Abstract Submitted
for the DAMOP05 Meeting of
The American Physical Society

Properties of Multiple Adiabatic Rapid Passage Sequences[1] X. MIAO, T. LU[2], H. METCALF, Physics, Stony Brook University, Stony Brook, NY 11794-3800 — Multiple repetitions of adiabatic rapid passage (ARP) sweeps can enable huge optical forces on atoms with light beams of different $\vec{k}$-vectors. Alternation of the ARP-induced atomic inversion can coherently transfer momentum between the beams, thereby imparting the difference $\hbar\overrightarrow{\Delta k}$ to the atoms. When the rate of these sweeps $\omega_m \equiv 2\pi/T \gg \gamma$, $F_{ARP} \sim \hbar k\omega_m/\pi \gg \hbar k\gamma/2$, the usual radiative force that has been used for laser cooling since the early 1980's. We have expanded on our earlier studies[3] of ARP forces. Since the process is more efficient if the start and end points of $\vec{\Omega}(t)$ are closer to the polar axis of the Bloch sphere, we consider a pulse whose frequency sweeps through atomic resonance. Each cycle consisting of two pulses changes the initial Bloch vector $\vec{R}(t)$ to $\vec{R}(t+T) \equiv \hat{U}[t, \vec{\Omega}(t)]\vec{R}(t)$ where the operator $\hat{U}$ depends on the laser sweep parameters. We show that $\hat{U}$ simply rotates the Bloch vector, and we view this as a rotation of the Bloch sphere instead. Thus a sequence of periodic pulses is just a sequence of identical rotations. Even with a small non-adiabatic transition probability during each sweep, the sequence of $\vec{R}(nT)$'s is bounded on a small circle near the South pole (n = integer). Thus the force still adds coherently.

[1]Supported by ONR and NSF
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[3]M. Cashen et al., J. Opt. B: Quant. Semiclass., **4**, 75 (2002).

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Date submitted: 27 Jan 2005 Electronic form version 1.4