

Thermodynamic anomaly specific to PD phase of spin frustration system CuFeO₂

S. Mitsuda(A), T. Nakajima(A), T. Fujii(A), N. Terada(B),
(A) Department of Physics, Tokyo University of Science, (B) RIKEN/SPring8

Delafossite compound CuFeO₂ has been extensively investigated as one of model materials for triangular lattice antiferromagnets (TLA). Although CuFeO₂ is considered to be a Heisenberg spin TLA with $S=5/2$ of orbital singlet Fe³⁺, a sinusoidally amplitude-modulated magnetic state with a temperature dependent incommensurate magnetic propagation vector ($q, q, 3/2$) is thermally induced from 4-sublattice ground state as a partially disordered (PD) state characteristic to Ising spin TLA.[1]

We have reported anomalous thermal behavior specific to the PD phase and suggested that changes in microscopic magnetic state with variation of the propagation wave number q is accompanied by additional latent heat in the PD phase. [2] In present study, to investigate accurately how change in the propagation wave number q reflecting the microscopic magnetic state correlate with extra heat absorption and generation during thermal cycles found in the specific heat measurement, we performed neutron diffraction experiments with varying the temperature as was in the specific heat measurement, using HQR spectrometer at JRR3M in JAERI (Tokai) for single-crystal sample of CuFeO₂. The incident wavelength of neutron is 2.44[Å] and collimation of open-'40-'40-open is employed.

As shown in Fig.1, starting 1st-heating process from $T \sim 11.65$ K, variation of the wave number q well follows the T-increasing-Guide-line shown in the inset of Fig.1. In subsequent 1st-cooling process, with decreasing the temperature from the highest temperature ~ 11.85 K, the point $q(T)$ depicted by blue circle moves horizontally on the wave number q v.s. Temperature (q - T) plane, meets and follows the T-decreasing-Guide-line. In subsequent 2nd-

heating process starting from $T \sim 11.65$ K, the point $q(T)$ moves horizontally, meets and follows the T-increasing-Guide-line on T - q plane. In such a way, we measured the trajectory of the point $q(T)$ on q - T plane up to 3rd temperature-cycle for various temperature width dT and confirmed that the trajectory of the point $q(T)$ extracted from knee-points in the temperature response of the sample in the specific heat measurement with the relaxation technique is well coincide with that from present neutron diffraction measurements. From these results, we concluded that extra heat absorption and heat generation in the PD phase occur for decreasing and increasing of the propagation wave number q , respectively, suggesting a kind of Devil's Staircase for the PD state of CuFeO₂.

References

- [1] S. Mitsuda et al, JPSJ 67, 4026 (1998).
- [2] T. Fujii et al, ISSP-NSL Activity Report Vol.13

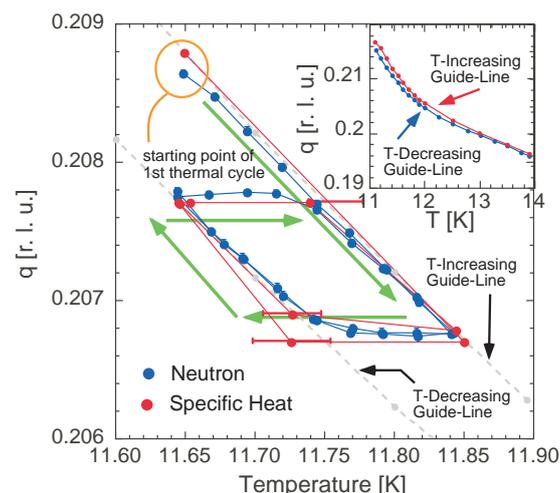


Fig. 1. Trajectory of the wave number q for temperature-cycles with the temperature width of $dT=0.20$ K. [inset] Temperature dependence of the magnetic propagation wave number q in PD state,.