MAR09-2008-020090

Abstract for an Invited Paper
for the MAR09 Meeting of
the American Physical Society

Order Parameters and Phase Diagram of Multiferroic RMn2O5

A. BROOKS HARRIS, University of Pennsylvania

Recently there has been great interest in systems which display phase transitions at which incommensurate magnetic order and a spontaneous polarization develop simultaneously. Perhaps the most puzzling and seemingly complicated behavior occurs in the series of compounds RMn_2O_5, where R=Y, Ho, Er, Tb, Tm, and Dy. (For references to experimental data, see [1].) The sequence of magnetoelectric phases of the type I systems R=Tb, Ho, and Dy is slightly different from that of the type II systems R= Y, Tm, and Er. At about 45K both types develop essentially collinear modulated magnetic order into a "high-temperature ordered" (HTO) phase with a wave vector $\mathbf{q} = (1/2 - \delta, 0, 1/4 + \epsilon)$ where δ and $|\epsilon|$ are of order 0.01 and the spontaneous polarization is zero. There is a lower-temperature phase transition to a ferroelectric phase in which transverse magnetic order appears and produces a magnetic spiral with $\delta = \epsilon = 0$. In type I systems, this transition occurs directly from the HTO phase, whereas for type II systems, there is an intervening ferroelectric phase in which $\epsilon = 0$, but δ remains nonzero. and II description. I will discuss a Landau free energy[1] which allows both type I and type II sequences of phase transitions. This theory is couched in terms of the uniform polarization vector $\mathbf{P}$ and two complex-valued magnetic order parameters $\sigma_1(\mathbf{q})$ and $\sigma_2(\mathbf{q})$ whose symmetry follows from the magnetic structure analyses.[2] The magnetoelectric coupling and the competition between commensurate and incommensurate phases are analyzed.

[1] A. B. Harris, A. Aharony, and O. Entin-Wohlman, Phys. Rev. Lett. **100**, 217202 (2008) and J. Phys. Condens. Mat. **20**, 434202 (2008).

[2] A. B. Harris, Phys. Rev. **76**, 054447 (2007); A. B. Harris, M. Kenzelmann, A. Aharony, and O. Entin-Wohlman, Phys. Rev. B **78**, 014407 (2008).