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Quantum information experiments with 2D arrays of hundreds of trapped ions KEVIN GILMORE, JUSTIN BOHNET, NIST, Boulder, CO, BRIAN SAWYER, GTRI, Atlanta Ga., JOSEPH BRITTON, Army Research Lab, Adelphi, Md., MICHAEL WALL, JILA, Boulder, CO, MICHAEL FOSS-FEIG, Army Research Lab, Adelphi, Md., ANA MARIA REY, JILA, Boulder, CO, JOHN BOLLINGER, NIST, Boulder, CO — We summarize recent experimental work with 2D arrays of hundreds of trapped $^9Be^+$ ions stored in a Penning trap. Penning traps utilize static magnetic and electric fields to confine ions, and enable the trapping and laser cooling of ion crystals larger than typically possible in RF ion traps. We work with single-plane ion crystals where the ions form a triangular lattice through minimization of their Coulomb potential energy. The crystals rotate, and we present numerical studies that determine optimal operating parameters for producing low temperature, stable 2-dimensional crystals with Doppler laser cooling and a rotating wall potential. Our qubit is the electron spin-flip transition in the ground state of $^9Be^+$ and is sensitive to magnetic field fluctuations. Through mitigation of part-per-billion, vibration-induced magnetic field fluctuations we demonstrate T2 coherence times longer than 50 ms. We engineer long-range Ising interactions with spin-dependent optical dipole forces, and summarize recent measurements that characterize the entanglement generated through single-axis twisting. Supported by: JILA-NSF-PFC-1125844, NSF-PHY-1521080, ARO, AFOSR, AFOSR-MURI.

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