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DOUBLE MESON PRODUCTION IN PROTON-DEUTERON COLLISIONS.II

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Norman E. Booth, Alexander Abashian, and Kenneth M. Crowe

August 1961

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In a previous publication we reported measurements of the momentum spectra of He^3 and H^3 nuclei produced in collisions of 740-MeV protons with deuterium. [1] The He^3 spectrum exhibited an anomaly in the form of a peak in the region corresponding to double pion production. For reactions resulting in a He^3 the two pions (or particle) can be in isotopic spin states 0 or 1; if a H^3 nucleus results only I = 1 is allowed.

We have since repeated the experiment with a new arrangement which enabled us to measure both the He^3 and H^3 spectra with improved resolution and accuracy. The results are shown in Figs. 1 and 2 and Tables I and II. The anomalous bump found previously[1] in the He^3 spectrum is clearly evident. Figure 3 shows the I = 0 part of the He^3 spectrum obtained by subtracting the I = 1 part as deduced from the H^3 data. Details of the subtraction are given in Table III. We conclude that the anomaly must be assigned an isotopic spin I = 0. For comparison with the width of the anomaly we show in Fig. 4 the He^3 momentum resolution function for the region near 1400 MeV/c. At the time of writing we are studying possible explanations for the anomaly. Results of the analysis will be presented at a later date.

* This work was performed under the auspices of the U. S. Atomic Energy Commission.

[1] A. Abashian, N. E. Booth, and K. M. Crowe, Phys. Rev. Letters 5, 258 (1960).

Figure Captions

Fig. 1. Momentum spectrum of He^3 nuclei observed at 11.8 deg in the laboratory system. The peak at 1533 MeV/c is due to the reaction

$$p + d \rightarrow He^3 + \pi^0.$$

Fig. 2. Momentum spectrum of H^3 nuclei. The peaks at 1530 MeV/c and 820 MeV/c are due to the reaction $p + d \rightarrow H^3 + \pi^+$ at H^3 c.m. angles of 50 and 156 deg respectively.

Fig. 3. I = 0 part of the He^3 spectrum.

Fig. 4. Resolution function for He^3 momenta near 1400 MeV/c.

