Selective Scattering of Slow Neutrons

In addition to the experiments described in the foregoing letter we have investigated the scattering of slow neutrons from various scatterers using In and Rh detectors. The Rh detector used was 0.1 mm thick (0.122 g/cm^2), the In detector 0.15 mm (0.109 g/cm^2), while the Ag detector was 0.1 mm (0.105 g/cm^2).

Complete scattering curves were run, with a Rh detector, for the scatterers Ni, C, and Zn while a sufficient number of points was observed on the curve for Fe to show the trend of the curve. Typical results are shown in Fig. 1 where the full curves give the scattering with Ag detector and the dashed curves that for the Rh detector. In addition, single points were obtained with the Rh detector for the metals Pb, Cu, Al and Bi. Because of the long period of In no curves were run with this detector, but points were taken showing the scattering for the metals Fe, Ni, Pb, and Cu. In Table I are shown the relative cross section for scattering for the Ag and Rh detectors for scatterers for which these data are available. Table II gives the comparative scattering (in percent) for the various detectors at specified thickness of the various scattering materials. It will be seen that large differences exist between the measured scattering from a single element by using different detectors. Similar results have been obtained by Tillman[1] on the scattering of slow neutrons by using Cu, Ag, and I, as detectors. Furthermore, the absorption coefficient of various metals has been found by several authors[2] to depend on the detector. In discussing the results it should be noted that each detector contained approximately the same number of g/cm^2 and, on account of the closeness in atomic weights of the three metals, about the same number of atoms cm/^{2} (to within 15 percent). Let us consider Ag and Rh, since more data exist for these elements. Several explanations are possible. (1) Neutrons which are absorbed by Rh are not scattered back by the various scatterers in such great numbers as those absorbed by Ag. (2) The absorption *vs.* velocity curve may be of such a form that in the region of a most probable velocity for absorption it is steeper and narrower in the case of Rh than in the case of Ag, so that a larger proportion of neutrons having the necessary energy to activate Rh strongly are absorbed in the first passage through the metal than in the case of silver. Probably some combination of the two explanations is actually the real one. In favor of (1) the authors have shown[3] that, by using an Ag detector and filtering the neutrons through 0.65 mm Cd, a smaller cross section for the scattering by ions was obtained than with unfiltered neutrons.

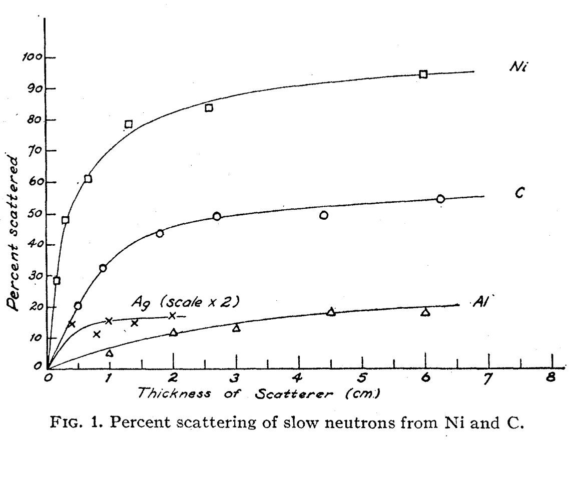

FIG. 1. Percent scattering of slow neutrons from Ni and C.

TABLE I. *Relative scattering cross sections, Ag and Rh detectors.*

SCATTERER	$\sigma^2 \times 10^{24}$cm^2 Ag DETECTOR	$\sigma^2 \times 10^{24}$cm^2 Rh DETECTOR
C	3.2	2.2
Fe	9.9	4.3
Ni	17	7.2
Zn	3.4	2.9

TABLE II. *Comparison of various detectors (percent scattering).*

SCATTERER / DETECTOR	1 cm Fe	0.65 cm Ni	1 cm Pb	1.3 cm Cu	2.1 cm Sn	5 cm Al	2 cm Bi	1 cm C	1 cm Zn
Ag	59	60.5	25.0	45.0	22.0	18.0	35	35.0	20.0
Rh	32.8	42.0	26.8	—	19.6	18.7	26.1	21.0	19.0
In	51.0	51.0	18.2	40.2	—	—	—	—	—

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ALLAN C. G. MITCHELL
EDGAR J. MURPHY
MARTIN D. WHITAKER

New York University,
University Heights,
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[1] J. R. Tillman, Nature **137**, 107 (1936).
[2] Moon and Tillman, Nature **135**, 904 (1935); Tillman and Moon, Nature **136**, 66 (1935); Ridinour and Yost, Phys. Rev. **48**, 383 (1935); Szillard, Nature, **136**, 950 (1935).
[3] A. C. G. Mitchell and E. J. Murphy, Phys. Rev. **48**, 653 (1935).

Disintegration of the Deuteron by Gamma-Rays

The cross section for photoelectric disintegration of a deuteron by gamma-rays on the assumption of a short range interaction force between neutron and proton, was found by Bethe and Peierls,[1] to be of the order of 7×10^{-28} cm^2 for $h\nu=2.62$ MEV. This appears to be in satisfactory agreement with the experimental result 5×10^{-28} cm^2 of Chadwick and Goldhaber,[2] who allow a factor two for experimental uncertainties.

However, it now seems possible with this experimental accuracy, or with accuracy only slightly improved over this, to set an upper limit on the range of the proton-neutron interaction. The argument is something as follows:

The Bethe-Peierls result for the cross section σ may be considered an exact evaluation if the interaction occurs only over a distance r_0, where r_0 tends to the limit zero. But if r_0 is in the neighborhood of 1.5×10^{-13} cm, in accordance with the idea of various writers, changes occur which tend to increase σ substantially over the value 7×10^{-28} cm^2. These changes were studied for several types of $n-p$ interaction, including a potential hole of width r_0 and depth V_0, and the exponential function $V=-V_0\exp(-r/r_0)$. In all cases the