

# Theory of Condensed Matter: Hard Condensed Matter

April 13, 2016 at 10:30 a.m.  
Staudingerweg 7, room 01-327, 55128 Mainz

Michael Fechner  
ETH Zürich

## **Parity odd magnetism in transition metal oxides and the pseudo-gap phase in cuprate superconductors**

A characteristic of ferroic materials is the emergence of a temporally static finite expectation value of an order parameter. Here, we introduce a new mechanism [1] for ferroic order, in which a non-zero quasi-static magnetoelectric quadrupolar order appears due the coupling of fluctuating spin magnetic dipole moments and optical phonons. We show that our proposed mechanism is consistent, to our knowledge, with many experimental observations for the onset of the pseudo-gap phase in cuprate superconductors and therefore propose the quasi-static magnetoelectric quadrupole as a possible pseudo-gap order parameter. By using first-principles calculations in combination with our recent developed formalism [2], to calculate multipole moments within a Berry phase approach, we calculate the magnitude of the effect for the the prototypical cuprate superconductor,  $\text{HgBa}_2\text{CuO}_{4+\delta}$ . Using these results we finally show that our mechanism embraces several key findings of experimental reports and in addition also aspects of previous theoretical models.

[1] M. Fechner, M. J. A. Fierz, F. Thöle, U. Staub, and N. A. Spaldin, arXiv cond-mat.supr-con, (2015).

[2] F. Thöle, M. Fechner, and N. A. Spaldin, arXiv cond-mat.mtrl-sci, (2016).