Inelastic Neutron Scattering Study on Triangular Lattice Antiferromagnet $CuFeO_2$

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Geometrically frustrated magnetic systems have received considerable attention in recent years due to the presence of extraordinary magnetic properties. As a model material of the magnetically frustrated triangular lattice antiferromagnet, $CuFeO_2$ shows successive magnetic phase transitions from an Ising-like 4-sublattice phase (↑↑↓↓) to a paramagnetic phase through a partially disordered phase ($T_{N2} \sim 10.5$ K $< T < T_{N1} \sim 14.0$ K).[1] To understand these complicated magnetic orderings, it is needed to elucidate magnons and phonons in the $CuFeO_2$ system in the wide temperature range. In this study, we measure inelastic neutron scattering spectra of powder $CuFeO_2$ below and over T_{N1} and T_{N2}.

Inelastic neutron scattering measurements were carried out by the use of a cold neutron spectrometer, AGNES. A wave length of the incident neutron was 4.22 Å. The energy value of the scattered neutron was determined by the time-of-flight method. The energy resolution was about 0.1 meV in the present experimental condition. The data acquisition time was about 20 h. Powder $CuFeO_2$ sample was synthesized by the solid state reaction method as described elsewhere.[2]

Figure 1 shows inelastic neutron scattering intensitiy, $S(\omega)$, of the $CuFeO_2$ powder taken at 7.5, 10, 11, 12.5, and 16 K, where ω is the angular frequency. The horizontal axis is the energy transfer values of the incidence. The negative side of the spectra corresponds to the energy loss side, i.e. the Stokes side. The central peaks at 0 meV are the elastic scattering components. There is a large and broad peak around -2 meV in each spectrum below 12.5 K, corresponding to the creation of locarized magnon mode. One possible reason of its broadning is the creation of magnon branches.[3, 4] As the temperature increases, the peak position moves closer to the central peak, i.e. the frequency of the magnon mode becomes lower. This temperature dependence is conceivably due to the spin-wave interactions.[5] It should be noted that a broad magnetic critical scattering component appears in the spectra taken at 12.5 K and 16 K.

References

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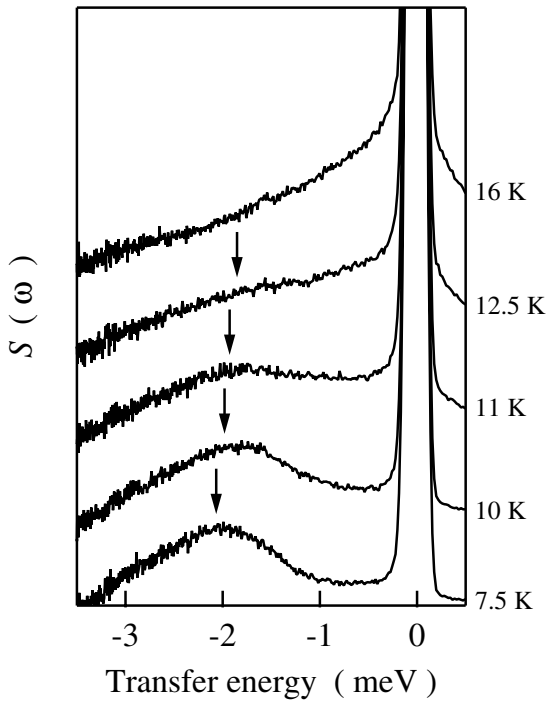

Fig. 1. Inelastic neutron scattering spectra of $CuFeO_2$ powder at 7.5, 10, 11, 12.5, and 16 K.