

Magnetic structure of square lattice antiferromagnets $A_2MGe_2O_7$

Shohei Hayashida, Takatsugu Masuda

The Institute for Solid State Physics, The University of Tokyo

Recent theoretical study on the square-lattice antiferromagnet with integer spins predicts the existence of Higgs mode in the excitation spectrum [1]. Among vast number of the model compounds, $A_2MGe_2O_7$ (A = alkali earth metal, M = $3d$ metal) exhibit reasonable energy scale for this type of studies [2-4]. We have succeeded in the synthesis of $Ba_2FeGe_2O_7$ and $Sr_2FeGe_2O_7$ where Fe^{2+} ions carry $S = 2$ spins. FeO_4 tetrahedra form the square lattice in the crystallographic ab - plane and they are separated by Ba or Sr ions. Preliminary measurements of magnetic susceptibility were performed, exhibiting a weak ferromagnetic transition at 15 K in Ba compound and a Néel-like transition at 17 K in Sr compound.

We performed neutron diffraction experiment to identify the magnetic structures of these compounds. The polycrystalline samples of $Ba_2FeGe_2O_7$ and $Sr_2FeGe_2O_7$ were prepared by a solid state reaction method. The masses of the samples were 3.7 g for the Ba and 1.9 g for the Sr. ECHIDNA spectrometer was used. Ge 331 monochromator was chosen to obtain the neutrons with the wave length of 2.4385 Å. Figure 1(a) shows the diffraction profile of $Ba_2FeGe_2O_7$ at 3 K and 30 K and figure 1(b) shows that of $Sr_2FeGe_2O_7$. The nuclear scattering profiles for both compounds measured at 30 K are consistent with the crystal structure previously reported. In Ba compound we observed the magnetic Bragg peaks at $2\theta = 16.8^\circ, 30.7^\circ, 38.1^\circ$, etc., which were indexed as $(1, 0, 0)$, $(1, 0, 1)$, $(1, 2, 0)$, etc as shown in Fig. 1(a). Similarly in Sr compound we observed several magnetic Bragg peaks as shown in Fig. 1(b). The magnetic propagation vectors were identified as $\mathbf{q} = (0, 0, 0)$ for Ba compound and $\mathbf{q} = (0, 0, 1/2)$ for Sr compound. By performing Rietveld analyses

we found that the magnetic structures are collinear with the moments confined in the ab - plane for both compounds.

References

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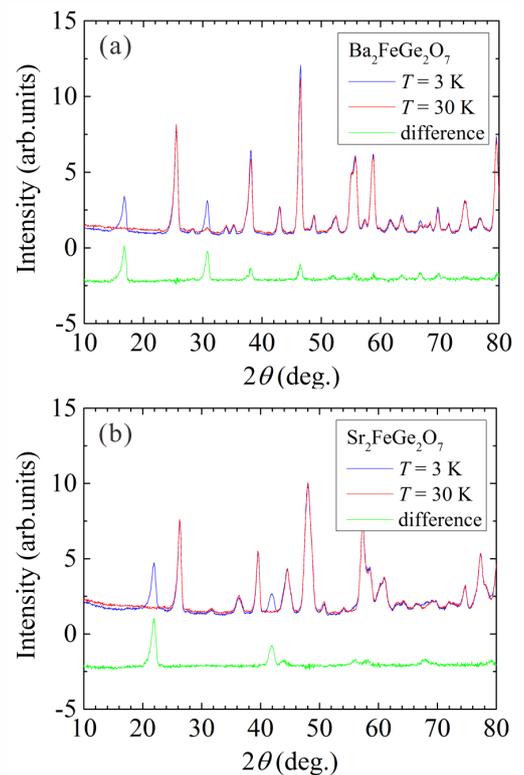


Fig. 1. Neutron diffraction profile of (a) $Ba_2FeGe_2O_7$ and (b) $Sr_2FeGe_2O_7$. Red and blue lines are data at 30 K and 3 K. Green ones are difference between the red and blue profiles.