Abstract Submitted
for the MAR14 Meeting of
The American Physical Society

Engineered long-range interactions on a 2D array of trapped ions[1]
JOSEPH W. BRITTON, BRIAN C. SAWYER, JOHN J. BOLLINGER, NIST, JAMES K. FREERICKS, Georgetown Univ. — Ising interactions are one paradigm used to model quantum magnetism in condensed matter systems. At NIST Boulder we confine and Doppler laser cool hundreds of $^9Be^+$ ions in a Penning trap. The valence electron of each ion behaves as an ideal spin-1/2 particle and, in the limit of weak radial confinement relative to axial confinement, the ions naturally form a two-dimensional triangular lattice. A variable-range anti-ferromagnetic Ising interaction is engineered with a spin-dependent optical dipole force (ODF) through spin-dependent excitation of collective modes of ion motion. We have also exploited this spin-dependent force to perform spectroscopy and thermometry of the normal modes of the trapped ion crystal. The high spin-count and long-range spin-spin couplings achievable in the NIST Penning trap brings within reach simulation of computationally intractable problems in quantum magnetism. Examples include modeling quantum magnetic phase transitions and propagation of spin correlations resulting from a quantum quench. The Penning system may also be amenable to observation of spin-liquid behavior thought to arise in systems where the underlying lattice structure can frustrate long-range ordering.

[1]Supported by DARPA OLE and NIST

John Bollinger
NIST

Date submitted: 13 Nov 2013 Electronic form version 1.4