Computations for Al, Ni, and Pt for different values of the parameters V, W, r_0, and a, with $r_1=r_0$, show that rounding the nuclear potential significantly modifies the cross sections. As a increases and the rounding becomes greater, the large-angle cross sections decrease for the heavier elements and, as shown in Fig. 1, for the particular parameter values $V=38$ Mev, $W=9$ Mev, $r_0=8.24\times10^{-13}$ cm and $a=0.49\times10^{-13}$ cm, the computed cross sections are actually very close to the experimental ones. Also shown in Fig. 1 is a plot of the potential for this set of parameters. The results are *not* sensitive to the radius of the nuclear charge distribution; there is essentially no change when r_1 decreases from r_0 to 0.8 r_0, this latter value being of the order of that indicated by the experiments on x-rays from the mu-mesonic atoms.[5] However, information about the shape of the nuclear potential itself yields some information on the charge radius. Indeed, a rough calculation, assuming neutron and proton gases which fill states to the same Fermi level, indicates that the value of a quoted above is in the region required to give the observed charge radius.

Results for lighter elements are not yet so satisfactory, as indicated in Fig. 2 for Ni, although the results are at least qualitatively correct. However, only a limited range of the parameters has so far been investigated. Further computations are now in progress.

It is planned to extend the calculations to other elements and to other energies. It is also planned to calculate differential cross sections for the elastic scattering of neutrons in this energy region[6] using the same model.

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Neutron-Proton Scattering at 300 Mev*

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A WILSON cloud chamber,[1,2] containing only hydrogen and water vapor, was photographed stereoscopically in a magnetic field[3] of strength 22 000

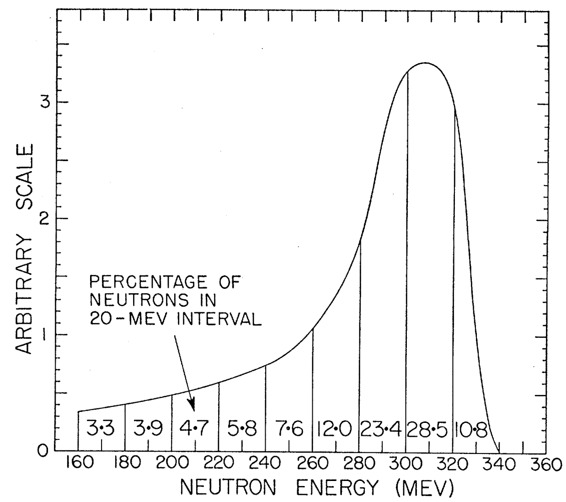

Fig. 1. The unfolded neutron energy spectrum from 340-Mev protons in a $1\frac{3}{4}$-in. thick LiD target. Errors of measurement were taken from the original data by an error-unfolding process.

gauss to obtain data[2,4] on the protons scattered by 300-Mev neutrons. Certain selection criteria were adopted for the measurements of the tracks, which were obtained in two runs at the Berkeley cyclotron. A lower limit of 155 Mev was set on the neutron energy for a track to be accepted. Definite regions of the cloud chamber were chosen for the measurements in each of the two runs. Tracks whose dip angles exceeded 50° were excluded from measurement. The scatter angle was generally limited to 85°, although a few trackes were measured with angles up to 86° to make sure no 85° tracks were missed.

The energy spectrum for the neutrons that were produced in a LiD target, $1\frac{3}{4}$ in. thick, by 340-Mev protons inside the cyclotron is shown in Fig. 1. This spectrum was derived from the original histogram of the cloud-chamber data by an error-unfolding process. A total of 1435 tracks were selected from the angular group (scatter angles less than 85° and dip angles less than 25°) for which the energy measurements are best. The omission of tracks with dip angles exceeding 25° is accounted for by applying a geometrical correction factor,[5] based on the assumption of azimuthal symmetry. The effect of the variation[6] of the total n-p scattering cross section with the neutron energy was included in the error-unfolding process.

