MAR08-2007-002962

Abstract for an Invited Paper
for the MAR08 Meeting of
the American Physical Society

Thermodynamics and dynamics of artificial square ice and related dipolar nanoarrays

GUNNAR MOLLER, University of Cambridge

Spin ice is a geometrically frustrated magnetic phase which has attracted much attention since the discovery of rare earth pyrochlores reproducing the zero-point entropy of ice found by Pauling in the 1930's. Square ice is a two-dimensional analogue of this phase, sharing its algebraic correlations and finite entropy at zero temperature, as well as connections to exact solutions, quantum magnetism, unusual quasiparticles such as magnetic monopoles, exotic dynamics and gauge theories. Experimental realizations of two-dimensional magnetic systems could recently be achieved using lithographic fabrication techniques and local magnetic probes to detect and manipulate individual magnetic degrees of freedom [1]. We study the frustrated dipolar arrays recently manufactured by Wang *et al.* [1] in order to realize the square ice model in an artificial structure. In particular, we discuss models for thermodynamics and dynamics of this system [2]. We show that an ice regime can be stabilized by small changes in the array geometry; a different magnetic state, kagome ice, can similarly be constructed. At low temperatures, the square ice regime is terminated by a thermodynamic ordering transition, which can be chosen to be ferro- or antiferromagnetic. We argue that the arrays do not fully equilibrate experimentally, and identify a likely dynamical bottleneck.

[1] Wang *et al.*, Nature **439**, 303 (2006).

[2] G. Möller and R. Moessner, Phys. Rev. Lett. **96**, 237202 (2006).