Probing Spin Dynamics in a New Multiferroic $Ba_3NbFe_5Si_2O_{14}$

H. D. Zhou, L. L. Lumata, P. L. Kuhns, A. P. Reyes, E. S. Choi, N. S. Dalal, J. Lu, Y. J. Jo, L. Balicas, J. S. Brooks and C. R. Wiebe (NHMFL-FSU)

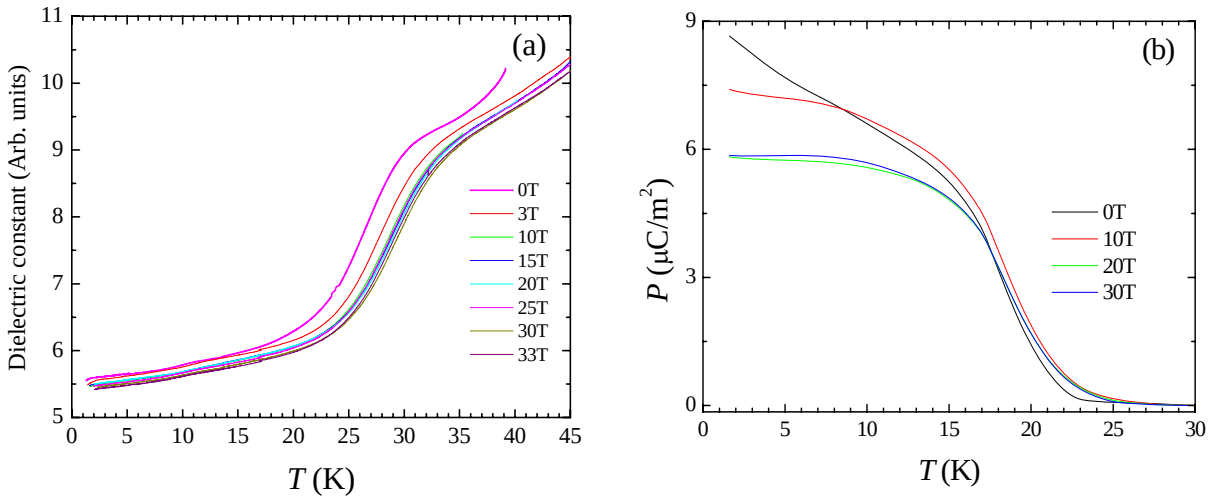
Introduction

In $Ba_3NbFe_3Si_2O_{14}$, the Fe^{3+} ions form a corner-sharing triangular network in *ab* plane, which is a geometrically frustrated spin arrangement. The DC susceptibility measurement on single crystal sample shows an antiferromagnetic transition at T_N = 26 K with a large Curie-Weiss constant θ_{cw} = -190 K, demonstrating the presence of a frustration index of f = 7. A preliminary neutron scattering experiment suggested that an incommensurate ordering appears at T_N=26 K [1], but there have been no reports in the literature concerning the possibility of multiferroicity in this compound. We synthesized single crystal sample $Ba_3NbFe_3Si_2O_{14}$ by floating zone technique and characterized via dielectric constant and electric polarization measurements.

Experimental

For the polarization experiments under the magnetic field, two electrodes were painted onto the surface of the single crystals with silver epoxy. The dielectric constant was obtained by measuring the capacitance with a manual capacitance bridge, an excitation signal of 30 V at 5 kHz, and a lock-in amplifier. To obtain the electric polarization, we measured the pyroelectric current with an electrometer at a rate of 3 K/min after cooling the specimens from 40 to 1.5 K in a static poling electric field. The polarization was measured after removing the poling field. We used 33 T resistive magnet and ^{3}He cryostat for controlling the magnetic field and the temperature.

Results and Discussion



<Fig.1 Temperature dependences of the dielectric constant (a) and polarization (b) for $Ba_3NbFe_3Si_2O_{14}$>

The dielectric constant and polarization measured with the electric field along the *c*-axis are plotted in Fig. 1 (a) and (b), respectively. The dielectric constant shows a broad drop, which begins around 30 K. At the same time, the polarization sharply increases around 24 K. The spontaneous polarization develops below T_N=26 K but the polarization is not saturated under the magnetic field. The polarization changes at 24 K, which is a little lower than T_N. It is possible that the electronic transition is separated from the magnetic transition, which occurs for many other multiferroic systems.[2] These kinds of anomalies which appear near the magnetic transition clearly show that $Ba_3NbFe_3Si_2O_{14}$ is a potential geometrically magnetic frustrated multiferroic system.

References

[1] Marty, K., *et al.*, arXiv:0809.3067 (2008).
[2] Cheong, S. W., *et al.*, Nature, **6**, 13 (2007)