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The Bichromatic Force for Laser Cooling Without Spontaneous Emission[1] CHRISTOPHER CORDER, BRIAN ARNOLD, HAROLD METCALF, Physics Department, Stony Brook University, Stony Brook NY 11794-3800 — The bichromatic force (F_b) can produce laser cooling without relying on spontaneous emission (SpE).[2] It is implemented with two laser frequencies $\omega_\ell = \omega_a \pm \delta$ where ω_a is the atomic transition frequency and δ is a detuning, $\delta \gg \gamma = 1/\tau$ where τ is the excited atomic state lifetime. This produces multiple absorption-stimulated emission cycles to cause many momentum exchanges on a timescale faster than τ. The resulting magnitude of $F_b = 2\hbar k\delta/\pi$ is much larger than the radiative optical force ($\hbar k\gamma/2$) and spans a much larger velocity range ($\Delta v_b = \delta/2k$). Previous measurements have demonstrated F_b over time scales that included many SpE events.[3] We have made measurements with a F_b cooling time ($M\Delta v_b/F_b$) that is on the order of τ, thus having zero or at most one SpE during the experimental interaction time. Our intensity dependent studies show the atomic velocities changing over a range of many atomic recoils and accumulating at the edge of the F_b velocity profile, and we have developed numerical simulations that corroborate these results.

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[2]H. Metcalf, Phys. Rev. A **77**, 061401 (2008).
[3]M. Partlow et al., Phys. Rev. Lett. **93**, 213004 (2004).

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