Abstract Submitted
for the DAMOP12 Meeting of
The American Physical Society

Ultrafast spin-motion entanglement and interferometry in single atomic qubits[1] CRYSTAL SENKO, JONATHAN MIZRAHI, WESLEY C. CAMPBELL, KALE G. JOHNSON, Joint Quantum Institute, University of Maryland Department of Physics and National Institute of Standards and Technology, College Park, Maryland 20742, CHARLES W.S. CONOVER, Colby College Physics Department, Waterville, Maine 04901, CHRISTOPHER MONROE, Joint Quantum Institute, University of Maryland Department of Physics and National Institute of Standards and Technology, College Park, Maryland 20742 — We report entanglement between the hyperfine spin state and motional dynamics of a single atom on a timescale of 15 ns. We extract single pulses from a picosecond mode-locked laser and split them into short pulse trains tailored to create the desired spectrum by tuning the relative delays and frequency shifts appropriately. The resulting interaction imparts a momentum transfer of $2\hbar k$ to each of the two spin states in opposite directions. We apply pairs of momentum kicks to create an interferometer and probe the collapse and revival of spin coherence as the motional wavepacket is split and recombined. This technique holds promise for applications such as interferometry [1] and scalable entangling gates [2,3].

[1] J.F. Poyatos et al., PRA 54, 1532 (1996)
[2] J.J. Garcia-Ripoll et al., PRL 91, 157901 (2003)
[3] L.-M. Duan, PRL 93, 100502 (2004).

[1]This work is supported by grants from the U.S. Army Research Office with funding from the DARPA OLE program, IARPA, and the MURI program; the NSF PIF Program; the NSF Physics Frontier Center at JQI; and the European Commission AQUTE program.

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Date submitted: 27 Jan 2012 Electronic form version 1.4