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Route towards perfect antiferromagnetic ground state ordering in field demagnetized artificial square spin systems

Assemblies of interacting ferromagnetic nanostructures allow real space imaging of the exotic properties often associated with frustrated magnetism. This capability to explore the rich many-body physics of frustrated spin systems through magnetic imaging triggered a wealth of studies at the frontier between nanomagnetism, condensed matter and statistical physics.
Imaging partial or complex magnetic ordering and correlations in disordered magnetic phases require to bring reliably artificial spin systems into low-energy states, where collective phenomena emerge. To do so, two main routes have been followed so far: field demagnetization protocols and thermal annealing procedures. Both approaches have been used successfully, although reaching perfect ground state ordering in frustrated and unfrustrated artificial spin systems remains challenging.
In this work, we propose a strategy to improve the efficiency of field demagnetization protocols applied to square arrays of nanomagnets. This strategy consists in connecting the nanomagnets at the vertices of the square lattice and in engineering the vertex geometry to destabilize the formation of type II domain walls separating type I ground state domains. The main idea behind our proposal is to incorporate a hole at each vertex site by removing a fraction of magnetic materials, but still leaving the nanomagnets constituting the arrays physically connected. The key ingredient to facilitate the field demagnetization protocol is to make these holes anisotropic to lift the energy degeneracy between the different type II vertices.

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