Successive magnetic phase transition of the new frustrated compound $KCu_3OCl(SO_4)_2$

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Geometrically frustrated magnets have attracted much interest recently because some new physical states including spin liquids are expected to be realized in them. One of the most studied spin lattices is the pyrochlore lattice, in which spin tetrahedrons are connected by their vertices to form a 3D frustrated lattice. If tetrahedrons are coupled only along one direction, we have a one-dimensional (1D) pyrochlore lattice in which new quantum phases or states can be generated by both low-dimensional and frustration effects.

We attempted to find model compounds for the 1D pyrochlore and found $KCu_3OCl(SO_4)_2$ (mineral name, kamchatkite).[1)] The copper ions form distorted tetrahedra that are connected along the crystallographic c axis to form 1D pyrochlore. We synthesized a kamchatkite powder sample and measured its magnetic susceptibility and specific heat.[2)] The specific heat result revealed three successive phase transitions at about T_c=15, T_m=11, and T_N = 3 K. The 15 K and 3 K transitions are considered to be weak ferromagnetic and antiferromagnetic transitions, respectively. These complex successive phase transitions including the magnetic transition originate from the spin frustration. A new phase may appear due to the interplay between the spin frustration and characteristic crystal structure of kamchatkite.

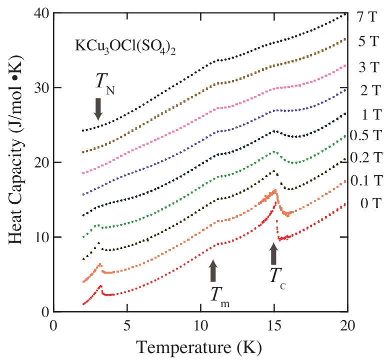

Fig. 1. Temperature dependence of the specific heat of kamchatkite measured under various magnetic fields up to 7 T.

In order to investigate the properties of these phase transitions from microscopic and dynamic points of view, tentative μSR measurements under zero magnetic field were carried out. Contrary to the first expectation that μSR would show anomalies at the three phase temperatures, the relaxation rate λ and asymmetry parameter show an anomaly at only one temperature around T_c =15 K. Moreover, drastic changes of these parameters suggest that the transition at T_c is a first order transition, although no thermal hysteresis is observed in the specific heat. We need further relaxation data including LF measurements to determine the nature of the transition at T_c.

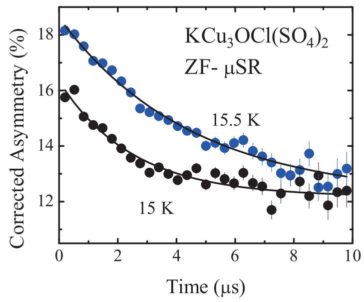

Fig. 2. ZF-μSR spectra measured at 15 and 15.5 K. Drastic change is observed at around T_c=15 K.

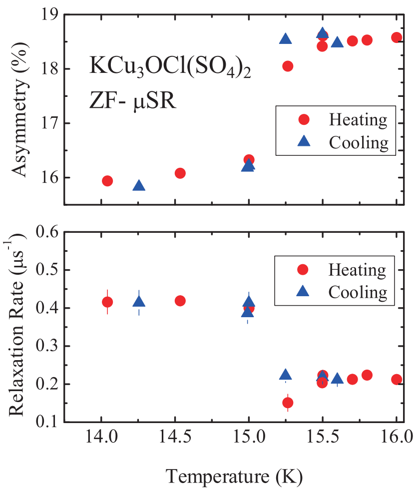

Fig. 3. Temperature dependence of the asymmetry parameter and relaxation time λ obtained from ZF-μSR spectra.

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References

1) T. V. Varaksina et al.: Mineralogical Magazine **54**, 613 (1990).
2) H. Kikuchi, K. Kunieda, Y Fujii, A. Matsuo, K. Kindo: submitted to Proc. HFM2016 (Taipei, 2016).