON PI+ (1)		
PROTON DELTA(1238)+	.15	.07
DELTA(1238)+ → PROTON PI0 (1)		
PROTON N*(1470)+	.50	.15
N*(1470)+ → NEUTRON PI+ (2)		
PROTON N*(1470)+	.25	.15
N*(1470)+ → PROTON PI0 (2)		
PROTON 'N*(1688)+'	.10	.05
'N*(1688)+' → NEUTRON PI+ (1)		
PROTON 'N*(1688)+'	.10	.05
'N*(1688)+' → PROTON PI0 (1)		
NEUTRON DELTA(1920)++	.45	.20
DELTA(1920)++ → PROTON PI+ (1)		

(1) FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.
(2) FITTED FOR MASS AND/OR WIDTH (MASS = 1.435 GEV; WIDTH = .200 GEV), AND THEN TOOK ONLY EVENTS ABOVE (FITTED) BACKGROUND.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (FIGURE 2)

LABORATORY BEAM MOMENTUM = 8.1 +- .1 GEV/C.
NUMBER OF EVENTS = 3220.

(PRIVATE COMMUNICATION FROM GINESTET, MAY, 1970)

(THE CONVERSION FACTOR FROM NUMBER OF EVENTS TO MILLIBARNS WAS CALCULATED BY US)

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2 (1)		NO. EVENTS
.00(2)		79.6 +-	3.3	
.06	.08	45.0	2.5	333
.08	.10	37.3	2.2	276
.10	.12	34.6	2.2	256
.12	.14	29.8	2.0	221
.14	.16	27.7	1.9	205
.16	.10	23.2	1.8	172
.19	.20	17.5	1.5	130
.20	.22	16.9	1.5	125
.22	.24	13.5	1.3	100
.24	.26	10.1	1.2	75
.26	.30	11.3	1.2	84
.28	.30	9.2	1.1	68
.30	.32	7.6	1.0	56
.32	.34	6.1	.9	45
.34	.36	5.9	.9	44
.36	.38	5.4	.9	40
.38	.40	3.6	.7	27
.40	.42	3.4	.7	25
.42	.44	4.5	.8	33

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

(1) COUNTS WERE MULTIPLIED BY .135 TO GET THESE. ERRORS ARE TAKEN AS PROPORTIONAL TO THE SQUARE-ROOT OF THE COUNTS.
(2) EXTRAPOLATED POINT.

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 2)

LABORATORY BEAM MOMENTUM = 8.1 +- .1 GEV/C.

DATA IS FIT OVER -T FROM .06 TO .50 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

FITTED FORMULA IS D-SIGMA/D-T = A*EXP(LAMBDA*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 80. +- 3.
LAMBDA = 7.5 +- .2

- -

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON • NEUTRON DELTA(1238)++. [FIGURE 5]
DELTA(1238)++ • PROTON PI+ [1]

LABORATORY BEAM MOMENTUM = 8.1 +- .1 GEV/C.
NUMBER OF EVENTS = 225.

[PRIVATE COMMUNICATION FROM GINESTET, MAY, 1970]

(THE CONVERSION FACTOR FROM NUMBER OF EVENTS TO MILLIBARNS WAS CALCULATED BY US)

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2 [2]		NO. EVENTS
.00	.02	6.5 +-	.5	48
.02	.04	3.6	.7	27
.04	.06	3.6	.7	27
.06	.08	2.6	.6	19
.08	.10	2.0	.5	15
.10	.12	2.2	.5	16
.12	.14	1.6	.5	12
.14	.16	.8	.3	6
.16	.18	1.2	.4	9
.18	.20	.7	.3	5
.20	.22	.8	.3	6
.22	.24	1.2	.4	9
.24	.26	.3	.2	2
.26	.28	.3	.2	2
.28	.30	.3	.2	2
.30	.32	.0	.1	0
.32	.34	.1	.1	1
.34	.36	.1	.1	1
.36	.38	.0	.1	0
.38	.40	.3	.2	2
.40	.42	.0	.1	0

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (DELTA(1238)++).

[1] USED SIMPLE MASS CUT.
[2] COUNTS WERE MULTIPLIED BY .135 TO GET THESE. ERRORS ARE TAKEN AS PROPORTIONAL TO THE SQUARE-ROOT OF THE COUNTS.

132 DELTA(1236)++ DELTA(1236)- PRODUCTION IN P N COLLISIONS AT 6.98 GEV/C. (WEIZMANN INST REPORT (1970))

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ABSTRACT THE REACTION PN • DELTA++ DELTA- WITH A CROSS SECTION OF 1.1 +- 0.2 MB IS STUDIED AT 6.98 GEV/C. COMPARISON WITH THE REACTIONS PBAR P • DELTA-BAR DELTA AND PP • DELTA DELTA AT DIFFERENT INCIDENT MOMENTA SHOWS THAT THEIR CROSS-SECTION BEHAVES LIKE P(LAB) EXP(-2.5+-0.3), CONSISTENT WITH ONE-PION-EXCHANGE. THE PRODUCTION AND DECAY OF DELTA++ DELTA- AGREES WITH THE O.P.E.MODEL WITH SHARP CUT-OFF AT R=1.3 FERMI, THE DECAY CORRELATIONS ARE ALSO COMPARED WITH SOME QUARK MODEL PREDICTIONS.

CITATIONS
PHYS. REV. 154, 1284 (1967), NUOVO CIMENTO 55, 66 (1968), NUC. PHYS. 318, 30 (1970), NUC. PHYS. B5, 169 (1968), NUOVO CIMENTO 48A, 360 (1967), PHYS. REV. 123, 1307 (1968), PHYS. LETTERS 26B, 598 (1968), NUC. PHYS. B6, 465 (1968), PHYS. REV. 160, 1410 (1968), PHYS. REV. 173, 1322 (1968), NUC. PHYS. B17, 289 (1969), AND NUOVO CIMENTO 38, 518 (1965).

ARTICLE READ BY ODETTE BENARY IN 6/70, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON DEUTERON AT 6.98 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 80 IN. (H) BUBBLE CHAMBER. A TOTAL OF 94000 PICTURES ARE REPORTED ON.

KEY WORDS • CROSS SECTION DELTA(1238) MASS SPECTRUM ANGULAR DISTRIBUTION MODELS
DIFFERENTIAL CROSS SECTION FITS DENSITY MATRIX

COMPOUND KEY WORDS • FITS DIFFERENTIAL CROSS SECTION

- -

CROSS SECTION FOR PROTON NEUTRON • PROTON NEUTRON PI+ PI-. [PAGE 4]
GLAUBER CORRECTION APPLIED

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS
6.98	3.72 +- .22

- -

CROSS SECTION FOR PROTON NEUTRON • DELTA(1238)++ DELTA(1238)-. [PAGE 5]
DELTA(1238)++ • PROTON PI+ [1,2]
DELTA(1238)- • NEUTRON PI- [1,2]
GLAUBER CORRECTION APPLIED

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS
6.98	1.1 +- .2

[1] NON-INTERFERING AMPLITUDES ASSUMED.
[2] FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.

133 LARGE-ANGLE PD SCATTERING AT 580 MEV. (PHYS. REV. LETTERS 24, 236 (1970))

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ABSTRACT THE ELASTIC SCATTERING OF PROTONS FROM DEUTERONS HAS BEEN MEASURED AT 580 MEV. THE RESULTS FOR LARGE-ANGLE SCATTERING ARE PRESENTED AND DISCUSSED HERE. THE BACKWARD PEAK OBSERVED IN THE EXPERIMENT IS CONSISTENT WITH A BARYON-EXCHANGE MECHANISM INCLUDING THE TRANSFER OF BARYON RESONANCES.

CLOSELY RELATED REFERENCES
THIS ARTICLE SUPERSEDES BULL. AM. PHYS. SOC. 13, 872 (1968).

ADDITIONAL CITATIONS
PHYS. REV. LETTERS 16, 761 (1966), PHYS. REV. LETTERS 19, 387 (1967), NUOVO CIMENTO 51A, 369 (1967), NUOVO CIMENTO 56 838 (1968), PHYS. REV. 180, 1483 (1969), PHYS. REV. LETTERS 20, 1116 (1968), ANNUAL REV. OF NUCLEAR SCIENCE 13, 261 (1963), PHYS. LETTERS 28B, 299 (1968), PHYS. LETTERS 29B, 211 (1969), PHYS. REV. 177, 2075 (1969), PHYS. REV. LETTERS 21, 1496 (1968), AND PHYS. REV. LETTERS 22, 370 (1969).

ARTICLE READ BY ODETTE BENARY IN 6/70, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON DEUTERIUM COMPOUND AT 1.194 GEV/C. (BEAM KINETIC ENERGY = .58 GEV)

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - DIFFERENTIAL CROSS SECTION

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON DEUTERON. (FIGURE 1)

LABORATORY BEAM ENERGY = .58 GEV.

(PRIVATE COMMUNICATION FROM J.S.VINCENT, JUNE, 1970)

(THESE DATA ARE CORRECTED FOR DEUTERON BREAKUP. THE TWO POINTS AT THETA=20.3 DEGREES ARE OBTAINED BY DIFFERENT TECHNIQUES.)

THETA DEGREES	D-SIGMA/D-OMEGA MB/SR	
16.9	11.900 +-	1.900
20.3	7.700	.600
20.3	6.900	.600
25.3	3.700	.600
28.6	3.100	.500
33.6	1.240	.100
36.8	.820	.070
44.7	.380	.020
44.9	.270	.020
49.6	.150	.010
52.8	.110	.010
57.4	.091	.005
60.5	.081	.005
65.0	.091	.005
72.7	.083	.005
79.5	.071	.003
86.2	.055	.003
93.7	.048	.003
99.0	.039	.005
104.9	.028	.002
110.6	.023	.003
116.0	.022	.002
126.0	.020	.003
134.0	.037	.003
142.8	.071	.007
149.5	.117	.019
154.0	.121	.009
155.6	.172	.008
161.2	.168	.007
166.2	.172	.026

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

134 SMALL ANGLE PROTON-PROTON SCATTERING AT 7.85 GEV/C. (PHYS. LETTERS 14, 54 (1965))

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A.ASHMORE,W.S.CHAPMAN,D.F.FALLA,W.H.RANGE,D.B.SCOTT (QUEEN MARY COLLEGE, LONDON, ENGLAND)
A.ASTBURY , F.CAPOCCI,T.G.WALKER (RUTHERFORD HIGH EN. LAB., CHILTON, DID, BERK, ENGLAND)

CITATIONS
BNL 832, ANNALS OF PHYSICS 3, 190 (1958), NUOVO CIMENTO 27, 427 (1963), PHYS. REV. LETTERS 11, 427 (1963), PHYS. LETTERS 13, 93 (1964), PHYS. LETTERS 8, 285 (1964), AND PHYS. LETTERS 13, 78 (1964).

ARTICLE READ BY ODETTE BENARY IN 10/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 7.85 GEV/C.

THIS EXPERIMENT USES SPARK CHAMBERS.

KEY WORDS - CROSS SECTION DIFFERENTIAL CROSS SECTION REAL (AMPLITUDE)/IMAGINARY (AMPLITUDE)

- -

PROTON PROTON TOTAL CROSS SECTION. (PAGE 55)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS
7.850 +- .018	40.0 +- .6

- -

THE RE/IM RATIO FOR THE FORWARD ELASTIC AMPLITUDE FOR PROTON PROTON. (PAGE 56)

LABORATORY BEAM MOMENTUM GEV/C	ALPHA (1)
7.850 +- .018	-.29 +- .03

(1) ERRORS INCLUDE SYSTEMATICS.

135 HIGH ENERGY NUCLEON-NUCLEON TOTAL CROSS SECTIONS. (PHYS. REV. LETTERS 9, 32 (1962))

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CITATIONS
PHYS. REV. LETTERS 5, 576 (1960), REVIEW OF SCIENTIFIC INSTRUMENTS 25, 1070 (1954), PHYS. REV. 125, 701 (1962), PHYS. REV. LETTERS 5, 333 (1960), PHYS. REV. LETTERS 7, 185 (1961), PHYS. REV. 103, 211 (1956), PHYS. REV. 100, 242 (1955), PHYS. REV. 98, 1393 (1955), PHYS. REV. 123, 1850 (1961), AND PHYS. REV. 8, 142 (1962).

ARTICLE READ BY ODETTE BENARY IN 4/67, AND VERIFIED BY LEROY PRICE.

BEAM NO. 1 IS PROTON ON HYDROGEN COMPOUND FROM 3.27 TO 7.75 GEV/C.
NO. 2 IS PROTON ON DEUTERIUM COMPOUND FROM 3.27 TO 7.75 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS • CROSS SECTION

PROTON PROTON TOTAL CROSS SECTION. (TABLE 1)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS	+-
3.27	47.1	.9
4.51	42.1	.7
5.83	41.6	.6
7.75	41.6	1.1

PROTON NEUTRON TOTAL CROSS SECTION. (TABLE 1)

(NP CROSS SECTION OBTAINED BY USING D2O AND H2O.GLAUBER CORRECTION NOT APPLIED.)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS	+-
3.27	37.1	1.3
4.51	36.8	.9
5.83	37.0	.8
7.75	37.6	1.6

136 A POSSIBLE Y = 2, S = 0 PP PI+ RESONANCE AT 2520 MEV. (PHYS. LETTERS 16, 75 (1965))

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F.CONTE, G.TOMASINI (UNIV. DI GENOVA, GENOVA, ITALY)

CLOSELY RELATED REFERENCES
PART OF THIS ARTICLE SUPERSEDED BY NUOVO CIMENTO 58A, 175 (1968).
CONTINUATION OF PREVIOUS EXPERIMENT IN SIENNA CONFERENCE 1 591 (1963), AND SIENNA CONFERENCE 1 348 (1963).

ADDITIONAL CITATIONS
CERN 1370/P, PHYS. REV. 110, 765 (1958), PHYS. REV. 105, 1874 (1957), NUOVO CIMENTO 30, 240 (1963), NUOVO CIMENTO 27, 1450 (1962), PHYS. REV. 113, 1640 (1959), REV. MOD. PHYS. 33, 458 (1961), PHYS. REV. 120, 599 (1960), NUOVO CIMENTO 15, 465 (1960), PHYS. REV. 125, 2091 (1962), PHYS. REV. LETTERS 8, 329 (1962), PHYS. REV. 126, 747 (1962), PHYS. REV. 9, 133 (1962), PHYS. REV. LETTERS 10, 142 (1963), PHYS. REV. LETTERS 12, 674 (1964), PHYS. REV. LETTERS 6, 641 (1961), PHYS. REV. LETTERS 8, 82 (1962), NUOVO CIMENTO 32, 227 (1964), PHYS. REV. LETTERS 12, 134 (1964), PHYS. REV. LETTERS 13, 696 (1964), PHYS. REV. LETTERS 13, 815 (1964), AND PHYS. REV. LETTERS 14, 339 (1965).

ARTICLE READ BY ODETTE BENARY IN 5/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 4 GEV/C.

THIS EXPERIMENT USES THE SACLAY 81 CM (H) BUBBLE CHAMBER.

KEY WORDS • CROSS SECTION MASS SPECTRUM MODELS DELTA(1238) NON-STRANGE DIBARYON STATE AT 2520 MEV

CROSS SECTION FOR PROTON PROTON • PROTON PROTON PI+ PI-.

• • THIS DATA SHOULD NOT BE USED • • (MORE RECENT VALUE PUBLISHED IN NC 58A,175(1968))

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS	NO. EVENTS
4.	2.95 +- .15	929

137 ELASTIC SCATTERING OF 580 MEV NEUTRONS BY PROTONS AND NEUTRONS. (CERN CONFERENCE 2 115 (1956))

V.P.DZHELEPOV,B.M.GOLOVIN, Y.M.KAZARINOV,N.N.SEMENOV (JOINT INST. FOR NUCL. RESEARCH, DUBNA, USSR)

CITATIONS
IZV. AKAD. NAUK. SSSR 19 573 (1955), DOKL. AKAD. NAUK. SSSR 104 717 (1955), ZURN. EKSP. TEOR. FIZ. 28, 727 (1953), PHYS. REV. 97, 1186 (1955), IZV. AKAD. NAUK. SSSR 19 548 (1955), THE PROBLEMS OF MODERN PHYSICS 7 7 (1954), NUOVO CIMENTO 12, 499 (1954), ZURN. EKSP. TEOR. FIZ. 30, 424 (1956), DOKL. AKAD. NAUK. SSSR 104 380 (1955), PHYS. REV. 96, 398 (1954), PHYS. REV. 96, 1310 (1954), PHYS. REV. 77, 441 (1950), PHYS. REV. 75, 1664 (1949), DOKL. AKAD. NAUK. SSSR 99 943 (1954), AND PHYS. REV. 95, 591 (1954).

ARTICLE READ BY ODETTE BENARY IN 10/69, AND VERIFIED BY LEROY PRICE.

BEAM NO. 1 IS NEUTRON ON PROTON FROM .927 TO 1.257 GEV/C. (BEAM KINETIC ENERGY = .38 TO .63 GEV)
NO. 2 IS NEUTRON ON DEUTERON FROM .927 TO 1.257 GEV/C. (BEAM KINETIC ENERGY = .38 TO .63 GEV)

THIS EXPERIMENT USES COUNTERS.

KEY WORDS • CROSS SECTION DIFFERENTIAL CROSS SECTION FITS

COMPOUND KEY WORDS • FITS DIFFERENTIAL CROSS SECTION

NEUTRON PROTON TOTAL CROSS SECTION. [PAGE 115]

LABORATORY BEAM ENERGY GEV [1]	MILLI-BARNS	
.38	34. +-	2.
.50	35.	2.
.59	36.	2.
.63	37.	4.

[1] MEAN VALUES.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. [TABLE 1]

LABORATORY BEAM ENERGY = .58 GEV (MEAN VALUE).

THETA DEGREES	D-SIGMA/D-OMEGA MB/SR [1,2]	
180.	8.40 +-	.70
169.	5.30	.50
157.	3.40	.30
147.	2.10	.20
135.	1.70	.13
124.	1.00	.07
114.	.78	.05
103.	.78	.05
93.	.91	.06
83.	1.10	.08
73.	1.60	.13
63.	2.10	.20
54.	2.30	.17
45.	3.00	.30
35.	3.70	.20

THETA IS THE ANGLE THAT THE NEUTRON MAKES WITH THE BEAM IN THE GRAND C.M.

[1] ERRORS ARE STASTICAL ONLY.
[2] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 13 PER CENT.

- -

NEUTRON PROTON ELASTIC CROSS SECTION. [TABLE 2]

LABORATORY BEAM ENERGY GEV [1]	MILLI-BARNS	
.38	33. +-	2.
.58	26.	3.

[1] MEAN VALUES.

- -

I = 0 NUCLEON NUCLEON ELASTIC CROSS SECTION. [TABLE 2]

LABORATORY BEAM ENERGY GEV [1]	MILLI-BARNS	
.38	42. +-	3.
.58	27.	4.

[1] MEAN VALUES.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON NEUTRON. [TABLE 3]

LABORATORY BEAM ENERGY = .59 GEV (MEAN VALUE).

THETA DEGREES	D-SIGMA/D-OMEGA MB/SR	
30.	5.80 +-	.80
49.	4.70	.50
55.	3.80	.40
67.	2.90	.35
78.	2.30	.30
89.	2.50	.25

THETA IS THE ANGLE THAT THE NEUTRON MAKES WITH THE BEAM IN THE GRAND C.M.

138 THE PRODUCTION OF NUCLEON RESONANCES IN PROTON-PROTON COLLISIONS AT HIGH ENERGY AND LARGE MOMENTUM TRANSFERS. (PHYS. LETTERS 28B, 229 (1968))

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ABSTRACT EXPERIMENTAL RESULTS ARE PRESENTED ON THE EXCITATION OF THE NUCLEON ISOBARS N*(1518) AND N*(1688) IN PROTON-PROTON COLLISIONS AT AN INCIDENT MOMENTUM OF 19.2 GEV/C AND IN THE RANGE OF FOUR-MOMENTUM SQUARED 0.6 ≤/T/≤5.8 (GEV)SQUARED.

CITATIONS
PHYS. REV. LETTERS 7, 450 (1961), PHYS. REV. 128, 1823 (1962), PHYS. LETTERS 8, 134 (1964), PHYS. LETTERS 18, 167 (1965), PHYS. REV. LETTERS 16, 855 (1966), PHYS. REV. LETTERS 17, 789 (1966), PHYS. REV. LETTERS 19, 397 (1967), PHYS. REV. 170, 1223 (1968), PHYS. LETTERS 28B, 67 (1968), PHYS. LETTERS 26B, 161 (1968), VIENNA CONFERENCE PAPER 563 (1968), PHYS. REV. 137B, 708 (1965), CERN NP/68-17, CERN TH/914, AND CERN TH/916.

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 19.2 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS * DIFFERENTIAL CROSS SECTION N*(1520)D13 'N*(1688)'

- -
- -

DIFFERENTIAL CRCSS SECTICN FCR PROTON PROTON + PROTON N*(1520)+. (TABLE 1)

LABORATORY BEAM MOMENTUM = 19.2 GEV/C.

T (GEV/C)**2	D-SIGMA/D-T UB/(GEV/C)**2	PER CENT
.56	57.0C0 +-	20
.87	21.000	2C
1.23	3.6C0	2C
1.66	.390	2C
2.14	.160	2C
2.66	.320	2C
3.23	.020	2C
3.83	.013	20
5.81	.001	50

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (CUTGOING PROTON).

- -

CIFFERENTIAL CROSS SECTION FOR PROTON PROTON + PROTON 'N*(1688)+'. (TABLE 1)

LABORATORY BEAM MOMENTUM = 19.2 GEV/C.

T (GEV/C)**2	D-SIGMA/C-T UB/(GEV/C)**2	PER CENT
.55	100.C0 +-	2C
.86	26.C0	20
1.22	4.20	2C
1.64	.64	2C
2.10	.31	2C
2.62	.33	20
3.18	.03	2C
3.77	.02	20
5.72	.C0	5C

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (CUTGOING PROTON).

139 PROTON-PROTON INTERACTION AT 56C MEV. (NUOVO CIMENTO 26, 1376 (1962))

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S.FEMINO, F.MEZZANARES (INS. DI FISICA DELL UNIV., MESSINA, ITALY)
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ABSTRACT IN THIS PAPER RESULTS ARE GIVEN CN THE PROTON-PROTON INTERACTION AT 560 MEV. THE EXPERIMENT WAS PERFORMED AT CERN USING A HYDROGEN BUBBLE CHAMBER. THE EXPERIMENTAL RESULTS SHOW EVIDENCE FOR THE PION-NUCLEON AND PROTON-NEUTRON FINAL STATE INTERACTIONS.

CITATIONS
NUOVO CIMENTO 16, 184 (1960), PHYS. REV. 119, 1716 (1960), NUOVO CIMENTO 10, 525 (1958), CERN CONFERENCE 125 (1956), DOKL. AKAD. NAUK. SSSR 100 677 (1955), JETP 5 1033 (1957), PROC. OF THE ROYAL SOCIETY OF LONDON 244, 491 (1958), NUOVO CIMENTO 2, 1269 (1955), CERN CONFERENCE 53 (1958), NUOVO CIMENTO 16, 1073 (1960), PHYS. REV. 105, 1874 (1957), AND ZURN. EKSP. TEOR. FIZ. 32, 750 (1957).

ARTICLE READ BY ODETTE BENARY IN 5/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PRCTON ON PROTON AT 1.168 GEV/C. (BEAM KINETIC ENERGY = .56 GEV)

THIS EXPERIMENT USES A HYCROGEN BUBBLE CHAMBER. A TOTAL OF 16000 PICTURES ARE REPORTED ON.

GENERAL CCMMENTS ON THIS ARTICLE
1 CROSS SECTICNS HAVE BEEN NORMALIZED TO AN ELASTIC CROSS SECTION OF 25.2 +-.8 MB.

KEY WORDS + CROSS SECTION DIFFERENTIAL CROSS SECTION ANGULAR DISTRIBUTION

- -
- -

(TABLE 1)

LABCRATORY BEAM ENERGY = .560 +- .005 GEV.

REACTION	MILLI-BARNS		NO. EVENTS
PROTON PRCTON +			
DEUTERON PI+	2.75 +-	.29	109
PROTON PROTON PIO	.91	.15	40
PROTCN NEUTRON PI+	5.21	.44	233
TOTAL INELASTIC	8.87	.66	397

- -

ELASTIC DIFFERENTIAL CRCSS SECTION FCR PROTCN PROTON. (FIGURE 1)

LABORATORY BEAM ENERGY = .560 +- .005 GEV.
NUMBER OF EVENTS = 1224.

. THIS DATA WAS READ FROM A GRAPH .

COS(THETA)	D-SIGMA/D-OMEGA MB/SR	
.76	4.50 +-	.30
.66	4.05	.35
.56	4.00	.35
.46	4.20	.4C
.36	3.9C	.40
.26	3.50	.35
.16	3.50	.35
.06	3.1C	.30

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRANC C.M.

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON - DEUTERON PI+. (FIGURE 2)

LABORATORY BEAM ENERGY = .560 +- .005 GEV.

. THIS DATA WAS READ FROM A GRAPH .

COS(THETA) MIN	MAX	NO. EVENTS
-.8	-.7	8
-.7	-.6	5
-.6	-.5	4
-.5	-.4	6
-.4	-.3	5
-.3	-.2	2
-.2	-.1	1
-.1	.0	5
.0	.1	5
.1	.2	5
.2	.3	9
.3	.4	4
.4	.5	3
.5	.6	4
.6	.7	5
.7	.8	12

THETA IS THE ANGLE THAT THE DEUTERON MAKES WITH THE BEAM IN THE GRAND C.M.

140 MEASUREMENT OF THE POLARIZATION PARAMETER IN PI+-P, K+-P, PP, AND PBAR P ELASTIC SCATTERING AT 6 GEV/C. (PHYS. LETTERS 31B, 405 (1970))

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G.COIGNET, C.CRONENBERGER,G.GREGOIRE,K.KURODA,A.MICHALOWICZ,M.POULET,D.SILLOU (UNIV. DE PARIS, FAC. DES SCI., ORSAY, FRANCE)
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ABSTRACT EXPERIMENTAL RESULTS ARE PRESENTED FOR THE POLARIZATION PARAMETER P(0) IN PI+-P, K+-P, PP, AND PBAR P ELASTIC SCATTERING AT 6 GEV/C, AND IN THE RANGE OF THE INVARIANT FOUR-MOMENTUM TRANSFER SQUARED -T FROM 0.05 TO APPROXIMATELY 2.0 (GEV/C)SQUARED.

CLOSELY RELATED REFERENCES
CONTINUATION OF PREVIOUS EXPERIMENT IN PHYS. LETTERS 24B, 77 (1967).

ADDITIONAL CITATIONS
NUCLEAR INSTRUMENTS AND METHODS 72, 45 (1969), PHYS. REV. 148, 1297 (1966), PHYS. REV. LETTERS 21, 1410 (1968), PHYS. LETTERS 29B, 1924 (1969), PHYS. REV. 179, 1480 (1969), NUC. PHYS. B9, 549 (1969), PHYS. REV. 177, 2318 (1969), NUOVO CIMENTO 63A, 141 (1969), AND CERN TH-1109 (1969).

ARTICLE READ BY ODETTE BENARY IN 3/70, AND VERIFIED BY LEROY PRICE.

