Neutron scattering in $Ba_2MnGe_2O_7$

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$Ba_2MnGe_2O_7$ is a 2D square-lattice antiferromagnet 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. The isostructural compound $Ba_2CuGe_2O_7$ [1] is well known as spiral magnet with Dzyaloshinskii-Moriya and KSEA interaction. The remarkable difference is found in the energy scale of exchange constants J. In $Ba_2MnGe_2O_7$ $J \sim 0.05$ meV is estimated by magnetic susceptibility measurements. The boundary energy is calculateed to be 0.5meV from spin-wave approximation. Hence the spin dispersion can be measured by cold neutron scattering experiment. This exchange energy corresponds to the saturation field of about 9 T. This means that the spin dispersion can be fully tuned by the magnetic field by using available superconducting magnet. To study the behavior of spin wave in the strong magnetic field [2], we planned to characterize the following magnetic properties: (i) magnetic sturcture analysis, (ii) inelastic cold neutron scattering in zero field, and (iii) inelastic cold neutron scattering in magnetic field.

We had grown good-looking single crystal of $Ba_2MnGe_2O_7$ by floating zone furnaces. In prior to neutron experiment powder XRD was performed to confirm the absence of impurity. We observed beautiful 4-fold axis in Laue picture. Rocking curve with sharp line width was also obtained. After these careful sample characterization, we started neutron experiment at PONTA spectrometer in 5G beamline to collect magnetic Bragg diffractions. To our surprise we found that the intensities of fundamental nuclear Bragg peaks were very weak. For example the intensity of (1 1 0) reflection, which is the 2nd strongest peak, of the sample the dimension of $5 \times 5\text{mm}^3$ was only 2000 cps. Furthermore, we found a few more (1 1 0) reflections in arbitrary directions, even though each rocking curves were in resolution limited.

Hence we had to conclude that our sample was multi-domain crystal even ghouth the bulk sample seems to have good plane and beautiful Laue picture was obtained by using x-ray. textbf The lesson that we learned is that preliminary crystal check must be done by using neutron beams. X-ray diffraction is not enough to check the big crystal for neutron use.

In the given maschine time we changed our plan and we did the neutron scattering study in O_2 absorbent magnet: the proposal ID 6459. Now we are trying to grow the single crystal of $Ba_2MnGe_2O_7$ by using different growth conditions.

References

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