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Continuous transition between Ising magnetic order and a chiral spin liquid

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The competition between fractionalized spin-liquid states and magnetically ordered phases is an important paradigm in frustrated magnetism. Spin-orbit coupled Mott insulators with Ising-like magnetic anisotropies, such as Kitaev materials, are a particularly rich playground to explore this competition. In this work, we use effective field theory methods to show that a direct quantum phase transition can occur in two-dimensional (2D) Ising spin systems between a topologically ordered chiral spin liquid and a phase with magnetic long-range order. Such a transition can be protected by lattice symmetries and is described by a theory of massless Majorana fields coupled to non-Abelian SO(N) gauge fields with a Chern-Simons term. We further show that Euclidean Majorana zero modes bound to $\mathbb{Z}2$ monopole-instantons in the emergent non-Abelian gauge field are key to understanding spontaneous symmetry breaking in the ordered phase.