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Topological frustration of artificial spin ice JASPER DRISKO, THOMAS MARSH, JOHN CUMINGS, University of Maryland, College Park —
Dislocations are topological defects ubiquitous in crystalline materials, although they are often neglected in experimental and theoretical studies due to their complexity. Artificial spin ices (ASIs), lithographically patterned arrays of ferromagnetic nanostructures, are highly tunable systems that allow for detailed investigations of frustration by providing exquisite control and insight at the single-spin level. Here, we introduce controlled topological defects into thermally active square ASI lattices and directly observe the resulting spin configurations upon annealing. Whereas a canonical square ASI lattice can support perfect ground state ordering, we find the presence of a dislocation results in extended frustration within the system. Locally, the magnets are unfrustrated, but frustration of the lattice persists due to its topology. A chain of higher energy vertices always originates from each dislocation point and either extends to an edge of our finite crystal, or rarely, to a second dislocation point if it is present in the same crystal. We also simulate our work using a kinetic Monte Carlo technique and find remarkably similar behavior between the simulations and our experiments, with the same types of domain walls and domain patterns as in our experimental samples. Our results indicate that topological defects have non-trivial consequences and should receive more attention in investigations of three dimensional crystals with $\mathbf{q} \neq \mathbf{0}$ order parameters.

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