

Abstract Submitted  
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**Arbitrary Ultrafast Manipulation of a Trapped Ion Qubit<sup>1</sup>**

JONATHAN MIZRAHI, Joint Quantum Institute, University of Maryland Department of Physics and National Institute of Standards and Technology, College Park, Maryland 20742, WESLEY C. CAMPBELL, CRYSTAL SENKO, CHRIS MONROE — We demonstrate ultrafast spin flips of a trapped ion, using pulses from a mode-locked laser to drive Raman transitions between hyperfine qubit levels [1]. The laser's large bandwidth and intensity allow an individual pulse to coherently transfer more than 50% population in about 10 ps. Furthermore, the large intensity allows us to be far detuned from resonance, which makes spontaneous emission and AC Stark shift negligible. Complete control over the quantum state can be accomplished by splitting the pulse into two halves and varying the relative delay and intensity to drive x- or z-rotations of variable angle. This amounts to full SU(2) control of the qubit in tens of picoseconds. We plan to use this to implement proposals for motional gates which can be performed much faster than the trap period [2,3]. [1] W.C. Campbell et al., PRL 105, 090502 (2010). [2] J.J. Garcia-Ripoll et al., PRL 91, 157901 (2003). [3] L.-M. Duan, PRL 93, 100502 (2004).

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Jonathan Mizrahi  
Joint Quantum Institute, University of Maryland Dept of Physics and  
National Institute of Standards and Technology,  
College Park, Maryland 20742

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