Letters to the Editor

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The Scattering of Neutrons of Energy Between 12 Mev and 13 Mev by Protons

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THE angular distribution of the recoil protons in the neutron-proton scattering process has been investigated in a high pressure (25 atmospheres) cloud chamber. The recoil protons were produced in methane gas by a well-collimated homogeneous beam of neutrons one-half inch in diameter taken in the forward direction from the $D(d, n)He^3$ reaction. A thin (0.5-Mev) deuterium gas target was employed and a magnetic field deflected the deuteron beam from the forward direction after passing through the target. This prevented neutrons from sources other than the deuterium target from entering the cloud chamber. The neutron spectrum of this arrangement was examined with the cloud chamber and showed a strong peak between 12.0 Mev and 13.0 Mev, superimposed on a low intensity continuous spectrum originating from the thin-foil windows on the entrance and exit of the target.

A total of 2000 recoil protons have been measured, of which 1636 were produced by neutrons between 12-Mev and 13-Mev energy and satisfied selection criteria. The data are given in Table I.

The aximuthal correction factors given were determined from the experimental data and are in good agreement with the correction factors calculated from the geometry and the illuminated height of the chamber. For each scattering angle interval the data were plotted in 20° azimuthal angular intervals. The shape of this distribution was in good agreement with the calculated shape based on purely geometrical considerations. The number of recoil protons scattered into those azimuthal angle intervals in which all tracks were observable determined the number which would have been measured if all the tracks in all the azimuthal angle intervals could have been measured. The ratio of this number to the actual observed number yielded the azimuthal correction factors.

TABLE I. Experimental data for recoil protons produced by neutrons of energy between 12 Mev and 13 Mev.

Angular interval c.m. system	No. of recoil protons	Azimuthal correction factors	Length correction factors	Solid angle interval $\times 1/2\pi$	No. of recoil protons per unit solid angle $\times 2\pi/10$
0–21	96	1.12	2.78	0.066	452±10.5%
21–41	174	1.94	2.32	0.179	438± 9.3%
41–61	280	2.25	1.82	0.270	425± 7.0%
61–81	447	2.07	1.39	0.320	391± 5.7%
81–101	639	1.78	1.18	0.347	387± 5.1%

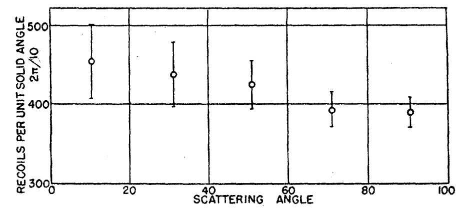

FIG. 1. Angular distribution of recoil protons per unit solid angle in the center of mass system.

Since the neutron beam is collimated, all recoil protons originate from a ½-inch diameter cylinder through the center of the chamber, and since the light beam height is known, a calculation of the expected azimuthal correction factor is quite straightforward.

A length correction factor is necessary since for each different scattering angle interval the recoil protons have a different energy and length. Since these lengths and the chamber geometry were well known, these factors could be calculated from simple geometrical considerations.

The graph in Fig. 1 shows the number of recoil protons per unit solid angle per scattering angle interval in the center of mass system plotted *versus* the scattering angle in the center of mass system. Probable statistical errors are indicated in each interval. A ratio of the differential cross sections for neutron scattering in the backward direction to scattering in the perpendicular direction in the center of mass system of either unity (spherically symmetric scattering) or slightly greater than unity can be consistent with these data. This possible small asymmetry is in the opposite direction to that found by Amaldi[1] and co-workers and by Champion and Powell.[2] Later results by Powell[3] apparently show spherically symmetric scattering. A complete discussion of these data and the analysis will be published later.

[1] E. Amaldi, D. Bocciarelli, B. Ferretti, and G. C. Trabacchi, *Naturwiss.* **30**, 582 (1942).
[2] F. C. Champion and C. F. Powell, Proc. Roy. Soc. **A183**, 64 (1944).
[3] Reference 38, G. Wentzel, Rev. Mod. Phys. **19**, 10 (1947).

Erratum: The *K* X-Ray Absorption Edge of Silicon

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IT was erroneously stated in the above paper that in Table I the wave-lengths were corrected only for normal refraction. Actually the terms for the anomalous effect had also been applied for quartz and the four micas, which are the only ones needing such a correction. The anomalous terms increased the observed wave-lengths by 0.6 x.u. for quartz and by 3.0 x.u. for the micas.