PROGRESS TOWARD SLOWING AND COOLING OF CaF WITH OPTICAL BICHROMATIC FORCES

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While rapid progress has been made on slowing and cooling of molecules by optical radiative forces,[a] there remain major obstacles because molecules do not have true two-level cyling transitions — eventually they are "lost" to radiative decay into a dark state. The optical bichromatic force (BCF) can multiply the available velocity change for a given number of radiative cycles, by employing alternating cycles of excitation and stimulated emission from opposing directions. We recently proposed methods for BCF deceleration of CaF molecules with about 12.4 times the acceleration of the usual radiative force,[b] and demonstrated the feasibility of the scheme with test experiments in metastable helium. Experiments on the CaF molecule are now getting underway, similar to the scheme in Ref. [*b*] except that we utilize the 531 nm $B\,^2\Sigma^+ \leftrightarrow X\,^2\Sigma^+$ transition rather than the $A \leftrightarrow X$ transition. Although our initial tests will emphasize transverse deflection, which is particularly easy to achieve, longitudinal deceleration by 150 m/s or more should eventually be possible. We also expect significant laser-induced cooling due to the non-adiabatic BCF velocity profile. This research is supported by the National Science Foundation.

[a] J. F. Barry, E. S. Shuman, E. B. Norrgard, and D. DeMille, *Phys. Rev. Lett.*, accepted (2012).
[b] M. A. Chieda and E. E. Eyler, *Phys. Rev. A* **84**, 063401 (2011).