BEAM NO. 1 IS PI+ ON HYDROGEN COMPOUND AT 6 GEV/C. TARGET IS POLARIZED 35 PER CENT (NORMAL TO THE BEAM DIRECTION).
NO. 2 IS PI- ON HYDROGEN COMPOUND AT 6 GEV/C. TARGET IS POLARIZED 35 PER CENT (NORMAL TO THE BEAM DIRECTION).
NO. 3 IS K+ ON HYDROGEN COMPOUND AT 6 GEV/C. TARGET IS POLARIZED 35 PER CENT (NORMAL TO THE BEAM DIRECTION).
NO. 4 IS K- ON HYDROGEN COMPOUND AT 6 GEV/C. TARGET IS POLARIZED 35 PER CENT (NORMAL TO THE BEAM DIRECTION).
NO. 5 IS PROTON ON HYDROGEN COMPOUND AT 6 GEV/C. TARGET IS POLARIZED 35 PER CENT (NORMAL TO THE BEAM DIRECTION).
NO. 6 IS ANTI-PROTON ON HYDROGEN COMPOUND AT 6 GEV/C. TARGET IS POLARIZED 35 PER CENT (NORMAL TO THE BEAM DIRECTION).

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - POLARIZATION

- -

ELASTIC POLARIZATION FOR PROTON PROTON. (TABLE 5)

LABORATORY BEAM MOMENTUM = 6. GEV/C.

-T (GEV/C)**2	+-	POLARIZATION (1)	+-
.075	.025	.108	.032
.125	.025	.129	.008
.175	.025	.137	.007
.225	.025	.131	.007
.275	.025	.142	.009
.325	.025	.112	.009
.375	.025	.124	.011
.425	.025	.113	.013
.475	.025	.099	.015
.525	.025	.090	.017
.575	.025	.052	.019
.625	.025	.112	.029
.675	.025	.107	.029
.725	.025	.097	.030
.775	.025	.107	.037
.825	.025	.064	.042
.875	.025	.039	.045
.925	.025	.034	.056
.975	.025	.100	.060
1.050	.050	.131	.062
1.150	.050	.217	.073
1.250	.050	.244	.083
1.400	.100	.154	.069
1.600	.100	.074	.086
1.800	.100	.120	.127
2.000	.100	.086	.102
2.300	.200	.060	.092

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 5 PER CENT.

141 PION PRODUCTION IN PROTON-PRCTON INTERACTICNS AT 6.6 GEV/C. (UCLA 1025 (1968))

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ABSTRACT THIS DISSERTATICN IS A STUDY OF PROTON-PROTON COLLISIONS RESULTING IN REACTIONS OF THE TYPE PROTON + PRCTCN + NUCLEON + NUCLEON + M PI WHERE M IS AN INTEGER INDICATING THE NUMBER OF PIONS PRODUCED. IN THIS WORK JUST THE CASES FOR M = 0, 1, 2, AND 3 WILL BE DEALT WITH. THE INTERACTIONS WERE PHOTOGRAPHED IN THE LAWRENCE RADIATION LABORATORY'S 72-INCH LIQUID HYDROGEN BUBBLE CHAMBEP WHICH WAS EXPOSED TO A 6.6 GEV/C SEPARATED EXTERNAL PROTON BEAM. TWO PRODUCTION TOPOLOGIES WERE ANALYZED. THE TWO- PRONG EVENTS WITH NO KINKING SECONDARIES YIELDED THE REACTIONS

PP + PP (1)
PP + FP PIC (2)
PP + PP PI+, (3)

AND THE FOUR-PRONG EVENTS YIELDEC THE REACTIONS

PP + F PI+ PI (4)
PP + PP PI+ PI- PIC (5)
PP + FN FI+ PI+ PI- . (6)

AT 6.6 GEV/C THE PRODUCTICN CROSS SECTICNS FOR REACTIONS (1) THROUGH (6) ARE, RESPECTIVELY, 10.2 +- 0.5 MB, 2.06 +- 0.19 MB, 4.89 +- 0.28 MB, 2.70 +- 0.16 MB, 2.15 +- 0.13 MB, AND 2.47 +- 0.15 MB. FOR THE ELASTIC SCATTERING HYPOTHESIS (1) THE DIFFERENTIAL CRCSS SECTICN C-SIGMA/DT IS DISPLAYEC. THE DATA ARE CONSISTENT WITH AN EXPONENTIAL T DEPENDENCE OF THE FORM EXP(-AT) WHICH IS PREDICTED BY A SIMPLE OPTICAL MCDEL OF DIFFRACTION SCATTERING WITH NO SPIN DEPENDENCE. FOR BOTH OF THE THREE-BOCY FINAL STATES THE INVARIANT MASS, CHEW-LOW AND DALITZ PLCTS ARE PRESENTED. THE DATA, IN EACH CASE, ARE INCONSISTENT WITH THE PREDICTICNS OF LORENTZ-INVARIANT ISOTROPIC THREE-BODY PHASE SPACE. IN PARTICULAR, THE NUCLECN CENTER OF MASS ANGULAR DISTRIBUTIONS ARE EXTREMELY PEAKED IN THE FCRWARD AND BACKWARD HEMISPHERES SUGGESTING A PERIPHERAL ONE-PARTICLE-EXCHANGE MECHANISM. THE DATA FOR REACTIONS (2) AND (3) AND FCR THE QUASI-TWO-BODY INTERMEDIATE STATE

PP + N*++(1238) N (3')

(WHICH REPRESENTS 25-30 PER CENT CF THE P N PI+ SAMPLE) CAN BE CESCRIBED QUITE WELL BY THE PREDICTIONS OF SIMPLE ONE-PION-EXCHANGE (OPE) MODELS MODIFIED BY SUITABLE FORM FACTORS. EIGHTY PER CENT OF THE EVENTS WHICH FORM THE SAMPLE FOR REACTICN (4) PROCEEC THROUGH THE QUASI-THREE-BODY STATE

PP + N*++(1238) P PI- . (4')

IN THE MAJORITY OF THESE EVENTS THE N*++ IS PRODUCED PERIPHERALLY. A DETAILED OPE CALCULATION, USING THE MAXIMUM LIKELIHOOD METHOD, WAS CARRIED OUT ON A SUBSAMPLE OF THE N*++ EVENTS. THE DATA ARE FOUND TO AGREE WELL WITH THE PREDICTIONS OF THE OPE DIAGRAM WITH PI +- P ELASTIC SCATTERING AT EACH VERTEX. THE OBSERVED N*(1400) EFFECT AND ITS RELATICN TO OPE ARE CISCUSSED. N*++ PRODUCTION IS ALSO OBSERVED IN STATES LEADING TO THE FIVE BODY REACTIONS (5) AND (6) APPROXIMATELY 60 AND 50 PER CENT OF THE TIME, RESPECTIVELY. FOR THE PERIPHERAL N*++ EVENTS, THE OPE MODEL WITH OFF-MASS-SHELL PI- P SCATTERING AT ONE VERTEX AND N*++ PRODUCTIO AT THE OTHER WAS USED TO DETERMINE THE RATIOS OF THE OFF-MASS SHELL SCATTERING CROSS SECTICNS FOR PI- P + PI- P, PI- P + PI- P PIO, AND PI- P + PI- PI+ N AS A FUNCTION OF T AND PI- P C.M. ENERGY. THESE RATIOS WERE COMPARED WITH THEIR KNOWN ON-SHELL VALUES AND WERE FOUND TC AGREE CUANTITATIVELY FCR LCW T.

CLOSELY RELATED REFERENCES
THIS ARTICLE SUPERSEDES PART OF PHYS. REV. LETTERS 17, 884 (1966).

ADDITIONAL CITATIONS
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ARTICLE REAC BY OCETTE BENARY IN 9/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 6.6 GEV/C.

THIS EXPERIMENT USES THE L.R.L. 72 IN. (H) BUBBLE CHAMBER.

KEY WORDS + CROSS SECTION MASS SPECTRUM ANGULAR DISTRIBUTION DIFFERENTIAL CROSS SECTION FITS MODELS DALITZ PLOT DELTA(1238) KAON OMEGA(783)

COMPOUND KEY WORDS + FITS DIFFERENTIAL CROSS SECTION

(TABLE 5)

LABCRATORY BEAM MOMENTUM = 6.6 GEV/C +- .15(PER CENT).

REACTION	MILLI-BARNS		NO. EVENTS
PROTON PROTON +			
ELASTIC	10.20 +-	.50	2400
PROTON PROTON PIO	2.06	.19	486
PROTON NEUTRON PI+	4.89	.28	1155
DEUTERON PI+	< .01		2

(TABLE 7)

LABORATORY BEAM MOMENTUM = 6.6 GEV/C +- .15(PER CENT).

REACTION	MILLI-BARNS		NO. EVENTS
PROTON PROTON +			
PROTON PROTON PI+ PI-	2.700 +-	.160	627
PROTON PROTON PI+ PI- PIO	2.150	.130	500
PROTON NEUTRON PI+ PI+ PI-	2.470	.150	573
PRCTON PROTON K+ K-	.034	.012	8
4 PRONGS	10.500	.460	2440

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. [FIGURE 18]

LABORATORY BEAM MOMENTUM = 6.6 GEV/C +- .15(PER CENT).

. THIS DATA WAS READ FROM A GRAPH .

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2 [1]	+-	NO. EVENTS
.00	.02	16.5	2.0	66
.02	.04	62.0	3.9	248
.04	.06	60.5	3.9	242
.06	.08	53.0	3.6	212
.08	.10	40.0	3.2	160
.10	.12	38.0	3.1	152
.12	.14	38.0	3.1	152
.14	.16	30.0	2.7	120
.16	.18	24.0	2.4	96
.18	.20	21.0	2.3	84
.20	.22	17.0	2.1	68
.22	.24	14.0	1.9	56
.24	.26	14.0	1.9	56
.26	.28	11.0	1.7	44
.28	.30	9.0	1.5	36
.30	.32	6.0	1.2	24
.32	.34	5.5	1.2	22
.34	.36	6.5	1.3	26
.36	.38	4.5	1.1	18
.38	.40	3.0	.9	12
.40	.42	2.5	.8	10
.42	.44	3.8	1.0	15
.44	.46	3.5	.9	14
.46	.48	2.0	.7	8
.48	.50	2.8	.8	11
.50	.52	2.8	.8	11
.52	.54	1.5	.6	6
.54	.56	1.5	.6	6

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

[1] COUNTS WERE MULTIPLIED BY .25 TO GET THESE. ERRORS ARE TAKEN AS PROPORTIONAL TO THE SQUARE-ROOT OF THE COUNTS.

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. [PAGE 63]

LABORATORY BEAM MOMENTUM = 6.6 GEV/C +- .15(PER CENT).

DATA IS FIT OVER T FROM .06 TO .60 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

FITTED FORMULA IS D-SIGMA/D-T = EXP[A+B*T]

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND T IS IN (GEV/C)**2.

FITTED VALUES

A = 4.49 +- .09
B = -7.71 +- .24

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. [PAGE 63]

LABORATORY BEAM MOMENTUM = 6.6 GEV/C +- .15(PER CENT).

DATA IS FIT OVER T FROM .06 TO .60 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (LUIGUING PRUIUN).

FITTED FORMULA IS D-SIGMA/D-T = EXP[A+BT+CT**2]

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND T IS IN (GEV/C)**2.

FITTED VALUES

A = 4.54 +- .11
B = -8.25 +- .92
C = 1.05 +- 1.72

142 EXPERIMENTAL STUDY OF PP+PN* AT INCIDENT ENERGIES OF 6-30 BEV. (PHYS. REV. LETTERS 16, 855 (1966))

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CITATIONS
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ARTICLE READ BY ODETTE BENARY IN 4/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON FROM 6 TO 30 GEV/C.

THIS EXPERIMENT USES SPARK CHAMBERS.

GENERAL COMMENTS ON THIS ARTICLE
1 THE CROSS SECTIONS FOR PP+PN* WERE OBTAINED BY MEASURING THE RESONANCES PRODUCTION AT SMALL MOMENTUM TRANSFERS AND INTEGRATING OVER THE WHOLE T PHYSICAL REGION BY ASSUMING AN EXPONENTIAL DEPENDENCE OF THE DIFFERENTIAL CROSS SECTION ON T

KEY WORDS • CROSS SECTION DIFFERENTIAL CROSS SECTION FITS DELTA(1238) N*(1470)P11 N*(1520)D13 'N*(1688)' N*(2190)G17

COMPOUND KEY WORDS • FITS DIFFERENTIAL CROSS SECTION

- -
- -

CROSS SECTION FOR PROTON PROTON + PROTON DELTA(1238)+. (TABLE 1)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS	
6.	.376 +-	.076
10.	.184	.050
15.	.142	.100

- -

CROSS SECTION FOR PROTON PROTON + PROTON N*(1470)+. (TABLE 1)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS	
10.	.544 +-	.090
15.	.602	.106
20.	.660	.150
30.	.744	.350

- -

CROSS SECTION FOR PROTON PROTON + PROTON N*(1520)+. (TABLE 1)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS	
10.	.196 +-	.056
15.	.160	.032
20.	.170	.030
30.	.166	.042

- -

CROSS SECTION FOR PROTON PROTON + PROTON 'N*(1688)+'. (TABLE 1)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS	
10.	.562 +-	.058
15.	.638	.068
20.	.560	.070
30.	.576	.084

- -

CROSS SECTION FOR PROTON PROTON + PROTON N*(2190)+. (TABLE 1)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS	
20.	.128 +-	.024
30.	.108	.036

- -

FIT TO DIFFERENTIAL CROSS SECTION FOR PROTON PROTON + PROTON DELTA(1238)+. (TABLE 1)

LABORATORY BEAM MOMENTUM = 6. GEV/C.

DATA IS FIT OVER -T FROM .01 TO .11 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (DELTA(1238)+).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 2.96 +- .56
B = 15.8 +- 2.9

- -

FIT TO DIFFERENTIAL CROSS SECTION FOR PROTON PROTON + PROTON DELTA(1238)+. (TABLE 1)

LABORATORY BEAM MOMENTUM = 10. GEV/C.

DATA IS FIT OVER -T FROM .01 TO .13 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (DELTA(1238)+).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 1.6 +- .5
B = 17.3 +- 2.0

- -

FIT TO DIFFERENTIAL CROSS SECTION FOR PROTON PROTON + PROTON DELTA(1238)+. (TABLE 1)

LABORATORY BEAM MOMENTUM = 15. GEV/C.

DATA IS FIT OVER -T FROM .02 TO .13 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (DELTA(1238)+).
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 1.5 +- 1.0
B = 21.1 +- 4.4

FIT TO DIFFERENTIAL CROSS SECTION FOR PROTON PROTON - PROTON N*(1470)+. [TABLE 1]

LABORATORY BEAM MOMENTUM = 10. GEV/C.

DATA IS FIT OVER -T FROM .01 TO .11 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING PROTON] AND THE [N*(1470)+].
FITTED FORMULA IS D-SIGMA/D-T = A*EXP[B*T]

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 6.06 +- 1.00
B = 22.3 +- 3.4

FIT TO DIFFERENTIAL CROSS SECTION FOR PROTON PROTON - PROTON N*(1470)+. [TABLE 1]

LABORATORY BEAM MOMENTUM = 15. GEV/C.

DATA IS FIT OVER -T FROM .02 TO .14 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING PROTON] AND THE [N*(1470)+].
FITTED FORMULA IS D-SIGMA/D-T = A*EXP[B*T]

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 4.8 +- .9
B = 15.5 +- 2.3

FIT TO DIFFERENTIAL CROSS SECTION FOR PROTON PROTON - PROTON N*(1470)+. [TABLE 1]

LABORATORY BEAM MOMENTUM = 20. GEV/C.

DATA IS FIT OVER -T FROM .02 TO .14 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING PROTON] AND THE [N*(1470)+].
FITTED FORMULA IS D-SIGMA/D-T = A*EXP[B*T]

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 4.75 +- 1.20
B = 14.4 +- 2.5

FIT TO DIFFERENTIAL CROSS SECTION FOR PROTON PROTON - PROTON N*(1470)+. [TABLE 1]

LABORATORY BEAM MOMENTUM = 30. GEV/C.

DATA IS FIT OVER -T FROM .07 TO .13 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING PROTON] AND THE [N*(1470)+].
FITTED FORMULA IS D-SIGMA/D-T = A*EXP[B*T]

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = 0.02 +- 4.20
B = 23.5 +- 5.1

FIT TO DIFFERENTIAL CROSS SECTION FOR PROTON PROTON - PROTON N*(1520)+. [TABLE 1]

LABORATORY BEAM MOMENTUM = 10. GEV/C.

DATA IS FIT OVER -T FROM .3 TO .8 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING PROTON] AND THE [N*(1520)+].
FITTED FORMULA IS D-SIGMA/D-T = A*EXP[B*T]

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = .39 +- .12
B = 3.95 +- .51

FIT TO DIFFERENTIAL CROSS SECTION FOR PROTON PROTON - PROTON N*(1520)+. [TABLE 1]

LABORATORY BEAM MOMENTUM = 15. GEV/C.

DATA IS FIT OVER -T FROM .2 TO .9 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING PROTON] AND THE [N*(1520)+].
FITTED FORMULA IS D-SIGMA/D-T = A*EXP[B*T]

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = .31 +- .07
B = 3.98 +- .45

FIT TO DIFFERENTIAL CROSS SECTION FOR PROTON PROTON - PROTON N*(1520)+. [TABLE 1]

LABORATORY BEAM MOMENTUM = 20. GEV/C.

DATA IS FIT OVER -T FROM .2 TO .9 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE [INCOMING PROTON] AND THE [N*(1520)+].
FITTED FORMULA IS D-SIGMA/D-T = A*EXP[B*T]

