



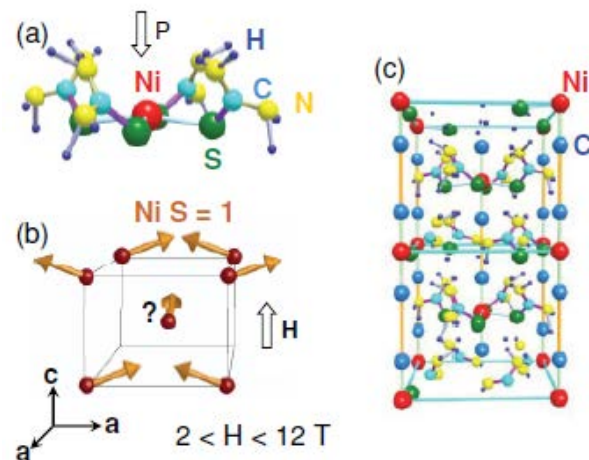
# Magneto-electric effects in an organo-metallic quantum magnet

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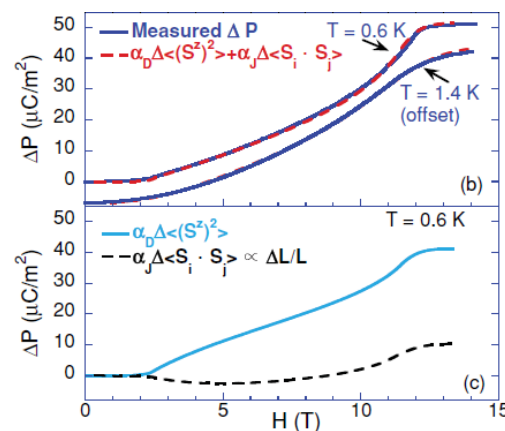


Magneto-electric multiferroics are materials that combine magnetic and electric order coupled to each other. The fundamental science governing the interaction between electricity and magnetism is probed. Possible applications include novel circuits, energy-efficiency, and magnetic memory. We explore new ways to design magneto-electric coupling using organo-metallics, materials combining transition-metal magnetism with insulating organic frameworks. Advantages of organo-metallics include designability, electrically polar elements, and soft lattices that encourage magnetic forces to strain the electrically polar lattice.

We report strong magneto-electric coupling in a material with Ni S=1 antiferromagnetism and electrically polar thiourea (SC(NH<sub>2</sub>)<sub>2</sub>) (fig 1). **The fast pulsed fields at the NHMFL-PFF allow extremely sensitive magnetic field-induced electric polarization measurements.** Close collaboration between theory and experiment results in a near-perfect agreement between Quantum Monte Carlo (QMC) simulations and experiments (fig 2) of the magnetic field-induced electric polarization. The mechanism for magneto-electric coupling is magneto-striction due to magnetic exchange (J) and crystal electric fields (D).



**Fig 1:** Structure of NiCl<sub>2</sub>-4SC(NH<sub>2</sub>)<sub>2</sub> showing (a) polar thiourea bonded to Ni b) Ni S = 1 antiferromagnetism and c) the full structure.



**Fig 2:** a) Magnetic field-induced electric polarization  $\Delta P(H)$  (blue) compared to theory (red). b) Two predicted components of  $\Delta P(H)$  from crystal electric fields  $\langle S_z \rangle^2$  and magnetic exchange  $\langle S_i \cdot S_j \rangle$

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