Spin Dependent Forces and Entanglement of Atomic Qubits using Optical Frequency Combs

D. HUCUL, D. HAYES, D.N. MATSUKEVICH, P. MAUNZ, S. OLMSCHENK, Q. QURAISHI, W. CAMPBELL, J. MIZRAHI, C. SENKO, C. MONROE, University of Maryland Department of Physics and National Institute of Standards and Technology, College Park, MD 20742 — The spectral purity and large bandwidth of pulsed lasers makes them attractive candidates for precision control of multi-level atomic systems. We use a train of off resonant picosecond pulses from a mode-locked laser to drive stimulated Raman transitions between the hyperfine levels (~10 GHz spacing) of trapped ytterbium ions and to cool to the quantum ground state of motion. By simultaneously addressing the spin and the motion of trapped ions using a train of laser pulses, we apply spin-dependent forces to create a single-ion Schrodinger cat state and implement a gate between two trapped ions to entangle their spins [1]. We also use high-intensity pulses to demonstrate fast (<10 ps) single qubit operations that can be used as the building blocks for fast multi-qubit entangling gates [2]. [1]. D. Hayes et al. arXiv:1001.2127v2 [2] García-Ripoll et al., PRL 91, 157901 (2003). Duan, PRL 93, 100502 (2004).

1This work is supported by the ARO with funds from the DARPA OLE Program, IARPA under ARO contract, the NSF Physics at the Information Frontier Program, and the NSF Physics Frontier Center at JQI.

David Hucul
University of Maryland Department of Physics and National Institute of Standards and Technology, College Park, MD 20742

Date submitted: 22 Jan 2010

Electronic form version 1.4