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUES

A = .33 +- .07
B = 3.83 +- .37

```
FIT TO DIFFERENTIAL CROSS SECTION FOR    PROTON PROTON  -  PROTON N*(1520)+.        (TABLE 1)

     LABORATORY BEAM MOMENTUM  =  30. GEV/C.

     DATA IS FIT OVER -T FROM .2 TO .9 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE
          (N*(1520)+).
     FITTED FORMULA IS         D-SIGMA/D-T  =  A*EXP(B*T)

          WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

     FITTED VALUES

          A  =  .36 +- .10
          B  =  4.3 +- .5

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

FIT TO DIFFERENTIAL CROSS SECTION FOR    PROTON PROTON  -  PROTON 'N*(1688)+'.        (TABLE 1)

     LABORATORY BEAM MOMENTUM  =  10. GEV/C.

     DATA IS FIT OVER -T FROM .01 TO .80 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE
          ('N*(1688)+').
     FITTED FORMULA IS         D-SIGMA/D-T  =  A*EXP(B*T)

          WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

     FITTED VALUES

          A  =  1.28 +- .10
          B  =  4.5 +- .5

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

FIT TO DIFFERENTIAL CROSS SECTION FOR    PROTON PROTON  -  PROTON 'N*(1688)+'.        (TABLE 1)

     LABORATORY BEAM MOMENTUM  =  15. GEV/C.

     DATA IS FIT OVER -T FROM .02 TO .60 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE
          ('N*(1688)+').
     FITTED FORMULA IS         D-SIGMA/D-T  =  A*EXP(B*T)

          WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

     FITTED VALUES

          A  =  1.61 +- .17
          B  =  5.05 +- .38

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

FIT TO DIFFERENTIAL CROSS SECTION FOR    PROTON PROTON  -  PROTON 'N*(1688)+'.        (TABLE 1)

     LABORATORY BEAM MOMENTUM  =  20. GEV/C.

     DATA IS FIT OVER -T FROM .04 TO .80 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE
          ('N*(1688)+').
     FITTED FORMULA IS         D-SIGMA/D-T  =  A*EXP(B*T)

          WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

     FITTED VALUES

          A  =  1.47 +- .20
          B  =  5.25 +- .48

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

FIT TO DIFFERENTIAL CROSS SECTION FOR    PROTON PROTON  -  PROTON 'N*(1688)+'.        (TABLE 1)

     LABORATORY BEAM MOMENTUM  =  30. GEV/C.

     DATA IS FIT OVER -T FROM .07 TO .90 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE
          ('N*(1688)+').
     FITTED FORMULA IS         D-SIGMA/D-T  =  A*EXP(B*T)

          WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

     FITTED VALUES

          A  =  1.79 +- .29
          B  =  6.19 +- .50

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

FIT TO DIFFERENTIAL CROSS SECTION FOR    PROTON PROTON  -  PROTON N*(2190)+.        (TABLE 1)

     LABORATORY BEAM MOMENTUM  =  20. GEV/C.

     DATA IS FIT OVER -T FROM .07 TO .80 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE
          (N*(2190)+).
     FITTED FORMULA IS         D-SIGMA/D-T  =  A*EXP(B*T)

          WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

     FITTED VALUES

          A  =  .328 +- .072
          B  =  5.14 +- .56

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

FIT TO DIFFERENTIAL CROSS SECTION FOR    PROTON PROTON  -  PROTON N*(2190)+.        (TABLE 1)

     LABORATORY BEAM MOMENTUM  =  30. GEV/C.

     DATA IS FIT OVER -T FROM .00 TO .60 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE
          (N*(2190)+).
     FITTED FORMULA IS         D-SIGMA/D-T  =  A*EXP(B*T)

          WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

     FITTED VALUES

          A  =  .274 +- .100
          B  =  5.07 +- .90
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143 STRUCTURE IN THE ANGULAR DISTRIBUTION OF PROTON-PROTON ELASTIC SCATTERING AT LARGE MOMENTUM TRANSFERS. (CERN 68-7 580 (1968))

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CLOSELY RELATED REFERENCES
THIS ARTICLE SUPERSEDES PART OF PHYS. LETTERS 23, 389 (1966), AND PHYS. LETTERS 25B, 156 (1967).

ADDITIONAL CITATIONS
PHYS. REV. 138, B165 (1965), PHYS. LETTERS 13, 190 (1964), PHYS. REV. 159, 1738 (1967), PHYS. REV. LETTERS 19, 1149 (1967), BNL 11360 (1967), UCRL 16275 (1966), UCRL 17257 (1966), PHYS. REV. LETTERS 11, 425 (1963), PHYS. REV. LETTERS 15, 45 (1965), NUOVO CIMENTO 38, 60 (1965), PHYS. REV. 152, 1162 (1966), PHYS. REV. LETTERS 9, 111 (1962), PHYS. REV. LETTERS 16, 1217 (1966), AND NUOVO CIMENTO 41, 167 (1966).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON HYDROGEN COMPOUND FROM 7.1 TO 12.1 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - DIFFERENTIAL CROSS SECTION FITS

COMPOUND KEY WORDS - FITS DIFFERENTIAL CROSS SECTION

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 7.1 +- .1 GEV/C.

THETA DEGREES		D-SIGMA/D-OMEGA UB/SR [1]	PER CENT
60.0 +-	.2	4.050 +-	4
62.0	.2	3.500	4
65.0	.2	2.540	4
68.0	.2	2.000	4
71.0	.2	1.548	4
75.0	.2	1.174	4
80.0	.2	.831	4
90.0	.2	.625	4

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7 PER CENT.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 8.1 +- .1 GEV/C.

(THIS DATA REPLACES VALUES GIVEN EARLIER IN ALLABY, ET AL., PHYS. LETTERS 25B, 156 (1967))

THETA DEGREES		D-SIGMA/D-OMEGA UB/SR [1]	PER CENT
40.0 +-	.2	18.020 +-	4
43.0	.2	13.110	4
46.0	.2	9.050	4
49.0	.2	6.370	4
52.0	.2	4.810	4
55.0	.2	3.320	4
58.0	.2	2.370	4
60.0	.2	1.996	4
62.0	.2	1.504	4
65.0	.2	1.051	4
68.0	.2	.777	4
71.0	.2	.586	4
75.0	.2	.376	4
80.0	.2	.297	4
90.0	.2	.158	4

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7 PER CENT.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 9.2 +- .1 GEV/C.

(THIS DATA REPLACES VALUES GIVEN EARLIER IN ALLABY, ET AL., PHYS. LETTERS 25B, 156 (1967))

THETA DEGREES		D-SIGMA/D-OMEGA UB/SR [1]	PER CENT
40.0 +-	.2	8.7900 +-	4
43.0	.2	6.6900	4
46.0	.2	5.1400	4
49.0	.2	3.8900	4
52.0	.2	2.4200	4
55.0	.2	1.6940	4
58.0	.2	1.1450	4
60.0	.2	.8450	4
62.0	.2	.6160	4
65.0	.2	.3910	4
68.0	.2	.2640	4
71.0	.2	.1999	4
75.0	.2	.1457	4
80.0	.2	.1112	4
90.0	.2	.1051	4

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

[1] PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7 PER CENT.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 10.1 +- .1 GEV/C.

(THIS DATA REPLACES VALUES GIVEN EARLIER IN ALLABY, ET AL., PHYS. LETTERS 25B, 156 (1967))

THETA DEGREES		D-SIGMA/D-OMEGA UB/SR (1)	PER CENT
40.0 +-	.2	5.9700 +-	4
42.0	.2	5.5800	4
44.0	.2	4.4900	4
46.0	.2	3.4100	4
48.0	.2	2.5100	4
50.0	.2	1.8650	4
52.0	.2	1.3170	4
54.0	.2	.9880	4
56.0	.2	.6440	4
58.0	.2	.4810	4
60.0	.2	.3450	4
62.0	.2	.2550	4
65.0	.2	.1686	4
68.0	.2	.1282	4
71.0	.2	.0934	4
75.0	.2	.0791	4
80.0	.2	.0600	4
90.0	.2	.0516	4

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7 PER CENT.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 11.1 +- .1 GEV/C.

(THIS DATA REPLACES VALUES GIVEN EARLIER IN ALLABY, ET AL., PHYS. LETTERS 25B, 156 (1967))

THETA DEGREES		D-SIGMA/D-OMEGA UB/SR (1)	PER CENT
40.0 +-	.2	5.1300 +-	4
43.0	.2	3.3200	4
46.0	.2	2.0100	4
49.0	.2	1.1930	4
52.0	.2	.6660	4
55.0	.2	.3600	4
58.0	.2	.2230	4
60.0	.2	.1569	4
62.0	.2	.1099	4
65.0	.2	.0771	4
68.0	.2	.0572	4
71.0	.2	.0465	4
75.0	.2	.0384	4
80.0	.2	.0335	4
90.0	.2	.0304	4

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7 PER CENT.

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 12.1 +- .1 GEV/C.

THETA DEGREES		D-SIGMA/D-OMEGA UB/SR (1)	PER CENT
40.0 +-	.2	3.5200 +-	4
43.0	.2	1.9500	4
46.0	.2	1.0440	4
49.0	.2	.5540	4
52.0	.2	.2960	4
55.0	.2	.1610	4
58.0	.2	.0914	4
60.0	.2	.0714	4
62.0	.2	.0565	4
65.0	.2	.0357	6
68.0	.2	.0298	6
71.0	.2	.0252	6
75.0	.2	.0192	6
80.0	.2	.0173	6
90.0	.2	.0166	6

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 7 PER CENT.

144 POLARIZATION AND SPIN CORRELATION PARAMETERS MEASUREMENTS IN 600 MEV PROTON-PROTON SCATTERING USING A POLARIZED PROTON TARGET. (NUOVO CIMENTO 43A, 708 (1966))

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ABSTRACT USING A POLARIZED OR UNPOLARIZED PROTON BEAM PREVIOUSLY DESCRIBED AND A POLARIZED PROTON TARGET (70 PER CENT) WE MEASURED THE PARAMETERS P(THETA) AND (C(N,N))(THETA) IN THE ANGULAR INTERVAL FROM 23 DEG. TO 104 DEG. IN THE CENTER-OF-MASS SYSTEM AT ABOUT 600 MEV. THE EXPERIMENTAL SET-UP AND THE WAY IN WHICH THE DATA WERE CARRIED OUT ARE DISCUSSED. RESULTS ARE PRESENTED AND COMPARED TO THOSE ALREADY OBTAINED IN THE SAME ENERGY REGION.

CITATIONS
JETP 6 28 (1958), JETP 17 98 (1963), UCRL 11440 (1964), UCRL 11877 (1965), NUOVO CIMENTO 43A, 701 (1966), HELVETICA PHYSICA ACTA 38 660 (1965), UCRL 11149 (1964), NUCLEAR INSTRUMENTS AND METHODS 15, 323 (1962), AND UCRL 11565 (1964).

ARTICLE READ BY ODETTE BENARY IN 5/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 1.212 GEV/C. TARGET IS POLARIZED 70 PER CENT (NORMAL TO THE BEAM DIRECTION).

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - POLARIZATION

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- -

ELASTIC POLARIZATION FOR PROTON PROTON.

LABORATORY BEAM ENERGY = .595 +- .006 GEV.

THETA DEGREES	POLARIZATION	
23.0	.4446 +-	.0740
32.0	.4735	.1170
36.5	.5260	.0270
41.0	.4878	.0265
45.4	.4875	.0250
49.8	.4585	.0205
54.2	.4255	.0220
62.9	.3805	.0200
67.0	.2970	.0145
75.6	.2305	.0130
79.7	.1605	.0130
83.9	.1055	.0110
87.9	.0405	.0110
91.2	-.0183	.0095
96.0	-.0840	.0105
103.9	-.2350	.0140

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

145 NEUTRON-PROTON ELASTIC SCATTERING FROM 3 TO 10 GEV. [NUOVO CIMENTO 59A, 1 (1969)]

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ABSTRACT NEW DATA ON THE NEUTRON-PROTON DIFFERENTIAL CROSS-SECTION IN THE MOMENTUM-TRANSFER RANGE FROM 0.06 TO 0.30 (GEV/C)SQUARED, FOR TWO ENERGY REGIONS (FROM 3 TO 6 GEV AND FROM 6 TO 10 GEV), ARE REPORTED.

CITATIONS
PHYS. REV. LETTERS 16, 1217 (1966), NUOVO CIMENTO 41A, 167 (1966), PHYS. REV. LETTERS 9, 509 (1962), PRIBORI I TECH TECH. EXP. 1 41 (1939), DUBNA P-2916 (1966), DUBNA P-1468 (1963), ZURN. EKSP. TEOR. FIZ. 44, 1481 (1963), DUBNA P 1136 (1963), DUBNA P-215 (1965), PHYS. REV. 96, 448 (1954), ZURN. EKSP. TEOR. FIZ. 42, 392 (1962), PHYS. LETTERS 7, 80 (1963), DUBNA D-880, DUBNA D-780, ZURN. EKSP. TEOR. FIZ. 44, 1411 (1963), JACERN. FIZ. 1, 134 (1965), NUOVO CIMENTO 49A, 479 (1967), ZURN. EKSP. TEOR. FIZ. 44, 1487 (1963), PHYS. REV. LETTERS 11, 425 (1963), PHYS. REV. LETTERS 11, 503 (1963), PHYS. REV. LETTERS 15, 45 (1963), PHYS. LETTERS 10, 376 (1963), PHYS. LETTERS 10, 543 (1963), AND DUBNA P-2424 (1965).

ARTICLE READ BY ODETTE BENARY IN 2/69, AND VERIFIED BY LEROY PRICE.

BEAM IS NEUTRON ON HEAVY LIQUID FROM 3.826 TO 10.900 GEV/C. (BEAM KINETIC ENERGY = 3 TO 10 GEV)

THIS EXPERIMENT USES THE DUBNA 24 LITER (HLBC) BUBBLE CHAMBER. A TOTAL OF 40000 PICTURES ARE REPORTED ON.

KEY WORDS • CROSS SECTION DIFFERENTIAL CROSS SECTION FITS

COMPOUND KEY WORDS • FITS DIFFERENTIAL CROSS SECTION

- -
- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON.

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM 3. TO 6. GEV/C.
NUMBER OF EVENTS = 80.

(PRIVATE COMMUNICATION FROM C.BESLIU APRIL 1969)

-T (GEV/C)**2 MIN	MAX	ARBITRARY UNITS	
.02	.04	83. +-	25.
.04	.06	105.	30.
.06	.08	90.	30.
.08	.10	115.	35.
.10	.12	85.	30.
.12	.14	50.	20.
.14	.20	56.	20.
.20	.40	21.	6.

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

- -

ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON.

DATA IS AVERAGED OVER LABORATORY BEAM MOMENTUM FROM 6. TO 10. GEV/C.
NUMBER OF EVENTS = 100.

(PRIVATE COMMUNICATION FROM C.BESLIU APRIL 1969)

-T (GEV/C)**2 MIN	MAX	ARBITRARY UNITS	
.02	.04	76. +-	25.
.04	.06	105.	30.
.06	.08	115.	35.
.08	.10	76.	25.
.10	.12	41.	15.
.12	.14	79.	25.
.14	.20	45.	25.
.20	.40	13.	4.

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

- -

NEUTRON PROTON ELASTIC CROSS SECTION. [PAGE 6]

(ASSUMING OPTICAL THEOREM AND TAKING FOR THE TOTAL NP CROSS SECTION THE VALUE OF 41.2 MILIBARNS.)

LABORATORY BEAM MOMENTUM GEV/C MIN	MAX	MILLI-BARNS
3.	10.	12.5 +- .8

FIT TO ELASTIC DIFFERENTIAL CRCSS SECTION FOR NEUTRON PROTON. (TABLE 1)

DATA IS FIT OVER LABCRATCRY BEAM MOMENTUM FROM 3. TO 6. GEV/C.

DATA IS FIT CVER T FRCM .06 TO .30 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRCN) AND THE (CUTGOING NEUTRCN).
FITTED FORMULA IS NC. EVENTS = A*EXP(-B*T)

WHERE T IS IN (GEV/C)**2.

FITTED VALUES

B = 6.9 +- 1.C

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 1)

DATA IS FIT OVER LABORATCRY BEAM MOMENTUM FROM 6. TO 10. GEV/C.

DATA IS FIT CVER T FRCM .06 TO .30 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (CUTGOING NEUTRCN).
FITTED FORMULA IS NC. EVENTS = A*EXP(-B*T)

WHERE T IS IN (GEV/C)**2.

FITTED VALUE

B = 8.6 +- .9

146 ABSOLUTE MEASUREMENTS CF PROTCN-PRCTON SMALL-ANGLE ELASTIC SCATTERING AND TOTAL CROSS SECTIONS AT 10, 19, AND 26 GEV/C. (PHYS. LETTERS 14, 164 (1965))

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CITATIONS
PHYS. REV. 178, 579 (1959), PHYS. REV. LETTERS 9, 108 (1962), SIENNA CONFERENCE 1 593 (1963), PHYS. REV. 130, 1182 (1963), PHYS. REV. LETTERS 11, 425 (1963), SIENNA CONFERENCE 1 598 (1963), CERN 64-30P.183 (1964), CERN 64-30P.211 (1964), ANNALS OF PHYSICS 3, 19C (1958), PHYS. LETTERS 12, 252 (1964), PHYS. LETTERS 14, 54 (1965), PHYS. LETTERS 13, 93 (1964), DUBNA E-1820 (1964), AND PHYS. LETTERS 13, 78 (1964).

ARTICLE READ BY OCETTE BENARY IN 10/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTCN FROM 10.1 TO 26.4 GEV/C.

THIS EXPERIMENT USES SPARK CHAMBERS.

KEY WORDS - CROSS SECTICN DIFFERENTIAL CROSS SECTION REAL (AMPLITUDE)/IMAGINARY (AMPLITUDE)

PROTCN PROTCN TOTAL CROSS SECTICN. (TABLE 1)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS
10.11	40.C +- .3
19.33	38.9 .3
26.42	38.8 .3

THE RE/IM RATIO FOR THE FORWARD ELASTIC AMPLITUDE FOR PROTON PROTON. (TABLE 1)

(THESE VALUES ASSUME THAT THE SPIN-DEPENDENT CCNTRIBUTION IS ZERO)

LABORATORY BEAM MCMENTUM GEV/C	ALPHA
10.11	-.430 +- .043
19.33	-.330 .C33
26.42	-.320 .C33

147 AN INVESTIGATION OF THE 1.4 GEV NUCLECN ISCBAR IN PROTON-PROTON INTERACTIONS. (PHYS. LETTERS 28B, 195 (1968))

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ABSTRACT THE PRODUCTION OF N*(14CC) ISOBAR IN THE REACTICN PP - P N*+(1400), WHERE N*(1400) - N PI+ AND P PI0, IS INVESTIGATED WITH THE AID CF ONE-PION EXCHANGE MODEL. THE ONE-PION EXCHANGE MECHANISM DOES NOT SEEM TO DOMINATE THE PRODUCTION PROCESS. THE ISOSPIN OF N*(1400) IS FCUND TO BE I = 1/2, AND THE ELASTICITY OF THE RESONANCE IS ESTIMATED TO BE 0.66.

CITATIONS
PHYS. REV. LETTERS 12, 340 (1964), PHYS. LETTERS 26B, 161 (1968), PHYS. REV. 165, 1730 (1968), PHYS. REV. LETTERS 19, 397 (1967), PHYS. REV. LETTERS 17, 789 (1966), PHYS. REV. LETTERS 16, 855 (1966), NUOVO CIMENTO 35, 1052 (1965), PHYS. LETTERS 8, 134 (1964), PHYS. REV. LETTERS 17, 789 (1966), AND NUOVO CIMENTO 40A, 899 (1965).

ARTICLE READ BY OCETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PRCTON ON PROTON AT 6.C7 GEV/C.

THIS EXPERIMENT USES THE L.R.L. 72 IN. (H) BUBBLE CHAMBER.

KEY WORDS - CROSS SECTION MASS SPECTRUM MODELS N*(1470)P11 DIFFERENTIAL CROSS SECTICN FITS DELTA(1238) N*(1520)D13 'N*(1688)'

COMPOUND KEY WORDS - FITS DIFFERENTIAL CROSS SECTION

(FROM PAGE 195 AND TABLE 1)

LABORATORY BEAM MOMENTUM = 6.07 GEV/C.

REACTION	MILLI-BARNS	
PROTON PROTON +		
PROTON NEUTRON PI+	6.70 +-	.50
PROTON PROTON PIO	2.80	.30
PROTON DELTA(1238)+	.28	.08
DELTA(1238)+ + NEUTRON PI+ [1]		
PROTON N*(1470)+	.27	.13
N*(1470)+ + NEUTRON PI+ [2]		
PROTON N*(1520)+	.15	.09
N*(1520)+ + NEUTRON PI+ [1]		
PROTON 'N*(1688)+'	.19	.09
'N*(1688)+' + NEUTRON PI+ [1]		
PROTON DELTA(1238)+	.52	.13
DELTA(1238)+ + PROTON PIO [1]		
PROTON N*(1470)+	.11	.09
N*(1470)+ + PROTON PIO [2]		
PROTON N*(1520)+	.08	.05
N*(1520)+ + PROTON PIO [1]		
PROTON 'N*(1688)+'	.10	.05
'N*(1688)+' + PROTON PIO [1]		

[1] FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.
[2] FITTED FOR MASS AND/OR WIDTH [MASS = 1.390 GEV; WIDTH = .150 GEV], AND THEN TOOK ONLY EVENTS ABOVE (FITTED) BACKGROUND.

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FIT TO DIFFERENTIAL CROSS SECTION FOR PROTON PROTON + N*(1470)+ PROTON. (PAGE 197)

LABORATORY BEAM MOMENTUM = 6.07 GEV/C.
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(ALPHA*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (N*(1470)+).

FITTED VALUE

ALPHA = 10.4 +- 1.0

148 TOTAL CROSS SECTIONS OF PROTONS, ANTIPROTONS, AND PI AND K MESONS ON HYDROGEN AND DEUTERIUM IN THE MOMENTUM RANGE 6-22 GEV/C. (PHYS. REV. 138, B913 (1965))

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ABSTRACT THE TOTAL CROSS SECTIONS SIGMA(T) OF P, ANTI-P, CHARGED PI AND CHARGED K ON HYDROGEN AND DEUTERIUM HAVE BEEN MEASURED BETWEEN 6 AND 22 GEV/C AT INTERVALS OF 2 GEV/C TO AN ACCURACY GREATER THAN PREVIOUSLY REPORTED. THE METHOD UTILIZED WAS A CONVENTIONAL GOOD-GEOMETRY TRANSMISSION EXPERIMENT WITH SCINTILLATION COUNTERS SUBTENDING VARIOUS SOLID ANGLES AT TARGETS OF LIQUID H(2) AND D(2). WITH THE INCREASE IN STATISTICAL ACCURACY OF THE DATA, IT WAS FOUND THAT A PREVIOUSLY ADOPTED PROCEDURE OF LINEARLY EXTRAPOLATING TO ZERO SOLID ANGLE THE PARTIAL CROSS SECTIONS MEASURED AT FINITE SOLID ANGLES WAS NOT A SUFFICIENTLY ACCURATE PROCEDURE FROM WHICH TO DEDUCE SIGMA(T). THE PARTICLE-NEUTRON CROSS SECTIONS ARE DERIVED BY APPLYING THE GLAUBER SCREENING CORRECTION TO THE DIFFERENCE BETWEEN THE PARTICLE-DEUTERON AND PARTICLE-PROTON CROSS SECTIONS. THE TOTAL CROSS SECTIONS OF PI+D AND PI-D ARE EQUAL AT ALL MEASURED MOMENTA, WHICH CONFIRMS THE VALIDITY OF CHARGE SYMMETRY UP TO 20 GEV/C. RESULTS ARE PRESENTED SHOWING THE VARIATION OF CROSS SECTIONS WITH MOMENTUM; EVIDENCE IS PRESENTED FOR A SMALL BUT SIGNIFICANT DECREASE IN PP TOTAL CROSS SECTIONS AND PN TOTAL CROSS SECTIONS IN THE MOMENTUM REGION ABOVE 12 GEV/C.

CITATIONS
FORTSCHRITTE DER PHYSIK 9, 549 (1961), PHYS. REV. LETTERS 10, 262 (1963), PHYS. REV. LETTERS 13, 205 (1964), PHYS. REV. LETTERS 7, 185 (1961), PHYS. REV. LETTERS 7, 352 (1961), PHYS. REV. LETTERS 5, 576 (1960), PHYS. REV. LETTERS 7, 127 (1961), PHYS. REV. LETTERS 8, 173 (1962), PHYS. REV. LETTERS 9, 32 (1962), NUOVO CIMENTO 34, 825 (1964), PHYS. REV. 129, 2285 (1963), PHYS. REV. 123, 1850 (1961), INT'L. CONGRESS ON NUCLEAR PHYSICS,PARIS,FRANCE 162 (1964), JETP 15 272 (1962), JETP 18 1239 (1963), PHYS. REV. LETTERS 3, 285 (1959), PHYS. REV. 128, 869 (1962), PHYS. REV. 100, 242 (1955), PHYS. REV. 123, 320 (1961), PHYS. REV. LETTERS 7, 182 (1961), JETP 34 499 (1958), NUOVO CIMENTO 14, 951 (1959), NUOVO CIMENTO 18, 947 (1960), PHYS. REV. LETTERS 9, 108 (1962), PHYS. REV. LETTERS 10, 376 (1963), PHYS. REV. LETTERS 10, 543 (1963), PHYS. REV. LETTERS 11, 425 (1963), PHYS. REV. LETTERS 11, 503 (1963), UCRL 3421 (1956), NUCLEAR ELECTRONICS 1, 63 (1962), REVIEW OF SCIENTIFIC INSTRUMENTS 25, 1070 (1934), PHYS. REV. 135, B358 (1964), PHYS. LETTERS 14, 164 (1965), PHYS. REV. 134, B633 (1964), AND PHYS. REV. 134, B630 (1964).

ARTICLE READ BY NAOMI BARASH-SCHMIDT IN 3/68, AND VERIFIED BY LEROY PRICE.

BEAM NO. 1 IS PI+ ON PROTON FROM 6 TO 20 GEV/C.
NO. 2 IS PI- ON PROTON FROM 6 TO 20 GEV/C.
NO. 3 IS PI+ ON DEUTERON FROM 6 TO 20 GEV/C.
NO. 4 IS PI- ON DEUTERON FROM 6 TO 20 GEV/C.
NO. 5 IS K+ ON DEUTERON FROM 6 TO 20 GEV/C.
NO. 6 IS K+ ON PROTON FROM 6 TO 20 GEV/C.
NO. 7 IS K- ON DEUTERON FROM 6 TO 18 GEV/C.
NO. 8 IS K- ON PROTON FROM 6 TO 20 GEV/C.
NO. 9 IS PROTON ON DEUTERON FROM 6 TO 22 GEV/C.
NO. 10 IS PROTON ON PROTON FROM 6 TO 22 GEV/C.
NO. 11 IS ANTI-PROTON ON DEUTERON FROM 6 TO 18 GEV/C.
NO. 12 IS ANTI-PROTON ON PROTON FROM 6 TO 18 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS + CROSS SECTION

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K+ DEUTERON TOTAL CROSS SECTION. (TABLE 3)

LABORATORY BEAM MOMENTUM GEV/C	PER CENT	MILLI-BARNS	
6. +-	1.75	33.4 +-	.3
8.	1.75	33.9	.3
10.	1.75	33.8	.3
12.	1.75	33.9	.3
14.	1.75	33.8	.3
16.	1.75	33.4	.3
18.	1.75	33.7	.3
20.	1.75	34.2	.3

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K+ PROTCN TCTAL CROSS SECTION. (TABLE 3)

LABORATORY BEAM MOMENTUM GEV/C	PER CENT	MILLI-BARNS	
6.	+- 1.75	17.C	+- .1
8.	1.75	17.3	.1
10.	1.75	17.3	.1
12.	1.75	17.3	.1
14.	1.75	17.4	.1
16.	1.75	17.0	.1
18.	1.75	17.1	.1
20.	1.75	17.5	.1

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K+ NEUTRON TOTAL CROSS SECTION. (TABLE 3)

(UNFOLDED FROM DEUTERIUM CATA)

LABCRATORY BEAM MOMENTUM GEV/C	PER CENT	MILLI-BARNS	
6.	+- 1.75	17.5	+- .4
8.	1.75	17.6	.4
10.	1.75	17.5	.4
12.	1.75	17.6	.4
14.	1.75	17.5	.4
16.	1.75	17.4	.4
18.	1.75	17.6	.4
20.	1.75	17.7	.4

- -

K- CEUTERCN TOTAL CROSS SECTION. (TABLE 3)

LABORATORY BEAM MCMENTUM GEV/C	PER CENT	MILLI-BARNS	
6.	+- 1.75	44.1	+- .3
8.	1.75	41.7	.3
10.	1./5	41.5	.3
12.	1.75	40.3	.3
14.	1.75	40.1	.3
16.	1.75	40.1	.4
18.	1.75	39.9	.7

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K- PROTCN TOTAL CROSS SECTION. (TABLE 3)

LABORATORY BEAM MOMENTUM GEV/C	PER CENT	MILLI-BARNS	
6.	+- 1.75	24.0	+- .3
8.	1.75	23.6	.2
10.	1.75	22.5	.2
12.	1.75	21.6	.2
14.	1.75	21.5	.2
16.	1.75	21.3	.4
18.	1.75	21.0	.8
20.	1.75	22.4	4.6

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K- NEUTRON TOTAL CROSS SECTION.

(UNFOLDED FRCM DEUTERIUM CATA)

LABCRATCRY BEAM MOMENTUM GEV/C	PER CENT	MILLI-BARNS	
6.	+- 1.75	21.9	+- .4
8.	1.75	19.7	.4
10.	1.75	20.6	.4
12.	1.75	20.2	.4
14.	1.75	20.1	.4
16.	1.75	20.3	.6
10.	1.75	30.3	1.1

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PI+ PROTCN TOTAL CROSS SECTION. (TABLE 2)

LABORATORY BEAM MOMENTUM GEV/C	PER CENT	MILLI-BARNS	
6.	+- 1.75	26.2	+- .2
8.	1.75	25.1	.2
10.	1.75	24.8	.2
12.	1.75	24.2	.2
14.	1.75	23.9	.2
16.	1.75	23.4	.2
18.	1.75	23.5	.2
20.	1.75	23.4	.2

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PI- PROTON TOTAL CROSS SECTION. (TABLE 2)

LABORATORY BEAM MOMENTUM GEV/C	PER CENT	MILLI-BARNS	
6.	+- 1.75	28.5	+- .3
8.	1.75	27.5	.3
10.	1.75	26.5	.3
12.	1.75	25.9	.3
14.	1.75	25.4	.3
16.	1.75	25.1	.3
18.	1.75	25.0	.3
20.	1.75	24.8	.3

PI+ DEUTERON TOTAL CROSS SECTION. (TABLE 2)

LABORATORY BEAM MOMENTUM GEV/C	PER CENT	MILLI-BARNS	
6.	+- 1.75	52.8	+- .5
8.	1.75	50.5	.5
10.	1.75	49.3	.5
12.	1.75	48.2	.5
14.	1.75	46.9	.5
16.	1.75	46.6	.5
18.	1.75	46.3	.5
20.	1.75	45.9	.5

PI- DEUTERON TOTAL CROSS SECTION. (TABLE 2)

LABORATORY BEAM MOMENTUM GEV/C	PER CENT	MILLI-BARNS	
6.	+- 1.75	52.7	+- .5
8.	1.75	51.0	.5
10.	1.75	49.3	.5
12.	1.75	47.9	.5
14.	1.75	47.1	.5
16.	1.75	46.4	.5
18.	1.75	46.4	.5
20.	1.75	45.8	.5

PROTON DEUTERON TOTAL CROSS SECTION. (TABLE 4)

LABORATORY BEAM MOMENTUM GEV/C	PER CENT	MILLI-BARNS	
6.	+- 1.75	77.4	+- 1.3
8.	1.75	76.2	1.3
10.	1.75	75.8	1.3
12.	1.75	74.4	1.3
14.	1.75	74.0	1.3
16.	1.75	73.7	1.3
18.	1.75	72.8	1.3
20.	1.75	72.1	1.3
22.	1.75	71.6	1.3

PROTON PROTON TOTAL CROSS SECTION. (TABLE 4)

LABORATORY BEAM MOMENTUM GEV/C	PER CENT	MILLI-BARNS	
6.	+- 1.75	40.6	+- .6
8.	1.75	40.0	.6
10.	1.75	39.9	.6
12.	1.75	39.4	.6
14.	1.75	39.1	.6
16.	1.75	38.7	.6
18.	1.75	38.7	.6
20.	1.75	38.4	.6
22.	1.75	38.3	.6

PROTON NEUTRON TOTAL CROSS SECTION. (TABLE 4)

(UNFOLDED FROM DEUTERIUM DATA.)
GLAUBER CORRECTION APPLIED

LABORATORY BEAM MOMENTUM GEV/C	PER CENT	MILLI-BARNS	
6.	+- 1.75	42.6	+- 1.7
8.	1.75	41.8	1.7
10.	1.75	41.5	1.7
12.	1.75	40.4	1.7
14.	1.75	40.2	1.7
16.	1.75	40.2	1.7
18.	1.75	39.2	1.7
20.	1.75	38.7	1.7
22.	1.75	38.2	1.7

PBAR DEUTERON TOTAL CROSS SECTION. (TABLE 4)

LABORATORY BEAM MOMENTUM GEV/C	PER CENT	MILLI-BARNS	
6.	+- 1.75	106.9	+- 1.3
8.	1.75	102.7	1.3
12.	1.75	96.1	1.3
14.	1.75	95.0	1.4
16.	1.75	93.2	1.6
18.	1.75	87.2	6.1

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PBAR PROTON TOTAL CROSS SECTION. (TABLE 4)

LABORATORY BEAM MOMENTUM GEV/C	PER CENT	MILLI-BARNS	
6.	+- 1.75	59.3	+- 1.1
8.	1.75	56.4	.8
16.	1.75	49.2	.8
18.	1.75	50.3	3.6
12.	1.75	51.7	.8
14.	1.75	50.7	.9

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NEUTRON PBAR TOTAL CROSS SECTION. (TABLE 4)

(UNFOLDED FROM DEUTERIUM DATA)

LABORATORY BEAM MOMENTUM GEV/C	PER CENT	MILLI-BARNS	
6.	+- 1.75	59.5	+- 4.0
8.	1.75	57.3	3.9
12.	1.75	53.8	3.7
14.	1.75	53.4	3.7
16.	1.75	52.7	3.7
18.	1.75	44.4	9.0

149 NEUTRON-PROTON ELASTIC SCATTERING FROM 1 TO 6 GEV. (PHYS. REV. LETTERS 16, 1217 (1966))

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CITATIONS
PHYS. REV. LETTERS 15, 38 (1965), NUOVO CIMENTO 41, 167 (1966), PHYS. REV. LETTERS 11, 287 (1963), PHYS. REV. LETTERS 15, 838 (1965), RUTHERFORD HIGH ENERGY LAB. RPP/H/13 (1966), JINR JINR-E2413 (1965), UCRL 11441 (1964), NUOVO CIMENTO 27, 856 (1963), AND PHYS. REV. 137, B708 (1965).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS NEUTRON ON PROTON FROM 1.697 TO 7.179 GEV/C. (BEAM KINETIC ENERGY = 1.0 TO 6.3 GEV)

THIS EXPERIMENT USES SPARK CHAMBERS.

KEY WORDS = DIFFERENTIAL CROSS SECTION FITS

COMPOUND KEY WORDS = FITS DIFFERENTIAL CROSS SECTION

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ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (FIGURE 2)

DATA IS AVERAGED OVER LABORATORY BEAM ENERGY FROM 1. TO 2. GEV.

....
. THIS DATA WAS READ FROM A GRAPH .
....

-T (GEV/C)**2	D-SIGMA/D-T MB/(GEV/C)**2	
.25	21.00	+- 2.00
.35	8.00	1.00
.50	7.00	1.00
.60	2.55	5.00
.70	2.50	.45
.80	1.50	.40
.85	1.65	.45
1.00	.80	.30
1.20	.70	.10
1.45	.50	.10

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

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ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (FIGURE 2)

DATA IS AVERAGED OVER LABORATORY BEAM ENERGY FROM 2. TO 3. GEV.

. THIS DATA WAS READ FROM A GRAPH .

-T	D-SIGMA/D-T	
(GEV/C)**2	MB/(GEV/C)**2	
.25	24.00 +-	2.00
.35	15.00	2.00
.45	5.40	.70
.55	5.60	.60
.65	2.65	.45
.75	1.10	.30
.90	1.15	.30
1.00	1.05	.25
1.20	.80	.15
1.40	.40	.10
1.80	.40	.05
2.5C	.16	.03
3.20	.15	.04

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

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ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (FIGURE 2)

DATA IS AVERAGED OVER LABORATORY BEAM ENERGY FROM 3. TO 4. GEV.

. THIS DATA WAS READ FROM A GRAPH .

-T	D-SIGMA/D-T	
(GEV/C)**2	MB/(GEV/C)**2	
.20	18.000 +-	2.000
.30	9.000	1.000
.40	4.300	.700
.55	2.700	.400
.70	1.400	.300
.80	.900	.200
.90	.600	.130
.95	.350	.110
1.10	.340	.060
1.40	.310	.070
1.75	.080	.020
2.50	.054	.008
3.50	.037	.010
4.60	.034	.006

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

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ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (FIGURE 2)

DATA IS AVERAGED OVER LABORATORY BEAM ENERGY FROM 4. TO 5. GEV.

. THIS DATA WAS READ FROM A GRAPH .

-T	D-SIGMA/D-T	
(GEV/C)**2	MB/(GEV/C)**2	
.20	14.000 +-	1.000
.35	6.500	.500
.45	4.000	.300
.55	.850	.140
.65	1.100	.100
.75	.440	.070
.85	.610	.100
1.00	.330	.090
1.15	.110	.020
1.35	.090	.020
1.75	.050	.010
2.50	.016	.004
3.60	.006	.002
4.70	.005	.002
5.50	.006	.003
6.50	.008	.003

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

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ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (FIGURE 2)

DATA IS AVERAGED OVER LABORATORY BEAM ENERGY FROM 5.0 TO 6.3 GEV.

. THIS DATA WAS READ FROM A GRAPH .

-T	D-SIGMA/D-T	
(GEV/C)**2	MB/(GEV/C)**2	
.25	14.000 +-	1.000
.35	6.700	.500
.40	3.100	.200
.50	1.300	.200
.60	.930	.150
.70	.800	.130
.80	.400	.090
.90	.250	.060
1.10	.100	.030
1.35	.040	.012
1.70	.027	.008
2.50	.013	.003
3.50	.004	.001
4.40	.004	.002
6.30	.002	.001
7.50	.004	.002
8.50	.008	.003

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 1)

DATA IS FIT OVER LABORATORY BEAM ENERGY FROM 1. TO 2. GEV.
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(-B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

FITTED VALUE

B = -6.321 +- .647

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FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 1)

DATA IS FIT OVER LABORATORY BEAM ENERGY FROM 2. TO 3. GEV.
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(-B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

FITTED VALUE

B = -5.527 +- .463

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FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 1)

DATA IS FIT OVER LABORATORY BEAM ENERGY FROM 3. TO 4. GEV.
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(-B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

FITTED VALUE

B = -6.655 +- .432

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FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 1)

DATA IS FIT OVER LABORATORY BEAM ENERGY FROM 4. TO 5. GEV.
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(-B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

FITTED VALUE

B = -7.720 +- .411

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FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (TABLE 1)

DATA IS FIT OVER LABORATORY BEAM ENERGY FROM 5.0 TO 6.3 GEV.
FITTED FORMULA IS D-SIGMA/D-T = A*EXP(-B*T)

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND T IS IN (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING NEUTRON) AND THE (OUTGOING NEUTRON).

FITTED VALUE

B = -7.562 +- .391

150 THE REACTION PP - PN PI+ AT 10 GEV/C AND THE OPE MODEL. (NUOVO CIMENTO 53A, 232 (1968))

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ABSTRACT THE REACTION PP - PN PI+ AND ISOBAR PRODUCTION IN PP - N*++(1236) N HAVE BEEN STUDIED AT 10 GEV/C. OUR DATA ARE COMPARED WITH ONE-PION EXCHANGE MODELS WITH FORM FACTORS AND WITH ABSORPTION CORRECTIONS.

CLOSELY RELATED REFERENCES
DATA SUPERSEDED BY PHYS. REV. 174, 1638 (1968).

ADDITIONAL CITATIONS
UCRL 10335 (1962), NUOVO CIMENTO 48A, 676 (1967), NUOVO CIMENTO 42A, 323 (1966), NUOVO CIMENTO 41A, 635 (1966), NUOVO CIMENTO 44A, 777 (1966), PHYS. REV. 144, 1122 (1966), PHYS. REV. 154, 1284 (1967), NUOVO CIMENTO 42A, 179 (1966), NUOVO CIMENTO 45A, 1010 (1966), NUOVO CIMENTO 33, 309 (1964), PHYS. REV. 125, 2082 (1962), PHYS. REV. 123, 2160 (1961) PHYS. REV. 133, B1017 (1964), NUOVO CIMENTO 49A, 479 (1967), PHYS. REV. 138, B670 (1965), NUOVO CIMENTO 27, 1450 (1963), BOULDER CONFERENCE 183 (1964), NUOVO CIMENTO 40A, 236 (1965), DUBNA CONFERENCE 1 148 (1966), NUOVO CIMENTO 26 186 (1962), NUOVO CIMENTO 34, 735 (1964), PHYS. REV. 137, B153C (1965), REV. MOD. PHYS. 37, 484 (1965), AND PHYS. REV. LETTERS 16, 855 (1966).

ARTICLE READ BY ODETTE BENARY IN 3/68, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 10.01 GEV/C.

THIS EXPERIMENT USES THE SACLAY 81 CM (H) BUBBLE CHAMBER. A TOTAL OF 30000 PICTURES ARE REPORTED ON.

GENERAL COMMENTS ON THIS ARTICLE
1 ONLY EVENTS HAVING A PI+ IN THE BACKWARD HEMISPHERE OF THE OVER-ALL CMS WERE USED FOR THE ANALYSIS. THE GIVEN CROSS SECTIONS WERE CORRESPONDINGLY CORRECTED.

KEY WORDS - CROSS SECTION MASS SPECTRUM DIFFERENTIAL CROSS SECTION MODELS DENSITY MATRIX MOMENTUM TRANSFER

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(FROM PAGE 233 AND PAGE 235)

LABORATORY BEAM MOMENTUM = 10.01 GEV/C.

(THIS DATA SHOULD NOT BE USED - MORE RECENT VALUES MAY BE FOUND IN ALMEIDA ET AL., PHYS. REV. 174, 1638 (1968))

REACTION	MILLI-BARNS	NO. EVENTS
PROTON PROTON →		
PROTON NEUTRON PI+	4.10 +- .40	341
NEUTRON DELTA(1238)++	1.18 .14	
DELTA(1238)++ → PROTON PI+ (1)		

(1) FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.

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DIFFERENTIAL CROSS SECTION FOR PROTON PROTON → DELTA(1238)++ NEUTRON. (FIGURE 2A)
