LETTERS TO THE EDITOR

Prompt publication of brief reports of important discoveries in physics may be secured by addressing them to this department. Closing dates for this department are, for the first issue of the month, the eighteenth of the preceding month, for the second issue, the third of the month. Because of the late closing dates for the section no proof can be shown to authors. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents.

Communications should not in general exceed 600 words in length.

Scattering of Slow Neutrons by Paramagnetic Salts*

Bloch[1] and Schwinger[2] have investigated theoretically the polarization effects when neutrons interact with magnetized ferromagnetic material. Experiments have been performed to demonstrate these effects.[3-6] Halpern and Johnson[7, 8] have pointed out that magnetic scattering will occur in every type of magnetic material and that the magnetic and nuclear contributions to the neutron scattering may be separated by studying the scattering of certain metals in different valence states.

Preliminary results on scattering of neutrons by paramagnetic substances reported by one of us[9] indicated the necessity for making investigations of the neutron scattering at small angles.

Experiments have now been carried out in which scattering by paramagnetic substances has been studied by two methods:

(1) Measurement of the effective cross section of the paramagnetic salts as compared to the *additive* cross sections for the elements which compose them, under conditions in which neutrons scattered through angles greater than approximately 3° were not detected.

(2) Measurement of the angular distribution of the scattered neutrons.

A neutron beam approximately 100 cm long from source to boron chamber was shielded by B_4C and accurately collimated by cadmium channels. The cross sections of the compounds were then measured with the sample interposed in this beam approximately midway between the source and the detector, so that practically no scattered neutrons were detected. The cross section of an identical physical mixture was then determined as in the case of MnS, or else cross sections of the constituent elements were measured separately under the same conditions. The results are shown in Table I. The differences in column four are believed to be correct for the samples used within $\pm 0.8\times 10^{-24}$ cm^2.

TABLE I. *Results for the observed, nuclear, and magnetic cross sections for various paramagnetic salts.*

Paramagnetic Salt	Observed Cross Section (cm^2)	Nuclear Additive Cross Sections (cm^2)	Magnetic Cross Section for Salt (cm^2)
$MnSO_4$	33.6×10^{-24}	31.3×10^{-24}	2.3×10^{-24}
MnS	19.1	15.1*	4.0
MnO	19.9	18.1	1.8
Fe_2O_3	39.2	36.0	3.2†

* Physical mixture.
† This number should be increased by twice the magnetic scattering cross section of the metallic iron atom when unmagnetized.

The results show an increase in scattering for the paramagnetic salts over the *additive* cross sections of the elements which compose them. Carefully selected materials were used in all cases and special precautions were taken to exclude water contamination.

The angular distribution of the scattered neutrons has been studied by comparing the transmission of the paramagnetic salts when placed near the center of the beam and close to the detector. With the sample close to the detector an appreciable solid angle was subtended by the sample at the chamber. The effective change in solid angle subtended between the two points in the beam was experimentally measured with carbon as a scattering material. Iron was also used in this way and the iron and carbon data indicate a scattering cross section for iron of 8.5×10^{-24} cm^2 and a capture cross section for iron of 3.5×10^{-24} cm^2. The total cross section for iron was measured in this beam and found to be $12.0\pm 0.1\times 10^{-24}$ cm^2.

MnS gave pronounced evidence of small angle scattering. From an experimental point of view the MnS was the most favorable of the paramagnetic salts as the cross section of the negative ion was the smallest, and also a physical mixture was easily obtainable to make a comparison. A preliminary study of our data obtained with the MnS indicates that the form factor for the magnetic scattering has decreased noticeably in the region 20 to 45 degrees. These results seem to indicate conclusively the existence of magnetic scattering of slow neutrons by paramagnetic materials.

We are indebted to Professors Halpern and Johnson for many helpful discussions.

A paper giving the details of our work will follow.

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