

shows that the remanent magnetization, and thus the spontaneous magnetization (curve III) is indeed reversed at about 38°C.

When a rod of this material is magnetized and suspended torsion-free in a small magnetic field ($<H_c$), the turning of the rod over an angle of 180° on heating or cooling through the compensation temperature provides an illuminating demonstration of the existence of ferrimagnetism.

According to Néel's theory² this phenomenon could occur for spinels containing only one type of magnetic ions (e.g., Fe³⁺), when a certain relation (reference 1, p. 151) holds between the distribution of the magnetic ions among the tetrahedral and octahedral positions and the ratios between the tetr.-oct., tetr.-tetr. and oct.-oct. (indirect) exchange interactions.

As these ratios are fixed by the angles Me-O-Me,³ and the distances Me-O (Me = magnetic ion) according to unknown laws,¹⁰ it seems likely that for one type of magnetic ion only this relation can be fulfilled for a very narrow range of ionic distributions only.

For a material containing two types of magnetic ions Me_i and Me_{ii} there are, in addition, differences between the interactions Me_i-Me_i, Me_i-Me_{ii} and Me_{ii}-Me_{ii}, so that here a corresponding relation may be more easily fulfilled.

X-ray investigation of the above series of solid solutions¹¹ shows *inter alia* that with increasing Cr-content *a* an increasing proportion of Li ions occupies the tetrahedral position. This accounts for the fact that the low temperature saturation magnetization of Li_{0.5}Fe_{1.25}Cr_{1.25}O₄ is unequal to zero, which value should have been expected for an arrangement [Fe]^{tet}[Li_{0.5}Fe_{0.25}Cr_{1.25}]^{oct}O₄.

The magnetic investigation of the system Li_{0.5}Fe_{2.5-a}Cr_aO₄ will be reported upon in the near future.¹² An interesting behavior of the *g* factor as a function of temperature was found by van Wieringen.¹³

¹ P. P. Ewald and C. Hermann, *Strukturberichte* (Akademische Verlagsgesellschaft, Leipzig, 1931), Vol. I, p. 350.

² L. Néel, *Ann. phys.* 3, 137 (1948).

³ *International Tables for X-ray Crystallography* (Kynoch Press, Birmingham, England, 1952), Vol. I, p. 340.

⁴ E. W. Gorter, *Nature* 165, 798 (1950); or *Compt. rend.* 230, 192 (1950).

⁵ L. Néel, *Compt. rend.* 230, 190, 375 (1950).

⁶ C. Guillaud *et al.*, *Compt. rend.* 229, 1133 (1949); 230, 1256, 1458 (1950); 232, 944 (1951).

⁷ Shull, Wollan, and Strauser, *Phys. Rev.* 81, 483 (1951).

⁸ For long-range order phenomena at the limiting compositions, see P. B. Braun, *Nature* 170, 1123 (1952) and reference 10.

⁹ P. W. Anderson, *Phys. Rev.* 79, 350 (1950); E. W. Gorter, *J. phys. et radium* 12, 237 (1951).

¹⁰ R. S. Weiss, *Ceramic Age* 59, 35 (1952), suggests an empirical formula for this relationship, which cannot, however, easily be tested because of the large possible error in the experimental oxygen parameter values. Theoretical background is still lacking.

¹¹ P. B. Braun, *Physica* (to be published).

¹² E. W. Gorter and J. A. Schulkes, *Physica* (to be published).

¹³ J. S. van Wieringen, *Phys. Rev.* 89, 488 (1953).

Anomalous Behavior of the *g* Factor of LiFeCr Spinels as a Function of Temperature

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IN the preceding letter¹ ferromagnetic LiFeCr spinels are described with a curious $\sigma-T$ curve. For a certain range of values of *a* in the mixed crystal series Li_{0.5}Fe_{2.5-a}Cr_aO₄, the magnetization changes sign at a "compensation" temperature that depends on *a*. For Li_{0.5}Fe_{1.25}Cr_{1.25}O₄ (*a* = 1.25), this compensation temperature is situated at 38°C. We measured the ferromagnetic resonance absorption of polycrystalline samples of Li_{0.5}Fe_{1.25}Cr_{1.25}O₄ at 3.1-cm wavelength as a function of temperature. The samples were placed near the bottom of a TE111 resonant cavity. The cavity could be heated up by a filament or cooled down by a stream of cooled air. Two spheres of Li_{0.5}Fe_{1.25}Cr_{1.25}O₄ of radii 0.5 and 0.2 mm, respectively, gave the same temperature dependence of *g*. Near the compensation temperature strong variations are found in the *g* factor (Fig. 1).

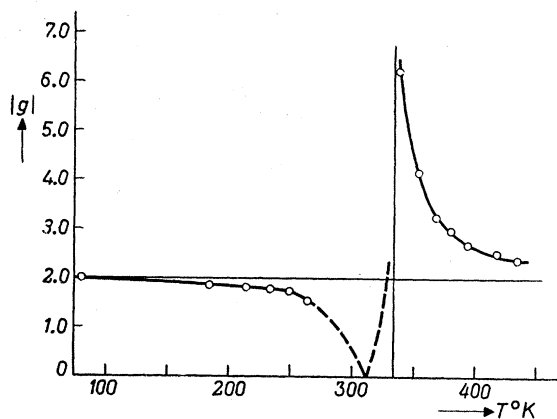


FIG. 1. *g* factor of Li_{0.5}Cr_{1.25}Fe_{1.25}O₄ as a function of temperature. Dashed curve: approximate extrapolation making use of Kittel's *g*-factor formula (1).

Between 263 and 337°K the resonance absorption was too weak to be observed. This is the temperature region where the magnetic moment is very small.¹ Hence the resonance peak may be expected to have a small height here. Its height is still further reduced, because the half-width increases in the same temperature region.

The general behavior of the *g* vs *T* curve can be understood from Kittel's formula² for the spectroscopic *g* factor

$$g = \frac{2mc}{e} \frac{M_{\text{spin}} + M_{\text{orbit}}}{J_{\text{spin}}} \quad (1)$$

Here M_{spin} and M_{orbit} are the mean spin and orbital magnetic moments, respectively, and J_{spin} is the mean spin angular momentum averaged over the two sublattices. The total magnetic moment, $M_{\text{spin}} + M_{\text{orbit}}$, is shown in Fig. 2 of the preceding letter.¹ It changes sign at 38°C; hence *g* should be zero there. From a comparison of Eq. (1) and Fig. 1 it follows that J_{spin} goes through zero at about 60°C.

A sphere (radius 0.2 mm) of Li_{0.5}FeCr_{1.5}O₄ (*a* = 1.5) showed a similar resonance behavior.

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It is intended to publish a more detailed account in *Physica*.

¹ E. W. Gorter and J. A. Schulkes, preceding letter, *Phys. Rev.* 89, 487 (1953).

² C. Kittel, *Phys. Rev.* 76, 743 (1949).

Semiconducting Intermetallic Compounds

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THE development of solid state electronic devices has been handicapped by the very small number of semiconducting materials that have been found suitable for practical application in spite of extensive investigations of the properties of the elements and of compounds of the elements of group six of the periodic table. It seems, however, that the existence of a number of semiconductors with promising properties has been largely overlooked, namely, the semiconducting intermetallic compounds. It was pointed out by Mott and Jones¹ that intermetallic compounds with the fluorspar structure, such as Mg₂Sn, should be characterized by an unusually low conductivity, since the number of available states within the first Brillouin zone is just equal to the number of available valence electrons. This unusually low conductivity was first observed experimentally by Kurnakov and Stephanov.² More recently the semiconducting nature of Mg₂Sn