DELTA(1238)++ → PROTON PI+ (1)

LABORATORY BEAM MOMENTUM = 10.01 GEV/C.

. THIS DATA WAS READ FROM A GRAPH .

-T (GEV/C)**2 MIN	MAX	D-SIGMA/D-T MB/(GEV/C)**2	
.00	.02	6.70 +-	1.70
.02	.04	5.00	1.60
.04	.06	3.30	1.10
.06	.08	2.50	1.00
.08	.10	2.50	1.00
.10	.12	1.70	.85
.12	.14	.80	.55
.14	.16	1.70	.85
.16	.18	2.30	.70
.20	.22	.85	.60
.22	.24	.42	.42
.24	.26	.42	.42
.26	.28	.85	.60
.28	.30	.42	.42

T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (DELTA(1238)++).

(1) USED SIMPLE MASS CUT (MASS CUT FROM 1.125 TO 1.325 GEV).

151 HIGH-ENERGY PROTON-PROTON DIFFRACTION SCATTERING (PHYS. REV. LETTERS 9, 108 (1962))

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CITATIONS
PHYS. REV. LETTERS 7, 450 (1961), PHYS. REV. 125, 1386 (1962), BULL. AM. PHYS. SOC. 6, 343 (1961), NUOVO CIMENTO 20, 1012 (1961), INT'L. CONF. ON ELEM. PARTICLES, AIX-EN-PROVENCE 433 (1961), AND INST. FOR NUC. RES., WARSAW, POLAND 255/VI (1961).

ARTICLE READ BY ODETTE BENARY IN 4/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON FROM 12.1 TO 26.2 GEV/C.

THIS EXPERIMENT USES COUNTERS

KEY WORDS - DIFFERENTIAL CROSS SECTION CROSS SECTION

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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 12.1 GEV/C.

THETA DEGREES	D-SIGMA/D-OMEGA MB/SR	PER CENT
2.66	146.0 +-	19
5.73	96.0	16
8.72	45.0	16
11.75	21.3	16
14.70	9.9	16

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 15.5 GEV/C.

THETA DEGREES	D-SIGMA/D-OMEGA MB/SR	PER CENT
3.02	165.0 +-	18
6.40	76.0	15
9.71	27.0	15
13.25	6.4	16
16.50	1.1	21

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

ELASTIC DIFFERENTIAL CRCSS SECTICN FCR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 18.6 GEV/C.

THETA DEGREES	C-SIGMA/D-OMEGA MB/SR	PER CENT
3.82	2C9.00 +-	22
7.30	66.00	20
10.70	12.6C	2C
14.40	1.60	24
17.8C	.25	27

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

- -

ELASTIC CIFFERENTIAL CRCSS SECTICN FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 21.4 GEV/C.

THETA DEGREES	C-SIGMA/D-OMEGA MB/SR	PER CENT
3.29	182.00 +-	21
7.3C	43.00	18
11.18	6.40	1S
15.30	.52	2C
19.0C	.C4	34

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

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ELASTIC DIFFERENTIAL CRCSS SECTICN FCR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 26.2 GEV/C.

THETA DEGREES	C-SIGMA/D-OMEGA MB/SR	PER CENT
4.21	189.00 +-	22
8.6C	22.40	21
12.88	1.24	22
17.03	.08	28

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

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PROTON PROTON ELASTIC CROSS SECTION. (TABLE 2)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS	
12.1	10.4 +-	1.7
15.5	9.2	1.4
18.6	9.0	1.8
21.4	8.0	1.6
26.2	9.8	2.2

152 THE REAL PART OF THE ELASTIC P-P SCATTERING AMPLITUDE IN THE RANGE 2-10 GEV. (PHYS. LETTERS 13, 93 (1964))

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CLOSELY RELATED REFERENCES
SEE ALSO SOVIET JNP 1 379 (1965).

ADDITIONAL CITATIONS
CERN CONFERENCE 582 (1962), ZURN. EKSP. TEOR. FIZ. 45, 1261 (1963), ANNALS OF PHYSICS 3, 190 (1958), SIENNA CONFERENCE 683 (1963), AND PHYS. LETTERS 8, 286 (1963).

ARTICLE READ BY ODETTE BENARY IN 10/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTCN FROM 2.784 TO 10.898 GEV/C. (BEAM KINETIC ENERGY = 2 TO 10 GEV)

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - REAL (AMPLITUDE)/IMAGINARY (AMPLITUDE)

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THE RE/IM RATIO FOR THE FORWARD ELASTIC AMPLITUDE FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY GEV	ALPHA	
2.	-.17 +-	.C8
10.	-.25	.C7

153 PP INTERACTIONS AT 10 GEV/C. [PHYS. REV. 174, 1638 (1968)]

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ABSTRACT ABOUT 3700 TWO-PRONG AND 5600 FOUR-PRONG EVENTS OF 10 GEV/C PP INTERACTIONS IN THE SACLAY 81-CM HYDROGEN BUBBLE CHAMBER HAVE BEEN MEASURED AND ANALYZED. THE RELIABILITY OF THE IDENTIFICATION OF THE DIFFERENT FINAL STATES HAS BEEN CHECKED USING MONTE CARLO-GENERATED EVENTS. FOR THE CHANNELS ACCESSIBLE TO ANALYSIS, CROSS SECTIONS AND INVARIANT-MASS DISTRIBUTIONS ARE GIVEN. THE C.M. ANGULAR DISTRIBUTIONS AND THE MEAN VALUES OF THE TRANSVERSE MOMENTUM FOR ALL FINAL-STATE PARTICLES ARE SHOWN AND DISCUSSED. PRODUCTION OF DELTA++(1236) ACCOUNTS FOR ABOUT 30 PER CENT OF THE CROSS SECTION SIGMA(PP→PN PI+) = 4.1 +- 0.4 MB. ABOUT 50 PER CENT OF THE CROSS SECTION SIGMA(PP → PP PI+ PI-) = 2.4 +- 0.2 MB CAN BE ACCOUNTED FOR BY DELTA++ PRODUCTION. PRODUCTION OF NUCLEON ISOBARS AT 1450, 1520, AND 1730 MEV AND THEIR SUBSEQUENT DECAY INTO P PI+ PI- ARE INVESTIGATED. THEIR CROSS SECTIONS, T DEPENDENCES, AND BRANCHING RATIOS ARE DETERMINED, USING A ONE-PION-EXCHANGE MODEL (OPEM) FOR CALCULATING THE BACKGROUND DISTRIBUTIONS. THE PRODUCTION OF RESONANCES DECAYING INTO P PI- AT 1236, 1500, AND 1690 MEV IS SEEN, AND CROSS SECTIONS ARE GIVEN. RESONANCE PRODUCTION IN THE PP PI+ PI- PIO AND PN PI+ PI+ PI- REACTIONS IS STUDIED USING BACKGROUND CURVES CALCULATED WITH A MODEL BASED ON SIMPLE PARAMETERIZATIONS OF THE C.M. MOMENTUM DISTRIBUTIONS. THE PRODUCTION OF NUCLEON ISOBARS ACCOUNTS FOR NEARLY 100 PER CENT OF THESE REACTIONS. FOR THE REACTIONS PP→PP OMEGA, PP ETA, AND PP FO, THE CROSS SECTIONS FOUND ARE 0.16 +- 0.03, 0.16 +- 0.07, AND 0.10 +- 0.04 MB, RESPECTIVELY, CORRECTED FOR UNOBSERVED DECAY MODES. IT IS SHOWN THAT MOST OF THE GROSS FEATURES OF THE PION-PRODUCTION REACTIONS CAN BE EXPLAINED BY THE OPEM WITH THE FORM FACTORS OF FERRARI AND SELLERI.

CLOSELY RELATED REFERENCES
SEE ALSO NUOVO CIMENTO 57A, 20 (1968), AND NUOVO CIMENTO 51A, 305 (1967).
THIS ARTICLE SUPERSEDES NUOVO CIMENTO 50A, 1000 (1967), AND NUOVO CIMENTO 53A, 232 (1968).

ADDITIONAL CITATIONS
PHYS. REV. 154, 1284 (1967), NUOVO CIMENTO 49A, 479 (1967), PHYS. REV. 161, 1387 (1967), PRINCETON-PENN ACCELERATOR PPAD-600P (1966), NUOVO CIMENTO 55A, 66 (1968), PHYS. REV. 177, 1421 (1968), BULL. AM. PHYS. SOC. 12, 10 (1967). BULL. AM. PHYS. SOC. 12, 10 (1967), BULL. AM. PHYS. SOC. 12, 488 (1967), BNL 10573 (1966), HEIDELBERG CONFERENCE 522 (1967), HEIDELBERG CONFERENCE 521 (1967), HEIDELBERG CONFERENCE 527 (1967). BULL. AM. PHYS. SOC. 13, 682 (1968), PHYS. REV. LETTERS 16, 855 (1966), PHYS. REV. LETTERS 17, 789 (1966), PHYS. REV. LETTERS 18, 89 (1967), PHYS. REV. LETTERS 19, 397 (1967), PHYS. REV. LETTERS 19, 190 (1967), PHYS. REV. LETTERS 19, 201 (1967), CERN TC/02 (1962), DESY [illegible], PHYS. LETTERS 14, 164 (1965), PHYS. LETTERS 19, 705 (1966), PHYS. REV. LETTERS 19, 857 (1967), UCRL 10335 (1962), PHILOSOPHICAL MAGAZINE 6 657 (1961), NUOVO CIMENTO 41A, 417 (1966), PHYS. REV. LETTERS 18, 1218 (1967), NUOVO CIMENTO 42A, 954 (1966), PHYS. REV. LETTERS 11, 425 (1963), PHYS. REV. LETTERS 15 , 45 (1965), NUOVO CIMENTO 38, 60 (1965), PHYS. REV. 138, B165 (1965), PHYS. REV. 159, 1138 (1967), PHYS. LETTERS 25B. 156 (1967), PHYS. REV. LETTERS 17, 884 (1966), NUOVO CIMENTO 34, 1644 (1964), PHYS. REV. 138, B190 (1965), PHYS. REV. 165, 1730 (1968), PHYS. REV. LETTERS 19, 476 (1967), PHYS. REV. LETTERS 20, 964 (1968), NUOVO CIMENTO 40, 839 (1965), NUOVO CIMENTO 47A, 232 (1967), PHYS. LETTERS 20, 554 (1966), PHYS. REV. LETTERS 16, 863 (1966), PHYS. REV. 159, 1156 (1967), PHYS. REV. LETTERS 12, 340 (1964), CERN TH-705 (1966), HEIDELBERG CONFERENCE 79 (1967), REV. MOD. PHYS. 40, 77 (1968), NUOVO CIMENTO 27, 1450 (1963), DUBNA CONFERENCE 1 148 (1964), PHYS. REV. LETTERS 15, 207 (1965), HEIDELBERG CONFERENCE 512 (1967). DUBNA P1.3146 (1967), NUOVO CIMENTO 47A, 675 (1967), NUOVO CIMENTO 1, 1146 (1955), NUOVO CIMENTO 7, 19 (1958), FORTSCHRITTE DER PHYSIK 6, 524 (1958), NUOVO CIMENTO 15, 402 (1960), NUOVO CIMENTO 18, 40 (1960), CERN TH 747 (1967), PHYS. REV. LETTERS 19, 1453 (1967), PHYS. REV. LETTERS 20, 238 (1968), NUOVO CIMENTO 24, 453 (1962), NUOVO CIMENTO 30, 240 (1963), NUOVO CIMENTO 39, 169 (1965), AND NUOVO CIMENTO 40A, 236 (1965).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 10.01 GEV/C.

THIS EXPERIMENT USES THE SACLAY 81 CM (H) BUBBLE CHAMBER. A TOTAL OF 80000 PICTURES ARE REPORTED ON.

KEY WORDS → CROSS SECTION MASS SPECTRUM DALITZ PLOT ANGULAR DISTRIBUTION MODELS OMEGA(783) ETA(548) F(1260) N*(1520)D13 N*(1700)S11 'N*(1688)' DELTA(1238) N*(1470)P11

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(FROM PAGE 1640 AND TABLE 2)

LABORATORY BEAM MOMENTUM = 10.01 +- .01 GEV/C.

REACTION	MILLI-BARNS	
PROTON PROTON →		
TOTAL	41.1 +-	1.7
ELASTIC	10.2	.6
PROTON PROTON PIO	1.4	.3
PROTON NEUTRON PI+	4.1	.4
PROTON PROTON PI+ PI-	2.4	.2
PROTON PROTON PI+ PI- PIO	2.3	.2
PROTON NEUTRON PI+ PI+ PI-	2.4	.2
PROTON PROTON MM≥2PIO	1.5	[1]
PROTON NEUTRON PI+ MM≥1PIO	5.3	[1]
NEUTRON NEUTRON PI+ PI+ MM≥0PIO	2.2	[1]
PROTON PROTON PI+ PI- MM≥2PIO	.7	[1]
PROTON NEUTRON PI+ PI+ PI- MM≥1PIO	4.1	[1]
NEUTRON NEUTRON PI+ PI+ PI+ PI- MM≥0PIO	.8	[1]

[1] VALUE IS APPROXIMATE ONLY.

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(TABLE 4)

LABORATORY BEAM MOMENTUM = 10.01 +- .01 GEV/C.

REACTION	MILLI-BARNS	
PROTON PROTON →		
DELTA(1238)++ NEUTRON	1.18 +-	.14
DELTA(1238)++ → PROTON PI+ [1]		
DELTA(1920)++ NEUTRON	.38	.11
DELTA(1920)++ → PROTON PI+ [1]		
N*(1470)+ PROTON	.20	.13
N*(1470)+ → NEUTRON PI+ [1]		

[1] FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.

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(TABLE 6)

LABORATORY BEAM MOMENTUM = 10.01 +- .01 GEV/C.

REACTION	MILLI-BARNS	
PROTON PROTON →		
DELTA(1238)++ PROTON PI-	1.250 +-	.140
DELTA(1238)++ → PROTON PI+ [1]		
N*(1470)+ PROTON	.180	.040
N*(1470)+ → PROTON PI+ PI- [2]		
N*(1520)+ PROTON	.150	.040
N*(1520)+ → PROTON PI+ PI- [3]		
'N*(1688)+' PROTON	.220	.070
'N*(1688)+' → PROTON PI+ PI- [4]		
PROTON PROTON F(1260)	.064	.027
F(1260) → PI+ PI- [5]		

[1] FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.
[2] FITTED FOR MASS AND/OR WIDTH [MASS = 1.450 GEV; WIDTH = .210 GEV], AND THEN TOOK ONLY EVENTS ABOVE (FITTED) BACKGROUND.
[3] FITTED FOR MASS AND/OR WIDTH [MASS = 1.525 GEV; WIDTH = .105 GEV], AND THEN TOOK ONLY EVENTS ABOVE (FITTED) BACKGROUND.
[4] FITTED FOR MASS AND/OR WIDTH [MASS = 1.734 GEV; WIDTH = .140 GEV], AND THEN TOOK ONLY EVENTS ABOVE (FITTED) BACKGROUND.
[5] FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH [MASS = 1.254 GEV; WIDTH = .117 GEV] AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.

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(TABLE 6)

LABORATORY BEAM MOMENTUM = 10.01 +- .01 GEV/C.

REACTION	MILLI-BARNS	PER CENT
PROTON PROTON →		
DELTA(1238)0 PROTON PI+	.29 +-	40.
DELTA(1238)0 → PROTON PI- [1]		
N*(1520)0 PROTON PI+	.15	40.
N*(1520)0 → PROTON PI- [1]		
'N*(1688)0' PROTON PI+	.16	40.
'N*(1688)0' → PROTON PI- [1]		

[1] FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.

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(TABLE 7)

LABORATORY BEAM MOMENTUM = 10.01 +- .01 GEV/C.

REACTION	MILLI-BARNS	
PROTON PROTON →		
DELTA(1238)++ PROTON PI- PI0	1.020 +-	.130
DELTA(1238)++ → PROTON PI+ [1]		
DELTA(1238)+ PROTON PI+ PI-	.420	.130
DELTA(1238)+ → PROTON PI0 [1]		
DELTA(1238)0 PROTON PI+ PI0	.580	.130
DELTA(1238)0 → PROTON PI- [1]		
N*(1520)0 PROTON PI+ PI0	.140	.120
N*(1520)0 → PROTON PI- [1]		
PROTON PROTON OMEGA(783)	.145	.030
OMEGA(783) → PI+ PI- PI0 [1]		
PROTON PROTON ETA(548)	.036	.015
ETA(548) → PI+ PI- PI0 [1]		

[1] FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.

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(TABLE 8)

LABORATORY BEAM MOMENTUM = 10.01 +- .01 GEV/C.

REACTION	MILLI-BARNS	
PROTON PROTON →		
DELTA(1238)++ NEUTRON PI+ PI- +		
DELTA(1238)++ DELTA(1238)- PI+	1.11 +-	.14
DELTA(1238)++ → PROTON PI+ [1]		
DELTA(1238)- → NEUTRON PI- [1]		
DELTA(1238)+ PROTON PI+ PI-	.58	.14
DELTA(1238)+ → NEUTRON PI+ [1]		
DELTA(1238)0 NEUTRON PI+ PI+	.12	.07
DELTA(1238)0 → PROTON PI- [1]		
DELTA(1238)- PROTON PI+ PI+ + DELTA(1238)++		
DELTA(1238)- PI+	.77	.10
DELTA(1238)- → NEUTRON PI- [1]		
DELTA(1238)++ → PROTON PI+ [1]		
DELTA(1238)++ DELTA(1238)- PI+	.57	.15
DELTA(1238)++ → PROTON PI+ [1]		
DELTA(1238)- → NEUTRON PI- [1]		
N*(1520)+ PROTON PI+ PI-	.07	.07
N*(1520)+ → NEUTRON PI+ [1]		
'N*(1688)0' PROTON PI+	.16	[2]
'N*(1688)0' → NEUTRON PI+ PI- [1]		

[1] FITTED DISTRIBUTION WITH FIXED MASS AND WIDTH AND TOOK EVENTS ONLY ABOVE (FITTED) BACKGROUND.
[2] VALUE IS APPROXIMATE ONLY.

154 ON THE REACTION PP → PP OMEGA AT 19 GEV/C INCIDENT MOMENTUM. (LUND CONFERENCE (1969))

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P.GROSSMANN,T.JACOBSEN,F.SAETRE, S.O.SORENSEN (OSLO UNIV., OSLO, NORWAY)
G.EKSPONG,L.GRANSTROM,S.O.HOLMGREN,S.NILSSON,T.OLHEDE (STOCKHOLMS UNIV., STOCKHOLM, SWEDEN)

ABSTRACT THE EFFECTIVE MASS DISTRIBUTION OF THE PI+ PI- PIO SYSTEM IN THE CHANNEL PP → PP PI+ PI- PIO AT 19 GEV/C INCIDENT MOMENTUM SHOWS PRODUCTION OF THE OMEGA MESON WITH A CROSS-SECTION OF 0.08 +- 0.02 MB. THE DATA FOR THE REACTION PP PP OMEGA ARE COMPARED WITH A DOUBLE REGGE-POLE EXCHANGE MODEL (CLA-MODEL). THE AGREEMENT FOUND SHOWS THAT A DOUBLE EXCHANGE MODEL CAN DESCRIBE THE REACTION.

CITATIONS
PHYS. REV. 161, 1387 (1967), PHYS. REV. 154, 1284 (1967), NUOVO CIMENTO 55A, 66 (1968), NUOVO CIMENTO 58A, 475 (1968) , PHYS. REV. 174, 1638 (1968), PHYS. REV. LETTERS 18, 89 (1967), PHYS. REV. LETTERS 19, 198 (1967), NUOVO CIMENTO 46A, 438 (1966), AND NUOVO CIMENTO 57A, 93 (1968).

ARTICLE READ BY ODETTE BENARY IN 9/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 19 GEV/C.

THIS EXPERIMENT USES THE CERN 2M (H) BUBBLE CHAMBER. A TOTAL OF 120000 PICTURES ARE REPORTED ON.

KEY WORDS • CROSS SECTION OMEGA(783) MODELS MASS SPECTRUM ANGULAR DISTRIBUTION DALITZ PLOT

COMPOUND KEY WORDS • OMEGA(783) CROSS SECTION

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CROSS SECTION FOR PROTON PROTON → PROTON PROTON OMEGA(783). (PAGE 1)
OMEGA(783) → PI+ PI- PIO (1)

* * THIS DATA SHOULD NOT BE USED * * (SAME VALUE AS IN BOGGILD SUBMITTED TO VIENNA,1968.)

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS
19.	.08 +- .02

(1) COUNTED ONLY EVENTS ABOVE BACKGROUND.

155 ELASTIC SCATTERING OF 630 MEV NEUTRONS BY PROTONS. (JETP 37 1125 (1960))

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ABSTRACT THE DIFFERENTIAL CROSS SECTION SIGMA-NP(THETA) FOR ELASTIC N-P SCATTERING WAS MEASURED AT ANGLES THETA = 11 TO 180 DEG. IN THE C.M.S. FOR A MEAN NEUTRON ENERGY 630 MEV. WITHIN THE LIMITS OF ERROR, THE DATA THUS OBTAINED WAS IDENTICAL WITH RESULTS OF MEASUREMENTS CARRIED OUT PREVIOUSLY WITH NEUTRONS OF MEAN ENERGY 580 MEV. THE DEPENDENCE OF SIGMA-NP(THETA) ON ANGLE IN THE NEIGHBORHOOD OF THETA = 180 DEG. WAS USED TO DETERMINE THE PION-NUCLEON COUPLING CONSTANT BY CHEW'S METHOD. A VALUE (F)SQUARED = 0.06 +- 0.02 WAS OBTAINED.

CITATIONS
JETP 4 161 (1957), JETP 7 37 (1958), JETP 9 516 (1959), PHYS. REV. 112, 1380 (1958), JETP 9 302 (1959), JETP 8 564 (1959), DOKL. AKAD. NAUK. SSSR 104 717 (1959), JETP 5 618 (1957), AND PROC. OF THE ROYAL SOCIETY OF LONDON A251, 233 (1959).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM IS NEUTRON ON PROTON AT 1.257 GEV/C. (BEAM KINETIC ENERGY = .63 GEV)

THIS EXPERIMENT USES COUNTERS.

KEY WORDS • DIFFERENTIAL CROSS SECTION

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ELASTIC DIFFERENTIAL CROSS SECTION FOR NEUTRON PROTON. (FIGURE 2)

LABORATORY BEAM ENERGY = .63 GEV (MEAN VALUE).

. THIS DATA WAS READ FROM A GRAPH .

THETA DEGREES	D-SIGMA/D-OMEGA MB/SR (1)
10.	8.3 +- 1.1
23.	5.0 .8
36.	3.7 .2
44.	2.6 .3
53.	2.2 .2
60.	1.7 .1
70.	1.5 .1
80.	1.2 .1
91.	1.1 .1
102.	1.0 .1
111.	1.0 .1
123.	1.4 .1
133.	1.6 .1
145.	2.6 .2
155.	3.5 .3
160.	4.0 .3
165.	4.7 .4
170.	6.0 .4
175.	6.6 .4
180.	8.0 .5

THETA IS THE ANGLE THAT THE NEUTRON MAKES WITH THE BEAM IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 19 PER CENT.

156 COMPARISON OF ISOBAR PRODUCTION IN PP AND ANTI-PROTON N INTERACTIONS AT 2.8 GEV/C .

(PHYS. REV. 162, 1320 (1967))

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ABSTRACT THE REACTIONS PP+N*++(1238)N AND ANTI-PROTON N + ANTI-N*(1238)++ P AT 2.8 GEV/C INCIDENT LABORATORY MOMENTUM ARE ANALYZED WITH THE BROOKHAVEN NATIONAL LABORATORY 20-IN. BUBBLE CHAMBER. ISOBAR AND ANTI-ISOBAR PRODUCTION DIFFERENTIAL CROSS SECTIONS AND DECAY ANGULAR DISTRIBUTIONS ARE COMPARED WITH THE PREDICTIONS OF AN ABSORPTIVE SINGLE-PION-EXCHANGE MODEL. THE ABSOLUTE VALUES, SHAPES, AND RATIOS OF THE CROSS SECTIONS ARE IN GOOD AGREEMENT WITH THE THEORY WHEN THE ABSORPTIVE PARAMETERS GAMMA(1) AND GAMMA(2) ARE 0.033 AND 0.016 FOR THE ANTI-PROTON N REACTION, AND 0.057 AND 0.015, RESPECTIVELY, FOR THE PP REACTION.

CLOSELY RELATED REFERENCES
CONTINUATION OF PREVIOUS EXPERIMENT IN PHYS. REV. 125, 2082 (1962).

ADDITIONAL CITATIONS
REV. MOD. PHYS. 37, 484 (1965), PHYS. REV. 139, B428 (1965), PHYS. REV. 139, B1420 (1965), NUOVO CIMENTO 34, 1644 (1964), REV. MOD. PHYS. 39, 1 (1967), AND PHYS. REV. 142, 1195 (1966).

ARTICLE READ BY ODETTE BENARY IN 1/69, AND VERIFIED BY LEROY PRICE.

BEAM NO. 1 IS PROTON ON PROTON AT 2.8 GEV/C.
NO. 2 IS ANTI-PROTON ON DEUTERON AT 2.8 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 20 IN. (H) BUBBLE CHAMBER.

KEY WORDS + CROSS SECTION DIFFERENTIAL CROSS SECTION MODELS MASS SPECTRUM DENSITY MATRIX ANTI-PROTON PROTON

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CROSS SECTION FOR PROTON PROTON + DELTA(1238)++ NEUTRON. (PAGE 1322)
DELTA(1238)++ + PROTON PI+ [1]

LABORATORY BEAM MOMENTUM GEV/C	MILLI-BARNS
2.8	10.63 +- .29

[1] FITTED FOR MASS AND/OR WIDTH [MASS = 1.200 GEV; WIDTH = .077 GEV], AND THEN TOOK ONLY EVENTS ABOVE (FITTED) BACKGROUND.

- -

DIFFERENTIAL CROSS SECTION FOR PROTON PROTON + DELTA(1238)++ NEUTRON. (FIGURE 10)
DELTA(1238)++ + PROTON PI+ [1]

LABORATORY BEAM MOMENTUM = 2.8 GEV/C.

. THIS DATA WAS READ FROM A GRAPH .

COS(THETA) MAX	MIN	D-SIGMA/D-OMEGA MB/SR [2]		NO. EVENTS
1.00	.98	16.9	+- 1.4	141.0
.98	.96	13.4	1.3	112.0
.96	.94	8.9	1.0	74.5
.94	.92	7.9	1.0	66.0
.92	.90	4.5	.7	37.5
.90	.88	4.0	.7	33.0
.88	.86	2.5	.5	21.0
.86	.84	2.5	.5	21.0
.84	.82	1.8	.5	15.0
.02	.00	1.6	.4	13.0
.80	.78	1.6	.4	13.0
.78	.76	1.4	.4	11.5
.76	.74	2.0	.5	16.5
.74	.72	1.2	.4	10.0
.72	.70	1.8	.5	15.0
.70	.68	.8	.3	6.5
.68	.66	1.0	.3	8.0
.66	.64	1.2	.4	10.0
.64	.62	1.4	.4	11.5
.62	.60	.8	.3	6.5
.60	.50	1.0	.3	9.0
.58	.56	.5	.2	4.0
.56	.54	.5	.2	4.0
.54	.52	1.0	.3	8.0
.52	.50	1.2	.4	10.0

THETA IS THE ANGLE THAT THE DELTA(1238)++ MAKES WITH THE BEAM IN THE GRAND C.M.

[1] COUNTED ALL EVENTS IN MASS BAND [MASS CUT FROM 1.160 TO 1.300 GEV].
[2] COUNTS WERE MULTIPLIED BY .12 TO GET THESE. ERRORS ARE TAKEN AS PROPORTIONAL TO THE SQUARE-ROOT OF THE COUNTS.

157 DOUBLE ELASTIC PROTON SCATTERING ON POLARIZED PROTON TARGET.

(PHYS. LETTERS 28B, 572 (1969))

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ABSTRACT THE TRIPLE SCATTERING DEPOLARIZATION TRANSFER PARAMETER (DT) IN ELASTIC PP SCATTERING WAS MEASURED AT THE ENERGY OF 660 MEV USING A POLARIZED PROTON TARGET. ALL MEASUREMENTS HAVE BEEN MADE WITH THE HELP OF AN OPTICAL SPARK CHAMBER. THE FOLLOWING RESULTS HAVE BEEN OBTAINED (DT) 90 DEG. = (D) 90 DEG. = 0.54 +- C.10; (DT) 130 DEG. = (D) 50 DEG. = 0.72 +- U.11.

CITATIONS
CZECH. J. PHYS. B18 S70.(1968), NUCLEAR INSTRUMENTS AND METHODS 63, 83 (1968), INSTRUMENTS AND EXPERIMENTAL TECHNIQUES 5 1102 (1966), JINR P1-3525 (1967), HELVETICA PHYSICA ACTA 39 579 (1966), ZURN. EKSP. TEOR. FIZ. 35, 1398 (1958), ZURN. EKSP. TEOR. FIZ. 38, 1451 (1960), SOVIET JNP 2 892 (1965), DUBNA CONFERENCE 11 (1964), AND DUBNA P1-3971 (1968).

ARTICLE READ BY LEROY PRICE IN 4/70, AND VERIFIED BY ODETTE BENARY.

BEAM IS PROTON ON PROTON AT 1.294 GEV/C. (BEAM KINETIC ENERGY = .66 GEV) TARGET IS POLARIZED 60 PER CENT (NORMAL TO THE BEAM DIRECTION).

THIS EXPERIMENT USES SPARK CHAMBERS.

KEY WORDS + POLARIZATION

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\+ NO DATA PUNCHED FOR THIS ARTICLE +

158 OBSERVATION OF Y**(1385) K+ AND N***(1236) RHOO DECAYS OF A NUCLEON RESONANCE. (PHYS. REV. 171, 1421 (1968))

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ABSTRACT AN ANALYSIS OF PP INTERACTIONS AT 6 BEV/C INDICATES THE PRESENCE OF A T = 3/2 NUCLEON RESONANCE WITH MASS NEAR 2.0 BEV/C(SQUARED), WITH DECAY MODES Y**(1385) K+, N***(1236) RHOO, AND N***(1236) PI+PI-. A PERIPHERAL PRODUCTION MODEL FOR THE REACTION PP → N N***(1950) GIVES EXCELLENT AGREEMENT WITH THE DATA, WITH A CROSS SECTION FOR N***(1950) PRODUCTION AND SUBSEQUENT DECAY INTO Y** K+ OF 13 +- 3 UB.

CLOSELY RELATED REFERENCES
THIS ARTICLE SUPERSEDES PART OF UCRL 17707 (1968).
PART OF THIS ARTICLE SUPERSEDED BY UCRL 18306 (1968).
CONTINUATION OF PREVIOUS EXPERIMENT IN PHYS. REV. 165, 1466 (1968).

ADDITIONAL CITATIONS
PHYS. REV. LETTERS 19, 397 (1967), PHYS. REV. LETTERS 17, 789 (1966), PHYS. REV. LETTERS 16, 855 (1966), NUOVO CIMENTO 35, 1052 (1965), PHYS. LETTERS 8, 134 (1964), PHYS. REV. 133, B1017 (1964), PHYS. REV. 128, 1823 (1962), PHYS. REV. LETTERS 7, 450 (1961), PHYS. REV. LETTERS 4, 611 (1960), PHYS. REV. 161, 1387 (1967), PHYS. REV. 154, 1284 (1967), NUOVO CIMENTO 49A, 475 (1967), PHYS. REV. 138, B670 (1965), NUOVO CIMENTO 40A, 839 (1965), PHYS. REV. 126, 747 (1962), PHYS. REV. 125, 2082 (1962), PHYS. REV. 125, 2091 (1962), PHYS. REV. 123, 2160 (1961), PHYS. REV. LETTERS 9, 133 (1962), PHYS. REV. LETTERS 18, 89 (1967), PHYS. REV. LETTERS 10, 192 (1963), PHYS. LETTERS 26B, 161 (1968), PHYS. REV. 165, 1730 (1968), REV. MOD. PHYS. 40, 77 (1968), PHYS. REV. LETTERS 19, 925 (1967), NUC. PHYS. B3, 10 (1967), NUOVO CIMENTO 27, 724 (1963), AND PHYS. LETTERS 24B, 307 (1967).

ARTICLE READ BY LEROY PRICE IN 4/70, AND VERIFIED BY ODETTE BENARY.

BEAM IS PROTON ON PROTON AT 6 GEV/C.

THIS EXPERIMENT USES THE L.R.L. 72 IN. (H) BUBBLE CHAMBER. A TOTAL OF 5500CC PICTURES ARE REPORTED ON.

KEY WORDS • CROSS SECTION MASS SPECTRUM STRANGE PARTICLES DELTA(1950) MODELS N*(1236) Y*(1385)

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(PAGE 1422)

LABORATORY BEAM MOMENTUM = 6.04 +- .03 GEV/C.

(THIS DATA REPLACES VALUES GIVEN EARLIER IN KINSEY, UCRL 17707 (1968))

REACTION	MILLI-BARNS
PROTON PROTON →	
PROTON PROTON PI+ PI-	3.2 +- .3
PROTON NEUTRON PI+ PI+ PI-	3.1 .5
PROTON PROTON PI+ PI- PIO	2.4 .4

- -

(PAGE 1423)

LABORATORY BEAM MOMENTUM = 6.04 +- .03 GEV/C.

(THIS DATA SHOULD NOT BE USED - MORE RECENT VALUES MAY BE FOUND IN KLEIN, UCRL 18306 (1968))

REACTION	MICRO-BARNS
PROTON PROTON →	
PROTON LAMBDA PI+ KO	67. +- 10.
PROTON LAMBDA PIO K+	45. 7.
NEUTRON LAMBDA PI+ K+	50. 7.

159 OBSERVATION OF A DELTA++(1900) RESONANCE DECAYING INTO DELTA++(1236) PI- PI+. (NUC. PHYS. B16, 503 (1970))

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ABSTRACT PRODUCTION OF DELTA++(APPROX. 1900) HAS BEEN OBSERVED IN THE REACTION PP →DELTA++(APPROX. 1900) N. THE OBSERVED DECAY MODE IS DELTA++(APPROX. 1900) →DELTA++(1236) PI- PI+. THE CROSS SECTION FOR THE PROCESS (1) MULTIPLIED BY THE BRANCHING RATIO OF THE OBSERVED DECAY MODE IS 29 +- 7 MICROBARNS. THERE IS NO INDICATION OF THE DECAY MODE DELTA++(APPROX. 1900) →DELTA++(1236) RHOO(765).

CLOSELY RELATED REFERENCES
SEE ALSO SUBMITTED TO THE VIENNA CONF., 1968 (1968).

ADDITIONAL CITATIONS
PHYS. REV. 137, B962 (1965), CERN NP/INT66-2, PHYS. REV. LETTERS 19, 198 (1961), PHYS. REV. 171, 1421 (1968), AND VIENNA CONFERENCE 139 (1968).

ARTICLE READ BY ODETTE BENARY IN 9/69, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 19 GEV/C.

THIS EXPERIMENT USES THE CERN 2M (H) BUBBLE CHAMBER. A TOTAL OF 120000 PICTURES ARE REPORTED ON.

KEY WORDS • CROSS SECTION MASS SPECTRUM DELTA(1920)

- -

CROSS SECTION FOR PROTON PROTON → NEUTRON DELTA(1920)++. (PAGE 2)
DELTA(1920)++ → DELTA(1238)++ PI+ PI- [1,2]
DELTA(1238)++ → PROTON PI+ [1,2]

LABORATORY BEAM MOMENTUM GEV/C	MICRO-BARNS
19.	29. +- 7.

[1] USED SIMPLE MASS CUT.
[2] COUNTED ONLY EVENTS ABOVE BACKGROUND.

160 THE SLOPE PARAMETER OF THE DIFFERENTIAL CROSS-SECTION OF ELASTIC P-P SCATTERING IN ENERGY RANGE 12-70 GEV. (PHYS. LETTERS 30B, 274 (1969))

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ABSTRACT THE MEASUREMENTS OF THE DIFFERENTIAL CROSS SECTION OF ELASTIC P-P SCATTERING IN RELATIVE UNITS WERE PERFORMED IN THE ENERGY RANGE OF 12-70 GEV. THE VALUES OF THE SLOPE PARAMETER WERE OBTAINED FROM THIS DATA. IT WAS SHOWN THAT THE SLOPE PARAMETER OF THE DIFFERENTIAL P-P SCATTERING IS MONOTONOUSLY INCREASING WHEN THE PROTON ENERGY RISES IN THE RANGE 12-70 GEV. WE HAVE OBTAINED THE SLOPE POMERANCHUK'S POLE TRAJECTORY FROM THIS DATA=0.40 + - 0.09.

CITATIONS
ANNALS OF PHYSICS 3, 190 (1958), JAERN. FIZ. 1, 533 (1965), PHYS. REV. LETTERS 11, 425 (1963), PHYS. LETTERS 14, 164 (1965), AND NUOVO CIMENTO 45, 574 (1966).

ARTICLE READ BY ODETTE BENARY IN 2/70, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON HYDROGEN COMPOUND FROM 12.904 TO 70.932 GEV/C. (BEAM KINETIC ENERGY = 12 TO 70 GEV)

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - DIFFERENTIAL CROSS SECTION FITS MODELS

COMPOUND KEY WORDS - FITS DIFFERENTIAL CROSS SECTION

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = 12.1 GEV.

DATA IS FIT OVER -T FROM .008 TO .120 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(-B*ABS(T))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

B = 9.81 +- .35

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = 14.8 GEV.

DATA IS FIT OVER -T FROM .008 TO .120 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(-B*ABS(T))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

B = 9.98 +- .12

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = 17.9 GEV.

DATA IS FIT OVER -T FROM .008 TO .120 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(-B*ABS(T))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

B = 10.46 +- .12

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = 20.9 GEV.

DATA IS FIT OVER -T FROM .008 TO .120 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(-B*ABS(T))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

B = 10.58 +- .12

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = 23.8 GEV.

DATA IS FIT OVER -T FROM .008 TO .120 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(-B*ABS(T))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

B = 10.59 +- .11

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = 26.7 GEV.

DATA IS FIT OVER -T FROM .008 TO .120 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(-B*ABS(T))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

B = 10.77 +- .11

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = 29.7 GEV.

DATA IS FIT OVER -T FROM .008 TO .120 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(-B*ABS(T))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

B = 10.68 +- .11

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = 32.6 GEV.

DATA IS FIT OVER -T FROM .008 TO .120 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(-B*ABS(T))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

B = 10.66 +- .11

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = 35.5 GEV.

DATA IS FIT OVER -T FROM .008 TO .120 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(-B*ABS(T))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

B = 10.77 +- .11

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = 38.6 GEV.

DATA IS FIT OVER -T FROM .008 TO .120 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(-B*ABS(T))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

B = 10.89 +- .10

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = 40.7 GEV.

DATA IS FIT OVER -T FROM .008 TO .120 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(-B*ABS(T))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

B = 10.87 +- .14

- -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = 44.2 GEV.

DATA IS FIT OVER -T FROM .008 TO .120 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).
FITTED FORMULA IS D-SIGMA/D-T = EXP(-B*ABS(T))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

B = 10.95 +- .10

- -

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FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON.        (TABLE 1)

    LABORATORY BEAM ENERGY  =  48. GEV.

    DATA IS FIT OVER -T FROM .008 TO .120 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE
         (OUTGOING PROTON).
    FITTED FORMULA IS          D-SIGMA/D-T  =  EXP(-B*ABS(T))

          WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

    FITTED VALUE

          B  =  11.19 +- .11

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FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON.        (TABLE 1)

    LABORATORY BEAM ENERGY  =  51.2 GEV.

    DATA IS FIT OVER -T FROM .008 TO .120 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE
         (OUTGOING PROTON).
    FITTED FORMULA IS          D-SIGMA/D-T  =  EXP(-B*ABS(T))

          WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

    FITTED VALUE

          B  =  11.31 +- .11

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FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON.        (TABLE 1)

    LABORATORY BEAM ENERGY  =  53.4 GEV.

    DATA IS FIT OVER -T FROM .008 TO .120 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE
         (OUTGOING PROTON).
    FITTED FORMULA IS          D-SIGMA/D-T  =  EXP(-B*ABS(T))

          WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

    FITTED VALUE

          B  =  11.24 +- .12

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FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON.        (TABLE 1)

    LABORATORY BEAM ENERGY  =  56.1 GEV.

    DATA IS FIT OVER -T FROM .008 TO .120 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE
         (OUTGOING PROTON).
    FITTED FORMULA IS          D-SIGMA/D-T  =  EXP(-B*ABS(T))

          WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

    FITTED VALUE

          B  =  11.16 +- .10

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FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON.        (TABLE 1)

    LABORATORY BEAM ENERGY  =  59.3 GEV.

    DATA IS FIT OVER -T FROM .008 TO .120 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE
         (OUTGOING PROTON).
    FITTED FORMULA IS          D-SIGMA/D-T  =  EXP(-B*ABS(T))

          WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

    FITTED VALUE

          B  =  11.40 +- .09

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FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON.        (TABLE 1)

    LABORATORY BEAM ENERGY  =  62.6 GEV.

    DATA IS FIT OVER -T FROM .008 TO .120 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE
         (OUTGOING PROTON).
    FITTED FORMULA IS          D-SIGMA/D-T  =  EXP(-B*ABS(T))

          WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

    FITTED VALUE

          B  =  11.76 +- .12

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON.        (TABLE 1)

    LABORATORY BEAM ENERGY  =  65.2 GEV.

    DATA IS FIT OVER -T FROM .008 TO .120 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE
         (OUTGOING PROTON).
    FITTED FORMULA IS          D-SIGMA/D-T  =  EXP(-B*ABS(T))

          WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

    FITTED VALUE

          B  =  11.52 +- .12
```

