Professor B. S. Hopkins of the University of Illinois and electrodes were made by packing nickel tubes with a mixture of the oxide and lanthanum metal. A heavier isotope was suggested by the atomic weight and the packing fraction curve.[1] Doubly charged ions were photographed, and it was found that the sample contained traces of ytterbium which unfortunately gave a mass at 176. On the other hand, no intensity occurred at mass 177 as strong as one one-thousandth of the intensity of the strong lutetium mass at 175. In the meantime, a second isotope has been found at 176 by Mattauch and Lichtblau[2] which gives good agreement with the atomic weight, and provides a striking exception to the usual isotopic structure of odd-numbered elements.

At the suggestion of Professor Hönigschmid, tantalum was examined, as its atomic weight with a packing fraction of 1.5×10^{-4} would imply the existence of a lighter isotope. If this isotope were at 179, it should have an intensity of approximately 5 percent of the main mass at 181. A spark between metallic tantalum electrodes served as a source, and singly, doubly, and triply charged ions were photographed. No mass could be found at 179 as strong as 0.1 percent of the main isotope at 181. A faint mass of approximately 0.15 percent was observed at 182 and also with doubly charged ions at 91. This is provisionally attributed to a hydride.

ARTHUR J. DEMPSTER

Ryerson Physical Laboratory,
University of Chicago,
Chicago, Illinois,
March 31, 1939.

[1] A. J. Dempster, Phys. Rev. **53**, 873 (1938).
[2] J. Mattauch and H. Lichtblau, Zeits. f. Physik **111**, 514 (1939).

On the Scattering of Fast Neutrons of Different Energy

In our previous papers,[1] the absorption scattering cross sections of atoms for D+D and Li+D neutrons were studied and it was found that cross sections depend upon the energy of neutrons. The neutrons were observed at right angle to the incident deuteron. In the present experiment, measurements were performed at various angles φ to the incident deuteron. The energy of the neutrons was changed between about 2.1 and 2.8 Mev. The accelerating voltage was 300 kv and the apparatus used was the same as that in previous work; the neutrons were detected by an ionization chamber, filled with methane at 20 atmospheres pressure, which was situated 30 cm from the target. The intensity of neutrons not coming from the target was estimated by inserting a thick paraffin block between the target and the chamber.

In calculating the mean energy of neutrons corresponding to various values of φ, it was assumed that our deuteron beam contained 30 percent atomic and 70 percent molecular ions and also that the target was thick. On account of the uncertainty of these assumptions, the energy values may be in error by about 0.15 Mev, except the value for $\varphi=90°$. But the relative spacing of the energy values are much more accurate. In correcting the transmission for the finite size of chamber and the absorber, the scattering of neutrons is assumed to be isotropic with respect to the center of gravity. The corrections were four percent of the scattered neutrons for atoms except H and D, and 16 percent and 9 percent for H and D, respectively. As the correction in the case of H is large, the experiment was repeated at 40 cm target-chamber distance where the correction was 9 percent, and the same result was obtained.

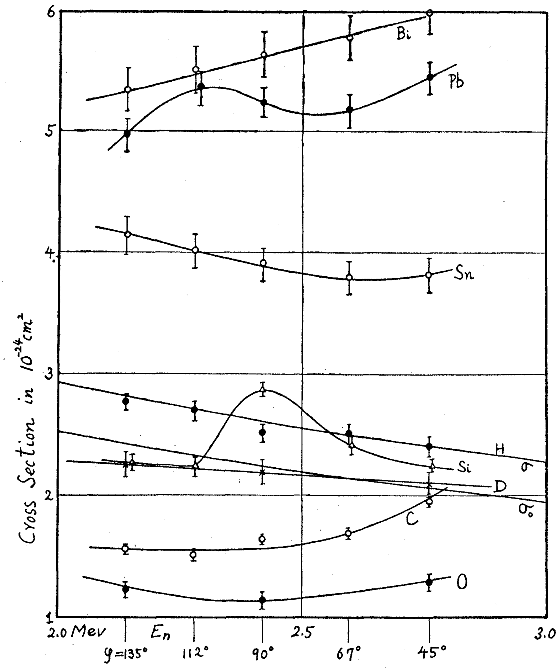

FIG. 1. Cross section for scattering of neutrons of various energies.

Thirty-two elements were examined and some of the results are shown in the figure. Paraffin and carbon were used for determining the cross sections of H and C, and D_2O, SiO_2 and Si were used to examine D, O_2 and Si. Complicated dependence of cross sections upon the energy of neutrons is observed in most cases. Si has a rather sharp resonance at 2.45 Mev. The cross section of H is larger than our previous value[1] (2.28 ± 0.09) and Ladenburg's[2] value (2.1 ± 0.2). The present value is not in agreement with the theoretical expression[3]

$$\sigma_0=\frac{4\pi\hbar^2}{M}\left(\frac{1}{4}\frac{1}{|E_1|+\frac{1}{2}E}+\frac{3}{4}\frac{1}{|E_0|+\frac{1}{2}E}\right)$$

but is in agreement with the following expression corrected for the final range of interaction of proton and neutron[4]

$$\sigma=\frac{4\pi\hbar^2}{M}\left(\frac{1}{4}\frac{1+\alpha_1r_0}{|E_1|+\frac{1}{2}E}+\frac{3}{4}\frac{1+\alpha_0r_0}{|E_0|+\frac{1}{2}E}\right)$$

when we assume $r_0=1.3\times10^{-13}$ cm.

The detailed report will soon appear in the *Proceedings of the Physico-Mathematical Society of Japan.*

HIROO AOKI

Physical Institute,
Osaka Imperial University,
Osaka, Japan,
March 5, 1939.

[1] Hiroo Aoki, Proc. Phys. Math. Soc. Jap. **21**, 40 (1939); Proc. Phys. Math. Soc. Jap. **21**, 75 (1939); Seishi Kipuchi and Hiroo Aoki, Phys. Rev. **55**, 108 (1939).
[2] R. Ladenburg and M. H. Kanner, Phys. Rev. **52**, 911 (1937).
[3] Cf. H. A. Bethe and R. F. Bacher, Rev. Mod. Phys. **8**, 117 (1936).
[4] Cf. H. A. Bethe and R. F. Bacher, Rev. Mod. Phys. **8**, 119 (1936).