Spin Dynamics of Rare Earth Antiferroquadrupolar Ordering Compound HoB2C2

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The RB2C2 (R=rare earth) compounds, which have the tetragonal LaB2C2 type structure with P4/mbm symmetry show diversified magnetic properties caused by coexistence of antiferroquadrupolar (AFQ) and antiferromagnetic (AFM) interactions. In particular, DyB2C2 is the first tetragonal rare earth compound in which an AFQ ordering is realised. Since the exact ground state by crystalline electric field under tetragonal symmetry has no degree of freedom on electric quadrupolar moments, it was thought that no AFQ ordering can be realised in the tetragonal rare earth compounds.

On the contrary, we have proved that some of RB2C2 are AFQ ordering compounds with higher TQ than other typical AFQ compounds. Thus, to understand necessary conditions of AFQ orderings in rare earth compounds, it is indispensable to clarify characters of the AFQ ordering in RB2C2. Of the RB2C2 system, HoB2C2 is particularly unique because of the following points: (i) the AFQ ordering in HoB2C2 is realised at TQ=4.5K below the magnetic ordering temperature, TN=5.9K[2], (ii) anomalous magnetic diffuse scattering is observed above TQ up to 2TQ[4].

We expect that the AFQ orderings in RB2C2 probably yield anomalies of dynamic properties because the lattice and spin systems in RB2C2 must be coupled by the AFQ orderings through the strong LS coupling. In particular, in HoB2C2, characteristic diffuse scattering is observed around the transition temperatures, implying some kind of spin fluctuation. Therefore, to observe magnetic excitations in HoB2C2, we performed inelastic scattering experiments on a single crystalline sample of HoB2C2 on the triple axis spectrometer HER at the C1-1 beam hole of JRR3-M of JAERI(Tokai). The collimation condition was g-open-PG filter-S- Radial -B, kf=1.550AA-1 with the horizontal focusing analyzer condition

In the experiments on C1-1, we observed obvious magnetic excitations at T=1.4K below TQ and TN around the (1,0,0) position which is the magnetic zone center. Figure shows the energy spectrum at (1,0,0) in HoB2C2 at T=1.42K . As shown in the figure, an obvious magnetic excitation was observed around 1meV, which shows the energy gap at the zone center. Moreover, in this experiments, we newly found higher magnetic excitation around 3meV. On the other hands, we observed no quasi-elastic scattering within the resolution limit even in the temperature region where the characteristic magnetic diffuse scattering is observed[4]. This indicates that the characteristic magnetic diffuse scattering in HoB2C2 is mainly due to elastic scattering not to some spin fluctuations.

References

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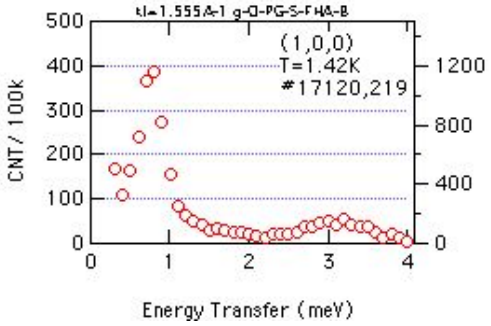

Fig. 1. Intensity distribution of magnetic excitations along the a* axis in HoB2C2 at T=1.5K around (1,0,0). Vertical and horizontal axes are the excitation energy and q vector.