counting statistics only. The function $P(x)$ is plotted in Fig. 2. The dotted line represents an exponential function with $L=320$ g/cm^2 and is seen to provide a good fit to the data for absorber thicknesses greater than $\sim$1.2 cm. A transition maximum for zero absorber thickness is clearly indicated. Since $P(x)$ represents an integrated value for neutron production over a half-inch of lead, the transition maximum for neutron production per unit volume of lead must occur within the first 1.25 cm (half-inch) of lead.

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Neutron Diffraction Investigation of the Atomic Magnetic Moment Orientation in the Antiferromagnetic Compound CrSb

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THE atomic magnetic moment orientation in the antiferromagnetic compound CrSb has been investigated at room temperature by neutron diffraction. The crystal structure and magnetic properties of this compound have been previously determined by Haraldsen, Rosenqvist, and Grønvold.[1] This compound has the nickel arsenide structure and shows a marked decrease in magnetic susceptibility as the temperature is lowered from the antiferromagnetic Curie point (450°C). The magnetic mass susceptibility falls from 10.97×10^{-6} at 450°C to 3.3×10^{-6} at 20°C. Lattice constants are $a_0=4.127$A and $c_0=5.451$A.

Calculation showed that all antiferromagnetic magnetic moment orientations which lead to a magnetic unit cell, one side of which is a multiple of the atomic (x-ray) unit cell, would cause the presence of strong new diffraction maxima at low angles in a neutron diffraction pattern. Such new maxima were not observed, although they were looked for carefully. Experimental data showed that the (101) maximum had twice the intensity of the (102) and (110) maxima, respectively. On the basis of nuclear scattering, with no magnetic scattering, these three maxima would be essentially equal in magnitude. This doubling in intensity of (101) relative to (102) and (110), respectively, is consistent with the atomic magnetic moments being aligned perpendicular to (001) planes, i.e., along the c axis, in such a manner that they are aligned in the same direction (ferromagnetically) in any one (001) plane but oppositely directed (antiferromagnetically) in adjacent (001) planes. Nearest neighbor chromium atoms (2.726A apart) are thus aligned antiferromagnetically whereas second nearest neighbors (4.127A apart) are aligned ferromagnetically. One unit cell is shown in Fig. 1. The possibility that the magnetic moments may be aligned parallel to the (001) planes may be eliminated since this arrangement would lead to an unobserved strong maximum at low angles.

On the basis of the relative intensity data, a conservative estimate for the average number of electrons per atom whose magnetic moments are aligned in the manner described above is 2.7±0.2, if the assumption is made that the orbital angular momentum contribution is completely quenched and the magnetic amplitude form factor of manganese[2] is used in the calculation.

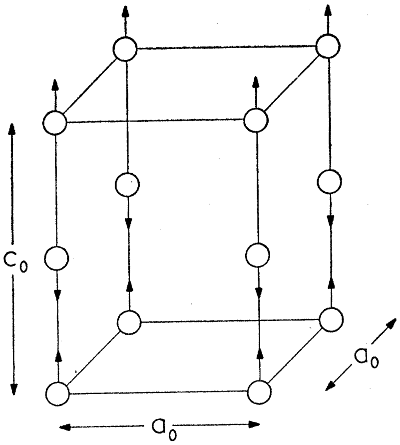

FIG. 1. Unit cell of CrSb. Arrows indicate the relative alignments of atomic magnetic moments. Only chromium atoms are shown.

The atomic magnetic moment orientation found above differs from that found in MnF$_2$ which is body-centered tetragonal with respect to the manganese atoms, where nearest neighbors (3.31A apart)[3] are ferromagnetically arranged and next nearest neighbors (3.82A apart)[3] are antiferromagnetically arranged.[4] The CrSb arrangement is somewhat similar to the arrangement in some of the (111) planes of the face-centered cubic compound FeO[2] since in FeO the moments are aligned perpendicular to some of the (111) planes and are aligned in opposite directions in adjacent (111) planes[4] of the particular sets considered.

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Nutational Resonance*

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APPLICATION of repeated radiofrequency pulses to proton-containing liquids in a magnetic field results in transient nuclear resonance absorption effects which we have reported[1] previously.

Recently we have observed an additional effect which results when both the time between pulses (off-time) and a pulse duration (on-time) are short compared with the relaxation times T_1 and T_2. Under these circumstances one might expect the nuclear resonance signal to be small in the case of power levels normally sufficient to saturate the sample. However, if a radiofrequency pulse contains an integral number of nutational periods it is possible for the signal to maintain a relatively large value as a result of a nutational resonance process. In case the magnetic field is homogeneous over the sample, the nutational frequency will be uniform and after an initial rf pulse lasting for an integral number of nutational periods the sample's magnetic moment will be left oriented along the magnetic field in its original condition except for some attenuation due to the net effect of the transverse and longitudinal relaxation processes. During the succeeding off-time, the moment's orientation will be undisturbed while its amplitude increases due to longitudinal relaxation. After a sufficient number