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Crystalline phases and devil's staircase in qubit spin ice 2

Abstract:

Motivated by the recent realization of an artificial quantum spin ice in an array of superconducting qubits with tunable parameters [King *et al*., Science **373**, 576 (2021)], we scrutinize a quantum six-vertex model on the square lattice that distinguishes type-I and type-II vertices. We map the zero-temperature phase diagram using numerical (exact diagonalization) and analytical (perturbation expansion, Gershgorin theorem) methods. Following a symmetry classification, we identify three crystalline phases alongside a subextensive manifold of isolated configurations. Monte Carlo simulations at the multicritical Rokhsar-Kivelson point provide evidence for a quantum phase exhibiting a cascade of transitions with increasing flux. By comparing structure factors, we find evidence for the emergence of the fully flippable and plaquette phases in the artificial quantum spin ice.