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Toward Quantum Simulation with $^9Be^+$ Ions in a Penning Trap[1]
BRIAN SAWYER, JOE BRITTON, NIST-Boulder, CO, HERMANN UYS, CSIR, South Africa, MICHAEL BIERCUK, University of Sydney, JOHN BOLLINGER, NIST-Boulder, CO — Experimental progress in the fields of atomic and molecular physics has allowed exquisite control over ensembles of cold and ultracold ions, neutral atoms, and polar molecules. A number of theoretical proposals have been put forward concerning direct simulation of quantum Hamiltonians in these systems. We report progress toward simulation of the transverse Ising model in a two-dimensional Coulomb crystal of $\sim$100 $^9Be^+$ ions confined within a Penning trap. Coupling between ions is controlled via optical dipole forces, thereby facilitating a wide range of interparticle interactions including infinite-range and nearest-neighbor coupling. Furthermore, the triangular lattice structure readily obtained within the planar Coulomb crystal allows for simulation of spin frustration in an antiferromagnetic system. Given our large ensembles of trapped $^9Be^+$, it may be possible to perform quantum simulations that are currently intractable with classical computers.

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