Magnetic charge injection in spin ice

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Abstract

The spin ice state emerges in pyrochlore lattices of vertex sharing tetrahedra when the magnetic moments are subjected to an effective ferromagnetic interaction and are constrained along the local directions joining the corners to the center of each tetrahedron. It is a macroscopically degenerate ground state called a Coulomb phase, in which the spins obey locally the ice-rule, which means that two spins point in and two spins point out of each tetrahedron. The spin ice elementary excitations, the magnetic monopoles, are obtained by reversing one spin at the center of a pair of tetrahedra.

We propose a new mechanism to inject monopoles in a spin ice through a staggered magnetic field. We show experimentally that this is realized in a rare-earth pyrochlore iridate where the iridium sublattice produces, at the rare-earth site, a staggered magnetic field, pointing inwards/outwards adjacent tetrahedra. A new peculiar ground state is stabilized originating from the competition between the antiferromagnetic-like molecular field and the ferromagnetic spin-ice correlation. Compared to conventional spin ices, the different nature of the excitations in this new state opens the way to novel field-induced and dynamical behaviors.

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