Antiferromagnetic arrangement in paramagnetic ErCo2

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The position of the Fermi level in the RCo2 Laves phases is located in the vicinity of a steep flank in the energy dependence of the density of states, i.e. near the critical condition for the Co-magnetic moment formation. Thus, Co 3d-electron system reacts sensitively either to the molecular field of the R partner element or to changes of external parameters such as magnetic field or pressure. Indeed, in the paramagnetic regime, when an external magnetic field is applied, the internal field generated by the polarized rare-earth sublattice is enough to generate a Co magnetic moment. At Tc= 32 K ErCo2 undergoes a first order magnetostructural transition to a ferrimagnetic state.

We have performed soft X-ray Magnetic Circular Dichroism (XMCD) experiments at the L2,3 Co and M4,5 Er absorption edges through the magnetic ordering transition at different applied magnetic fields (up to 6 T) in order to study this interesting system with an element-specific magnetometry, allowing to isolate the Co magnetization from the much larger one due to the Er sublattice. XMCD results clearly indicate the arrangement of Er and Co atoms with respect to the applied field: Er net magnetization is always dominant, remaining parallel to the applied field at all temperatures. The Co sublattice is polarized parallel to the applied field at high temperatures (as in every paramagnet) and it is ordered antiparallel to the field below Tc, as expected for a strongly uncompensated ferrimagnet.

Surprisingly, our experiments show that the temperature, Tf, at which the Co changes its orientation relative to the field is substantially higher than the critical temperature (Tf > Tc), well within the paramagnetic regime. Moreover, a.c. magnetic susceptibility measurements show, in addition to the expected well-defined peak at Tc, another peak at Tf, both in the real and imaginary components, indicating an energy absorption process at this temperature. Combining both techniques we are able to clearly determine the H-T paramagnetic ranges where Er and Co moments are antiparallel, giving rise to a novel "parimagnetic phase" in the H-T phase-diagram.