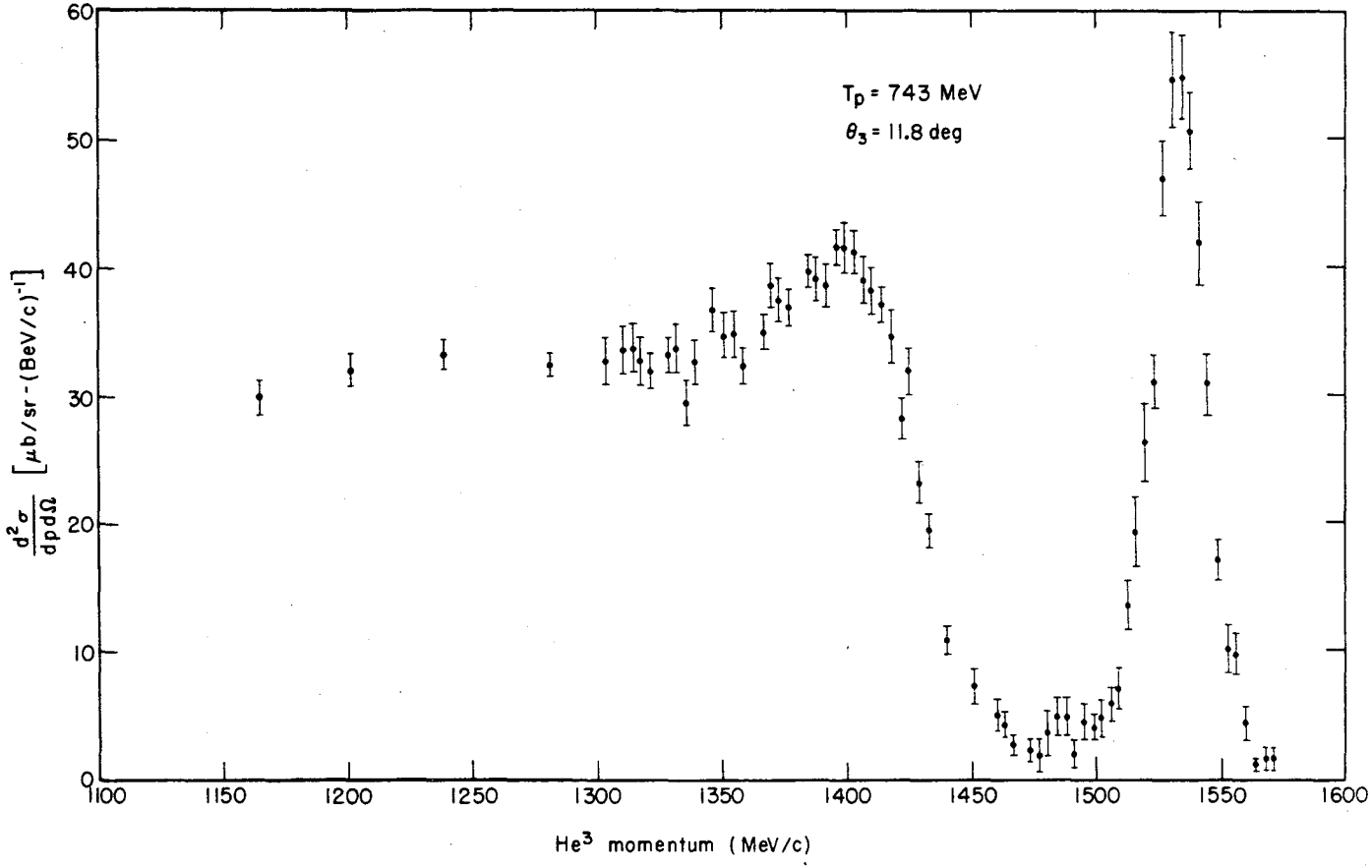

Fig. 1.

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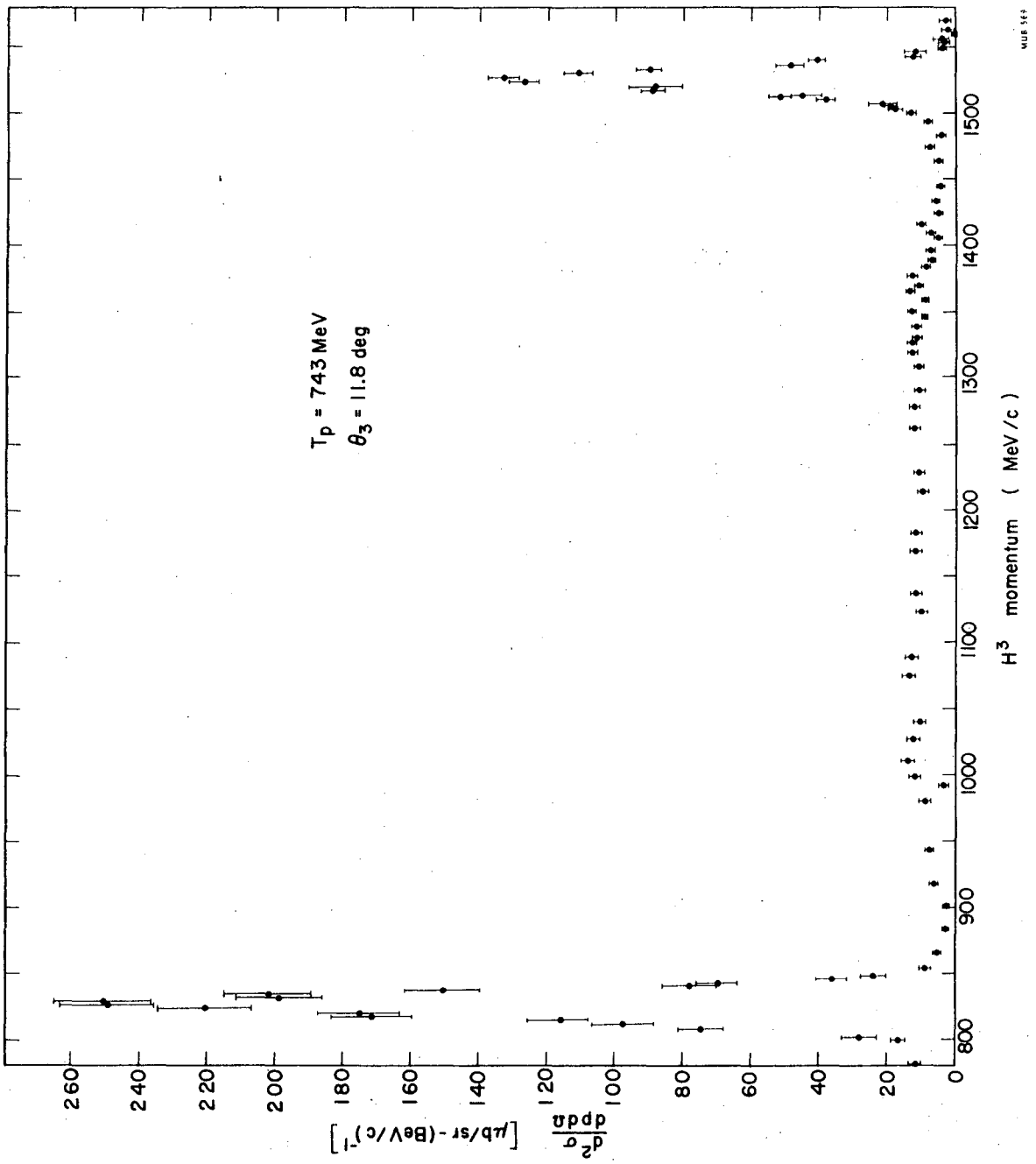
T_p = 743 MeV
θ_3 = 11.8 deg
$\frac{d^2\sigma}{d\Omega dp}$ [μb/sr-(BeV/c)$^{-1}$]
H^3 momentum (MeV/c)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
800
900
1000
1100
1200
1300
1400
1500