In order to justify the assumption of uniform distribution of the protons in the azimuthal angle (measured in a plane perpendicular to the direction of the neutron beam), tabulations[2] of the data were made. Figure 2 shows the azimuthal distribution for dip angles less than 40° and for neutron energies above 200 Mev. Tracks with dip angles greater than 40° fall into the excluded region and are not tabulated. The number of tracks for any square or partial square is given inside the square. The numbers within any vertical column

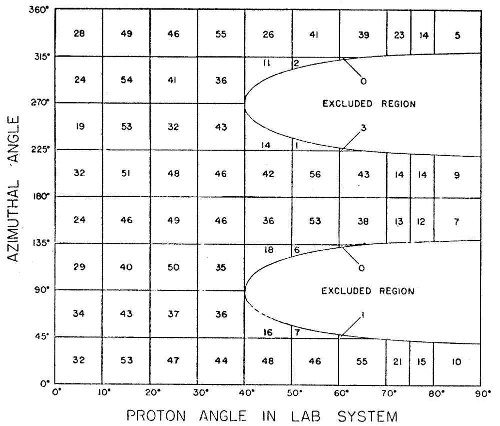

FIG. 2. Azimuthal distribution for dip angles less than 40°. Neutron energies are greater than 200 Mev.

and contained in whole squares should agree within the limitations imposed by the statistical errors of measurement. A consideration of these data shows that the assumption of uniformity of the azimuthal distribution is valid.

Table I lists the angular distribution data, based on 2057 tracks, for the neutrons in the center-of-mass system. The data are limited to neutrons with energies above 200 Mev and to protons with dip angles less than 40°. The geometrical correction factor has the value unity for proton deflection angles less than 40°, but above 40° the value of this factor rises steadily up to the value 2.25 at 90°. By assuming a total *n-p* cross section of 35 mb, it is possible to calculate the differential cross section from the total weighted number of tracks. However, the standard statistical errors in the differential cross section are based on the uncorrected number of tracks in the 10-degree angular intervals.

TABLE I. Angular distribution of neutrons in center-of-mass system for neutron energies above 200 Mev and for proton dip angles less than 40°.

Angle	Number of tracks first run	Number for both runs	Weighted number	mb per steradian
10–20	26	37	82.2	3.83±0.63
20–30	42	56	121.9	3.48±0.47
30–40	50	86	181.0	3.81±0.41
40–50	70	102	205.2	3.50±0.35
50–60	66	107	200.7	2.96±0.29
60–70	70	98	173.5	2.31±0.23
70–80	63	102	161.8	2.02±0.20
80–90	78	112	155.6	1.89±0.18
90–100	75	116	125.0	1.51±0.14
100–110	104	166	166.0	2.07±0.16
110–120	114	163	163.0	2.17±0.17
120–130	90	170	170.0	2.51±0.19
130–140	114	179	179.0	3.06±0.23
140–150	118	193	193.0	4.06±0.29
150–160	98	165	165.0	4.71±0.37
160–170	81	139	139.0	6.48±0.55
170–180	36	66	66.0	9.14±1.12

The upper limit on the standard error in the neutron angle in the center-of-mass system is estimated to be ±3.0°, while the average standard error is estimated to be ±1.5°.

The data contained in Table I are plotted in Fig. 3 in histogram form. They are to be compared with the data obtained with counters by Kelly, Leith, Segrè, and Wiegand,[7] who reported neutron energies (about 260 Mev) somewhat smaller than the neutron energies measured in the present experiment. The agreement is considered satisfactory. The special point was computed

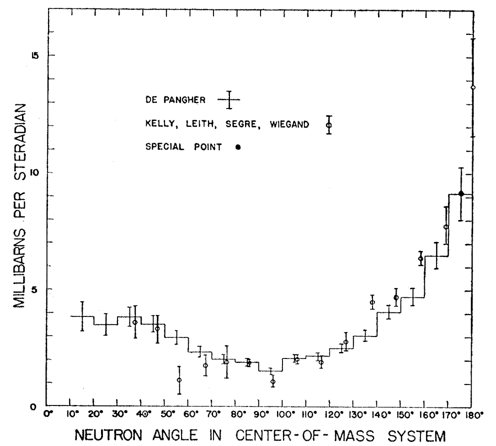

FIG. 3. Two sets of data are displayed here, the cloud chamber work (histogram) and the experimental points of Kelly *et al.* on the angular distribution of neutrons in the center-of-mass system. The meaning of the special point is given in the text.

from a smooth curve drawn through the counter data to illustrate how the cloud chamber with its selected 10-degree channel width would depict this rapidly changing portion of the angular-distribution curve. The cloud-chamber data extended into smaller neutron angles than do the counter data and clearly show a marked departure from symmetry about 90° in contrast to the 90-Mev data,[8,9] which exhibit symmetry about 90°.

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