FIT TO ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = 69. GEV.

DATA IS FIT OVER -T FROM .008 TO .120 (GEV/C)**2. T IS THE MOMENTUM TRANSFER BETWEEN THE (INCOMING PROTON) AND THE (OUTGOING PROTON).

FITTED FORMULA IS   D-SIGMA/D-T = EXP(-B*ABS(T))

WHERE D-SIGMA/D-T IS IN MB/(GEV/C)**2 AND -T IS IN (GEV/C)**2.

FITTED VALUE

B = 11.38 +- .11

161 PROTON-PROTON ELASTIC SCATTERING INVOLVING LARGE MOMENTUM TRANSFERS. (PHYS. REV. 138, B165 (1965))

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ABSTRACT TWENTY-NINE PROTON-PROTON DIFFERENTIAL ELASTIC CROSS SECTIONS FOR LAB MOMENTA P(0) FROM 11 TO 31.8 BEV/C, AT FOUR-MOMENTUM TRANSFERS SQUARED, -T, FROM 2.3 TO 24.4 (BEV/C)-SQUARED, HAVE BEEN MEASURED AT THE BROOKHAVEN ALTERNATING GRADIENT SYNCHROTRON. THE CIRCULATING PROTON BEAM IMPINGED UPON A THIN CH(2) INTERNAL TARGET. BOTH SCATTERED PROTONS FROM PP ELASTIC EVENTS WERE DETECTED BY SCINTILLATION-COUNTER TELESCOPES WHICH WERE PLACED DOWNSTREAM FROM DEFLECTION MAGNETS SET AT THE APPROPRIATE ANGLES TO THE INCIDENT BEAM. THE ANGULAR CORRELATION OF THE PROTONS, THEIR MOMENTA, AND THE COPLANARITY OF THE EVENTS WERE DETERMINED BY THE DETECTION SYSTEM. THE RESULTS SHOW THAT AT HIGH MOMENTUM TRANSFERS THE DIFFERENTIAL CROSS SECTION D-SIGMA/DT, DEPENDS STRONGLY UPON THE ENERGY; FOR -T = 10(BEV/C)-SQUARED, THE VALUE OF D-SIGMA/DT AT P(0) = 30 BEV/C IS SMALLER BY A FACTOR OF ABOUT 1000 THAN AT P(0) = 10 BEV/C. AT ALL ENERGIES, D-SIGMA/DT FALLS RAPIDLY WITH INCREASING /T/ FOR SCATTERING ANGLES UP TO ABOUT 65 DEG. (C.M.), WHILE IN THE RANGE FROM 65 TO 90 DEG. THE CROSS SECTION FALLS ONLY BY A FACTOR OF ABOUT 2. THE SMALLEST CROSS SECTION MEASURED WAS 9 X 10**-37 CM-SQUARED SR**-1(C.M.), AT P(0) = 31.8 BEV/C AND -T = 20.4 (BEV/C)-SQUARED; THIS IS ABOUT 3 X 10**-12 OF THE ZERO-DEGREE CROSS SECTION AT THE SAME ENERGY.

CLOSELY RELATED REFERENCES
THIS ARTICLE SUPERSEDES PHYS. REV. LETTERS 12, 132 (1964), AND PHYS. REV. LETTERS 11, 499 (1963).

ADDITIONAL CITATIONS
CERN CONFERENCE 576 (1962), PHYS. REV. LETTERS 9, 221 (1962), PHYS. REV. LETTERS 10, 376 (1963), PHYS. REV. LETTERS 11, 425 (1963), NUOVO CIMENTO 18, 818 (1960), PHYS. REV. 133, B1017 (1964), PHYS. REV. 107, 859 (1957), BNL GTD-2, CAN. J. PHYS. 40 926 (1962), PHYS. REV. 128, 2392 (1962), PHYS. REV. LETTERS 11, 217 (1963), PHYS. LETTERS 5, 365 (1963), PHYS. REV. LETTERS 12, 112 (1964), PHYS. REV. LETTERS 10, 357 (1963), REV. MOD. PHYS. 36, 649 (1964), PHYS. REV. LETTERS 13, 32 (1964), PHYS. REV. 135, B1456 (1964), PHYS. LETTERS 7, 198 (1963), PHYS. REV. LETTERS 12, 200 (1964), PHYS. REV. 135, B1263 (1964), NUOVO CIMENTO 33, 1167 (1964), PHYS. REV. 137, B1009 (1965), PHYS. REV. 137, B147 (1965), NUOVO CIMENTO 27, 203 (1963), NUOVO CIMENTO 27, 856 (1963), NUOVO CIMENTO 33, 643 (1964), PHYS. LETTERS 8, 287 (1964), PHYS. REV. LETTERS 12, 257 (1964), PHYS. REV. 134, B682 (1964), ENRICO FERMI INSTITUTE 64-11, PHYS. REV. 137, B177 (1965), PHYS. LETTERS 13, 190 (1964), AND PHYS. REV. 137, B708 (1965).

ARTICLE READ BY ODETTE BENARY IN 3/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON HYDROGEN COMPOUND FROM 11.0 TO 31.8 GEV/C.

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - DIFFERENTIAL CROSS SECTION

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 18.9 GEV/C +- 1(PER CENT).

THETA DEGREES	D-SIGMA/D-OMEGA UB/SR	PER CENT
29.9 +- .2	1.61	+ 25 / - 20

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 13. GEV/C +- 1(PER CENT).

THETA DEGREES	D-SIGMA/D-OMEGA UB/SR	PER CENT
37.0 +- .2	3.06	+ 25 / - 20

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 11. GEV/C +- 1(PER CENT).

THETA DEGREES	D-SIGMA/D-OMEGA UB/SR	PER CENT
48.1 +- .2	1.52	+ 25 / - 20

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 16.1 GEV/C +- 1(PER CENT).

THETA DEGREES	D-SIGMA/D-OMEGA UB/SR	PER CENT
40.8 +- .2	.512	+ 25 / - 20

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 24.9 GEV/C +- 1(PER CENT).

THETA DEGREES	D-SIGMA/D-OMEGA UB/SR	PER CENT
33.8 +- .2	.116	+ 25 - 20

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 13.1 GEV/C +- 1(PER CENT).

THETA DEGREES	D-SIGMA/D-OMEGA UB/SR	PER CENT
51.5 +- .2	.13	+ 25 - 20

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 18.1 GEV/C +- 1(PER CENT).

THETA DEGREES	D-SIGMA/D-OMEGA UB/SR	PER CENT
42.8 +- .2	.0743	+ 25 - 20

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 11.1 GEV/C +- 1(PER CENT).

THETA DEGREES	D-SIGMA/D-OMEGA UB/SR	PER CENT
68.3 +- .2	.0402	+ 25 - 20

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 15.7 GEV/C +- 1(PER CENT).

THETA DEGREES	D-SIGMA/D-OMEGA UB/SR	PER CENT
55.4 +- .2	.0129	+ 25 - 20

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 21.7 GEV/C +- 1(PER CENT).

THETA DEGREES	D-SIGMA/D-OMEGA NANOBARNS/SR	PER CENT
46.2 +- .2	5.98	+ 25 - 20

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 31.5 GEV/C +- 1(PER CENT).

THETA DEGREES	D-SIGMA/D-OMEGA NANOBARNS/SR	PER CENT
37.7 +- .2	3.53	+ 25 - 20

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON.        (TABLE 1)

    LABORATORY BEAM MOMENTUM  =  12.9 GEV/C +- 1(PER CENT).

    THETA                  D-SIGMA/D-OMEGA
   DEGREES                   NANOBARNS/SR
                                    PER CENT
 72.1 +- .2                  9.83 +  25
                                  -  20

    THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON.        (TABLE 1)

    LABORATORY BEAM MOMENTUM  =  18.2 GEV/C +- 1(PER CENT).

    THETA                  D-SIGMA/D-OMEGA
   DEGREES                   NANOBARNS/SR
                                    PER CENT
 58.8 +- .2                  2.52 +  25
                                  -  20

    THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON.        (TABLE 1)

    LABORATORY BEAM MOMENTUM  =  25. GEV/C +- 1(PER CENT).

    THETA                  D-SIGMA/D-OMEGA
   DEGREES                   NANOBARNS/SR
                                    PER CENT
 49.1 +- .2                  .978 +  25
                                  -  20

    THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON.        (TABLE 1)

    LABORATORY BEAM MOMENTUM  =  11.4 GEV/C +- 1(PER CENT).

    THETA                  D-SIGMA/D-OMEGA
   DEGREES                   NANOBARNS/SR
                                    PER CENT
 90.0 +- .2                  22.4 +  25
                                  -  20

    THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON.        (TABLE 1)

    LABORATORY BEAM MOMENTUM  =  14.2 GEV/C +- 1(PER CENT).

    THETA                  D-SIGMA/D-OMEGA
   DEGREES                   NANOBARNS/SR
                                    PER CENT
 78.4 +- .2                   5.1 +  25
                                  -  20

    THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON.        (TABLE 1)

    LABORATORY BEAM MOMENTUM  =  20.9 GEV/C +- 1(PER CENT).

    THETA                  D-SIGMA/D-OMEGA
   DEGREES                   NANOBARNS/SR
                                    PER CENT
 62.1 +- .2                  .484 +  25
                                  -  20

    THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON.        (TABLE 1)

    LABORATORY BEAM MOMENTUM  =  28.7 GEV/C +- 1(PER CENT).