Fig. 2.

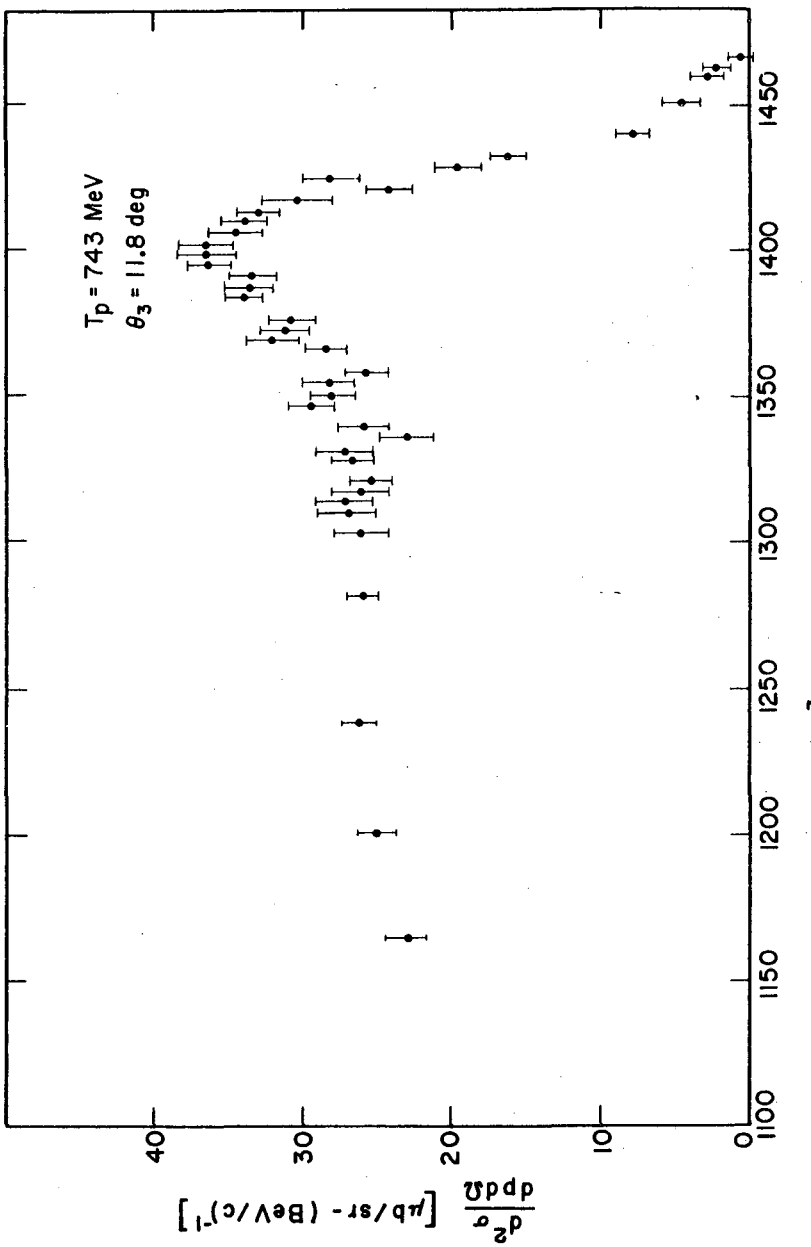
T_p = 743 MeV
θ_3 = 11.8 deg
$\frac{d^2\sigma}{dpd\Omega}$ [μb/sr - (BeV/c)$^{-1}$]
He^3 momentum (MeV/c)
0
10
20
30
40
1100
1150
1200
1250
1300
1350
1400
1450

