Abstract Submitted
for the DAMOP09 Meeting of
The American Physical Society

Ultrafast Manipulation of Trapped Ion Qubits[1] WES CAMPBELL, QUDSIA QURAISHI, JONATHAN MIZRAHI, CHRIS MONROE, University of Maryland and JQI — Ultrashort light pulses are an attractive tool for trapped ion quantum information processing. High pulse intensity permits far-detuned (>10 nm) operation, where decoherence from differential AC Stark shifts and spontaneous emission is suppressed. Short pulse duration allows interaction times shorter than a trap oscillation, circumventing the need for cooling to the Lamb-Dicke limit. We describe an experiment with trapped $^{171}Yb^{+}$ using a vanadate laser (∼10 ps pulses at 355 nm). Since the single pulse bandwidth exceeds the $S_{1/2}$ hyperfine splitting, coherent Raman transitions between qubit states should be possible. This is in contrast to our previous work [1] with near-resonant pulses that coherently transfer population to the P-state. It should also be possible to use a series of multiple pulses to impart spin-dependent forces. By controlling the pulse timing and phase we could then entangle multiple ions in a temperature insensitive manner [2,3]. [1] Madsen *et al.*, PRL **97**, 040505 (2006). [2] García-Ripoll *et al.*, PRL **91**, 157901 (2003). [3] Duan, PRL **93**, 100502 (2004).

[1]This work is supported by the DARPA OLE Program under ARO contract, IARPA under ARO contract, the NSF PIF Program, the IC Postdoc Program administered by the NGA, and the NSF Physics Frontier Center at JQI.

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Date submitted: 23 Jan 2009 Electronic form version 1.4