Magnetic excitation in Kagome-Triangular antiferromagnet $NaBa_2Mn_3F_{11}$

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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 Kagome-Triangular 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 Kagome-Triangular lattice with the F J_1 and AF J_2 suggests Cuboc structure. Meanwhile the powder neutron diffraction performed at ANSTO exhibited that the magnetic moments form 120° structure in the *ab* - plane and they cant along the *c* - axis. The result indicates that some additional term(s) of the magnetic interaction such as anisotropy exchange interaction or/and inter-plane exchange interaction is/are necessary to realize the magnetic structure. We, thus, performed powder inelastic neutron scattering to measure the magnetic excitations and to identify the spin model.

We prepared polycrystalline sample of $NaBa_2Mn_3F_{11}$ with the total mass of 18.9 g. The cell was installed in dilution cryostat to achieve the base temperature of 60 mK. We performed inelastic neutron scattering (INS) experiment at IN4 spectrometer with the incident neutron wave length of 3.00 Å and 3.99 Å. Figures 1(a) and (b) show the INS spectra measured at 6 K and 60 mK. A diffusive excitation in wide Q - $\hbar\omega$ range was observed in Fig. 1(a), which means that the magnetic short-range order exists at high temperature. In contrast at 60 mK we observed well-defined magnetic excitation around 1.6 meV in Fig. 1(b). We found that the excitation extends up to about 2.5 meV, which was consistent with Weiss temperature. We calculated $S(\boldsymbol{q}, \omega)$ of the spin wave assuming the simple 120° structure in the *ab* - plane based on J_1-J_2 model. The calculated spectrum, however, exhibits van-Hove like anomaly at low energy region and it is qualitatively different from the experiment. The inconsistency suggests that the spin model realized in the compound is not explained by the classical J_1-J_2 model even though additional anisotropy term and inter-plane term are included. Non-negligible quantum effect would play important role in the exotic spectrum. Further study requires high-energy resolution experiment.

Reference

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

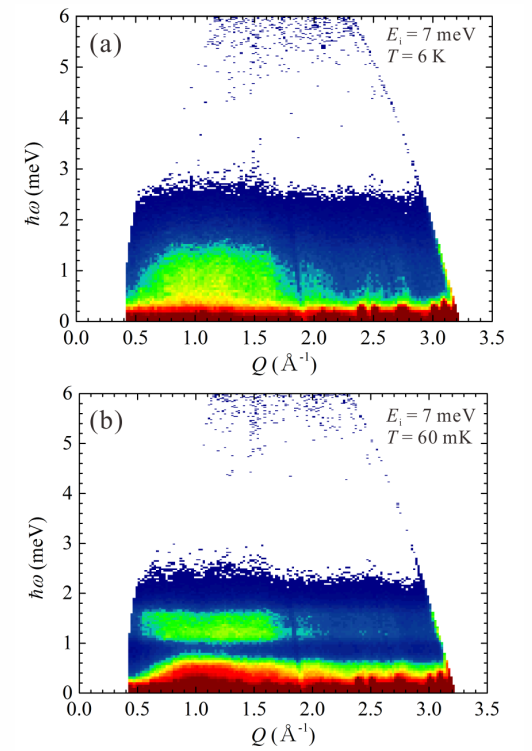

Fig. 1. Spectra of the inelastic neutron scattering at (a) 6 K and (b) 60 mK.