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Quantum Simulation of Frustrated Ising Spins with Trapped Ions[1]

CHRISTOPHER MONROE, JQI, University of Maryland Dept. of Physics and NIST

Trapped atomic ions are among the most promising candidates for quantum information hardware, with entangling quantum gates available through state-dependent laser forces applied to individual ions in a Coulomb crystal. When such a laser force is applied globally, an effective spin-spin interaction emerges whose sign and range can be precisely controlled with the laser, and any possible spin correlation function can be measured with standard state-dependent fluorescence techniques. This allows the quantum simulation of interesting spin models that possess nontrivial ground states, the investigation of the relationship between frustration and entanglement, and the potential to calculate features of spin models that cannot be predicted classically. I will review recent experiments along these lines with a few ions, and speculate how this might be scaled to one hundred or more spins.

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