# Evidence for Field-Induced Recovery of Inversion Symmetry in Ferroelectric Ising Chain Magnet

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## Introduction

The last few years have seen a dramatic resurgence of studies about the magnetoelectric effect [1] motivated by the multiple applications predicted for the so-called multiferroic materials, i.e., materials that display both ferroelectricity and ferromagnetism. Most compounds reported to date are insulators possessing either three- or two-dimensional like structures, such as some the manganites which lack inversion symmetry, a pre-requisite for electrical polarization. Recently [2], multiferroic behavior has been reported in a new compound, conformed by magnetic 1D chains ordered in a particular Ising like structure according to neutron scattering studies, inducing ionic-order i.e., breaking inversion symmetry and leading to sizeable dielectrical polarization below the magnetic ordering temperature, $T_{MO} \sim 20$ K.

## Experiment

We performed measurements of the dielectric constant, dielectrical polarization, magnetization, and magnetic in this Ising chain compound using a resistive magnet in conjunction with a $^3$He refrigerator.

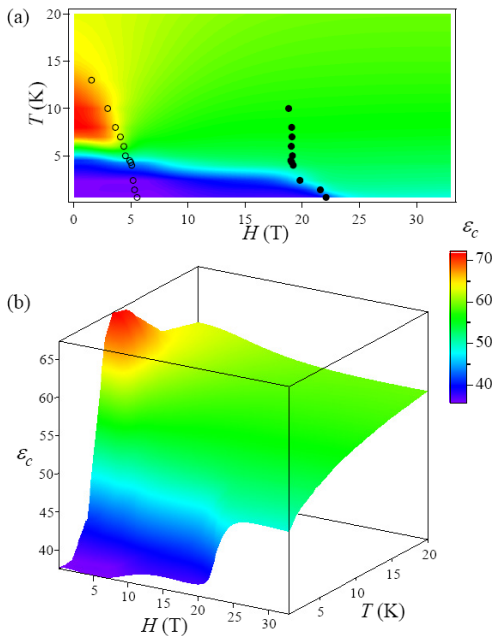


Fig. 1 (a) contour plot showing the dielectric constant as a function of field and temperature. Solid lines correspond to magnetic phase transitions. (b) Same as in (a) but in a tri-dimensional display.

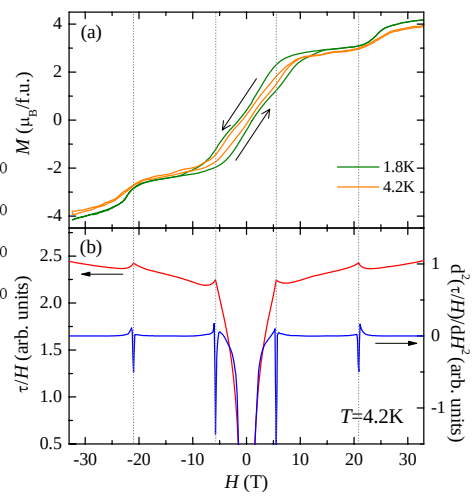


Fig. 2 (a) Magnetization as a function of field for two temperatures. (b) The corresponding magnetic torque normalized by the field and its derivative, revealing a series of magnetic transitions.

## Results and Discussion

The dielectrical constant, Fig. 1, and dielectric polarization, i.e., concomitant multiferroic behavior, are suppressed as the field polarizes the magnetic sub-lattices conforming the 1D Ising chain through a series of magnetic phase-transitions as seen in the magnetization and magnetic torque, Fig 2. This represents compelling evidence for the magnetically-induced ionic order proposed in Ref. [2]: as the original magnetic ordered is suppressed by the field the dielectric polarization associated with the ionic order disappears.

## Conclusions

In conclusion the suppression of magnetic ordering suppresses the concomitant ionic ordering and the dielectric response in this system. It necessarily implies important magnetoelastic effects leading to the recovery of lattice inversion symmetry.

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## References

[1] M. Fiebig, J. Phys. D: Appl. Phys. **38**, R123 (2005)
[2] Y. J. Choi et al., Phys. Rev. Lett. (in press).