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State-dependent Energy Shift of Rydberg Atoms in a Ponderomotive Optical Lattice[1] S.E. ANDERSON, K.C. YOUNGE, University of Michigan, B. KNUFFMAN, NIST Gaithersburg, MD, G. RAITHEL, University of Michigan — We investigate, experimentally and in calculations, the state-dependence of the ponderomotive energy shift of Rydberg atoms in an optical lattice. In the utilized lattice, the size of the Rydberg wavefunctions approaches the lattice period. As a result, Rydberg atoms in the lattice experience energy shifts that are state-dependent and deviate from the free-electron ponderomotive shift. We report measurements of these energy shifts obtained via microwave spectroscopy of nS→(n+1)S transitions of cold ^{85}Rb Rydberg atoms. The lattice is formed using a one Watt, retro-reflected 1064 nm laser beam, focused into a spot of 13 μm diameter, resulting in ponderomotive lattices with depths up to 50 MHz. The observed microwave spectra of Rydberg atoms in the lattice exhibit side-bands that are shifted by several hundred kHz from the lattice-free transition. The spectra depend strongly on both the Rydberg state and the lattice depth. The experimental results are supported by a semi-classical simulation that reproduces all features of the spectra.

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