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Magnetic Charge Organization and Screening in Thermalized Artificial Spin Ice[1]

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Artificial spin ice is a material-by-design in which interacting single-domain ferromagnetic nanoislands are used to model Ising spins in frustrated spin systems. Artificial spin ice has proved a useful system in which to directly probe the physics of geometrical frustration, allowing us to better understand materials such as spin ice. Recently, several new experimental techniques have been developed that allow effective thermalization of artificial spin ice [1-3]. Given the intense interest in magnetic monopole excitations in spin ice materials and artificial spin ice's success in modeling these materials, it should not come as a surprise that interesting monopole physics emerges here as well. The first experimental investigation of thermalized artificial square spin ice determined that the system's monopole-like excitations obeyed a Boltzmann distribution and also found evidence for monopole-antimonopole interactions [1]. Further experiments have implicated these monopole excitations in the growth of ground state domains [2]. Our recent study of artificial kagome spin ice [3], whose odd-coordinated vertices always possess a net magnetic charge, has revealed a theoretically-predicted magnetic charge ordering transition which has not been previously observed experimentally. We have also investigated the details of magnetic charge interactions in lattices of mixed coordination number. This work was done in collaboration with Sheng Zhang, Cristiano Nisoli, Gia-Wei Chern, Michael Erickson, Liam O'Brien, Chris Leighton, Paul Lammert, Vincent Crespi, and Peter Schiffer.

[1] J.P. Morgan et al., Nature Phys. 7, 75 (2011).
[2] A. Farhan et al., Phys. Rev. Lett. 111, 057204 (2013).
[3] S. Zhang, et al., Nature 500, 553 (2013).

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