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Quantum spin ices and magnetic states from dipolar-octupolar doublets on the pyrochlore lattice

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We consider a class of electron systems in which dipolar-octupolar Kramers doublets arise on the pyrochlore lattice. In the localized limit, the Kramers doublets are described by the effective spin1/2 pseudospins. The most general nearest-neighbor exchange model between thesepseudospins is the XYZ model. In additional to dipolar ordered and octupolar ordered magnetic states, we show that this XYZ model exhibits two distinct quantum spin ice (QSI) phases, that we dub dipolar QSI and octupolar QSI. These two QSIs are distinct symmetry enriched U(1) quantum spin liquids, enriched by the lattice symmetry. Moreover, the XYZ model is absentfrom the notorious sign problem for a quantum Monte Carlo simulation in a large parameterspace.We discuss the potentialrelevance to real material systems such as Dy2Ti2O7, Nd2Zr2O7, Nd2Hf2O7, Nd2Ir2O7, Nd2Sn2O7 and Ce2Sn2O7.

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