METHODS FOR MANIPULATING CaF USING OPTICAL POLYCHROMATIC FORCES

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We are undertaking theoretical and experimental studies of laser deceleration and cooling of molecules using coherent multi-frequency optical forces. A primary objective is to reduce radiative loss into dark states when a pure two-level cycling transition is unavailable. 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. Tests in atomic helium show that when the BCF is combined with frequency chirping, very large decelerations are achieved.[a] We report numerical studies of variations intended to further optimize deceleration, including a 4-color version. We describe progress on experimental tests using the 531 nm $B\,^2\Sigma^+ \leftrightarrow X\,^2\Sigma^+$ transition in CaF.

We also describe low-cost lasers and electronics developed for these experiments. Several versatile new instruments are based on 32-bit microcontrollers, interfaced to an Android tablet that provides a touch-screen graphical interface. These include a timing/ramp generator, a PZT driver, a temperature controller, and even a phase-synchronized dual 35-4000 MHz rf synthesizer that fits on a $2\frac{1}{4}" \times 4\frac{3}{4}"$ board. This research is supported by the National Science Foundation.

[a] M.A. Chieda and E.E. Eyler, *Phys. Rev. A* **86**, 053415 (2012); also *Phys. Rev. A* **84**, 063401 (2011).