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Magnetic ordering and spin gap in RB_{12} (R = Ho, Er, Tm and Yb): clathrate-like compounds with a B_{24}-cage structure

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The rare-earth dodecaboride RB_{12} has a B_{24} cage structure encapsulating a rare-earth atom at its body center site. Therefore the interaction connected by rattling-type lattice vibrations between a rare earth atom and a B_{24} cage is of interesting as seen in many clathrate compounds. From the neutron diffraction experiments for R = Ho, Er and Tm, the type II antiferromagnetic ordering with the order parameter of Q = (1/2, 1/2, 1/2) is induced by RKKY interaction at Neel temperature with a long periodic modulation. Additional modulations along with the [100] direction appears with decreasing temperature below their T_N. On the other hand, the Kondo semiconductor YbB_{12} without magnetic ordering has been also found to have antiferromagnetic Yb-Yb correlations with Q = (1/2, 1/2, 1/2) around 14.5 meV of an excitation energy by recent inelastic neutron scattering [1]. This spin gap was independently found by two groups using polycrystalline powder samples [2-3] but the anisotropy, which is open only for the [111] direction, was for the first time discovered by our experiments using single crystals. The inelastic scattering spectra in YbB_{12} has three magnetic excitations at 14.5, 20 and 35 meV and those spectral weights of all the magnetic components gradually move to those of the quasi-elastic scattering centered at zero excitation energy above 80 K. This means that YbB_{12} changes to a usual Kondo lattice without a spin gap near and above the Kondo temperature region. In summary, interactions between magnetic excitation and phonon excitation in RB_{12} at around the L-point (1/2, 1/2, 1/2) is important for formation mechanism of both AF magnetic ordering and a Kondo spin gap with AF correlations.

[1] J. -M. Mignot, P. A. Alekseev, K. Nemkovski, L. -P. Regnault, and F. Iga, LLB Scientific Report 2001-2002.
[2] A. Bouvet, T. Kasuya, M. Bonnet, L. P. Regnault, J. Rossat-Mignod, F. Iga, B. Fåk, A. Severing, J. Phys.: Condens. Matter **10** (1998) 5667.
[3] E. V. Nefeodova, P. A. Alekseev, J. -M. Mignot, V. N. Lazukov, I. P. Sadikov, Yu. B. Paderno, N. Yu. Shitsevalova and R. S. Eccleston, Phys. Rev. B **60** (1999) 13507.