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Ultrafast state detection and 2D ion crystals in a Paul trap MICHAEL IP, ANTHONY RANSFORD, WESLEY CAMPBELL, UCLA — Projective readout of quantum information stored in atomic qubits typically uses state-dependent CW laser-induced fluorescence. This method requires an often sophisticated imaging system to spatially filter out the background CW laser light. We present an alternative approach that instead uses simple pulse sequences from a mode-locked laser to affect the same state-dependent excitations in less than 1 ns. The resulting atomic fluorescence occurs in the dark, allowing the placement of non-imaging detectors right next to the atom to improve the qubit state detection efficiency and speed. We also study 2D Coulomb crystals of atomic ions in an oblate Paul trap. We find that crystals with hundreds of ions can be held in the trap, potentially offering an alternative to the use of Penning traps for the quantum simulation of 2D lattice spin models. We discuss the classical physics of these crystals and the metastable states that are supported in 2D. This work is supported by the US Army Research Office.

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