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Thermalization, Charge Ordering, and other Recent Developments in Artificial Spin Ice[1]

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Artificial spin ice consists of arrays of lithographically fabricated single-domain ferromagnetic elements, arranged in different geometries such that the magnetostatic interactions between the moments are frustrated. Magnetic force microscopy imaging of these arrays allows us to study the accommodation of frustration through the local correlations between the moments as a function of both the strength of the interactions and the geometry of the frustration. The interactions can be closely mapped onto those of the "spin ice" materials, and allow a detailed analysis of the local correlations and monopole-like excitations. We have probed a number of different lattice geometries and find both local ordering and disordered states that match classic models for frustrated spin systems. Our recent work has focused on thermalization of these arrays as well as investigation of lattice geometries that are unavailable in natural systems and are specifically designed to exhibit unusual behavior associated with frustration, e.g., the shakti lattice. Thermalization reveals ordering both of the moments and of the effective magnetic charges that characterize correlated many-body dynamics in these systems. Other recent work has involved studies of return point memory as well as measurements of electrical transport in these systems.

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