Abstract Submitted
for the DAMOP16 Meeting of
The American Physical Society

Proposal for Laser Cooling of Alkaline Earth Monoalkoxide Free Radicals LOUIS BAUM, IVAN KOZYRYEV, KYLE MATSUDA, JOHN M. DOYLE, Harvard-MIT Center for Ultracold Atoms and Department of Physics, Harvard University — Cold samples of polyatomic molecules will open new avenues in physics, chemistry, and quantum science. Non-diagonal Franck-Condon factors, technically challenging wavelengths, and the lack of strong electronic transitions inhibit direct laser cooling of nonlinear molecules. We identify a scheme for optical cycling in certain molecules with six or more atoms. Replacing hydrogen in alcohols with an alkaline earth metal (M) leads to alkaline earth monoalkoxide free radicals (MOR), which have favorable properties for laser cooling. M-O bond is very ionic, so the metal orbitals are slightly affected by the nature of R on the ligand. Diagonal Franck-Condon factors, laser accessible transitions, and a small hyperfine structure make MOR molecules suitable for laser cooling. We explore a scheme for optical cycling on the $A - X$ transition of SrOCH3. Molecules lost to dark vibrational states will be repumped on the $B - X$ transition. Extension to larger species is possible through expansion of the R group since transitions involve the promotion of the metal-centered nonbonding valence electron. We will detail our estimations of the Franck-Condon factors, simulations of the cooling process and describe progress towards the Doppler cooling of MOR polyatomics.

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Date submitted: 29 Jan 2016 Electronic form version 1.4