Abstract Submitted
for the DAMOP12 Meeting of
The American Physical Society

Sub-wavelength Resonance Imaging and Robust Addressing of Atoms in an Optical Lattice[1] ENRIQUE MONTANO, JAE HOON LEE, POUL JESSEN, University of Arizona, IVAN DEUTSCH, University of New Mexico — We demonstrate a resonance imaging protocol for optical lattices that enables robust preparation and single qubit addressing of atoms with sub-wavelength resolution in 1D. Our setup consists of a 3D optical lattice, and a superimposed long-period 1D "superlattice" that creates a position dependent shift of the transition frequency between two spin states in the ground manifold. We show that isolated planes of atoms can be prepared by flipping resonant spins with a microwave pulse and removing the remaining non-resonant spins. Consecutive microwave pulses in a translated superlattice allow us to image these planes with a resolution better than 200 nm. We show that composite pulse techniques can reduce the sensitivity of the addressing to small variations in the relative position and intensity of the lattices. Furthermore, with this technique, we show that we are able to perform independent unitaries (single qubit quantum gates) on adjacent lattice sites with a single composite pulse. Finally, we perform randomized benchmarking, similar to that done by Olmschenk et al., to measure the error per randomized computational gate for these numerically generated composite pulses.

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Date submitted: 31 Jan 2012 Electronic form version 1.4