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Fig. 3.

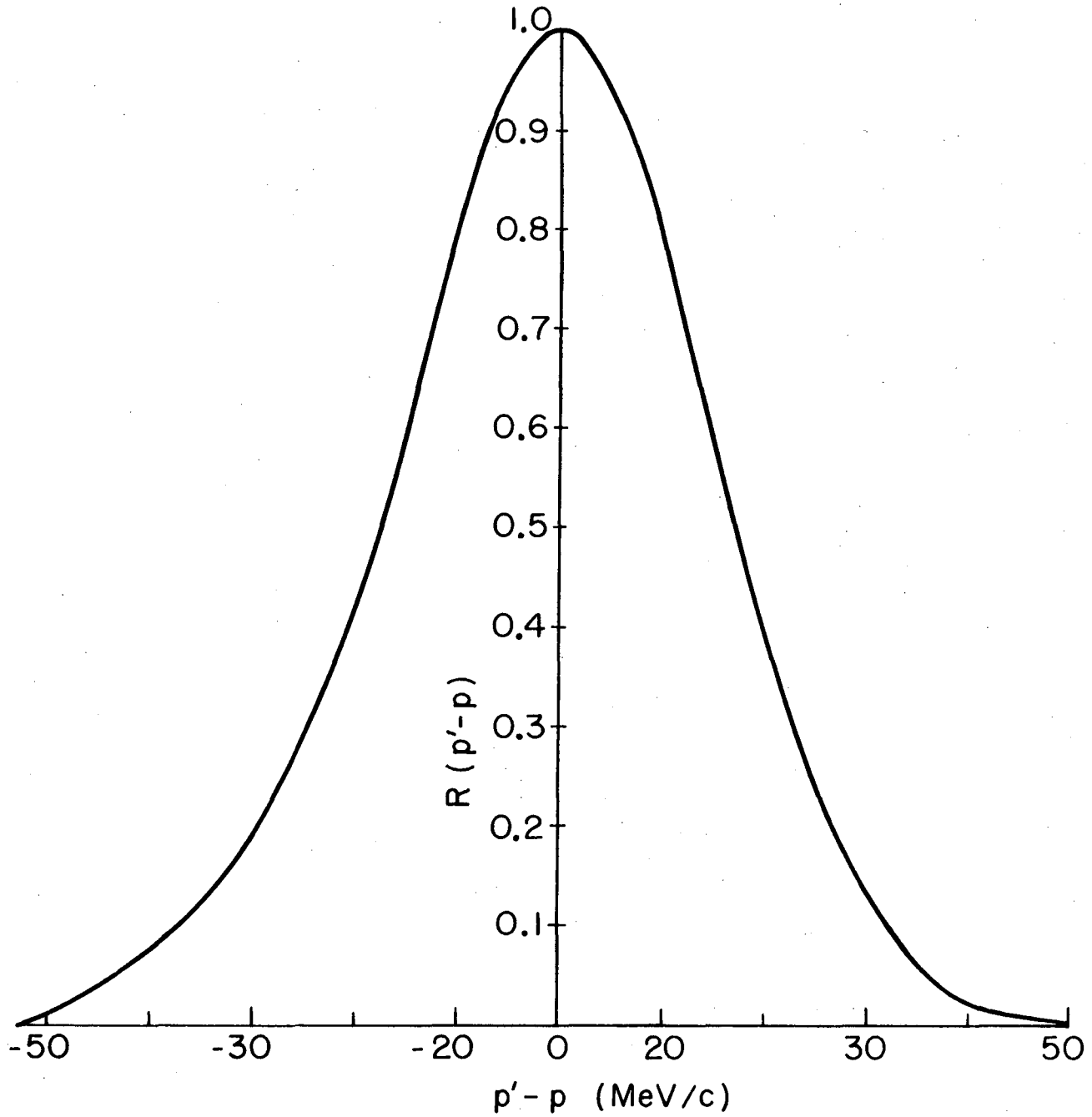

Fig. 4

Table I. He^3 momentum spectrum.

