PHASE TRANSFORMATION IN ERBIUM ETHYL SULPHATE SINGLE CRYSTAL WITH LOWERING OF TEMPERATURE

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In course of investigations on the magnetic behaviour of rare earth (Mookherji 1949) and iron (Bose 1948) group of ions in crystals, considerable change of the direction of the principal magnetic axes with change of temperature was observed in several monoclinic crystals. A change of orientation as large as 63.5 degrees for a change of temperature of 100°K was observed in the case of $Pr_2(SO_4)_3$, $8H_2O$ crystal, (Mookherji, 1949) having a magnetic anisotropy of 26% of the mean succeptibility. The earlier workers however, did not detect any change of the direction of the principal magnetic axes in hexagonal, tetragonal and trigonal crystals. We also had not so far detected any such change with hexagonal crystals like neodymium ethyl sulphate. Hence it is of considerable interest to find very recently a change of $\sim 75°$ in the setting angle (Table I) with single crystal of $Er_2(C_2H_5SO_4)_6\ 18H_2O$, belonging to hexagonal class having 9% magnetic anisotropy at 300°K.

TABLE I

Magnetic Anistropy $\Delta\chi$, change of setting angle and mean moment μ

T°K	300	250	200	150	100	80
$\Delta\chi.10^6$	3225	5227	8800	15124	32500	46227
μ	8.847	8.660	8.197	7.809	7.299	7.078
Change in Setting Angle	0	8.1°	16.7°	57.8°	73.2°	69.0°

Measurements on the magnetic anisotropy, $\Delta\chi = (\chi_\perp - \chi_\parallel)$; where $\chi_\parallel$ represents gram molecular susceptibility along hexagonal axis of the crystal and $\chi_\perp$ that normal to it and the change in setting angle were carried out by a modi-

fication of Stout and Griffel's (1950) method; and the mean magnetic moment $\mu = \frac{\mu_{\parallel}^2 + 2\mu_{\perp}^2}{3}$, by a modified Curie balance (Bose *et al.*, 1963). Temperature control for $\Delta\chi$ measurements was affected by a thermostatic device due to Bose (1948).

Jordahl's theory (1934) to explain this change of the direction of the principal magnetic axis can account only for a change of about 5 degrees where the difference of temperature is about 100°K, and that too only in cases of symmetry less orthorhombic.

Following Bose *et al* (1957) if this change is attributed to the instability in the crystal structure brought about mainly by anisotropic thermal expansion of the crystal, it may be concluded that there is a gradual change of crystal structure,, from on phase to another within the range of study as there is no unexpected thermal variation in the magnetic anisotropy (Table I). Table I further shows that $\Delta\chi$ and μ at 300°K have almost the same values as those obtained by Krishnan and Mookherji (1938) for the same crystal.

When the crystal was suspended with its hexagonal axis vertical no appreciable anistropy at 300°K was observed as is expected of a hexagonal crystal However an appreciable anisotropy (1.0%) was observed at 80°K. The setting angle also changed continuously with temperature. All these go to support our view that the symmetry of the crystal was changing from hexagonal to either monoclinic or triclinic with the change of temperature.

In order to ascertain whether this gradual phase change is of permanent character, measurements were first taken on $\Delta\chi$ in direct order (i.e. from 300°K to 80°K) and then in reverse order (i.e. from 80°K to 300°K). The anisotropy followed the same path suggesting that the rate of change of phase is the same in both the order i.e. there is no lag in the transformation.

Details will be published elsewhere.

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