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A Trapped Ion Quantum Simulator for Two-Dimensional Spin Systems[1] MARISSA DONOFRIO, YUANHENG XIE, AJ RASMUSSON, Indiana University Bloomington, NOAH SCHLOSSBERGER, University of Colorado Boulder, ANDREW HENDERSON, University of Notre Dame, MICHELLE LOLLIE, Louisiana State University, PHIL RICHERME, Indiana University Bloomington — Quantum simulation of complex materials addresses fundamental problems in systems that cannot be analytically solved due to exponential scaling of the Hilbert space with increasing particle number. Simulations have been realized in various systems including trapped ion chains, optical lattices, and superconducting circuits. Ion chains in particular have had great success investigating one-dimensional quantum interacting spin models. Using 171 Yb+ ions, we seek to extend these ideas to two dimensions by exploiting large axial frequencies in an rf Paul trap. Individual spins are embedded in two hyperfine ground states of each ion, and ions are lowered to mK temperatures with laser cooling. Spins can be initialized and allowed to evolve under an effective Hamiltonian created by radiation fields, which can be tuned adiabatically to vary interaction range or geometric frustration. Site-resolved imaging will allow for construction of any N-spin correlation function and characterization of system entanglement. This setup will allow us to address open questions related to geometric frustration, ground states and dynamics of long-range spin models, and formation of exotic phases of matter such as valence-bond states and quantum spin liquids.

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