Friday, February 4, 2011 • 4:00 P.M. • 2241 Chamberlin Hall

Coffee & Cookies Served at 3:30 p.m

Sang-Wook Cheong

Rutgers Center for Emergent Materials

Host: Perkins

Multiferroic Vortices and Graph Theory

Department of Physics Colloquium

InThe fascinating concept of topological defects permeates ubiquitously our understanding of the early-stage universe, hurricanes, quantum matters such as superfluids and superconductors, and also technological materials such as liquid crystals and magnets. Large-scale spatial configurations of these topological defects have been investigated only in a limited degree. Exceptions include the cases of supercurrent vortices or liquid crystals, but they tend to exhibit either trivial or rather-irregular configurations. Hexagonal $REMnO_3$ (RE= rare earths) with RE=Ho-Lu, Y, and Sc, is an improper ferroelectric where the size mismatch between RE and Mn induces a trimerization-type structural phase transition, and this structural transition leads to three structural domains, each of which can support two directions of ferroelectric polarization. We reported that domains in h-$REMnO_3$ meet in cloverleaf arrangements that cycle through all six domain configurations[1], Occurring in pairs, the cloverleafs can be viewed as vortices and antivortices, in which the cycle of domain configurations is reversed. Vortices and antivortices are topological defects: even in a strong electric field they won't annihilate. Recently we have found intriguing, but seemingly irregular configurations of a zoo of topological vortices and antivortices in h-$REMnO_3$ [2]. These configurations can be neatly analyzed in terms of graph theory and this graph theoretical analysis reflects the nature of self-organized criticality in complexity phenomena as well as the condensation and eventual annihilation processes of topological vortex-antivortex pairs.

[1] Insulating Interlocked Ferroelectric and Structural Antiphase Domain Walls in Multiferroic $YMnO_3$, T. Choi, Y. Horibe, H. T. Yi, Y. J. Choi, Weida. Wu, and S-W. Cheong, Nature Materials 9, 253-258 (2010).

[2] Self-Organization, Condensation and Annihilation of Topological Vortices and Antivortices in a Multiferroic, S. C. Chae, Y. Horibe, D. Y. Jeong, S. Rodan, N. Lee, and S.-W. Cheong, PNAS, in print.

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