Abstract Submitted
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Engineering 2D Ising Interactions in a Large (N>100) Ensemble of Trapped Ions[1] BRIAN SAWYER, JOSEPH BRITTON, NIST-Boulder, CO, ADAM KEITH, NCSU, Raleigh, NC, JOSEPH WANG, JAMES FREERICKS, Georgetown University, HERMANN UYS, CSIR, South Africa, MICHAEL BIERCUK, University of Sydney, JOHN BOLLINGER, NIST-Boulder, CO — Experimental progress in atomic, molecular, and optical physics has enabled exquisite control over ensembles of cold trapped ions. We have recently engineered long-range Ising interactions in a two-dimensional, 1-mK Coulomb crystal of hundreds of $^9Be^+$ ions confined within a Penning trap. Interactions between the $^9Be^+$ valence spins are mediated via spin-dependent optical dipole forces (ODFs) coupling to transverse motional modes of the planar crystal. A continuous range of inverse power-law spin-spin interactions from infinite ($1/r^0$) to dipolar ($1/r^3$) are accessible by varying the ODF drive frequency relative to the transverse modes. The ions naturally form a triangular lattice structure within the planar array, allowing for simulation of spin frustration using our generated antiferromagnetic couplings. We report progress toward simulating the ferromagnetic/antiferromagnetic transverse quantum Ising Hamiltonians in this large ensemble. We also report spectroscopy, thermometry, and sensitive displacement detection ($\sim$100 pm) via entanglement of valence spin and drumhead oscillations.

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