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Feedback-controlled radiation pressure cooling YEHIAM PRIOR, MARK VILENSKY, ILYA SH. AVERBUKH, Department of Chemical Physics, Weizmann Institute of Science, Rehovot, Israel 76100 — We propose a new approach to laser cooling of micromechanical devices, which is based on the phenomenon of optical bistability. These devices are modeled as a Fabry-Perot resonator with one fixed and one oscillating mirror. The bistability may be induced by an external feedback loop. When excited by an external laser, the cavity field has two co-existing stable steady-states depending on the position of the moving mirror. If the latter moves slow enough, the field in the cavity adjusts itself adiabatically to the mirror's instantaneous position. The mirror experiences radiation pressure corresponding to the intensity value. A sharp transition between two values of the radiation pressure force happens twice per every period of the mirror oscillation at non-equivalent positions (hysteresis effect), which leads to a non-zero net energy loss. The cooling mechanism resembles Sisyphus cooling in which the cavity mode performs sudden transitions between two stable states. We provide a dynamical stability analysis of the coupled moving mirror – cavity field system, and find the parameters for efficient cooling. Direct numerical simulations show that a bistable cavity provides much more efficient cooling compared to the regular one.

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