

Quantum Spin Ices and Topological Phases from Dipolar-Octupolar Doublets on the Pyrochlore Lattice

We consider a class of d - and f -electron systems in which dipolar-octupolar Kramers doublets arise on the sites of the pyrochlore lattice. For such doublets, two components of the pseudospin transform like a magnetic dipole, while the other transforms like a component of the magnetic octupole tensor. Based on a symmetry analysis, we construct and study models of dipolar-octupolar doublets in itinerant and localized limits. In both limits, the resulting models are of surprisingly simple form. In the itinerant limit, we find topological insulating behavior. In the localized limit, the most general nearest-neighbor spin model is the XYZ model. We show that this XYZ model exhibits two distinct quantum spin ice (QSI) phases, that we dub dipolar QSI, and octupolar QSI. We conclude with a discussion of potential relevance to real material systems.

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