Successive Magnetic Phase Transitions and Multiferroicity in Spin-1 Triangular Lattice Antiferromagnet $Ba_3NiNb_2O_9$

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Introduction

We have investigated the magnetic phase transitions and magnetoelectric effect of a triangular lattice antiferromagnet (TLAF) $Ba_3NiNb_2O_9$. The TLAFs is one of the most simple geometrically frustrated magnets and has been known to show successive magnetic phase transitions of 120 degree AFM ordering, up-up-down (*uud*) and the oblique phase (coplanar 2:1 canted) with increased magnetic field [1].

Experimental

The magnetoelectric effect (dielectric constant and the pyroelectric current) and the AC susceptibility were measured on polycrystalline samples using the SCM2 magnet. The DC magnetization measurement was done with a vibrating sample magnetometer in cell 8 with the 35 T resistive magnet.

Results and Discussion

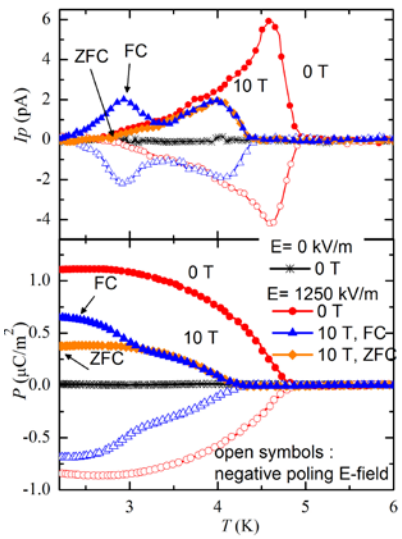

Fig.1 The *T*-dependence of the pyroelectric current (*Ip*) and the polarization (*P*) of $Ba_3NiNb_2O_9$.

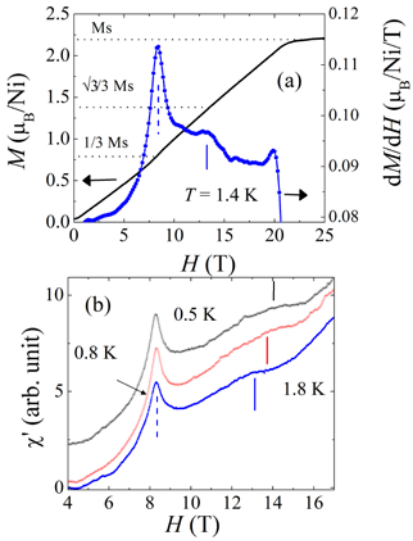

Fig.2 The *H*-dependence of the (a) DC magnetization and its derivative (d*M*/d*H*) (b) AC susceptibility of $Ba_3NiNb_2O_9$.

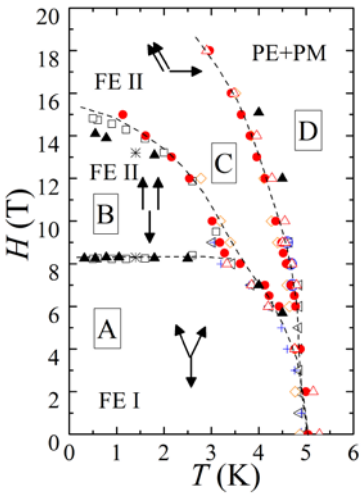

Fig.3 *H-T* phase diagram for $Ba_3NiNb_2O_9$ from different experimental techniques (please see Ref. [2] for detail).

The dielectric constant anomaly (not shown) and the emergence of spontaneous, reversible polarization at low temperatures suggest ferroelectric ground state, whose para-ferroelectric phase boundary also matches with those of magnetic phase transitions as shown in Fig. 3. The DC magnetization and AC susceptibility studies (Fig. 2) confirmed magnetic phase transitions following the theoretical prediction with change of spin structures as depicted in Fig. 3. One notable feature is the multiferroicity in the *uud* and the oblique phase, where the inversion symmetry in the collinear spin structures with underlying triangle lattice does not allow ferroelectric ground state. We speculate a distortion of the triangle lattice driven by magnetostriction breaks the inversion symmetry in favor of the observed multiferroicity.

Acknowledgements

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References

[1] Chubkov A. V. and Golosov D. I., J. Phys. Condens. Matter **3**, 69 (1991).
[2] Hwang J. *et al.*, arXiv:1212.0485 and Phys. Rev. Lett. (in press).