Inelastic neutron scattering study on crednerite $CuMnO_2$

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Triangular lattice antiferromagnets have received considerable attention in recent years due to the presence of extraordinary magnetic properties. In more than a decade, the crystal structure and the magnetic properties of delafossite-type oxide $CuFeO_2$ have been extensively studied. At room temperature, the crystal structure of the $CuFeO_2$ belongs to the rhombohedral space group ($R\bar{3}m$), and Fe^{3+} ions form the equilateral triangular lattice parallel to the ab-plane. Recently we performed the inelastic neutron scattering measurements for the $CuFeO_2$, and found the quasielastic neutron scattering (QNS) peak due to the spin-liquid phase between Néel temperature (10.5 K) and 100 K [1]. In contrast to the $CuFeO_2$, the $CuMnO_2$ has a crednerite structure belonging to the monoclinic space group ($C2/m$) at room temperature. The Jahn-Teller effect causes the distortion of MnO_6 octahedra, and Mn^{3+} ions form anisotropic triangular lattice. In the $CuMnO_2$ system, antiferromagnetic ordering is realized below 65 K [2]. In this study, we performed the inelastic neutron scattering measurements for the $CuMnO_2$ to investigate whether the spin-liquid phase appears in the anisotropic triangular lattice.

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 $CuMnO_2$ sample was synthesized by the solid state reaction method as described elsewhere.

Figure 1 shows the contour map of the inelastic neutron scattering intensity, $S(|Q|, E)$, on the $CuMnO_2$ powder at 70 K. The vertical axis is the energy transfer values E and the horizontal axis is the wave number $|Q|$. Although the QNS peak is found on both the $CuMnO_2$ and $CuFeO_2$ at around Néel temperature, the $|Q|$-dependence of the QNS peaks is quite different. The QNS peak of the $CuFeO_2$ appears in the whole $|Q|$ range, and the intensity and the half-width oscillate as a function of $|Q|$ [1]. On the other hand, the QNS peak of the $CuMnO_2$ appears only at the specific $|Q_0|$ ($|Q_0| \sim 1.4$ Å^{-1}). The magnetic structure of the $CuMnO_2$ is characterized by the propagation vector $q = \{-1/2, 1/2, 1/2\}$ [2] and the absolute value of the propagation vector $|q|$ is about 1.41 Å^{-1}, which is equal to $|Q_0|$. Thus we conclude that the origin of the QNS peak of the $CuMnO_2$ should be the antiferromagnetic spin fluctuation and the spin-liquid phase would not appear on the anisotropic triangular lattice antiferromagnet $CuMnO_2$.

References

[1] K. Hayashi *et al.*: Phys. Rev. B **80** (2009) 144413.

[2] F. Damay et al.: Phys. Rev. B **80** (2009) 094410.

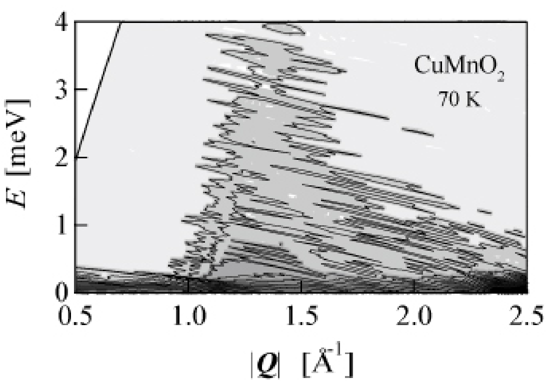

Fig. 1. Intensity contour map of inelastic neutron scattering on the $CuMnO_2$ powder at 70 K.