DAMOP08-2008-020076

Abstract for an Invited Paper
for the DAMOP08 Meeting of
the American Physical Society

An Approach to Quantum Computing with Neutral Atoms in a 3D Optical Lattice[1]

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The long coherence time of neutral atom ground states in optical traps make them promising qubits. In particular, three-dimensional (3D) optical lattices allow many atoms to be trapped, each with many near neighbors. They also present the possibility of both individual and parallel site addressing. As a first step toward such a quantum computer, we have trapped hundreds of single Cs atoms in a blue-detuned 3D optical lattice with 4.9 micron spacing, and reliably imaged where they are using laser cooling light. With tight trapping in all directions, these atoms can be well-cooled in all dimensions. We have also implemented state detection using state-selective imaging. We will show how to execute site-specific one and two qubit quantum gates in this geometry using microwaves and focused laser beams.

[1]Research performed with Xiao Li and Davis S. Weiss