Multiferroic Properties of Spin-1 Triangular Lattice Heisenberg Antiferromagnet $Ca_3NiNb_2O_9$

M. Lee (FSU Physics, NHMFL); E.S. Choi (NHMFL); H.D. Zhou (NHMFL, Univ. Of Tennessee)

Introduction

A triangular lattice, which is the simplest possible geometrically frustrated lattice, has several interesting properties. First of all, successive magnetic phase transitions have been predicted in theoretical studies and observed experimentally [1]. Second, a quantum magnetic plateau is stabilized in a finite range of magnetic field [2]. Lastly, ferroelectricity appears with the magnetic phases, thus multiferroicity [3]. Of these interesting properties, multiferroicity has been a long-standing unsolved problem [4]. Here, we report the multiferroic properties of $Ca_3NiNb_2O_9$, which is a spin-1 triangular lattice antiferromagnet.

Experimental

We have measured dielectric properties of polycrystalline $Ca_3NiNb_2O_9$ with a commercial capacitance bridge (AH 2700) in SCM 2. Pyroelectric current measurement was also done to measure the electric polarization. The magnetic properties were measured using a commercial SQUID magnetometer (QD-MPMS).

Results and Discussion

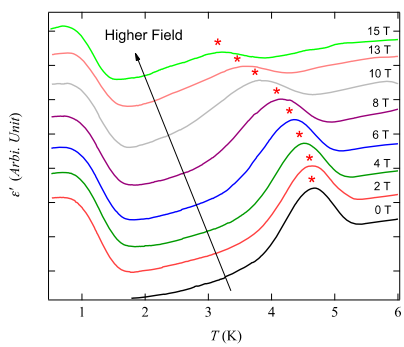

Fig. 1 Temperature-dependent dielectric constant at different fields. The red asterisk indicates the dielectric constant anomaly associated with a magnetic phase transition.

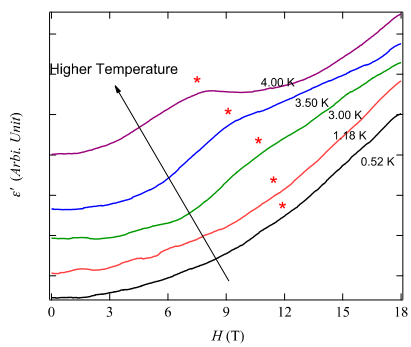

Fig. 2 Field-dependent dielectric constant at different temperatures. The red asterisk indicates the dielectric constant anomaly associated with a magnetic phase transition.

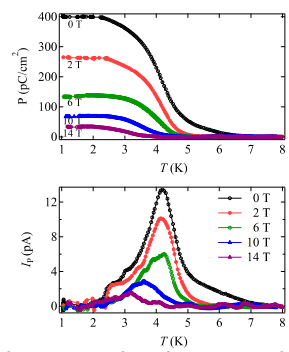

Fig. 3 Pyroelectric current data (top) and polarization curves (bottom) calculated from the pyroelectric current data.

Fig. 1 shows the dielectric constant measured at different fields. In the temperature-dependent dielectric constant curves, one peak appears, whose position moves towards to lower temperatures as the field increases. The zero-field transition temperature (4.8 K) is close to the long range AFM ordering temperature (T_N) of this compound obtained from a DC magnetic susceptibility measurement (data not shown here). In the field-dependent dielectric constant curves (see Fig. 2), a single peak was observed that shifts to lower field as the temperature increases. The peak positions are indicated with red asterisks. The pyroelectric current measurement reveals its ferroelectric ground state with spontaneous polarization (see Fig. 3), whose onset temperatures are close to those of dielectric constant anomalies. The polarization survives even at 14 T. In conclusion, $Ca_3NiNb_2O_9$ shows multiferroicity below 5 K and under wide range of magnetic fields.

Acknowledgements

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References

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