Towards Laser-Cooled Polyatomic Molecules for Electron EDM Measurements

BENJAMIN AUGENBRAUN, ZACK LASNER, ALEXANDER FRENETT, HIROMITSU SAWAOKA, CALDER MILLER, PHELAN YU, Harvard-MIT Center for Ultracold Atoms and Department of Physics, Harvard University, TIMOTHY STEIMLE, School of Molecular Sciences, Arizona State University, JOHN DOYLE, Harvard-MIT Center for Ultracold Atoms and Department of Physics, Harvard University — Trapped ultracold molecules are a potentially powerful platform for probing time-reversal-symmetry violating effects beyond the Standard Model, such as the electron electric dipole moment. However, laser-coolable diatomic molecules lack the parity doublet structure useful for suppressing key systematic errors. Certain polyatomic molecules simultaneously possess the desired parity doublet and an electronic structure that allows for laser cooling. Thus a large, generic class of such species combines internal co-magnetometers, the ability to trap large numbers for long times, and large effective electric fields that enhance the signature of time-reversal-violating effects. We present progress toward laser cooling and trapping of Yb-containing polyatomic molecules. A slow cryogenic buffer-gas beam of YbOH is characterized and work toward photon cycling in YbOH is presented. We also describe a novel magnetic decelerator for slowing molecular beams to near the capture velocity of 3D magneto-optical traps without scattering photons. In addition, we present observations of the EDM-sensitive symmetric top molecule YbOCH$_3$. The measured Franck-Condon factors indicate that YbOCH$_3$ is also amenable to laser cooling, as expected from theory, and a laser cooling scheme is presented.

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