He^3 momentum (MeV/c)	Cross section 10^{-31} $cm^2/sr\text{-}(MeV/c)^{-1}$
1165	.299±.014
1202	.321±.013
1239	.333±.012
1283	.323±.009
1304	.327±.019
1311	.336±.019
1315	.337±.019
1318	.327±.019
1322	.326±.014
1329	.341±.014
1332	.337±.019
1336	.294±.018
1340	.335±.014
1347	.378±.014
1351	.347±.018
1355	.348±.018
1359	.332±.014
1367	.360±.014
1370	.386±.017
1373	.375±.017
1377	.377±.014
1385	.408±.013
1388	.391±.017
1392	.386±.017
1396	.425±.014

Table I. (Cont'd)

He^3 momentum (MeV/c)	Cross section 10^{-31} $cm^2/sr\text{-}(MeV/c)^{-1}$
1399	.445 ± .019
1403	.433 ± .018
1407	.390 ± .018
1410	.382 ± .018
1414	.382 ± .015
1418	.346 ± .921
1422	.297 ± .017
1425	.319 ± .018
1429	.232 ± .016
1433	.206 ± .014
1440	.115 ± .011
1451	.073 ± .014
1455	.051 ± .012
1463	.043 ± .010
1466	.027 ± .008
1473	.023 ± .009
1477	.020 ± .013
1480	.036 ± .017
1484	.049 ± .015
1488	.049 ± .015
1491	.028 ± .011
1495	.045 ± .014
1499	.042 ± .010
1502	.048 ± .014
1506	.058 ± .013
1509	.072 ± .016

Table I. (Cont'd)

He^3 momentum (MeV/c)	Cross section 10^{-31} $cm^2/sr\text{-}(MeV/c)^{-1}$
1513	.137 ± .019
1516	.192 ± .027
1520	.263 ± .031
1524	.312 ± .022
1527	.475 ± .030
1531	.559 ± .038
1535	.554 ± .034
1538	.506 ± .030
1542	.425 ± .033
1545	.321 ± .024
1549	.176 ± .017
1553	.102 ± .020
1556	.097 ± .016
1560	.044 ± .013
1564	.033 ± .005
1568	.016 ± .009
1571	.018 ± .009
1575	- .003 ± .005
1579	.004 ± .004

Table II. H^3 momentum spectrum.

He^3 momentum (MeV/c)	Cross section 10^{-31} $cm^2/sr\text{-}(MeV/c)^{-1}$
781	.116 ± .016
799	.167 ± .022
801	.278 ± .051
807	.745 ± .066
811	.998 ± .091
814	1.181 ± .099
816.5	1.714 ± .120
819.5	1.795 ± .121
823	2.404 ± .139
825	2.491 ± .143
828	2.562 ± .143
830.7	2.034 ± .127
833.3	2.020 ± .128
836.5	1.544 ± .110
839.5	.798 ± .079
842	.698 ± .060
845	.364 ± .045
848	.243 ± .037
854	.089 ± .017
866.2	.051 ± .012
883.7	.030 ± .008
901	.027 ± .010
918	.063 ± .012
943	.077 ± .012
980	.090 ± .017
992	.039 ± .014

Table II. (Cont'd)

He^3 momentum (MeV/c)	Cross section 10^{-31} $cm^2/sr\text{-}(MeV/c)^{-1}$
998.5	.119 ± .018
1010.5	.146 ± .019
1026.5	.124 ± .019
1039.5	.110 ± .017
1074.5	.135 ± .019
1088.5	.134 ± .018
1122.5	.100 ± .017
1136.5	.124 ± .017
1168.5	.117 ± .017
1182.5	.123 ± .016
1214	.098 ± .015
1228	.113 ± .016
1261.5	.121 ± .016
1277.5	.128 ± .016
1290	.105 ± .015
1307.5	.109 ± .010
1318.5	.128 ± .014
1326.2	.130 ± .013
1329.5	.123 ± .013
1338	.116 ± .013
1345.4	.092 ± .010
1349.4	.132 ± .012
1357.2	.090 ± .010
1364.7	.134 ± .011
1369.1	.117 ± .011
1376.7	.129 ± .016

