Chiral Helimagnetism in CuB2O4

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Helical magnet copper metaborate CuB2O4 has been paid attention from the viewpoint of chiral helimagnetic ordering. It shows various magnetic phase transitions at low temperature: paramagnetic state above TN (= 20 K), commensurate phase with weak ferromagnetic ordering in the range of T* (= 10 K) < T < TN and incommensurate phase with helimagnetic ordering below T*. In the temperature close to the incommensurate-to-commensurate transition, neutron diffraction experiments show higher order satellite, which is an evidence for the formation of magnetic soliton lattice [1]. With increasing an applied magnetic field perpendicular to the helical c-axis, incommensurate phase II is observed in the region which was supposed to be commensurate magnetic structure [2]. The magnetic property of CuB2O4 can be interpreted by the lattice chiral XY model: commensurate-to-incommensurate transition is understood by the formation of chiral magnetic soliton lattice [3]. In order to detect chiral helimagnetic ordering, polarized neutron diffraction technique is powerful by comparing asymmetric magnetic satellite intensities between up-spin (+) and down-spin (-) neutron. Therefore, we performed polarized neutron diffraction experiments in the incommensurate phase.

The single crystal was grown by the spontaneous crystallization technique; slow cooling of CuO, Li2CO3 and B2O3 [3], using enriched 11B2O3 to avoid the large neutron absorption due to 10B. The polarized neutron diffraction experiments were performed at PONTA (5G), JRR-3M reactor in JAEA (Tokai). The experimental condition was 8 K under an applied magnetic field parallel to the scattering vector, due to aligning the neutron polarization parallel to the scattering vector. We observed incommensurate satellite peaks around (0,0,2), indexed as (0,0,2+q) and (0,0,2-q). As shown in Fig.1, we observed no difference between up-spin and down-spin neutron intensities, which indicates no chiral magnetic ordering. However, symmetry operation based on its space group, I-42d, allows antiferrochiral helimagnetic ordering, which alternates right and left handed screws. In case of the antiferrochiral helimagnetic ordering, observing (1,1,4+q) and (1,1,4-q) reflections, which is not parallel to magnetic propagation vector (0,0,q), is needed. Therefore, in order to investigate antiferrochiral helimagnetic ordering, additional experiments are now in progress.

References

[1] B. Roessli et al.: Phys. Rev. Lett. 86 (2001) 1885.
[2] To be submitted.
[3] To be submitted.

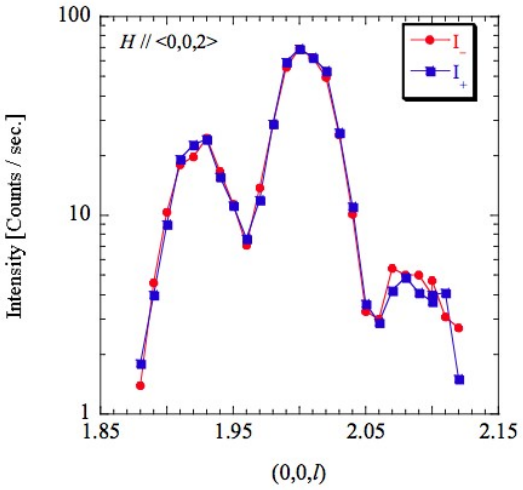

Fig. 1. Observed satellite intensities around (0,0,2) at 8 K.