THE EFFECT OF UNIAXIAL COMPRESSION ON THE CRITICAL FIELD OF THE "SPIN FLIP" TRANSITION IN Cr_2O_3

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A sharp dependence of the anisotropy energy of antiferromagnetic Cr_2O_3 on pressure has been found. The effect cannot get a trivial explanation by features of magneto-dipole interaction. It may be connected with the properties of the spin-orbit interaction in the crystal.

Of transition metal ion sesquioxides isomorphic in crystal structure with corundum the uniaxial antiferromagnetic Cr_2O_3 is the subject of close attention caused by the specific properties of its magnetic symmetry which allows the existence of a magneto-electric effect. Its anisotropy energy K has been measured [1], but its nature is not understood yet finally. It has been found [2] that about half K arises from a magneto-dipole interaction. The present letter reports the anisotropy energy to be so sensitive to lattice geometry, that the crystal prostration along the rhombohedral axis C_3 with the external stress ~7kbar would produce a zero anisotropy energy and spontaneous "spin-over" of the spins into the basal plane. This result has been obtained while studying the effect of uniaxial compression along the C_3 axis on the critical field of "spin flip" transition in Cr_2O_3. The measurements have been carried out at 20.4°K in a pulsed magnetic field oriented along the C_3 axis to within 5' using a pair of balanced pickup coils [3]. The dependence of the critical field on the applied stress is shown in fig. 1. Within the experimental errors it may be described by a straight line whose slope gives

$$\frac{1}{H_c(0)}\frac{dH_c}{dp} = 7.5 \times 10^{-2}\ \mathrm{kbar}^{-1}\ .$$

The value of critical field H_c and its dependence on the stress is given by K and the susceptibility difference $\Delta\chi = \chi_\perp - \chi_\parallel \approx \chi_\perp$:

$$H_c = (2K/\Delta\chi)^{\frac{1}{2}}\ , \qquad \frac{1}{H_c}\frac{dH_c}{dp} = \frac{1}{2}\left(\frac{1}{K}\frac{dK}{dp} - \frac{1}{\Delta\chi}\frac{d(\Delta\chi)}{dp}\right)\ .$$

The order of magnitude of the second summand may be got from the pressure dependence of the

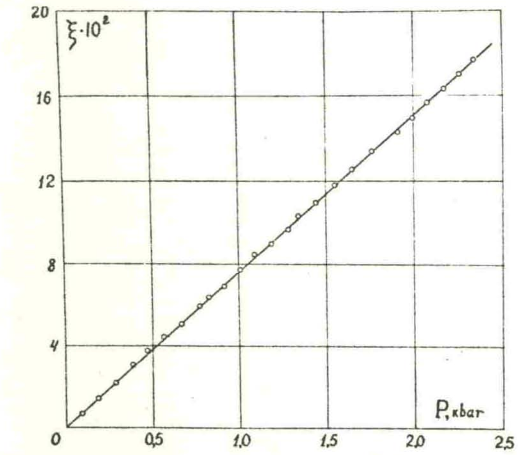

Fig. 1. Changes in the critical field of the "spin-flip" transition in Cr_2O_3 ($\xi = \{H_c(p) - H_c(0)\}/H_c(0)$) under uniaxial pressure along the rhombohedral axis. T = = 20.4°K.

Néel temperature since both T_N and $\chi_\perp$ describe the superexchange interaction value in the crystal. However, the pressure effect on T_N [4] appears to be too small ($dT_N/T_N dp = -5 \times 10^{-3}$ kbar^{-1}) and consequently the value of the effect observed is accounted for by the anisotropy constant. Taking $K = 2 \times 10^5$ erg/cm^3 [1] we find $dK/dp = 3.0 \times 10^{-5}$. It is interesting to note that the shift of H_c with pressure appeared to be by an order of magnitude larger than the corresponding one for Fe_2O_3, which was calculated from the magnetostriction jumps at the critical point [5]. Having the same crystalline structure and similar anisotropy energy and critical field values, Fe_2O_3 differs from Cr_2O_3 in the metal