    THETA                  D-SIGMA/D-OMEGA
   DEGREES                   NANOBARNS/SR
                                    PER CENT
 52.0 +- .2                  .147 +  30
                                  -  25

    THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 30.7 GEV/C +- 1(PER CENT).

THETA DEGREES	D-SIGMA/D-OMEGA NANOBARNS/SR	PER CENT
53.7 +- .2	.0447	+ 30 - 25

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 19.6 GEV/C +- 1(PER CENT).

THETA DEGREES	D-SIGMA/D-OMEGA NANOBARNS/SR	PER CENT
70.2 +- .2	.282	+ 30 - 25

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 16. GEV/C +- 1(PER CENT).

THETA DEGREES	D-SIGMA/D-OMEGA NANOBARNS/SR	PER CENT
81.4 +- .2	1.54	+ 25 - 20

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 23.8 GEV/C +- 1(PER CENT).

THETA DEGREES	D-SIGMA/D-OMEGA NANOBARNS/SR	PER CENT
65.2 +- .2	.0841	+ 30 - 25

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 21.9 GEV/C +- 1(PER CENT).

THETA DEGREES	D-SIGMA/D-OMEGA NANOBARNS/SR	PER CENT
73.1 +- .2	.069	+ 30 - 25

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 18. GEV/C +- 1(PER CENT).

THETA DEGREES	D-SIGMA/D-OMEGA NANOBARNS/SR	PER CENT
86.0 +- .2	.365	+ 25 - 20

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 26.6 GEV/C +- 1(PER CENT).

THETA DEGREES	D-SIGMA/D-OMEGA NANOBARNS/SR	PER CENT
68.1 +- .2	.0146	+ 30 - 25

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 26.2 GEV/C +- 1(PER CENT).

THETA DEGREES	D-SIGMA/D-OMEGA PICOBARNS/SR	PER CENT
77.9 +- .2	5.18	+ 35
		- 30

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 21.9 GEV/C +- 1(PER CENT).

THETA DEGREES	D-SIGMA/D-OMEGA NANOBARNS/SR	PER CENT
90.0 +- .2	.0515	+ 30
		- 25

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 31.8 GEV/C +- 1(PER CENT).

THETA DEGREES	D-SIGMA/D-OMEGA PICOBARNS/SR	PER CENT
72.8 +- .2	.92	+ 100
		- 50

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

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ELASTIC DIFFERENTIAL CROSS SECTION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM MOMENTUM = 30.9 GEV/C +- 1(PER CENT).

THETA DEGREES	D-SIGMA/D-OMEGA PICOBARNS/SR	PER CENT
82.4 +- .2	1.1	+ 100
		- 50

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.

162 LARGE-ANGLE NEUTRON-PROTON ELASTIC SCATTERING FROM 3.0 TO 6.8 GEV/C. (PHYS. REV. LETTERS 21, 641 (1968))

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ABSTRACT WE PRESENT EXTENSIVE NEW DATA ON CROSS SECTIONS FOR NEUTRON PROTON ELASTIC SCATTERING FROM 3.0 TO 6.8 GEV/C. AT THE HIGHER MOMENTA THE CROSS SECTIONS ARE FOUND TO BE NEARLY SYMMETRIC ABOUT 90 DEG. IN THE C.M. SYSTEM FOR /COS THETA/ $\leq$0.3. THIS SYMMETRY IMPLIES THAT THE CONTRIBUTION TO THE CROSS SECTION FROM INTERFERENCE TERMS BETWEEN THE ISOSPIN-0 AND ISOSPIN-1 AMPLITUDES IS SMALL IN THIS ANGULAR REGION. OTHER IMPLICATIONS OF THE DATA ARE ALSO DISCUSSED.

CLOSELY RELATED REFERENCES
DATA SUPERSEDED BY SLAC PUB-622.
THIS ARTICLE SUPERSEDES PHYS. REV. LETTERS 16, 1217 (1966), AND SLAC 66 (1966).

ADDITIONAL CITATIONS
PHYS. REV. 146, 980 (1966), PHYS. REV. 105, 302 (1957), PHYS. REV. LETTERS 21, 645 (1968), ANNUAL REV. OF NUCLEAR SCIENCE 8, 43 (1958), PHYS. REV. LETTERS 15, 38 (1965), NUOVO CIMENTO 41A, 167 (1966), PHYS. REV. 137, B708 (1965), NUOVO CIMENTO 27, 856 (1963), NUOVO CIMENTO 49A, 273 (1967), NUC. PHYS. B1, 309 (1967), PHYS. REV. 147, 1130 (1966), PHYS. REV. 159, 1169 (1967), PHYS. REV. LETTERS 19, 265 (1967), AND UCRL 16275 (1966).

ARTICLE READ BY LEROY PRICE IN 4/70, AND VERIFIED BY ODETTE BENARY.

BEAM IS NEUTRON ON PROTON FROM 3.0 TO 6.8 GEV/C.

THIS EXPERIMENT USES SPARK CHAMBERS.

KEY WORDS • ANGULAR DISTRIBUTION

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* NO DATA PUNCHED FOR THIS ARTICLE *
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163 MEASUREMENT OF POLARIZATION IN 667-MEV PP SCATTERING. [SOVIET JNP 2 636 (1966)]

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ABSTRACT POLARIZATION IS MEASURED IN DOUBLE PP SCATTERING AT C.M. ANGLES 4.4 DEG.≤ THETA ≤ 48.2 DEG. FOR LARGER ANGLES MEASUREMENTS AT 635 MEV WERE RENORMALIZED. AN ENHANCEMENT OF POLARIZATION IN PP SCATTERING IS OBSERVED WITH INCREASE OF THE ENERGY FROM 602 TO 656 MEV. THE ANGULAR DISTRIBUTION OF THE POLARIZATION AT 667 MEV SHOWS THAT A CONSIDERABLE CONTRIBUTION COMES FROM THE TRIPLET STATES WITH ORBITAL ANGULAR MOMENTUM UP TO L = 5. A SET OF PHASE SHIFTS DESCRIBING THE OBSERVED POLARIZATION AND OTHER EXPERIMENTAL DATA IN THE REGION CLOSE TO 660 MEV IS PRESENTED.

CITATIONS
DOKL. AKAD. NAUK. SSSR 145 61 (1962), PHYS. REV. 137, B620 (1965), JETP 6 28 (1958), PHYS. LETTERS 6, 196 (1963), JETP 20 830 (1965), UCRL 11440 (1964), UCRL 11877 (1965), JETP 78 810 (1964), JETP 19 728 (1965), JETP 18 806 (1964), AND PROGRESS OF THEORETICAL PHYSICS 31, 609 (1964).

ARTICLE READ BY ODETTE BENARY IN 3/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 1.302 GEV/C. (BEAM KINETIC ENERGY = .667 GEV)

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - POLARIZATION PHASE SHIFT

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ELASTIC POLARIZATION FOR PROTON PROTON.

LABORATORY BEAM ENERGY = .667 +- .005 GEV.

THETA DEGREES	POLARIZATION	
4.4	.012 +-	.028
4.9	.051	.024
7.2	.140	.029
10.4	.242	.026
12.1	.272	.017
16.3	.357	.019
21.3	.448	.028
27.9	.506	.016
48.2	.580	.046

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

164 SPIN ANALYSIS OF P PI+ PI- ENHANCEMENTS IN THE PP PI+ PI- FINAL STATE PRODUCED IN PP INTERACTIONS AT 22 GEV/C. [PHYS. REV. 187, 1844 (1969)]

J.I.RHODE,R.A.LEACOCK,W.J.KERNAN,R.A.JESPERSEN,T.L.SCHALK [IOWA STATE UNIV., AMES, IOWA, USA]

ABSTRACT WE HAVE INVESTIGATED DECAY ANGULAR DISTRIBUTIONS AND OTHER CHARACTERISTICS ASSOCIATED WITH ENHANCEMENTS NEAR 1450 AND 1700 MEV IN THE P PI+ PI- MASS DISTRIBUTION FOR THE PP PI+ PI- FINAL STATE PRODUCED IN PP INTERACTIONS AT 22 GEV/C. OUR RESULTS ARE CONSISTENT WITH A SPIN ASSIGNMENT OF 1/2 FOR THE 1450-MEV EFFECT IF THE DELTA++ PI- BRANCHING OF THIS EFFECT IS ASSUMED TO BE SMALL. WE ASSOCIATE THIS EFFECT WITH THE P11(1470) STATE INFERRED FROM PHASE-SHIFT ANALYSES. IN THE CASE OF THE 1700-MEV FEATURE, WE FAVOR STRONG CONTRIBUTIONS FROM A J = 5/2+ STATE WHICH CAN BE REASONABLY ASSOCIATED WITH THE F15(1690) STATE REPORTED IN THE PHASE SHIFT WORK.

CLOSELY RELATED REFERENCES
CONTINUATION OF PREVIOUS EXPERIMENT IN PHYS. REV. LETTERS 21, 1368 (1968), AND ATHENS CONFERENCE (1967).

ADDITIONAL CITATIONS
PHYS. REV. LETTERS 20, 964 (1968), PHYS. REV. 166, 1768 (1968), PHYS. REV. LETTERS 20, 1078 (1968), PHYS. REV. 174, 1638 (1968), PHYS. REV. LETTERS 21, 1839 (1968), VIENNA CONFERENCE 159 (1968), VIENNA CONFERENCE 139 (1968), ANNALS OF PHYSICS 7, 404 (1959), REV. MOD. PHYS. 41, 109 (1969), AND PHYS. REV. 139, B1023 (1965).

ARTICLE READ BY ODETTE BENARY IN 5/70, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON PROTON AT 22 GEV/C.

THIS EXPERIMENT USES THE B.N.L. 80 IN. (H) BUBBLE CHAMBER.

KEY WORDS - N*(1470)P11 N*(1688)F15 MASS SPECTRUM ANGULAR DISTRIBUTION

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* NO DATA PUNCHED FOR THIS ARTICLE *
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165 POLARIZATION PARAMETER IN PP SCATTERING FROM 1.7 TO 6.1 BEV. [PHYS. REV. 148, 1297 (1966)]

F.GRANNIS,J.ARENS,F.BETZ,O.CHAMBERLAIN,B.DIETERLE,C.SCHULTZ,G.SHAPIRO, H.STEINER,L.VANROSSUM,D.WELDON [U.C. LAWRENCE RAD. LAB., BERKELEY, CALIF., USA]

ABSTRACT THE POLARIZATION PARAMETER IN PROTON-PROTON SCATTERING HAS BEEN MEASURED AT INCIDENT PROTON KINETIC ENERGIES OF 1.7, 2.85, 3.5, 4.0, 5.05, AND 6.15 BEV AND FOR FOUR-MOMENTUM TRANSFER SQUARED BETWEEN 0.1 AND 1.0 (BEV/C)-SQUARED. THE EXPERIMENT WAS DONE WITH AN UNPOLARIZED PROTON BEAM FROM THE BEVATRON STRIKING A POLARIZED PROTON TARGET. BOTH FINAL-STATE PROTONS WERE DETECTED IN COINCIDENCE AND THE ASSYMMETRY IN COUNTING RATE FOR TARGET PROTONS POLARIZED PARALLEL AND ANTIPARALLEL TO THE SCATTERING NORMAL WAS MEASURED. THE MAXIMUM POLARIZATION WAS OBSERVED TO DECREASE FROM 0.4 AT 1.7 BEV TO 0.2 AT 6.1 BEV. THE MAXIMUM OF THE POLARIZATION AT ALL ENERGIES STUDIED OCCURS AT A FOUR-MOMENTUM TRANSFER SQUARED OF 0.3 TO 0.4 (BEV/C)-SQUARED.

CITATIONS
ANNALS OF PHYSICS 7, 404 (1959), ANNUAL REV. OF NUCLEAR SCIENCE 6, 43 (1956), PHYS. REV. 148, 1289 (1966), UCRL 16070 UCRL 11149, PROG. NUCL. TECH. INSTR. 1 173 (1964), ANNALS OF PHYSICS 5, 229 (1958), PHYS. REV. 124, 890 (1961), UCRL 11926, PHYS. REV. 105, 288 (1957), PHYS. REV. 95, 1694 (1954), PHYS. REV. 137, B620 (1965), PHYS. REV. LETTERS 16, 536 (1966), NUOVO CIMENTO 23, 690 (1962), NUOVO CIMENTO 20, 1049 (1961), MOSCOW INST. FOR THEOR. AND EXPTL. PHYSICS N-258, JETP 18 874 (1964), PHYS. REV. 121, 1534 (1961), PHYS. REV. 130, 1571 (1963), PHYS. REV. 131, 2226 (1963), NUOVO CIMENTO 28, 250 (1963), PHYS. REV. LETTERS 9, 475 (1962), PROGR. THEORET. PHYS. (KYOTO) 28 1048 (1962), PHYS. REV. LETTERS 14, 502 (1965), AND PHYS. REV. 148, 1491 (1966).

ARTICLE READ BY ODETTE BENARY IN 4/67, AND VERIFIED BY LEROY PRICE.

BEAM IS PROTON ON HYDROGEN COMPOUND FROM 2.465 TO 7.026 GEV/C. TARGET IS POLARIZED 45 PER CENT (NORMAL TO THE BEAM DIRECTION).

THIS EXPERIMENT USES COUNTERS.

KEY WORDS - POLARIZATION

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ELASTIC POLARIZATION FOR PROTON PROTON. (TABLE 1)

LABORATORY BEAM ENERGY = 1.7 GEV.

THETA DEGREES		POLARIZATION (1)	
23.3	+- 1.0	.431	+- .021
26.0	1.0	.389	.014
28.7	1.0	.423	.015
31.4	1.0	.404	.016
34.1	1.0	.396	.017
36.7	1.0	.362	.020

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12 PER CENT.

ELASTIC POLARIZATION FOR PROTON PROTON. (TABLE 2)

LABORATORY BEAM ENERGY = 2.85 GEV.

THETA DEGREES		POLARIZATION (1)	
16.6	+- 1.0	.151	+- .085
19.0	1.0	.188	.020
21.5	1.0	.237	.015
23.9	1.0	.245	.015
26.2	1.0	.255	.017
28.6	1.0	.260	.020
31.0	1.0	.221	.022
32.0	1.0	.270	.019
33.3	1.0	.283	.028
34.4	1.0	.242	.022
36.5	1.0	.225	.023
38.8	1.0	.196	.027
41.0	1.0	.142	.031
43.2	1.0	.218	.036
45.4	1.0	.156	.040
47.0	1.0	.130	.042
49.7	1.0	.171	.055
51.8	1.0	.104	.092

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12 PER CENT.

ELASTIC POLARIZATION FOR PROTON PROTON. (TABLE 3)

LABORATORY BEAM ENERGY = 3.5 GEV.

THETA DEGREES		POLARIZATION (1)	
20.8	+- 1.0	.171	+- .019
22.9	1.0	.205	.021
24.8	1.0	.203	.024
26.8	1.0	.218	.028
28.8	1.0	.207	.030
30.7	1.0	.224	.035
32.6	1.0	.131	.046
34.5	1.0	.123	.044
36.4	1.0	.083	.054
38.3	1.0	.127	.063

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12 PER CENT.

ELASTIC POLARIZATION FOR PROTON PROTON. (TABLE 4)

LABORATORY BEAM ENERGY = 4. GEV.

THETA DEGREES		POLARIZATION (1)	
15.6	+- 1.0	.144	+- .025
17.6	1.0	.191	.016
19.7	1.0	.211	.015
21.7	1.0	.193	.017
23.6	1.0	.217	.020
25.6	1.0	.181	.022
27.6	1.0	.134	.020

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12 PER CENT.

ELASTIC POLARIZATION FOR PROTON PROTON. (TABLE 5)

LABORATORY BEAM ENERGY = 5.05 GEV.

THETA DEGREES		POLARIZATION (1)	
12.5	+- 1.0	.089	+- .100
14.3	1.0	.152	.024
16.1	1.0	.166	.019
18.0	1.0	.153	.019
19.7	1.0	.178	.022
21.5	1.0	.185	.027
23.3	1.0	.136	.030
23.7	1.0	.226	.054
25.0	1.0	.138	.034
25.4	1.0	.201	.059
27.2	1.0	.145	.055
28.9	1.0	.008	.062
30.7	1.0	.231	.087
32.4	1.0	.206	.100
34.1	1.0	.100	.121
36.2	1.0	.041	.138

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12 PER CENT.

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ELASTIC POLARIZATION FOR PROTON PROTON. (TABLE 6)

LABORATORY BEAM ENERGY = 6.15 GEV.

THETA DEGREES		POLARIZATION (1)	
13.2	+- 1.0	.112	+- .049
15.0	1.0	.177	.031
16.7	1.0	.196	.028
18.4	1.0	.177	.031
20.1	1.0	.262	.037
21.8	1.0	.160	.042
23.1	1.0	.169	.027
23.5	1.0	.157	.053
24.7	1.0	.117	.032
25.2	1.0	.077	.064
26.4	1.0	.085	.042
28.1	1.0	.142	.053
29.7	1.0	.002	.074

THETA IS THE ANGLE THAT THE PROTON MAKES WITH THE BEAM IN THE GRAND C.M.
THE POLARIZATION IS OF THE PROTON ALONG THE NORMAL TO THE PRODUCTION PLANE IN THE GRAND C.M.

(1) PLUS POSSIBLE SYSTEMATIC ERROR OF +- 12 PER CENT.

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THE MAXIMUM POLARIZATION IN PROTON PROTON ELASTIC SCATTERING. (1) (FIGURE 7)

LABORATORY BEAM ENERGY GEV	MAXIMUM POLARIZATION	
.150	.230	+- .020
.210	.330	.020
.305	.405	.030
.307	.370	.030
.310	.395	.050
.400	.440	.015
.410	.430	.030
.500	.510	.050
.510	.400	.060

(1) TAKEN FROM A REVIEW ARTICLE.

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THE MAXIMUM POLARIZATION IN PROTON PROTON ELASTIC SCATTERING. (FIGURE 7)

....
. THIS DATA WAS READ FROM A GRAPH .
....

LABORATORY BEAM ENERGY GEV	MAXIMUM POLARIZATION	
1.70	.400	+- .020
2.85	.260	.030
3.50	.210	.030
4.00	.205	.030
5.05	.180	.030
6.15	.210	.030

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Section IV.

INDICES

With all of the information for each article stored in a computer - searchable fashion, one could generate numerous types of indices; two types that we have found most useful are included in this section.

1. MOMENTUM INDICES—Here we list all of our NN articles classified by input channel (pp, pn, or np) and then ordered according to increasing beam momentum. If a particular paper reports results at more than one energy, that paper is listed once for each momentum value reported. The reference number in the last column is the article number in Section III.

2. KEY WORDS CLASSIFICATION—As stated in Section III, each article is assigned certain KEY WORDS. These words (or phrases) are intended to indicate the contents of the article. As our list of KEY WORDS has grown, we generally have not yet gone back to older articles and inserted the appropriate new words. Thus references may be missing from some of the categories. We hope to have this remedied by our next edition of NN.

If you have any suggestions for other useful indices, please let us know. We believe that a good set of indices will make this report much more valuable.

Momentum Index (pp)

BEAM MOMENTUM	1ST AUTHOR	JOURNAL	VOLUME,PAGE	INSTITUTIONS	DETECTOR	YEAR PUBLISHED	REF.NR.
.551	GRANNIS	PR	148 1297	LRL	CNTR	66	165
.649	RYAN	PPPA	PPAR-11	LEHI PRIN	SPRK	69	37
.662	GRANNIS	PR	148 1297	LRL	CNTR	66	165
.816	GRANNIS	PR	148 1297	LRL	CNTR	66	165
.819	GRANNIS	PR	148 1297	LRL	CNTR	66	165
.823	GRANNIS	PR	148 1297	LRL	CNTR	66	165
.823	CHENG	PR	163 1470	LRL UCLA SPC	CNTR	67	44
.849	RYAN	PPPA	PPAR-11	LEHI PRIN	SPRK	69	37
.850	BETZ	PR	148 1289	LRL	CNTR	66	24
.949	RYAN	PPPA	PPAR-11	LEHI PRIN	SPRK	69	37
.954	GRANNIS	PR	148 1297	LRL	CNTR	66	165
.954	CHENG	PR	163 1470	LRL UCLA SPC	CNTR	67	44
.968	GRANNIS	PR	148 1297	LRL	CNTR	66	165
1.049	RYAN	PPPA	PPAR-11	LEHI PRIN	SPRK	69	37
1.090	GRANNIS	PR	148 1297	LRL	CNTR	66	165
1.090	COZZIKA	PR	164 1672	SACL CAEN	CNTR	67	124
1.090	CHENG	PR	163 1470	LRL UCLA SPC	CNTR	67	44
1.103	GRANNIS	PR	148 1297	LRL	CNTR	66	165
1.111	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
1.149	RYAN	PPPA	PPAR-11	LEHI PRIN	SPRK	69	37
1.168	BALDONI	NC	26 1376	BGNA MSNA PADO ROMA	HBC	62	139
1.213	COIGNET	NC	43A 708	IPN SACL	CNTR	66	144
1.219	MARTELLI	NC	21 581	BIRM	CNTR	61	114
1.219	CHENG	PR	163 1470	LRL UCLA SPC	CNTR	67	44
1.230	COZZIKA	PR	164 1672	SACL CAEN	CNTR	67	124
1.237	BETZ	PR	148 1289	LRL	CNTR	66	24
1.249	RYAN	PPPA	PPAR-11	LEHI PRIN	SPRK	69	37
1.263	KAZARINOV	RMP	39 509	JINR	CNTR	67	78
1.289	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
1.290	DUTTON	PL	26B 679	BIRM	SPRK	68	52
1.294	BYSTRICKY	PL	28B 572	JINR	SPRK	69	157
1.303	AZHGIREI	SJNP	2 636	JINR	CNTR	66	163
1.317	BETZ	PR	148 1289	LRL	CNTR	66	24
1.343	CHENG	PR	163 1470	LRL UCLA SPC	CNTR	67	44
1.349	RYAN	PPPA	PPAR-11	LEHI PRIN	SPRK	69	37
1.385	COZZIKA	PR	164 1672	SACL CAEN	CNTR	67	124
1.385	MCMANIGAL	PR	148 1280	LRL	CNTR	66	20
1.385	CENCE	PR	131 2713	LRL	CNTR	63	7
1.387	BETZ	PR	148 1289	LRL	CNTR	66	24
1.390	DUTTON	PL	26B 679	BIRM	SPRK	68	52
1.404	NEAL	PR	161 1374	ANNA	CNTR	67	66
1.408	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
1.420	LONGO	PR	125 701	LRL	CNTR	62	29
1.450	RYAN	PPPA	PPAR-11	LEHI PRIN	SPRK	69	37
1.475	MORRIS	PR	103 1472	YALE	CC	56	28
1.487	COZZIKA	PR	164 1672	SACL CAEN	CNTR	67	124
1.500	BRABSON	PRL	23 1306	IND	SPRK	69	123
1.540	DUTTON	PL	26B 679	BIRM	SPRK	68	52
1.540	DUTTON	PL	25B 245	BIRM	SPRK	67	51
1.549	RYAN	PPPA	PPAR-11	LEHI PRIN	SPRK	69	37
1.600	LONGO	PR	125 701	LRL	CNTR	62	29
1.607	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
1.609	COZZIKA	PR	164 1672	SACL CAEN	CNTR	67	124
1.649	RYAN	PPPA	PPAR-11	LEHI PRIN	SPRK	69	37
1.660	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
1.662	MCFARLANE	NC	28 943	BIRM	CNTR	63	67
1.662	BUGG	PR	133B1017	CAVE BIRM	HBC	64	46
1.685	CHAPMAN	PL	11 253	BIRM	CNTR	64	6
1.690	MURRAY	NC	49A 261	BIRM	CNTR	67	129
1.690	DUTTON	PL	25B 245	BIRM	SPRK	67	51
1.696	MARTELLI	NC	21 581	BIRM	CNTR	61	114
1.696	HEINZ	PR	167 1232	ANNA STAN	CNTR	68	70
1.700	DOWELL	PL	12 252	BIRM	CNTR	64	11
1.729	COZZIKA	PR	164 1672	SACL CAEN	CNTR	67	124
1.730	LONGO	PR	125 701	LRL	CNTR	62	29
1.730	NEAL	PR	161 1374	ANNA	CNTR	67	66
1.749	RYAN	PPPA	PPAR-11	LEHI PRIN	SPRK	69	37
1.780	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
1.858	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
1.890	LONGO	PR	125 701	LRL	CNTR	62	29
1.915	COZZIKA	PR	164 1672	SACL CAEN	CNTR	67	124
1.940	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
1.952	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
2.032	HEINZ	PR	167 1232	ANNA STAN	CNTR	68	70
2.050	LONGO	PR	125 701	LRL	CNTR	62	29
2.054	NEAL	PR	161 1374	ANNA	CNTR	67	66
2.079	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
2.200	KRUCHININ	SJNP	1 225	JINR	HLBC	65	118
2.212	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
2.230	EISNER	PR	138 B670	BNL	HBC	65	49
2.250	FOWLER	PR	103 1479	BNL	CC	56	77
2.251	HEINZ	PR	167 1232	ANNA STAN	CNTR	68	70
2.280	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
2.391	NEAL	PR	161 1374	ANNA	CNTR	67	66
2.419	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
2.450	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
2.466	GRANNIS	PR	148 1297	LRL	CNTR	66	165
2.466	HEINZ	PR	167 1232	ANNA STAN	CNTR	68	70
2.470	LONGO	PR	125 701	LRL	CNTR	62	29
2.592	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
2.680	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13

