Magnetic state in Kagome-Triangular lattice antiferromagnet NaBa2Mn3F11

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Recently Kagome-Triangular (KT) antiferromagnet $NaBa_2Mn_3F_{11}$ is discovered as a new frustrated-magnet [1]. The crystal structure is hexagonal with the space group $R\bar{3}c$. Mn^{2+} ion carries spin $S = 5/2$ and the MnF_7 pentagonal bipyramids form KT lattice in the crystallographic *ab* - plane. The magnetic susceptibility at high temperatures suggests that the nearest neighbor exchange interaction J_1 is ferromagnetic (F) and next nearest neighbor exchange interaction J_2 is antiferromagnetic (AF) in this system [1]. Heat capacity showed an anomaly at $T = 2$ K, indicating that the ground state is a magnetic long-range order. The classical calculation of the ground state on the KT lattice with the F J_1 and AF J_2 suggested Cuboc structure. Meanwhile the powder neutron diffraction performed at ANSTO exhibited that the magnetic moments form 120° structure in the *ab* - plane with a magnetic propagation vector $\boldsymbol{q}0 = (0, 0, 0)$, and they had component along the *c* - axis with an incommensurate (IC) propagation vector $\boldsymbol{q}_{\mathrm{IC}}$. The detailed strucure along the *c* - axis, however, has not been identified yet.

Polycrystalline sample of $NaBa_2Mn_3F_{11}$ was prepared with the total mass of 5.4 g. We put it in a vanadium-made cell and the cell was installed in a ^{3}He cryostat to achieve the base temperature of 0.25 K. The powder neutron diffraction was performed using a long-wavelength diffractometer WISH at ISIS. We chose a high resolution double frame mode. A temperature dependence of magnetic Bragg peaks was measured from 0.25 K to 3 K. The magnetic Bragg peaks were observed at $d = 4.6$ Å, 5.9 Å, 8.0 Å, 9.8 Å, and so on. The peak positions are consititent with those observed using ECHIDNA. In addtion, several new magnetic Bragg peaks are observed. Figure 1(a) shows the temperature variation of the peak profile at a magnetic Bragg peak of $d = 4.6$ Å. The neutron intensity goes to zero at 2.25 K, meaning that an exact magnetic transition temperature is 2.25 K. The magnetic Bragg peaks at $d = 4.6$ Å, and 5.9 Å are indexed with the magnetic propagation vector $\boldsymbol{q}_0 = (0, 0, 0)$. The other magnetic Bragg peaks such as ones at $d = 8.0$ Å, 9.8 Å place at IC positions. Indexing these peak by the IC propagation vector $\boldsymbol{q}_{\mathrm{IC}}$, it is found that they are indexed with the several IC propagation vectors. Figure 1(b) shows the temperature dpendences of the integrated intensity at $d = 4.6$ Å, 5.9 Å, 8.0 Å, and 9.8 Å. Since the integrated intensities of the magnetic Bragg peaks with the propagation vectors $\boldsymbol{q}_0$ and $\boldsymbol{q}_{\mathrm{IC}}$ show same temperature dependence, all of the magnetic Bragg peaks with $\boldsymbol{q}_0$ and $\boldsymbol{q}_{\mathrm{IC}}$ is induced by the same phase transition. Thus, the magnetic structure is a multiple-$\boldsymbol{q}$ structure with the several IC propagation vector in addtion to the 120° structure in the *ab* - plane. Indexing the IC magnetic peaks and magneitc structure analysis is now in progress.

Reference

[1] H. Ishikawa, *et al*., J. Phys. Soc. Jpn. **83**, 043703 (2014)

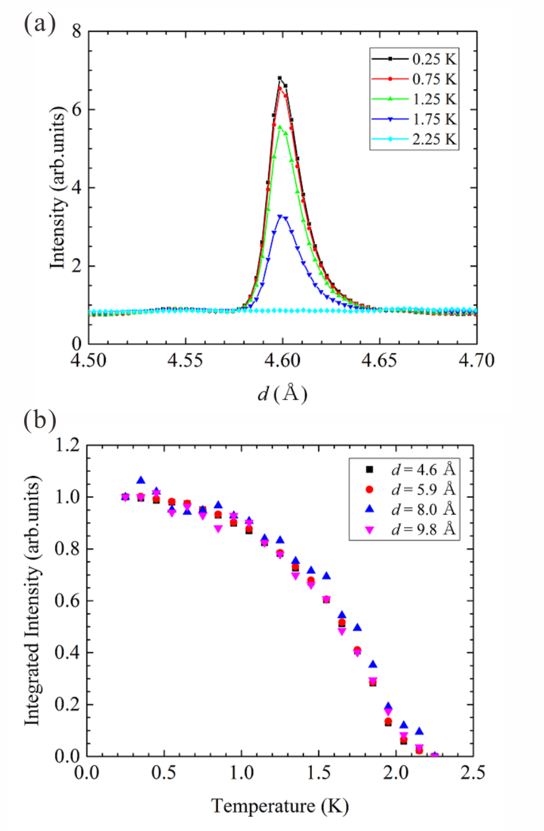

Fig. 1. (a) A temperature variation of peak profiles at a magnetic Bragg peak of $d = 4.6$ Å. (b) Temperature dependece of integrated intensities at magnetic Bragg peaks of $d = 4.6$ Å , 5.9 Å , 8.0 Å, and 9.8 Å.