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Ultrafast Optical Rabi Oscillations on a Single Ion[1] MARTIN MADSEN, PETER MAUNZ, DAVID MOEHRING, RUDY KOHN, CHRIS MONROE, FOCUS Center and University of Michigan Department of Physics — Ultrafast laser interactions with trapped ions open up the possibility to realize scalable, fast quantum logic gates for quantum information applications. In addition, the possibility for fast and efficient excitations from the ground to excited states of trapped ions will benefit probabilistic ion-photon and ion-ion entanglement experiments. We report the measurement of picosecond optical Rabi oscillations, coherently driving the optical S to P transition in a single trapped cadmium ion with near unitary probability. In a microwave Ramsey experiment, two ground state hyperfine levels in a coherent superposition are each driven to unique excited hyperfine levels by an ultrafast laser pulse. Upon spontaneous emission the hyperfine coherence is lost because the frequency of the emitted photon could potentially be measured. However, when a second pulse, delayed by a time shorter than the excited state lifetime, drives the population back towards the ground state, the phase information is preserved. Here, the phase is shifted by the phase accumulated during the time the ion spent in the excited state, evidence for entanglement between the atomic (hyperfine) qubit and the photonic (frequency) qubit.

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