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Abstract

Quantum Phase Transitions in Spin Systems

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Quantum spin systems are used to model the magnetic properties of Mott insulators. Different types of ground states can be realized, depending on the lattice and the range of the interactions. The antiferromagnetically ordered N\'eel state has its analogue in classical spin systems, but other states, e.g., magnetically disordered spin-liquid and valence-bond-solid (VBS) states, are manifestly quantum mechanical and more interesting. Quantum phase transitions between different types of ground states can occur as a function of some tunable parameter in the hamiltonian. In addition their use as models of specific magnetic materials, quantum spin systems are also important for studies of fundamental aspects of collective quantum states and quantum phase transitions. In this sense, quantum spin models now play a similar role in developing quantum many-body physics as the Ising model and other classical spin models have played in classical statistical mechanics. In this lecture I will give an overview of quantum spin models in which quantum-criticality can be studied, focusing in particular on numerical simulation (quantum Monte Carlo) studies in which unbiased results have been be obtained. I will also discuss spinons, e.g., fractionalized excitations of quantum magnets carrying spin S=1/2. They may play an important role in VBS states close to certain quantum-critical points.