2.704	BUGG	PR	146	980	RHEL CAVE	CNTR	66	13
2.784	KIRILLOVA	PL	13	93	JINR PRAG SOFI	CNTR	64	152
2.784	HEINZ	PR	167	1232	ANNA STAN	CNTR	68	70
2.800	BACON	PR	162	1320	VAND	HBC	67	156
2.807	PICKUP	PR	125	2091	BNL	HBC	62	80
2.807	FICKINGER	PR	125	2082	YALE BNL BNL	HBC	62	75
2.819	BUGG	PR	146	980	RHEL CAVE	CNTR	66	13
2.850	BLAIR	NC	63A	529	AERE QMCL	CNTR	69	58
2.850	BLAIR	PRL	17	789	AERE QMCL	CNTR	66	39
2.857	BUGG	PR	146	980	RHEL CAVE	CNTR	66	13
2.958	BUGG	PR	146	980	RHEL CAVE	CNTR	66	13
2.970	LONGO	PR	125	701	LRL	CNTR	62	29
2.980	ANKENBRAND	PR	170	1223	LRL	CNTR	68	47
2.994	BUGG	PR	146	980	RHEL CAVE	CNTR	66	13
3.000	ABRAMS	BNL	14125		BNL	CNTR	69	60
3.037	NEAL	PR	161	1374	ANNA	CNTR	67	66
3.054	BUGG	PR	146	980	RHEL CAVE	CNTR	66	13
3.110	BUGG	PR	146	980	RHEL CAVE	CNTR	66	13
3.131	BUGG	PR	146	980	RHEL CAVE	CNTR	66	13
3.142	BUGG	PR	146	980	RHEL CAVE	CNTR	66	13
3.200	ANDERSON	PRL	21	853	CHIC ANL CARL LASL	SPRK	68	111
3.204	REED	PR	168	1495	ROCH BNL	CNTR	68	105
3.270	DIDDENS	PRL	9	32	CERN	CNTR	62	135
3.277	BUGG	PR	146	980	RHEL CAVE	CNTR	66	13
3.300	ANDERSON	PRL	21	853	CHIC ANL CARL LASL	SPRK	68	111
3.303	BUGG	PR	146	980	RHEL CAVE	CNTR	66	13
3.300	HEINZ	PR	167	1232	ANNA STAN	CNTR	68	70
3.349	HOGAN	PR	166	1472	PRIN	CNTR	68	30
3.444	BUGG	PR	146	980	RHEL CAVE	CNTR	66	13
3.500	BRABSON	PRL	23	1306	IND	SPRK	69	123
3.500	ANDERSON	PRL	21	853	CHIC ANL CARL LASL	SPRK	68	111
3.546	BUGG	PR	146	980	RHEL CAVE	CNTR	66	13
3.567	BLOCK	PR	103	1484	DUKE CORN BNL	CC	56	10
3.580	LONGO	PR	125	701	LRL	CNTR	62	29
3.619	HEINZ	PR	167	1232	ANNA STAN	CNTR	68	70
3.660	NEAL	PR	161	1374	ANNA	CNTR	67	66
3.670	HART	PR	126	747	BNL	HBC	62	76
3.670	LOUTTIT	PR	123	1465	BNL CCNY	HBC	61	71
3.670	SMITH	PR	123	2160	YALE BNL	HBC	61	68
3.670	GRANNIS	PR	148	1297	LRL	CNTR	66	165
3.670	REED	PR	168	1495	ROCH BNL	CNTR	68	105
3.700	COHN	PL	26B	598	ORNL UCND TENN ORNL	HBC	68	109
3.701	HOGAN	PR	166	1472	PRIN	CNTR	68	30
3.731	BUGG	PR	146	980	RHEL CAVE	CNTR	66	13
3.800	BANNER	PL	25B	569	SACL CDEF	CNTR	67	116
3.800	ANDERSON	PRL	21	853	CHIC ANL CARL LASL	SPRK	68	111
3.856	HOGAN	PR	166	1472	PRIN	CNTR	68	30
3.908	BUGG	PR	146	980	RHEL CAVE	CNTR	66	13
4.000	KIDD	PL	16	75	MILA GENO	HBC	65	136
4.000	ANDERSON	PRL	21	853	CHIC ANL CARL LASL	SPRK	68	111
4.000	KIDD	SIENA CONF	1	348	MILA	HBC	63	81
4.000	COLETTI	NC	49A	479	MILA GENO	HBC	67	55
4.000	ANKENBRAND	PR	170	1223	LRL	CNTR	68	47
4.000	BODINI	NC	58A	175	MILA GENO	HBC	68	42
4.000	LONGO	PR	125	701	LRL	CNTR	62	29
4.037	BUGG	PR	146	980	RHEL CAVE	CNTR	66	13
4.265	BUGG	PR	146	980	RHEL CAVE	CNTR	66	13
4.300	ANDERSON	PRL	21	853	CHIC ANL CARL LASL	SPRK	68	111
4.338	GRANNIS	PR	148	1297	LRL	CNTR	66	165
4.510	DIDDENS	PRL	9	32	CERN	CNTR	62	135
4.550	BLAIR	NC	63A	529	AERE QMCL	CNTR	69	58
4.552	BUGG	PR	146	980	RHEL CAVE	CNTR	66	13
4.600	ANDERSON	PRL	21	853	CHIC ANL CARL LASL	SPRK	68	111
4.783	BUGG	PR	146	980	RHEL CAVE	CNTR	66	13
4.800	ANDERSON	PRL	21	853	CHIC ANL CARL LASL	SPRK	68	111
4.848	GRANNIS	PR	148	1297	LRL	CNTR	66	165
4.950	COLLERAINE	PR	161	1387	PRIN PPPA	HBC	67	45
4.950	SONDHI	PL	26B	645	PPPA	HBC	68	19
4.950	BIERMAN	PR	147	922	PRIN PPPA	HBC	66	8
4.966	BUGG	PR	146	980	RHEL CAVE	CNTR	66	13
5.000	VON DARDEL	PRL	5	333	CERN	CNTR	60	121
5.000	RUDDICK	PR	165	1442	MINN ANL IOWA ANNA	CNTR	68	112
5.000	ANDERSON	PRL	21	853	CHIC ANL CARL LASL	SPRK	68	111
5.000	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
5.020	ANKENBRAND	PR	170	1223	LRL	CNTR	68	47
5.100	ANDERSON	PRL	21	853	CHIC ANL CARL LASL	SPRK	68	111
5.100	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
5.150	BOOTH	PRL	21	651	EFIN ANL	CNTR	68	34
5.200	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
5.221	BUGG	PR	146	980	RHEL CAVE	CNTR	66	13
5.300	ANDERSON	PRL	21	853	CHIC ANL CARL LASL	SPRK	68	111
5.300	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
5.400	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
5.500	ANDERSON	PRL	21	853	CHIC ANL CARL LASL	SPRK	68	111
5.500	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
5.520	ALEXANDER	PR	154	1284	REHO	HBC	67	57
5.526	BUGG	PR	146	980	RHEL CAVE	CNTR	66	13
5.600	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
5.700	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
5.800	ANDERSON	PRL	21	853	CHIC ANL CARL LASL	SPRK	68	111
5.800	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
5.824	BUGG	PR	146	980	RHEL CAVE	CNTR	66	13
5.830	DIDDENS	PRL	9	32	CERN	CNTR	62	135
5.900	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
5.914	GRANNIS	PR	148	1297	LRL	CNTR	66	165
5.970	CASO	NC	55A	66	GENO MILA OXF	HBC	68	120
6.000	GALBRAITH	PR	138	B913	BNL CORN	CNTR	65	148
6.000	ANDERSON	PRL	16	855	BNL CARN	SPRK	66	142
6.000	BORGHINI	PL	31B	405	CERN ORSA	CNTR	70	140

6.000	KINSEY	UCRL	17707		BERK LRL	HBC	68	126
6.000	KLEIN	UCRL	18306		LRL	HBC	68	122
6.000	VON DARDEL	PRL	5	333	CERN	CNTR	60	121
6.000	ANDERSON	PRL	21	853	CHIC ANL CARL LASL	SPRK	68	111
6.000	BORGHINI	PL	24B	77	CERN	CNTR	67	48
6.000	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
6.040	CHINOWSKY	PR	171	1421	LRL BERK SLAC	HBC	68	158
6.050	CHINOWSKY	PR	165	1466	LRL SLAC	HBC	68	26
6.060	BLAIR	NC	63A	529	AERE QMCL	CNTR	69	58
6.070	TAN	PL	28B	195	SLAC LRL IRVN	HBC	68	147
6.070	ANKENBRAND	PR	170	1223	LRL	CNTR	68	47
6.100	ANDERSON	PRL	21	853	CHIC ANL CARL LASL	SPRK	68	111
6.100	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
6.200	ANDERSON	PRL	21	853	CHIC ANL CARL LASL	SPRK	68	111
6.200	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
6.300	ANDERSON	PRL	21	853	CHIC ANL CARL LASL	SPRK	68	111
6.400	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
6.600	COLTON	UCLA	1025		UCLA	HBC	68	141
6.600	BERGER	PRL	20	964	LRL BERK DART LRL	HBC	68	110
6.600	GELLERT	PRL	17	884	LRL UCLA	HBC	66	69
6.600	MA	PRL	23	342	MICH UCLA	HBC	69	65
6.600	COLTON	UCRL	19330		LRL BERK	HBC	69	64
6.600	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
6.800	ANDERSON	PRL	21	853	CHIC ANL CARL LASL	SPRK	68	111
6.800	FOLEY	PRL	11	425	BNL	CNTR	63	72
6.800	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
6.900	YEKUTIELI	REHO			REHO STRB TELA	HBC	69	83
6.920	ALEXANDER	PR	173	1322	REHO STRB	HBC	68	41
6.920	ALEXANDER	NC	53A	455	REHO	HBC	68	36
7.000	VON DARDEL	PRL	5	333	CERN	CNTR	60	121
7.000	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
7.026	GRANNIS	PR	148	1297	LRL	CNTR	66	165
7.100	ALLABY	CERN	68-7	580	CERN	CNTR	68	143
7.100	ANDERSON	PRL	21	853	CHIC ANL CARL LASL	SPRK	68	111
7.120	ANKENBRAND	PR	170	1223	LRL	CNTR	68	47
7.200	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
7.250	MC MANIGAL	PR	137	B620	LRL BERK	CNTR	65	108
7.300	ANDERSON	PRL	21	853	CHIC ANL CARL LASL	SPRK	68	111
7.400	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
7.600	ANDERSON	PRL	21	853	CHIC ANL CARL LASL	SPRK	68	111
7.600	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
7.750	DIDDENS	PRL	9	32	CERN	CNTR	62	135
7.800	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
7.820	FOLEY	PRL	19	857	BNL	CNTR	67	15
7.835	BUGG	PR	146	980	RHEL CAVE	CNTR	66	13
7.850	TAYLOR	PL	14	54	AERE QMCL	SPRK	65	134
7.870	FIREBAUGH	PR	172	1354	ILL	HBC	68	31
7.875	GRETHER	ILL	COO1195125		ILL	HBC	68	61
7.880	BLAIR	NC	63A	529	AERE QMCL	CNTR	69	58
7.880	BLAIR	PRL	17	789	AERE QMCL	CNTR	66	39
7.900	ANDERSON	PRL	21	853	CHIC ANL CARL LASL	SPRK	68	111
8.000	GALBRAITH	PR	138	B913	BNL CORN	CNTR	65	148
8.000	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
8.100	ALLABY	CERN	68-7	580	CERN	CNTR	68	143
8.100	GINESTET	NP	B13	283	SACL	HBC	69	131
8.100	ALLABY	PL	27B	49	CERN	CNTR	68	115
8.100	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
8.100	ALLABY	PL	25B	156	CERN	CNTR	67	40
8.110	KAYAS	NP	B5	169	ORSA SACL	HBC	68	82
8.200	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
8.300	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
8.400	ANDERSON	PRL	21	853	CHIC ANL CARL LASL	SPRK	68	111
8.400	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
8.500	HARTING	NC	38	60	CERN	SPRK	65	98
8.600	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
8.800	FOLEY	PRL	11	425	BNL	CNTR	63	72
8.800	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
8.940	DIDDENS	PRL	9	111	CERN	CNTR	62	53
9.000	ANDERSON	PRL	21	853	CHIC ANL CARL LASL	SPRK	68	111
9.000	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
9.100	ALLABY	PL	25B	156	CERN	CNTR	67	40
9.200	ALLABY	CERN	68-7	580	CERN	CNTR	68	143
9.200	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
9.400	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
9.500	ANDERSON	PRL	21	853	CHIC ANL CARL LASL	SPRK	68	111
9.600	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
9.800	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
9.800	FOLEY	PRL	19	857	BNL	CNTR	67	15
9.900	ASHMORE	PRL	5	576	CERN	CNTR	60	25
10.000	GALBRAITH	PR	138	B913	BNL CORN	CNTR	65	148
10.000	ANDERSON	PRL	16	855	BNL CARN	SPRK	66	142
10.000	VON DARDEL	PRL	5	333	CERN	CNTR	60	121
10.000	HOLMGREN	NC	57A	20	STOH	HBC	68	79
10.000	HOLMGREN	NC	51A	305	STOH	HBC	67	73
10.000	BORGHINI	PL	24B	77	CERN	CNTR	67	48
10.000	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
10.000	ALLABY	PL	25B	156	CERN	CNTR	67	40
10.010	ALMEIDA	PR	174	1638	CAVE	HBC	68	153
10.010	DEHNE	NC	53A	232	HAMB DESY	HBC	68	150
10.010	ALMEIDA	NC	50A	1000	CAVE HAMB DESY	HBC	67	38
10.100	ALLABY	CERN	68-7	580	CERN	CNTR	68	143
10.110	BELLETTINI	PL	14	164	CERN	SPRK	65	146
10.200	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
10.400	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
10.500	ANDERSON	PRL	21	853	CHIC ANL CARL LASL	SPRK	68	111
10.600	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43
10.700	VON DARDEL	PRL	5	333	CERN	CNTR	60	121
10.800	FOLEY	PRL	11	425	BNL	CNTR	63	72
10.800	AKERLOF	PR	159	1138	ANNA IOWA ANL MINN	CNTR	67	43

10.898	KIRILLOVA	PL	13 93	JINR PRAG SOFI	CNTR	64	152
10.940	FOLEY	PRL	15 45	BNL	CNTR	65	9
11.000	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
11.000	ANDERSON	PRL	21 853	CHIC ANL CARL LASL	SPRK	68	111
11.000	AKERLOF	PR	159 1138	ANNA IOWA ANL MINN	CNTR	67	43
11.000	ALLABY	PL	25B 156	CERN	CNTR	67	40
11.100	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
11.100	ALLABY	CERN	68-7 580	CERN	CNTR	68	143
11.200	AKERLOF	PR	159 1138	ANNA IOWA ANL MINN	CNTR	67	43
11.280	DIDDENS	PRL	9 111	CERN	CNTR	62	53
11.400	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
11.400	AKERLOF	PR	159 1138	ANNA IOWA ANL MINN	CNTR	67	43
11.500	ANDERSON	PRL	21 853	CHIC ANL CARL LASL	SPRK	68	111
11.600	AKERLOF	PR	159 1138	ANNA IOWA ANL MINN	CNTR	67	43
11.800	AKERLOF	PR	159 1138	ANNA IOWA ANL MINN	CNTR	67	43
11.900	FOLEY	PRL	19 857	BNL	CNTR	67	15
12.000	GALBRAITH	PR	138 B913	BNL CORN	CNTR	65	148
12.000	BORGHINI	PL	24B 77	CERN	CNTR	67	48
12.000	AKERLOF	PR	159 1138	ANNA IOWA ANL MINN	CNTR	67	43
12.100	DIDDENS	PRL	9 108	CERN	CNTR	62	151
12.100	ALLABY	CERN	68-7 580	CERN	CNTR	68	143
12.100	ALLABY	PL	27B 49	CERN	CNTR	68	115
12.200	AKERLOF	PR	159 1138	ANNA IOWA ANL MINN	CNTR	67	43
12.300	ANDERSON	PRL	21 853	CHIC ANL CARL LASL	SPRK	68	111
12.400	HARTING	NC	38 60	CERN	SPRK	65	98
12.400	AKERLOF	PR	159 1138	ANNA IOWA ANL MINN	CNTR	67	43
12.400	ASHMORE	PRL	5 576	CERN	CNTR	60	25
12.500	CRABB	PRL	21 830	ANNA ANL NAL	CNTR	68	104
12.500	RATNER	PR	166 1353	ANL IOWA ANNA	CNTR	68	103
12.500	AKERLOF	CERN 68-7	2 262	ANNA ANL IOWA	CNTR	68	102
12.500	ASBURY	PRL	21 1097	ANL NAL ANNA	CNTR	68	101
12.600	AKERLOF	PR	159 1138	ANNA IOWA ANL MINN	CNTR	67	43
12.800	FOLEY	PRL	11 425	BNL	CNTR	63	72
12.800	AKERLOF	PR	159 1138	ANNA IOWA ANL MINN	CNTR	67	43
12.900	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
12.990	DIDDENS	PRL	9 111	CERN	CNTR	62	53
13.000	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
13.000	MA	PRL	24 1031	MICH	HBC	70	99
13.000	AKERLOF	PR	159 1138	ANNA IOWA ANL MINN	CNTR	67	43
13.100	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
13.200	AKERLOF	PR	159 1138	ANNA IOWA ANL MINN	CNTR	67	43
13.400	AKERLOF	PR	159 1138	ANNA IOWA ANL MINN	CNTR	67	43
13.980	DIDDENS	PRL	9 111	CERN	CNTR	62	53
14.000	GALBRAITH	PR	138 B913	BNL CORN	CNTR	65	148
14.010	FOLEY	PRL	19 857	BNL	CNTR	67	15
14.200	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
14.250	ALLABY	PL	25B 156	CERN	CNTR	67	40
14.800	FOLEY	PRL	11 425	BNL	CNTR	63	72
14.930	FOLEY	PRL	15 45	BNL	CNTR	65	9
15.000	ANDERSON	PRL	16 855	BNL CARN	SPRK	66	142
15.500	DIDDENS	PRL	9 108	CERN	CNTR	62	151
15.700	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
15.800	ASHMORE	PRL	5 576	CERN	CNTR	60	25
15.890	DIDDENS	PRL	9 111	CERN	CNTR	62	53
15.960	DIDDENS	PRL	9 111	CERN	CNTR	62	53
16.000	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
16.000	GALBRAITH	PR	138 B913	BNL CORN	CNTR	65	148
16.000	RUSHBROOKE	PRL	22 248	CAVE	HBC	69	16
16.030	FOLEY	PRL	19 857	BNL	CNTR	67	15
16.100	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
16.700	FOLEY	PRL	11 425	BNL	CNTR	63	72
16.900	ALLABY	PL	25B 156	CERN	CNTR	67	40
16.900	ALLABY	PL	23 389	CERN	CNTR	66	35
17.300	DIDDENS	PRL	9 111	CERN	CNTR	62	53
17.700	ASHMORE	PRL	5 576	CERN	CNTR	60	25
17.750	DIDDENS	PRL	9 111	CERN	CNTR	62	53
17.910	FOLEY	PRL	19 857	BNL	CNTR	67	15
18.000	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
18.000	GALBRAITH	PR	138 B913	BNL CORN	CNTR	65	148
18.100	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
18.100	MA	PRL	24 1031	MICH	HBC	70	99
18.200	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
18.290	DIDDENS	PRL	9 111	CERN	CNTR	62	53
18.400	HARTING	NC	38 60	CERN	SPRK	65	98
18.600	DIDDENS	PRL	9 108	CERN	CNTR	62	151
18.690	DIDDENS	PRL	9 111	CERN	CNTR	62	53
18.900	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
18.970	DIDDENS	PRL	9 111	CERN	CNTR	62	53
19.000	BOGGILD	NP	B16 503	BOHR HELS OSLO	HBC	70	159
19.000	BOGGILD	LUND CONF		BOHR HELS	HBC	69	154
19.000	BOGGILD	SUB VNA		BOHR HELS OSLO	HBC	68	96
19.000	BOGGILD	PL	30B 369	BOHR HELS	HBC	69	62
19.200	ALLABY	PL	28B 229		CNTR	68	138
19.200	ALLABY	PL	29B 198		CNTR	69	22
19.200	ALLABY	PL	28B 67		CNTR	68	18
19.300	ALLABY	PL	25B 156	CERN	CNTR	67	40
19.330	BELLETTINI	PL	14 164	CERN	SPRK	65	146
19.400	ASHMORE	PRL	5 576	CERN	CNTR	60	25
19.400	ALLABY	PL	29B 198		CNTR	69	22
19.560	DIDDENS	PRL	9 111	CERN	CNTR	62	53
19.600	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
19.600	FOLEY	PRL	11 425	BNL	CNTR	63	72
19.750	DIDDENS	PRL	9 111	CERN	CNTR	62	53
19.840	FOLEY	PRL	15 45	BNL	CNTR	65	9
19.910	DIDDENS	PRL	9 111	CERN	CNTR	62	53
20.000	GALBRAITH	PR	138 B913	BNL CORN	CNTR	65	148
20.000	ANDERSON	PRL	16 855	BNL CARN	SPRK	66	142
20.220	FOLEY	PRL	19 857	BNL	CNTR	67	15
20.460	FOLEY	PRL	19 857	BNL	CNTR	67	15

20.900	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
21.100	MA	PRL	24 1031	MICH	HBC	70	99
21.100	ALLABY	PL	29B 198		CNTR	69	22
21.120	ALLABY	PL	28B 67		CNTR	68	18
21.300	ALLABY	PL	25B 156	CERN	CNTR	67	40
21.400	DIDDENS	PRL	9 108	CERN	CNTR	62	151
21.400	ASHMORE	PRL	5 576	CERN	CNTR	60	25
21.460	DIDDENS	PRL	9 111	CERN	CNTR	62	53
21.700	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
21.800	JESPERSEN	PRL	21 1368	AMES	HBC	68	90
21.880	DIDDENS	PRL	9 111	CERN	CNTR	62	53
21.880	FOLEY	PRL	15 45	BNL	CNTR	65	9
21.900	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
22.000	RHODE	PR	187 1844	AMES	HBC	69	164
22.000	GALBRAITH	PR	138 B913	BNL CORN	CNTR	65	148
22.000	FOLEY	PRL	19 857	BNL	CNTR	67	15
22.740	DIDDENS	PRL	9 111	CERN	CNTR	62	53
23.800	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
24.000	FOLEY	PRL	19 857	BNL	CNTR	67	15
24.000	LOHRMANN	PL	13 78	DESY CERN	EMUL	64	12
24.200	MA	PRL	24 1031	MICH	HBC	70	99
24.200	ASHMORE	PRL	5 576	CERN	CNTR	60	25
24.500	BREITENLOH	PL	7 73	BERN	HBC+	63	14
24.630	FOLEY	PRL	15 45	BNL	CNTR	65	9
24.800	EHRLICH	PRL	21 1839	RUTG COLU	HBC	68	50
24.900	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
25.000	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
26.000	FOLEY	PRL	19 857	BNL	CNTR	67	15
26.020	DIDDENS	PRL	9 111	CERN	CNTR	62	53
26.200	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
26.200	DIDDENS	PRL	9 108	CERN	CNTR	62	151
26.420	BELLETTINI	PL	14 164	CERN	SPRK	65	146
26.600	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
27.830	DIDDENS	PRL	9 111	CERN	CNTR	62	53
28.400	ASHMORE	PRL	5 576	CERN	CNTR	60	25
28.500	CONNOLLY	BNL	13694	BNL	HBC	69	97
28.500	CONNOLLY	BNL	11980	BNL	HBC	67	93
28.500	ELLIS	PRL	21 697	BNL	HBC	68	86
28.500	ELLIS	BNL	13671	BNL	HBC	69	74
28.600	CONNOLLY	CERN 68-7	2 208	BNL	HBC	68	117
28.700	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
30.000	ANDERSON	PRL	16 855	BNL CARN	SPRK	66	142
30.700	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
30.900	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
31.500	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161
31.900	COCCONI	PR	138 B165	CORN BNL	CNTR	65	161

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.823	CHENG	PR	163 1470	LRL UCLA SPC	CNTR	67	44
.954	CHENG	PR	163 1470	LRL UCLA SPC	CNTR	67	44
.989	WRIGHT	PR	175 1704	CHIC WISC	SPRK	68	106
1.090	CHENG	PR	163 1470	LRL UCLA SPC	CNTR	67	44
1.111	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
1.194	VINCENT	PRL	24 236	NASA CARN VPI UVC	CNTR	70	133
1.219	CHENG	PR	163 1470	LRL UCLA SPC	CNTR	67	44
1.263	KAZARINOV	RMP	39 509	JINR	CNTR	67	78
1.289	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
1.290	DUTTON	PRL	21 1416	BIRM	SPRK	68	54
1.343	CHENG	PR	163 1470	LRL UCLA SPC	CNTR	67	44
1.390	DUTTON	PRL	21 1416	BIRM	SPRK	68	54
1.408	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
1.540	DUTTON	PRL	21 1416	BIRM	SPRK	68	54
1.540	DUTTON	PL	25B 245	BIRM	SPRK	67	51
1.607	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
1.660	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
1.662	BATSON	P.ROY.SOC.	251 233	BIRM	CC	59	63
1.690	MURRAY	NC	49A 261	BIRM	CNTR	67	129
1.690	DUTTON	PL	25B 245	BIRM	SPRK	67	51
1.696	COLEMAN	PR	164 1655	ANNA	CNTR	67	17
1.780	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
1.825	BRUNT	PR	187 1856	CAVE	HBC	69	125
1.825	BRUNT	PL	26B 317	CAVE	HBC	68	119
1.858	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
1.940	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
1.952	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
2.032	COLEMAN	PR	164 1655	ANNA	CNTR	67	17

2.079	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
2.110	BRUNT	PR	187 1856	CAVE	HBC	69	125
2.110	BRUNT	PL	26B 317	CAVE	HBC	68	119
2.212	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
2.251	COLEMAN	PR	164 1655	ANNA	CNTR	67	17
2.280	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
2.419	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
2.450	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
2.592	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
2.680	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
2.704	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
2.784	COLEMAN	PR	164 1655	ANNA	CNTR	67	17
2.819	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
2.857	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
2.958	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
2.994	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
3.000	ABRAMS	BNL	14125	BNL	CNTR	69	60
3.054	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
3.110	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
3.131	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
3.142	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
3.270	DIDDENS	PRL	9 32	CERN	CNTR	62	135
3.277	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
3.303	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
3.444	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
3.546	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
3.731	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
3.908	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
4.037	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
4.265	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
4.510	DIDDENS	PRL	9 32	CERN	CNTR	62	135
4.552	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
4.783	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
4.966	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
5.221	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
5.526	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
5.824	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
5.830	DIDDENS	PRL	9 32	CERN	CNTR	62	135
6.000	GALBRAITH	PR	138 B913	BNL CORN	CNTR	65	148
6.980	SHAPIRA	REHO		REHO	HBC	70	132
7.000	SHAPIRA	PRL	21 1835	REHO	DBC	68	21
7.750	DIDDENS	PRL	9 32	CERN	CNTR	62	135
7.835	BUGG	PR	146 980	RHEL CAVE	CNTR	66	13
8.000	GALBRAITH	PR	138 B913	BNL CORN	CNTR	65	148
9.900	ASHMORE	PRL	5 576	CERN	CNTR	60	25
10.000	GALBRAITH	PR	138 B913	BNL CORN	CNTR	65	148
12.000	GALBRAITH	PR	138 B913	BNL CORN	CNTR	65	148
12.400	ASHMORE	PRL	5 576	CERN	CNTR	60	25
14.000	GALBRAITH	PR	138 B913	BNL CORN	CNTR	65	148
15.800	ASHMORE	PRL	5 576	CERN	CNTR	60	25
16.000	GALBRAITH	PR	138 B913	BNL CORN	CNTR	65	148
17.700	ASHMORE	PRL	5 576	CERN	CNTR	60	25
18.000	GALBRAITH	PR	138 B913	BNL CORN	CNTR	65	148
19.300	BELLETTINI	PL	19 341	CERN	SPRK	65	4
19.400	ASHMORE	PRL	5 576	CERN	CNTR	60	25
20.000	GALBRAITH	PR	138 B913	BNL CORN	CNTR	65	148
21.400	ASHMORE	PRL	5 576	CERN	CNTR	60	25
22.000	GALBRAITH	PR	138 B913	BNL CORN	CNTR	65	148
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28.400	ASHMORE	PRL	5 576	CERN	CNTR	60	25

