Superlattice Magnetic Reflections in Frustrated Magnet $HoBaCo_4O_7$

M. Soda

Ochanomizu Univ.

Geometrically frustrated magnets on the pyrochlore, triangular and kagome lattices exhibit various interesting magnetisms. One of the geometrically frustrated magnets is $RBaCo_4O_7$ (R=Ca, Y, and rare-earth elements)[1]. In the crystal structure of $RBaCo_4O_7$, the kagome and the large triangular lattices formed by CoO_4 tetrahedra stack alternately along the *c*-axis. The network of the exchange interaction between the spins in $RBaCo_4O_7$ is similar to that in the pyrochlore systems which have the alternating kagome and large triangular lattices along the [111] direction. The large antiferromagnetic interaction between the Co spins in $RBaCo_4O_7$ is expected to induce the magnetic frustration.

Recently, we have carried out the neutron experiment on $YBaCo_4O_7$ using in order to clarify the magnetic excitations of the triangular and kagome lattices. Then, the characteristic line-shape magnetic diffuse scattering has been observed just above T_{c2}=105 K. Around T_c=105 K, furthermore, the characteristic quasi-elastic magnetic scattering, which connects the superlattice reflection points, was observed. The temperature dependence of the quasi-elastic magnetic scattering indicates that the strongest intensity of the quasi-elastic magnetic scattering has been observed at around T_{c2}.[2] These behavior of the quasi-elastic magnetic scattering in $YBaCo_4O_7$ are consistent with the theoretical prediction for the Z_2 vortex transition.[3] Next challenge is to clarify the essence of the Z_2 vortex ordering by examining another candidate material with Z_2 vortex ordering. Then, we target $HoBaCo_4O_7$, the structurally isomorphic reference compound to $YBaCo_4O_7$.

The neutron measurement on $HoBaCo_4O_7$ single crystal was performed by using the HOrizontally Defocusing Analyzer Concurrent data Acquisition spectrometer (HODACA) and HER (C1-1) installed at JRR-3 in JAEA Japan. The final neutron energy was set at E_f=3.635 meV. The single crystal was oriented with the [100] and [010] axes with the hexagonal unit cell in the horizontal plane.

The superlattice magnetic reflections were observed at (h_0±1/2, k_0, l_0), (h_0±1/2, k_0±1/2, l_0) (h_0, k_0, and l_0 = integers), and the incommensurate $\boldsymbol{Q}$-points below T_c=105 K. Furthermore, the intensities of the magnetic reflections have the hysteresis behavior in the temperature region 10 < T < 70 K. This hysteresis behavior is consistent with the magnetization measurement. On the other hand, the quasi-elastic magnetic scattering was not observed in the wide temperature region. This is completely different from the magnetic properties in $YBaCo_4O_7$ and $YbBaCo_4O_7$. In order to clarify the Z_2-vortex order of the complicated three-dimensional network of the magnetic correlation, further studies are necessary.

[1] M. Valldor and M. Andersson, Solid State Sci. 4 923 (2002).

[2] M. Soda, M. Kofu, S. Ohira-Kawamura, S. Asai, T. Masuda, H. Yoshizawa, and H. Kawano-FurukawaJ. Phys. Soc. Jpn., 91, 094707 (2022).

[3] T. Okubo and H. Kawamura, J. Phys. Soc. Jpn. **79**, 084706 (2010).