INTERNAL FIELDS IN MAGNETICALLY ORDERED Dy AND Ho

RA-90-18, MÜNCHEN – UPPSALA

E. Schreier[*], M. Ekström[†], O. Hartmann[†], R. Wäppling[† S], G.M. Kalvius[*], A. Marelius[†], S. Henneberger[*], F.J. Burghart[*], A. Kratzer[* S]

∗ Physik–Department E15, Technische Universität München, D–85747 Garching, Germany
† Institute of Physics, University of Uppsala, S–75121 Uppsala, Sweden

For several years we have carried out systematic studies of the magnetic properties of the heavy rare earth (RE) metals Gd, Dy, Ho and Er covering the paramagnetic as well as the magnetically ordered states including especially in Gd the critical regime around T_C. Furthermore, we have performed high pressure studies, mainly in the magnetically ordered state. Single crystalline samples were used in all cases which allowed in addition measurements of orientational dependencies of relaxation rates. Results on Gd and Er have been reported previously. Here we give a brief summary of the data obtained for Ho and Dy in their magnetically ordered states.

Dysprosium: Large axial anisotropy confines the moments on Dy to the basal plane. Between $T_N = 178$ K and $T_C = 85$ K, a helical AFM spin structure is present. The helix angle decreases with lower temperature. At T_C an orthorhombic distortion of the hcp lattice occurs and the transition into the FM state is of first order. The spins point along the orthorhombic a axis. The amplitude of the spontaneous muon spin precession signal below T_N is larger in the $\mathbf{S}_\mu || c$ geometry, meaning that the local field lies predominantly in the basal plane as well. The temperature dependence of the precession frequency is shown in Fig. 1. The stopping site of the muon is not known, but calculations of the dipolar fields show that a small shift of the local muon field should take place at T_C (which is observed) if the muons occupy tetrahedral interstitial sites, but not if the site is octahedral. The detailed behaviour in the ferromagnetic regime, however, is more complex. An unusual reduction in frequency on approaching lowest temperatures is clearly visible. A first guess as to its origin is a slight re-orientation of spin directions. Dipolar field calculations were not successful in reproducing the observed effect under this assumption. At present we are forced to consider the behaviour of spin precession (*i.e.* of B_μ) in the ferromagnetic state as not understood. Further work is in progress.

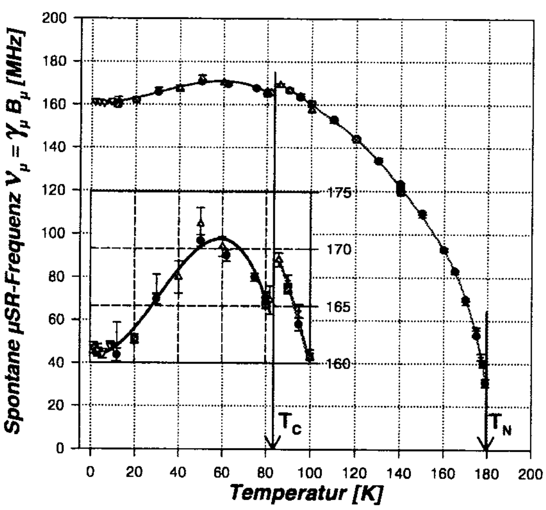

Figure 1: Temperature dependence of the spontaneous precession frequency in magnetically ordered Dy (single crystalline sample.)

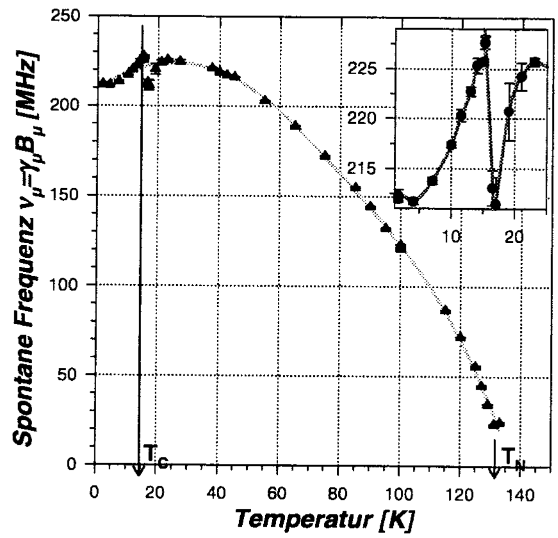

Figure 2: Temperature dependence of the spontaneous precession frequency in magnetically ordered Ho (single crystalline sample.)

Holmium: This RE metal possesses a rich variety of spin structures which are often almost continuously changing with temperature. In the helical spin structure formed below $T_N = 125$ K the helix becomes distorted with decreasing temperature. Before reaching $T_C = 18$ K, which leads into a shallow conical ferromagnetic structure pointing along the c axis, several spin slip transitions occur. The temperature dependence of the internal field (Fig. 2) shows no apparent irregularities at the spin-slip transitions (*e.g.* 97, 40, 25 K). As in the case of Dy an irregularity is seen around T_C. The field decreases again in the FM regime. The change in cone angle is the most obvious cause, but dipolar field calculations were unable to reproduce the observed effect. More complex interactions are probably present.