Neutron scattering in $Ba_2MnGe_2O_7$

T. Masuda, S. Kitaoka and M. Nishi[a]
International Graduate Schools of Arts and Sciences, Yokohama City University, 22-2 Seto, Kanazawa-ku, Yokohama, 236-0027
, [a]Neutron Scattering Laboratory, Institute for Solid State Physics, University of Tokyo, 106-1 Shirakata, Tokai, Ibaraki, 319-1106, Japan

$Ba_2MnGe_2O_7$ is an ideal 2D square-lattice antiferromagnet (AFM) with Mn^{2+} spin of $S = 5/2$. The crystal structure is tetragonal with space group $P-421m$, a = 8.4952 Å, and c = 5.5256 Å. From the magnetic susceptibility measurement the antiferromagnetic (AF) exchange interaction is estimated to be $J \sim 0.05$ meV. The spin wave calculation based on the obtained parameter predicts that the boundary energy would be about 0.8 meV; ideal energy scale for cold neutron scattering. This magnetic energy scale is also adequate for high magnetic field study. Since the saturation field is estimated to be 10 T, the exotic behavior of the spin dynamics in very high field[2] could be observed by using conventional superconducting magnet. Hence it is important to study the basic magnetic property of $Ba_2MnGe_2O_7$ in zero field as the first step of study in spin dynamics in high magnetic field. We performed magnetic diffraction in 5G PONTA and also in T11 HQR. The crystal is cylindrical shape with $\phi7$ mm $\times$ 7mm. Since the isostructural compound $Ba_2CuGe_2O_7$ [1] is well known as spiral magnet with Dzyaloshinskii-Moriya and KSEA interaction with the propagation vector of $(1-\zeta\ 1-\zeta\ 0)$, we searched the magnetic Bragg peak in the scattering plane of $(hk0)$ in the first experiment 5G. However any magnetic signal was not detected. Then we try next experiment in $(h\ 0\ l)$ plane in T11. The experimental set up was Guide - 40$'$ - PG filter - sample - 40 $'$ - 60$'$. To our surprise we found the magnetic peak at commensurate position of $(h\ 0\ n/2)$ (n is integer.) We collected 10 inequivalent magnetic peaks and we are now doing magnetic structure analysis. Next we performed inelastic neutron scattering in C11 HER. The sample size is $\phi7$ mm $\times$ 40 mm. The experimental setp up was guide - open - Be filter - sample - 80$'$ - 80 $'$ with e_f = 3meV. We performed a series of constant q scans in the $(h\ 0\ l)$ plane. We observed well defined magnetic excitation in $\hbar\omega \leq 0.6$ meV. The obtained dispersion relation is shown in Fig. **??**. The data is well explained by weakly coupled square lattice AFM with weak diagonal interaction with the exchange parameters of $J_1 = 0.029$ meV, $J_2 = 0.0015$ meV, and $J_{\rm inter} = 0.0007$ meV. Here J_1 is main interaction, J_2 is diagonal interaction, and $J_{\rm inter}$ is interplane interaction. As is deduced from crystal structure and bulk magnetic susceptibility measurement, $Ba_2MnGe_2O_7$ is an ideal square lattice AFM with moderate energy scale for both neutron scattering and magnetic field study.

References

[1] A. Zheludev *et al.,* Phys. Rev. B **54**, 1563 (1997).
[2] Z. E. Zhitomirsky *et al.,* Phys. Rev. Lett. **82**, 4536 (1999).

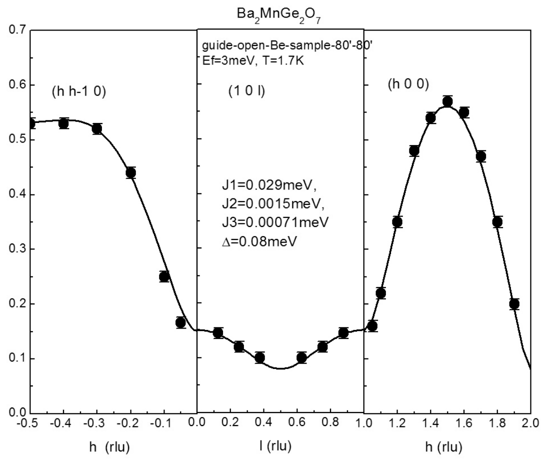

Fig. 1. The magnetic dispersion of $Ba_2MnGe_2O_7$. The solid line is the fitting by SW calculation.