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Engineered spin-spin interactions on a 2D array of trapped ions
JOE BRITTON, BRIAN SAWYER, JOHN BOLLINGER, NIST — We work with laser cooled $^9Be^+$ ions confined in a Penning trap to simulate quantum magnetic interactions. The valence electron of each ion behaves as an ideal spin-1/2 particle. We recently demonstrated a uniform anti-ferromagnetic Ising interaction on a naturally occurring two-dimensional (2D) triangular crystal of $100 < N < 350$ ions. The Ising interaction is generated by a spin-dependent optical dipole force (ODF). For spins separated by distance d, we show that the range can be tuned according to $(d/d0)^{-a}$, for $0 < a < 3$. For different operating parameters we can also generate an infinite range ferromagnetic Ising interaction. We also use the ODF for spectroscopy and thermometry of the normal modes of the trapped ion array. A detailed understanding of the modes is important because they mediate the spin-spin interactions. This work is supported by NIST and the DARPA OLE program.

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