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Direct Experimental Observation of a Practical AC Zeeman Force[1] CHARLES FANCHER, ANDREW PYLE, ANDREW ROTUNNO, SHUANGLI DU, SETH AUBIN, William and Mary College — We present measurements of the spin-dependent AC Zeeman force produced by microwave magnetic near-field gradients on an atom chip. We measure the AC Zeeman force on ultracold ^{87}Rb atoms by observing its effect on the motion of atoms in free-fall and on those confined in a trap. We have studied the force as a function of microwave frequency detuning from a hyperfine transition at 6.8 GHz at several magnetic field strengths and have observed its characteristic bipolar and resonant features predicted by two-level dressed atom theory. We find that the force is several times the strength of gravity in our setup, and that it can be targeted to a specific hyperfine transition while leaving other hyperfine states and transitions relatively unaffected. We find that our measurements are reasonably consistent with theory and are working towards a parameter-free comparison. AC Zeeman potentials offer the possibility of targeting qualitatively different trapping potentials to different spin states, a capability currently absent from the toolbox of atomic quantum control techniques. In particular, an AC Zeeman potential could be used as the beamsplitter for a spin-dependent atom interferometer or for engineering a quantum gate.

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