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NOTES

$CdEr_2S_4$: Magnetic and Mössbauer Measurements

$CdEr_2S_4$ had been studied structurally and magnetically (*1*) as part of the series $CdRE_2S_4$ (*RE* = Gd, Tb, Dy, Ho, Er, Tm, and Yb). This binary sulfide has a normal spinel structure, $Fd3m$ with the lattice constant a_0 = 11.128 Å (cf. *2–4*). The material was prepared from CdS (ultrapure Ventron Alfa Products) and Er_2S_3, (heating Er_2O_3 99.9%, Research Chemicals, in a stream of CS_2 at 1000°C for 12 hr).

Magnetic measurements in the range 77–300 K showed paramagnetic behavior with μ_{obs} = 9.6 ± 0.2 μ_B (μ_{calc} = 9.6 μ_B) and a small negative Θ (9°). For low temperatures, 4.2–50 K, $CdEr_2S_4$ showed some magnetic ordering: for a plot of magnetization vs field strength (0–17.5 kOe) at 4.2 K, one observes a steep curved line (See insert Fig. 1). This curve is quite far from saturation, and the magnetic moment obtained at 17.5 kOe is approximately 4μ_B. The curve at 9 K shows much less ordering. Figure 1 shows the moment and the reciprocal susceptibility vs temperature for a field strength of 10 kOe.

In order to verify the existence of magnetic ordering it was decided to carry out a Mössbauer study. Figure 2 shows the Mössbauer spectrum for $CdEr_2S_4$ at 4.2 K. The measurement was performed using the 80.4 keV transition and the source was in the form of $^{166}Ho_{0.4}Y_{0.6}H_2$ (*5*). The spectrum was analyzed by least squares and one can observe five narrow lines of practically equal intensity proving ordered magnetic behavior. The isomer shift compared to the source was approximately zero. The hyperfine interaction parameter: H_{eff} = 7280 ± 40 kOe is very close to that of the free ion (8100 kOe) showing that the magnetic moment of the Er ion is close to 9 μ_B. The quadrupole interaction parameter: eqQ = 1080(5) Mc/sec showing that although the material is a normal spinel (X-ray analysis), the site of the Er ion is not fully spherical symmetric.

The ordering temperature is in the range 4–10 K and it was not possible to fix it unequivocally from the magnetization curves.

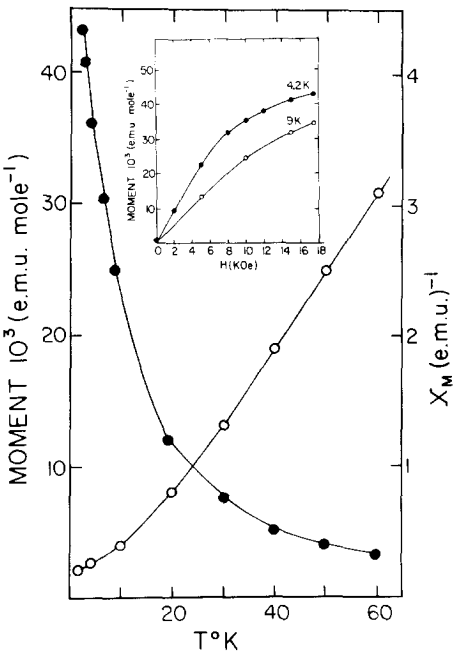

FIG. 1. Moment and reciprocal susceptibility vs temperature for $CdEr_2S_4$. Field strength 10 kOe. Insert: Magnetization vs field strength at 4.2 and 9 K.

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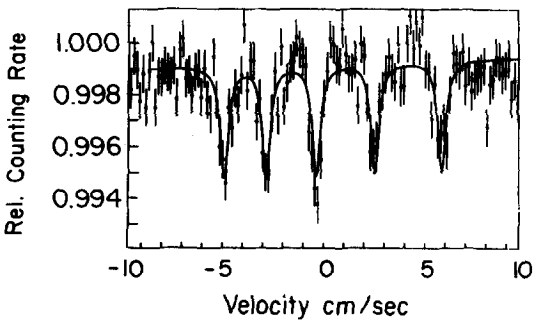

FIG. 2. Mössbauer spectrum for $CdEr_2S_4$ at 4.2 K.

The fact that the Curie temperature, Θ, obtained was negative and that the magnetic moment not too far from saturation is nearly one half of the saturation moment for free Er ion points to the fact that the interaction between the two erbium ions in $CdEr_2S_4$ is antiferromagnetic and the coupling is a superexchange through the S ions.

We have no explanation why $CdTm_2S_4$ which is rather similar behaves so differently (*1*): Magnetization vs field strength at 4.2 K is linear with a very small slope. $CdHo_2S_4$ seems to behave rather more like $CdEr_2S_4$, but at 17.50 kOe the behavior is *very* far from saturation and much higher fields (and lower temperature) is needed to observe ordering with this compound.

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