The magnetic field effect of ZnCr2O4

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ZnCr2O4 is a three-dimensional geometrical spin frustration system with a normal spinel structure, in which magnetic Cr3+ ions occupy the B-site and the nearest neighbor Cr3+ spins couple antiferromagnetically. ZnCr2O4 undergoes the first order phase transition to an antiferromagnetic phase accompanied by a tetragonal lattice distortion of the order of 0.2% at 12.5K. The magnetic structure in the ground state of ZnCr2O4 was studied by several authors in the past in the aspect of a fundamental magnetic system. However, the results are not clear due to the complex magnetic structure. Last year, we have performed the neutron scattering measurements with a ZnCr2O4 single crystal specimen. [1] The (hh0) (h= n/2, n= odd) series magnetic Bragg peaks disappeared when the magnetic field was applied along the [111] axis. It means that the magnetic structure turns into a new structure with higher symmetry than that in the ground state under a small magnetic field. In order to obtain further knowledge of the magnetic structure of ZnCr2O4 in the ground state, we performed the neutron scattering using isotropic powder ZnCr2O4 specimen under a magnetic field.

A powder sample was prepared by solid state reaction between stoichiometric amounts of ZnO and Cr2O3 in air. Experiments were performed on the T1-1 triple axis spectrometer installed at JRR-3M with a vertical magnetic field.

In elastic neutron scattering experiments, field cooled (FC) and zero field cooled (ZFC) states were measured. Figure shows the (2 1 1/2) magnetic Bragg peak obtained with and without magnetic field (H=4.5T). As a result, the disappearance of a magnetic Bragg peak was not observed in any series of indices. For the single crystal specimen, since the (hh0) magnetic peaks completely disappeared under the magnetic field, present data indicate that the (111) plane has a special meaning for the magnetic structure under the magnetic field.

In inelastic neutron scattering experiments, Q-dependence was measured by the constant E mode at E=2.5meV and 4.5meV. At E=2.5meV, dispersion was observed around the strong magnetic Bragg peaks. At E=4.5meV, however, dispersion was not observed. In addition, inelastic diffuse peak shifted towards the low angle side when the temperature was raised. From these experiments, we can conclude that the spin axis inclines gradually under the magnetic field and the magnetic structure with higher symmetry is stabilized.

Reference

[1] Y. Tsunoda, H. Suzuki, S. Katano, K. Siratori, E. Kita and K. Kohn: J. Phys. Soc. Jpn. 75. 064710 (2006)

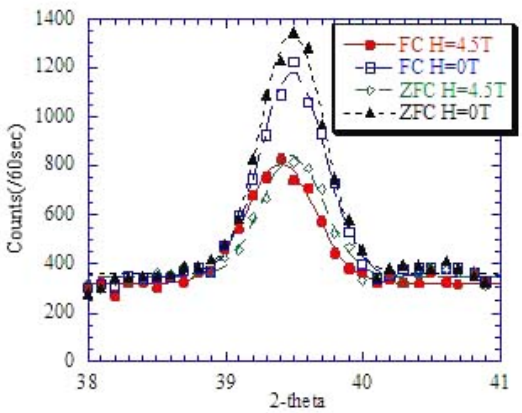

Fig. 1. The magnetic Bragg peak at (2 1 1/2) in elastic neutron scattering.