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Near-ground state cooling and sensing experiments with 2D arrays of hundreds of trapped ions M. AFFOLTER, K.A. GILMORE, J.E. JORDAN, J.J. BOLLINGER, NIST - Boulder, A. SHANKAR, R.J. LEWIS-SWAN, A.M. REY, M. HOLLAND, JILA, NIST, U. Colorado — We summarize recent experimental work with 2D arrays of hundreds of trapped $^{9}Be^{+}$ ions stored in a Penning trap. The goal of this work is quantum simulations and sensing with large trapped ion crystals. For improved sensing and simulation fidelity, electromagnetically induced transparency (EIT) cooling has recently been implemented [1], with near ground state cooling observed for all the drumhead modes. In previous simulations of these Doppler and EIT cooled axial mode spectra, ad hoc frequency fluctuations of the modes were required to produce the smooth mode spectra experimentally observed. Recent theoretical work shows that these fluctuations could be caused by the finite temperature of the in-plane modes. We also measure 70Hz fluctuations in the axial COM mode that, with currently available laser power, limit our ability to measure weak excitations of the axial COM mode. Using an rf tickle far from the axial center-of-mass (COM) mode, where these fluctuations can be ignored, a single measurement displacement sensitivity 40x smaller than the ground state wave function was achieved corresponding to an order-of-magnitude enhancement over previous work [2]. [1] J. E. Jordan et al. PRL 122, 053603 (2019). [2] K. A. Gilmore et al. PRL 118, 263602 (2017).

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