Low temperature magnetism and spin fluctuation in atacamite-type Ni2(OD)3Cl

M. Hagihala1, M. Fujihala1, X. G. Zheng1, Y. Oohara2
1 Department of Physics, Saga University; 2 ISSP, Univ. of Tokyo

A long-range order in magnets must reportedly be fully frozen to become static. Nevertheless, we recently obsered an exotic dynamic antiferromagnetic state in atacamite-type Ni2(OH)3Cl with a muSR study although magnetic susceptibility and specific heat measurements clearly suggested a long-range order occuring below TN=4K (1). Therefore, we further investigated this exotic state using neutron scattering.

Ni2(OH)3Cl belongs to the material category of the hydroxyhalide M2(OH)3X (M: 3d magnetic ions Cu, Ni, Co, Fe or Mn, X: Cl, Br, I), which are discovered by us to be a new geometrically frustrated materials series (2-4). Atacamite-type Ni2(OH)3Cl is the S=1 spin system on the deformed pyrochlore lattice. We performed neutron diffraction measurements using Ni2(OD)3Cl with the High Energy Resolution and High Q Resolution Triple-Axis Spectrometers HER and HQR, respectively, of the Institute for Solid State Physics, Tokyo University, installed at the experimental port of JRR-3 (JAEA).

The neutron diffraction pattern unambiguously demonstrates the development of a long-range antiferromagnetic order. Shown in Fig. 1 are the neutron diffraction patterns for Ni2(OD)3Cl powder sample at 10 K and 1.5 K, respectively, in which the antiferromagnetic reflection peaks are marked by the circles and triangles. The two kinds of magnetic peaks appeared at slightly different temperatures below TN=4 K, as illustrated by the inset plot. The ordering of Ni2+ spins is clearly of a long range order, judged from the peak width as compared with the lattice diffraction peaks.

Therefore, we clearly demonstrated a dynamic magnetic order in a new magnetic material Ni2(OH)3Cl. The short characteristic fluctuation time of 10-7 s witnessed by muSR and the long range order nature evidenced by neutron diffraction present a challenge to the current understanding of magnetic ordering. We believe further studies of Ni2(OH)3Cl engender innovation of our knowledge related to magnetism.

References

(1) X. G. Zheng, M. Hagihala, K. Nishiyama, T. Kawae: Physica B 404, 677-679 (2009).
(2) X. G. Zheng et al. Phy. Rev. B 71, 174404 (2005); ibid. 71, 052409 (2005); X.G. Zheng, M. Hagihala, T. Kawae, and C.N. Xu, ibid. 77, 024418 (2008).
(3) X.G. Zheng et al., Phys. Rev. Lett. 95, 057201 (2005); X.G. Zheng, T. Kawae, H. Yamada, K. Nishiyama, and C.N. Xu, ibid. 97, 247204 (2006).
(4) M. Hagihala, X.G. Zheng, T. Toriyi, and T. Kawae, J. Phys. Condens. Matter. 19, 145281 (2007).

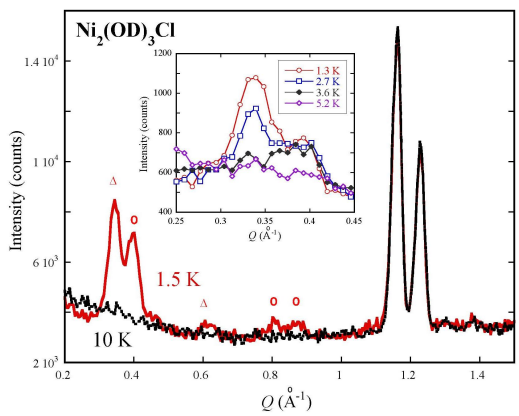

Fig. 1. Fig. 1 Neutron diffraction patterns for Ni2(OD)3Cl powder sample at 10 K and 1.5 K, respectively.