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Individual Optical Addressing of Atomic Clock Qubits With Stark Shifts[1] AARON LEE, JACOB SMITH, Univ of Maryland-College Park, PHILLIP RICHERME, Indiana University-Bloomington, BRIAN NEYENHUIS, PAUL HESS, JIEHANG ZHANG, CHRIS MONROE, Univ of Maryland-College Park — In recent years, trapped ions have proven to be a versatile quantum information platform, enabled by their long lifetimes and high gate fidelities. Some of the most promising trapped ion systems take advantage of groundstate hyperfine clock qubits, which are insensitive to background fields to first order. This same insensitivity also makes σ_z manipulations of the qubit impractical, eliminating whole classes of operations. We prove there exists a fourth-order light shift, or four-photon Stark shift, of the clock states derived from two coherent laser beams whose beatnote is close to the qubit splitting. Using a mode-locked source generates a large light shift with only modest laser powers, making it a practical σ_z operation on a clock qubit. We experimentally verify and measure the four-photon Stark shift and demonstrate its use to coherently individually address qubits in a chain of 10 Yb 171 ions with low crosstalk. We use this individual addressing to prepare arbitrary product states with high fidelity and also to apply independent σ_z terms transverse to an Ising Hamiltonian.

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