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4.500	ROBRISH	PL	31B 617	LRL ANNA	CNTR	70	130
4.595	PERL	SLAC	PUB-622	SLAC STAN ANNA PRIN	SPRK	69	89
4.747	PANTUEV	SJNP	1 93	JINR	CNTR	65	33
5.105	PERL	SLAC	PUB-622	SLAC STAN ANNA PRIN	SPRK	69	89
5.250	ROBRISH	PL	31B 617	LRL ANNA	CNTR	70	130
5.358	KREISLER	PRL	16 1217	STAN ANNA	SPRK	66	149
5.615	PERL	SLAC	PUB-622	SLAC STAN ANNA PRIN	SPRK	69	89
5.700	PARKER	PL	31B 246	MICH	CNTR	70	87
5.865	ATKINSON	PR	123 1850	LRL	CNTR	61	32
6.120	PERL	SLAC	PUB-622	SLAC STAN ANNA PRIN	SPRK	69	89
6.371	PANTUEV	SJNP	1 93	JINR	CNTR	65	33
6.371	KHACHATURY	PL	7 80	JINR	CNTR	63	2
6.500	BESLIU	NC	59A 1	BUCH	HLBC	69	145
6.500	ENGLER	PL	27B 599	KARL CERN	CNTR	68	1
6.522	KREISLER	PRL	16 1217	STAN ANNA	SPRK	66	149
6.775	PERL	SLAC	PUB-622	SLAC STAN ANNA PRIN	SPRK	69	89
6.800	COX	PRL	21 641	SLAC PRIN ANNA	SPRK	68	162
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10.899	VISHNEVSKI	SJNP	3 511	JINR	HLBC	66	84
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17.800	KREISLER	PRL	20 468	PRIN ANNA	CNTR	68	91
19.400	GIBBARD	PRL	24 22	ANNA SLAC PPL	SPRK	70	59
21.600	KREISLER	PRL	20 468	PRIN ANNA	CNTR	68	91
23.400	GIBBARD	PRL	24 22	ANNA SLAC PPL	SPRK	70	59
27.000	KREISLER	PRL	20 468	PRIN ANNA	CNTR	68	91
27.400	GIBBARD	PRL	24 22	ANNA SLAC PPL	SPRK	70	59
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1.257	DZHELEPOV	CERN CONF	2 115	JINR	CNTR	56	137
1.356	LARSEN	NC	18 1039	LRL	CNTR	60	3
1.380	PALEVSKY	PARIS CONF	1964 162	BNL	CNTR	64	5
2.359	PALEVSKY	PARIS CONF	1964 162	BNL	CNTR	64	5
2.996	PALEVSKY	PARIS CONF	1964 162	BNL	CNTR	64	5
3.413	PANTUEV	SJNP	1 93	JINR	CNTR	65	33
3.620	PALEVSKY	PARIS CONF	1964 162	BNL	CNTR	64	5
4.000	PARKER	PL	31B 246	MICH	CNTR	70	87
4.300	ENGLER	PL	27B 599	KARL CERN	CNTR	68	1
4.747	PANTUEV	SJNP	1 93	JINR	CNTR	65	33
5.700	PARKER	PL	31B 246	MICH	CNTR	70	87
6.371	PANTUEV	SJNP	1 93	JINR	CNTR	65	33
6.500	ENGLER	PL	27B 599	KARL CERN	CNTR	68	1
7.783	PANTUEV	SJNP	1 93	JINR	CNTR	65	33
9.192	PANTUEV	SJNP	1 93	JINR	CNTR	65	33
10.000	ENGLER	PL	27B 599	KARL CERN	CNTR	68	1
14.600	KREISLER	PRL	20 468	PRIN ANNA	CNTR	68	91
17.800	KREISLER	PRL	20 468	PRIN ANNA	CNTR	68	91
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[46] BUGG ET AL., PHYS. REV. 133, B1017 (1964)
[57] ALEXANDER ET AL., PHYS. REV. 154, 1284 (1967)
[69] GELLERT ET AL., PHYS. REV. LETTERS 17, 884 (1966)
[96] BOGGILD ET AL., SUBMITTED TO THE VIENNA CONF., 1968 (1968)
[120] CASO ET AL., NUOVO CIMENTO 55A, 66 (1968)
[125] BRUNT ET AL., PHYS. REV. 187, 1856 (1969)
[141] COLTON, UCLA 1025 (1968)
[153] ALMEIDA ET AL., PHYS. REV. 174, 1638 (1968)
[154] BOGGILD ET AL., LUND CONFERENCE (1969)
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[65] MA ET AL., PHYS. REV. LETTERS 23, 342 (1969)
[69] GELLERT ET AL., PHYS. REV. LETTERS 17, 884 (1966)
[99] MA ET AL., PHYS. REV. LETTERS 24, 1031 (1970)
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[31] FIREBAUGH ET AL., PHYS. REV. 172, 1354 (1968)
[36] ALEXANDER ET AL., NUOVO CIMENTO 53A, 455 (1968)
[41] ALEXANDER ET AL., PHYS. REV. 173, 1322 (1968)
[42] BODINI ET AL., NUOVO CIMENTO 58A, 175 (1968)
[45] COLLERAINE ET AL., PHYS. REV. 161, 1387 (1967)
[46] BUGG ET AL., PHYS. REV. 133, B1017 (1964)
[47] ANKENBRANDT ET AL., PHYS. REV. 170, 1223 (1968)
[49] EISNER ET AL., PHYS. REV. 138, B670 (1965)
[50] ERLICH ET AL., PHYS. REV. LETTERS 21, 1839 (1968)
[55] COLETTI ET AL., NUOVO CIMENTO 49A, 479 (1967)
[57] ALEXANDER ET AL., PHYS. REV. 154, 1284 (1967)
[58] BLAIR ET AL., NUOVO CIMENTO 63A, 529 (1969)
[73] HOLMGREN ET AL., NUOVO CIMENTO 51A, 305 (1967)
[75] FICKINGER ET AL., PHYS. REV. 125, 2082 (1962)
[76] HART ET AL., PHYS. REV. 126, 747 (1962)
[79] HOLMGREN ET AL., NUOVO CIMENTO 57A, 20 (1968)
[80] PICKUP ET AL., PHYS. REV. 125, 2091 (1962)
[81] KIDD ET AL., SIENNA CONFERENCE 1 348 (1963)
[82] KAYAS ET AL., NUC. PHYS. B5, 169 (1968)
[83] YEKUTIELI ET AL., WEIZMANN INST REPORT (1969)
[90] JESPERSEN ET AL., PHYS. REV. LETTERS 21, 1368 (1968)
[97] CONNOLLY ET AL., BNL 13694 (1969)
[109] COHN ET AL., PHYS. LETTERS 26B, 598 (1968)
[110] BERGER ET AL., PHYS. REV. LETTERS 20, 964 (1968)
[122] KLEIN, UCRL 18306 (1968)
[126] KINSEY, UCRL 17707 (1968)
[128] LYONS, NUC. PHYS. B8, 686 (1968)
[131] GINESTET ET AL., NUC. PHYS. B13, 283 (1969)
[132] SHAPIRA ET AL., WEIZMANN INST REPORT (1970)
[136] KIDD ET AL., PHYS. LETTERS 16, 75 (1965)
[141] COLTON, UCLA 1025 (1968)
[142] ANDERSON ET AL., PHYS. REV. LETTERS 16, 855 (1966)
[147] TAN ET AL., PHYS. LETTERS 28B, 195 (1968)
[153] ALMEIDA ET AL., PHYS. REV. 174, 1638 (1968)
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[31] FIREBAUGH ET AL., PHYS. REV. 172, 1354 (1968)
[57] ALEXANDER ET AL., PHYS. REV. 154, 1284 (1967)
[79] HOLMGREN ET AL., NUOVO CIMENTO 57A, 20 (1968)
[122] KLEIN, UCRL 18306 (1968)
[126] KINSEY, UCRL 17707 (1968)
[131] GINESTET ET AL., NUC. PHYS. B13, 283 (1969)
[159] BOGGILD ET AL., NUC. PHYS. B16, 503 (1970)
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[158] CHINOWSKY ET AL., PHYS. REV. 171, 1421 (1968)
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[57] ALEXANDER ET AL., PHYS. REV. 154, 1284 (1967)
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[41] ALEXANDER ET AL., PHYS. REV. 173, 1322 (1968)
[45] COLLERAINE ET AL., PHYS. REV. 161, 1387 (1967)
[55] COLETTI ET AL., NUOVO CIMENTO 49A, 479 (1967)
[57] ALEXANDER ET AL., PHYS. REV. 154, 1284 (1967)
[82] KAYAS ET AL., NUC. PHYS. B5, 169 (1968)
[131] GINESTET ET AL., NUC. PHYS. B13, 283 (1969)
[132] SHAPIRA ET AL., WEIZMANN INST REPORT (1970)
[150] DEHNE ET AL., NUOVO CIMENTO 53A, 232 (1968)
[156] BACON ET AL., PHYS. REV. 162, 1320 (1967)
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[45] COLLERAINE ET AL., PHYS. REV. 161, 1387 (1967)
[46] BUGG ET AL., PHYS. REV. 133, B1017 (1964)
[55] COLETTI ET AL., NUOVO CIMENTO 49A, 479 (1967)
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[3] LARSEN, NUOVO CIMENTO 18, 1039 (1960)
[4] BELLETTINI ET AL., PHYS. LETTERS 19, 341 (1965)
[6] CHAPMAN ET AL., PHYS. LETTERS 11, 253 (1964)
[9] FOLEY ET AL., PHYS. REV. LETTERS 15, 45 (1965)
[10] BLOCK ET AL., PHYS. REV. 103, 1484 (1956)
[11] DOWELL ET AL., PHYS. LETTERS 12, 252 (1964)

[12] LOHRMANN ET AL., PHYS. LETTERS 13, 78 (1964)
[14] BREITENLOHNER ET AL., PHYS. LETTERS 7, 73 (1963)
[17] COLEMAN ET AL., PHYS. REV. 164, 1655 (1967)
[18] ALLABY ET AL., PHYS. LETTERS 28B, 67 (1968)
[22] ALLABY ET AL., PHYS. LETTERS 29B, 198 (1969)
[23] KAZARINOV ET AL., JETP 16 24 (1963)
[27] PALEVSKY ET AL., PHYS. REV. LETTERS 9, 509 (1962)
[28] MORRIS ET AL., PHYS. REV. 103, 1472 (1956)
[30] HOGAN ET AL., PHYS. REV. 166, 1472 (1968)
[35] ALLABY ET AL., PHYS. LETTERS 23, 389 (1966)
[37] RYAN ET AL., PRINCETON-PENN ACCELERATOR PPAR-11 (1969)
[40] ALLABY ET AL., PHYS. LETTERS 25B, 156 (1967)
[41] ALEXANDER ET AL., PHYS. REV. 173, 1322 (1968)
[43] AKERLOF ET AL., PHYS. REV. 159, 1138 (1967)
[46] BUGG ET AL., PHYS. REV. 133, B1017 (1964)
[47] ANKENBRANDT ET AL., PHYS. REV. 170, 1223 (1968)
[49] EISNER ET AL., PHYS. REV. 138, B670 (1965)
[51] DUTTON ET AL., PHYS. LETTERS 25B, 245 (1967)
[52] DUTTON ET AL., PHYS. LETTERS 26B, 679 (1968)
[53] DIDDENS ET AL., PHYS. REV. LETTERS 9, 111 (1962)
[54] DUTTON ET AL., PHYS. REV. LETTERS 21, 1416 (1968)
[55] COLETTI ET AL., NUOVO CIMENTO 49A, 479 (1967)
[57] ALEXANDER ET AL., PHYS. REV. 154, 1284 (1967)
[58] BLAIR ET AL., NUOVO CIMENTO 63A, 529 (1969)
[59] GIBBARD ET AL., PHYS. REV. LETTERS 24, 22 (1970)
[63] BATSON ET AL., PROC. OF THE ROYAL SOCIETY OF LONDON 251, 233 (1959)
[65] MA ET AL., PHYS. REV. LETTERS 23, 342 (1969)
[67] MCFARLANE ET AL., NUOVO CIMENTO 28, 943 (1963)
[68] SMITH ET AL., PHYS. REV. 123, 2160 (1961)
[70] HEINZ ET AL., PHYS. REV. 167, 1232 (1968)
[72] FOLEY ET AL., PHYS. REV. LETTERS 11, 425 (1963)
[74] ELLIS ET AL., BNL 13671 (1969)
[75] FICKINGER ET AL., PHYS. REV. 125, 2082 (1962)
[77] FOWLER ET AL., PHYS. REV. 103, 1479 (1956)
[82] KAYAS ET AL., NUC. PHYS. B5, 169 (1968)
[85] FRIEDES ET AL., PHYS. REV. LETTERS 15, 38 (1965)
[88] ENGLER ET AL., PHYS. LETTERS 29B, 321 (1969)
[89] PERL ET AL., SLAC PUB-622 (1969)
[90] JESPERSEN ET AL., PHYS. REV. LETTERS 21, 1368 (1968)
[93] CONNOLLY ET AL., BNL 11980 (1967)
[94] SHEPARD ET AL., PPAR 10 (1969)
[95] MANNING ET AL., NUOVO CIMENTO 41A, 167 (1966)
[98] HARTING ET AL., NUOVO CIMENTO 38, 60 (1965)
[111] ANDERSON ET AL., PHYS. REV. LETTERS 21, 853 (1968)
[112] RUDDICK ET AL., PHYS. REV. 165, 1442 (1968)
[115] ALLABY ET AL., PHYS. LETTERS 27B, 49 (1968)
[123] BRABSON ET AL., PHYS. REV. LETTERS 23, 1306 (1969)
[129] MURRAY ET AL., NUOVO CIMENTO 49A, 261 (1967)
[131] GINESTET ET AL., NUC. PHYS. B13, 283 (1969)
[132] SHAPIRA ET AL., WEIZMANN INST REPORT (1970)
[133] VINCENT ET AL., PHYS. REV. LETTERS 24, 236 (1970)
[134] TAYLOR, PHYS. LETTERS 14, 54 (1965)
[137] DZHELEPOV ET AL., CERN CONFERENCE 2 115 (1956)
[138] ALLABY ET AL., PHYS. LETTERS 28B, 229 (1968)
[139] BALDONI ET AL., NUOVO CIMENTO 26, 1376 (1962)
[141] COLTON, UCLA 1025 (1968)
[142] ANDERSON ET AL., PHYS. REV. LETTERS 16, 855 (1966)
[143] ALLABY ET AL., CERN 68-7 580 (1968)
[145] BESLIU ET AL., NUOVO CIMENTO 59A, 1 (1969)
[146] BELLETTINI ET AL., PHYS. LETTERS 14, 164 (1965)
[147] TAN ET AL., PHYS. LETTERS 28B, 195 (1968)
[149] KREISLER ET AL., PHYS. REV. LETTERS 16, 1217 (1966)
[150] DEHNE ET AL., NUOVO CIMENTO 53A, 232 (1968)
[151] DIDDENS ET AL., PHYS. REV. LETTERS 9, 108 (1962)
[155] AMAGLOBELI ET AL., JETP 37 1125 (1960)
[156] BACON ET AL., PHYS. REV. 162, 1320 (1967)
[160] BEZNOGIKH ET AL., PHYS. LETTERS 30B, 274 (1969)
[161] COCCONI ET AL., PHYS. REV. 138, B165 (1965)

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[42] BODINI ET AL., NUOVO CIMENTO 58A, 175 (1968)
[45] COLLERAINE ET AL., PHYS. REV. 161, 1387 (1967)
[57] ALEXANDER ET AL., PHYS. REV. 154, 1284 (1967)
[64] COLTON ET AL., UCRL 19330 (1969)
[83] YEKUTIELI ET AL., WEIZMANN INST REPORT (1969)
[120] CASO ET AL., NUOVO CIMENTO 55A, 66 (1968)
[126] KINSEY, UCRL 17707 (1968)
[153] ALMEIDA ET AL., PHYS. REV. 174, 1638 (1968)

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[3] LARSEN, NUOVO CIMENTO 18, 1039 (1960)
[9] FOLEY ET AL., PHYS. REV. LETTERS 15, 45 (1965)
[17] COLEMAN ET AL., PHYS. REV. 164, 1655 (1967)
[21] SHAPIRA ET AL., PHYS. REV. LETTERS 21, 1835 (1968)
[22] ALLABY ET AL., PHYS. LETTERS 29B, 198 (1969)
[29] LONGO ET AL., PHYS. REV. 125, 701 (1962)
[35] ALLABY ET AL., PHYS. LETTERS 23, 389 (1966)
[37] RYAN ET AL., PRINCETON-PENN ACCELERATOR PPAR-11 (1969)
[40] ALLABY ET AL., PHYS. LETTERS 25B, 156 (1967)
[41] ALEXANDER ET AL., PHYS. REV. 173, 1322 (1968)
[42] BODINI ET AL., NUOVO CIMENTO 58A, 175 (1968)
[44] CHENG ET AL., PHYS. REV. 163, 1470 (1967)
[47] ANKENBRANDT ET AL., PHYS. REV. 170, 1223 (1968)
[49] EISNER ET AL., PHYS. REV. 138, B670 (1965)
[55] COLETTI ET AL., NUOVO CIMENTO 49A, 479 (1967)
[57] ALEXANDER ET AL., PHYS. REV. 154, 1284 (1967)
[58] BLAIR ET AL., NUOVO CIMENTO 63A, 529 (1969)
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[67] MCFARLANE ET AL., NUOVO CIMENTO 28, 943 (1963)
[82] KAYAS ET AL., NUC. PHYS. B5, 169 (1968)
[88] ENGLER ET AL., PHYS. LETTERS 29B, 321 (1969)
[89] PERL ET AL., SLAC PUB-622 (1969)
[90] JESPERSEN ET AL., PHYS. REV. LETTERS 21, 1368 (1968)
[93] CONNOLLY ET AL., BNL 11980 (1967)
[94] SHEPARD ET AL., PPAR 10 (1969)
[98] HARTING ET AL., NUOVO CIMENTO 38, 60 (1965)
[102] AKERLOF ET AL., CERN HADRON CONFERENCE 2 262 (1968)
[103] RATNER ET AL., PHYS. REV. 166, 1353 (1968)
[104] CRABB ET AL., PHYS. REV. LETTERS 21, 830 (1968)
[107] MOROZ ET AL., JINR E1-3940 (1968)
[110] BERGER ET AL., PHYS. REV. LETTERS 20, 964 (1968)
[118] KRUCHININ ET AL., SOVIET JNP 1 225 (1965)
[123] BRABSON ET AL., PHYS. REV. LETTERS 23, 1306 (1969)
[128] LYONS, NUC. PHYS. B8, 686 (1968)
[129] MURRAY ET AL., NUOVO CIMENTO 49A, 261 (1967)
[131] GINESTET ET AL., NUC. PHYS. B13, 283 (1969)
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[141] COLTON, UCLA 1025 (1968)
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[143] ALLABY ET AL., CERN 68-7 580 (1968)
[145] BESLIU ET AL., NUOVO CIMENTO 59A, 1 (1969)
[147] TAN ET AL., PHYS. LETTERS 28B, 195 (1968)
[149] KREISLER ET AL., PHYS. REV. LETTERS 16, 1217 (1966)
[160] BEZNOGIKH ET AL., PHYS. LETTERS 30B, 274 (1969)

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[153] ALMEIDA ET AL., PHYS. REV. 174, 1638 (1968)

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[31] FIREBAUGH ET AL., PHYS. REV. 172, 1354 (1968)
[122] KLEIN, UCRL 18306 (1968)

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[71] LOUTTIT ET AL., PHYS. REV. 123, 1465 (1961)
[84] VISHNEVSKII ET AL., SOVIET JNP 3 511 (1966)

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[8] BIERMAN ET AL., PHYS. REV. 147, 922 (1966)
[16] RUSHBROOKE ET AL., PHYS. REV. LETTERS 22, 248 (1969)
[19] SONDHI, PHYS. LETTERS 26B, 645 (1968)
[21] SHAPIRA ET AL., PHYS. REV. LETTERS 21, 1835 (1968)
[26] CHINOWSKY ET AL., PHYS. REV. 165, 1466 (1968)
[30] HOGAN ET AL., PHYS. REV. 166, 1472 (1968)
[31] FIREBAUGH ET AL., PHYS. REV. 172, 1354 (1968)
[36] ALEXANDER ET AL., NUOVO CIMENTO 53A, 455 (1968)
[38] ALMEIDA ET AL., NUOVO CIMENTO 50A, 1000 (1967)
[41] ALEXANDER ET AL., PHYS. REV. 173, 1322 (1968)
[42] BODINI ET AL., NUOVO CIMENTO 58A, 175 (1968)
[45] COLLERAINE ET AL., PHYS. REV. 161, 1387 (1967)
[46] BUGG ET AL., PHYS. REV. 133, B1017 (1964)
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[49] EISNER ET AL., PHYS. REV. 138, B670 (1965)
[50] ERLICH ET AL., PHYS. REV. LETTERS 21, 1839 (1968)
[55] COLETTI ET AL., NUOVO CIMENTO 49A, 479 (1967)
[57] ALEXANDER ET AL., PHYS. REV. 154, 1284 (1967)
[61] GRETHER, UNIV. OF ILLINOIS COO1195125 (1968)
[62] BOGGILD ET AL., PHYS. LETTERS 30B, 369 (1969)
[65] MA ET AL., PHYS. REV. LETTERS 23, 342 (1969)
[68] SMITH ET AL., PHYS. REV. 123, 2160 (1961)
[69] GELLERT ET AL., PHYS. REV. LETTERS 17, 884 (1966)
[71] LOUTTIT ET AL., PHYS. REV. 123, 1465 (1961)
[73] HOLMGREN ET AL., NUOVO CIMENTO 51A, 305 (1967)
[74] ELLIS ET AL., BNL 13671 (1969)
[75] FICKINGER ET AL., PHYS. REV. 125, 2082 (1962)
[76] HART ET AL., PHYS. REV. 126, 747 (1962)
[79] HOLMGREN ET AL., NUOVO CIMENTO 57A, 20 (1968)
[80] PICKUP ET AL., PHYS. REV. 125, 2091 (1962)
[81] KIDD ET AL., SIENNA CONFERENCE 1 348 (1963)
[82] KAYAS ET AL., NUC. PHYS. B5, 169 (1968)
[83] YEKUTIELI ET AL., WEIZMANN INST REPORT (1969)
[86] ELLIS ET AL., PHYS. REV. LETTERS 21, 697 (1968)
[90] JESPERSEN ET AL., PHYS. REV. LETTERS 21, 1368 (1968)
[93] CONNOLLY ET AL., BNL 11980 (1967)
[96] BOGGILD ET AL., SUBMITTED TO THE VIENNA CONF., 1968 (1968)
[97] CONNOLLY ET AL., BNL 13694 (1969)
[107] MOROZ ET AL., JINR E1-3940 (1968)
[109] COHN ET AL., PHYS. LETTERS 26B, 598 (1968)
[110] BERGER ET AL., PHYS. REV. LETTERS 20, 964 (1968)
[116] BANNER ET AL., PHYS. LETTERS 25B, 569 (1967)
[117] CONNOLLY ET AL., CERN HADRON CONFERENCE 2 208 (1968)
[119] BRUNT ET AL., PHYS. LETTERS 26B, 317 (1968)
[120] CASO ET AL., NUOVO CIMENTO 55A, 66 (1968)
[122] KLEIN, UCRL 18306 (1968)
[125] BRUNT ET AL., PHYS. REV. 187, 1856 (1969)
[126] KINSEY, UCRL 17707 (1968)
[127] ELLIS ET AL., BNL 13918 (1969)
[131] GINESTET ET AL., NUC. PHYS. B13, 283 (1969)
[132] SHAPIRA ET AL., WEIZMANN INST REPORT (1970)
[136] KIDD ET AL., PHYS. LETTERS 16, 75 (1965)
[141] COLTON, UCLA 1025 (1968)
[147] TAN ET AL., PHYS. LETTERS 28B, 195 (1968)
[150] DEHNE ET AL., NUOVO CIMENTO 53A, 232 (1968)
[153] ALMEIDA ET AL., PHYS. REV. 174, 1638 (1968)
[154] BOGGILD ET AL., LUND CONFERENCE (1969)
[156] BACON ET AL., PHYS. REV. 162, 1320 (1967)
[158] CHINOWSKY ET AL., PHYS. REV. 171, 1421 (1968)
[159] BOGGILD ET AL., NUC. PHYS. B16, 503 (1970)
[164] RHODE ET AL., PHYS. REV. 187, 1844 (1969)

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[16] RUSHBROOKE ET AL., PHYS. REV. LETTERS 22, 248 (1969)
[17] COLEMAN ET AL., PHYS. REV. 164, 1655 (1967)
[19] SONDHI, PHYS. LETTERS 26B, 645 (1968)
[21] SHAPIRA ET AL., PHYS. REV. LETTERS 21, 1835 (1968)
[26] CHINOWSKY ET AL., PHYS. REV. 165, 1466 (1968)
[29] LONGO ET AL., PHYS. REV. 125, 701 (1962)
[30] HOGAN ET AL., PHYS. REV. 166, 1472 (1968)
[31] FIREBAUGH ET AL., PHYS. REV. 172, 1354 (1968)
[32] ATKINSON ET AL., PHYS. REV. 123, 1850 (1961)
[34] BOOTH ET AL., PHYS. REV. LETTERS 21, 651 (1968)
[36] ALEXANDER ET AL., NUOVO CIMENTO 53A, 455 (1968)
[37] RYAN ET AL., PRINCETON-PENN ACCELERATOR PPAR-11 (1969)
[38] ALMEIDA ET AL., NUOVO CIMENTO 50A, 1000 (1967)
[41] ALEXANDER ET AL., PHYS. REV. 173, 1322 (1968)
[42] BODINI ET AL., NUOVO CIMENTO 58A, 175 (1968)
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[46] BUGG ET AL., PHYS. REV. 133, B1017 (1964)
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[49] EISNER ET AL., PHYS. REV. 138, B670 (1965)
[59] GIBBARD ET AL., PHYS. REV. LETTERS 24, 22 (1970)
[61] GRETHER, UNIV. OF ILLINOIS COO1195125 (1968)
[62] BOGGILD ET AL., PHYS. LETTERS 30B, 369 (1969)
[65] MA ET AL., PHYS. REV. LETTERS 23, 342 (1969)
[66] NEAL ET AL., PHYS. REV. 161, 1374 (1967)
[70] HEINZ ET AL., PHYS. REV. 167, 1232 (1968)
[76] HART ET AL., PHYS. REV. 126, 747 (1962)
[82] KAYAS ET AL., NUC. PHYS. B5, 169 (1968)
[83] YEKUTIELI ET AL., WEIZMANN INST REPORT (1969)
[85] FRIEDES ET AL., PHYS. REV. LETTERS 15, 38 (1965)
[86] ELLIS ET AL., PHYS. REV. LETTERS 21, 697 (1968)
[87] PARKER ET AL., PHYS. LETTERS 31B, 246 (1970)
[89] PERL ET AL., SLAC PUB-622 (1969)
[95] MANNING ET AL., NUOVO CIMENTO 41A, 167 (1966)
[96] BOGGILD ET AL., SUBMITTED TO THE VIENNA CONF., 1968 (1968)
[97] CONNOLLY ET AL., BNL 13694 (1969)
[98] HARTING ET AL., NUOVO CIMENTO 38, 60 (1965)
[99] MA ET AL., PHYS. REV. LETTERS 24, 1031 (1970)
[110] BERGER ET AL., PHYS. REV. LETTERS 20, 964 (1968)
[120] CASO ET AL., NUOVO CIMENTO 55A, 66 (1968)
[122] KLEIN, UCRL 18306 (1968)
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[126] KINSEY, UCRL 17707 (1968)
[128] LYONS, NUC. PHYS. B8, 686 (1968)
[131] GINESTET ET AL., NUC. PHYS. B13, 283 (1969)
[132] SHAPIRA ET AL., WEIZMANN INST REPORT (1970)
[136] KIDD ET AL., PHYS. LETTERS 16, 75 (1965)
[141] COLTON, UCLA 1025 (1968)
[147] TAN ET AL., PHYS. LETTERS 28B, 195 (1968)
[150] DEHNE ET AL., NUOVO CIMENTO 53A, 232 (1968)
[153] ALMEIDA ET AL., PHYS. REV. 174, 1638 (1968)
[154] BOGGILD ET AL., LUND CONFERENCE (1969)
[156] BACON ET AL., PHYS. REV. 162, 1320 (1967)
[158] CHINOWSKY ET AL., PHYS. REV. 171, 1421 (1968)
[160] BEZNOGIKH ET AL., PHYS. LETTERS 30B, 274 (1969)

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[109] COHN ET AL., PHYS. LETTERS 26B, 598 (1968)
[150] DEHNE ET AL., NUOVO CIMENTO 53A, 232 (1968)

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[136] KIDD ET AL., PHYS. LETTERS 16, 75 (1965)

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[119] BRUNT ET AL., PHYS. LETTERS 26B, 317 (1968)

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[117] CONNOLLY ET AL., CERN HADRON CONFERENCE 2 208 (1968)
[158] CHINOWSKY ET AL., PHYS. REV. 171, 1421 (1968)

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[38] ALMEIDA ET AL., NUOVO CIMENTO 50A, 1000 (1967)
[50] ERLICH ET AL., PHYS. REV. LETTERS 21, 1839 (1968)
[57] ALEXANDER ET AL., PHYS. REV. 154, 1284 (1967)
[58] BLAIR ET AL., NUOVC CIMENTO 63A, 529 (1969)
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