DAMOP12-2012-020046

Abstract for an Invited Paper
for the DAMOP12 Meeting of
the American Physical Society

Trapping Rydberg Atoms in an Optical Lattice[1]

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Optical lattice traps for Rydberg atoms are of interest in advanced science and in practical applications. After a brief discussion of these areas of interest, I will review some basics of optical Rydberg-atom trapping. The trapping potential experienced by a Rydberg atom in an optical lattice is given by the spatial average of the free-electron ponderomotive energy weighted by the Rydberg electron's probability distribution. I will then present experimental results on the trapping of ^{85}Rb Rydberg atoms in a one-dimensional ponderomotive optical lattice (wavelength 1064 nm). The principal methods employed to study the lattice performance are microwave spectroscopy, which is used to measure the lattice's trapping efficiency, and photo-ionization, which is used to measure the dwell time of the atoms in the lattice. I have achieved a 90% trapping efficiency for ^{85}Rb 50S atoms by inverting the lattice immediately after laser excitation of ground-state atoms into Rydberg states. I have characterized the dwell time of the atoms in the lattice using photo-ionization of $50D_{5/2}$ atoms. In continued work, I have explored the dependence of the Rydberg-atom trapping potential on the angular portion of the atomic wavefunction. Distinct angular states exhibit different trapping behavior in the optical lattice, depending on how their wavefunctions are oriented relative to the lattice planes. Specifically, I have measured the lattice potential depth of sublevels of ^{85}Rb nD atoms (50≤n≤65) in a one-dimensional optical lattice with a transverse DC electric field. The trapping behavior varies substantially for the various angular sublevels, in agreement with theory. The talk will conclude with an outlook into planned experiments.

[1]This work was performed under the supervision of Georg Raithel at the University of Michigan. We acknowledge support from DOE SCGF and NSF.