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Laser-Free Cold-Atom Gymnastics HARVEY GOULD, BENEDICT FEINBERG, CHARLES T. MUNGER JR., HIROSHI NISHIMURA, Lawrence Berkeley Natl Lab — We have performed beam transport simulations on ultra cold (2 μK) and cold (130 μK) neutral Cs atoms in the $F = M = +4$ (magnetic weak-field seeking) ground state. We use inhomogeneous magnetic fields to focus and accelerate the atoms. Acceleration of neutral atoms by an inhomogeneous magnetic field was demonstrated by Stern and Gerlach in 1922. In the simulations, a two mm diameter cloud of atoms is released to fall under gravity. A magnetic coil focuses the falling atoms. After falling 41 cm, the atoms are reflected in the magnetic fringe field of a solenoid. They return to their starting height, about 0.7 s later, having passed a second time through the focusing coil. The simulations show that $> 98\%$ of ultra cold Cs atoms and $> 70\%$ of cold Cs atoms will survive at least 15 round trips (assuming perfect vacuum). More than 100 simulations were run to optimize coil currents and focusing coil diameter and height. Simulations also show that atoms can be launched into a fountain. An experimental apparatus to test the simulations, is being constructed. This technique may find application in atomic fountain clocks, interferometers, and gravitometers, and may be adaptable for use in microgravity. It may also work with Bose-Einstein condensates of paramagnetic atoms.

Harvey Gould
Lawrence Berkeley Natl Lab

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