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AC Zeeman potentials for atom chip-based ultracold atoms

CHARLES FANCHER, ANDREW PYLE, AUSTIN ZILTZ, SETH AUBIN, College of William and Mary — We present experimental and theoretical progress on using the AC Zeeman force produced by microwave magnetic near-fields from an atom chip to manipulate and eventually trap ultracold atoms. These AC Zeeman potentials are inherently spin-dependent and can be used to apply qualitatively different potentials to different spin states simultaneously. Furthermore, AC Zeeman traps are compatible with the large DC magnetic fields necessary for accessing Feshbach resonances. Applications include spin-dependent trapped atom interferometry and experiments in 1D many-body physics. Initial experiments and results are geared towards observing the bipolar detuning-dependent nature of the AC Zeeman force at 6.8 GHz with ultracold ^{87}Rb atoms trapped in the vicinity of an atom chip. Experimental work is also underway towards working with potassium isotopes at frequencies of 1 GHz and below. Theoretical work is focused on atom chip designs for AC Zeeman traps produced by magnetic near-fields, while also incorporating the effect of the related electric near-fields. Electromagnetic simulations of atom chip circuits are used for mapping microwave propagation in on-chip transmission line structures, accounting for the skin effect, and guiding impedance matching.

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