Table II . (Cont'd)

He^3 momentum (MeV/c)	Cross section 10^{-31} $cm^2/sr\text{-}(MeV/c)^{-1}$
1383.5	.088 ± .013
1388.6	.077 ± .010
1396	.074 ± .012
1406.3	.052 ± .008
1409.6	.083 ± .012
1415.5	.102 ± .010
1424.5	.053 ± .006
1433.7	.062 ± .009
1444.9	.046 ± .005
1463.7	.057 ± .007
1473.8	.078 ± .011
1483.6	.046 ± .013
1493.5	.087 ± .009
1499.9	.134 ± .012
1503.4	.189 ± .022
1505.5	.194 ± .019
1506.9	.216 ± .040
1510.1	.383 ± .028
1512.3	.518 ± .031
1513.5	.477 ± .057
1516.7	.891 ± .037
1520.1	.894 ± .079
1523.1	1.275 ± .045
1526.3	1.332 ± .047
1530.0	1.158 ± .042
1533.0	.945 ± .039

Table II. (Cont'd)

He^3 momentum (MeV/c)	Cross section 10^{-31} $cm^2/sr\text{-}(MeV/c)^{-1}$
1536.1	.491 ± .041
1539.8	.430 ± .025
1542.5	.131 ± .022
1546.4	.120 ± .030
1549.3	.042 ± .014
1553.2	.037 ± .015
1556.1	.042 ± .020
1560.0	.003 ± .011
1562.8	.024 ± .016
1569.6	.031 ± .018

Table III. I = 0 part of He^3 Spectrum.

He^3 momentum (MeV/c)	Cross section (10^{-31} $cm^2/sr/\frac{MeV}{c}$) He^3 data	I = 1 part*	I = 0 part
1165	.299 ± .014	.060	.239 ± .014
1202	.321 ± .013	.060	.265 ± .013
1239	.333 ± .012	.060	.273 ± .012
1282	.323 ± .009	.060	.263 ± .009
1304	.327 ± .019	.060	.267 ± .019
1311	.336 ± .019	.060	.276 ± .019
1315	.337 ± .019	.060	.277 ± .019
1318	.327 ± .019	.060	.267 ± .019
1322	.326 ± .014	.060	.266 ± .014
1329	.341 ± .014	.060	.281 ± .014
1332	.337 ± .019	.060	.277 ± .019
1336	.294 ± .018	.060	.234 ± .018
1340	.335 ± .014	.060	.275 ± .014
1347	.378 ± .014	.060	.318 ± .014
1351	.347 ± .018	.059	.288 ± .018
1355	.348 ± .018	.057	.291 ± .018
1359	.332 ± .014	.054	.278 ± .014
1367	.360 ± .014	.049	.311 ± .014
1370	.386 ± .017	.047	.339 ± .017
1373	.375 ± .017	.045	.330 ± .017
1377	.377 ± .014	.043	.334 ± .014
1385	.408 ± .013	.038	.370 ± .013
1388	.391 ± .017	.036	.355 ± .017
1392	.386 ± .017	.033	.353 ± .017
1396	.425 ± .014	.031	.394 ± .014
1399	.415 ± .019	.029	.386 ± .019

Table III. (Cont'd)

He^3 momentum (MeV/c)	Cross section (10^{-31} $cm^2/sr/\frac{MeV}{c}$) He^3 data	I = 1 part*	I = 0 part
1403	.433 ± .018	.027	.406 ± .018
1407	.390 ± .018	.024	.366 ± .018
1410	.382 ± .018	.022	.360 ± .018
1414	.382 ± .015	.020	.362 ± .015
1418	.346 ± .021	.017	.329 ± .021
1422	.297 ± .017	.015	.282 ± .017
1425	.319 ± .018	.013	.306 ± .018
1429	.232 ± .016	.010	.222 ± .016
1433	.206 ± .014	.007	.199 ± .014
1440	.115 ± .011	.003	.112 ± .011
1451	.073 ± .014	0	.073 ± .014
1455	.051 ± .012	0	.051 ± .012
1463	.043 ± .010	0	.043 ± .010
1466	.027 ± .008	0	.027 ± .008
1473	.023 ± .009	0	.023 ± .009
1477	.020 ± .013	0	.020 ± .013

*In obtaining the I = 1 part a smooth curve was drawn through the H^3 spectrum and the resultant curve divided by two.

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