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Precision measurements with laser-cooled polyatomic molecules[1]

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Polar molecules are extremely sensitive platforms to search for physics Beyond the Standard Model, especially CP-violating electromagnetic moments that are amplified by large internal molecular fields. Molecule-based searches for the electron EDM are already probing the TeV scale, and their strong robustness against systematic errors via internal co-magnetometer states means that they can reach even higher energy scales in a variety of sectors. Molecule precision measurements are currently limited largely by interaction time, and could be enhanced by many orders of magnitude if suitable molecules could be cooled and trapped like their atomic counterparts. Laser-cooling of molecules is advancing rapidly, but current techniques only work for molecules with particular electronic structures that conflict with the requirements for internal co-magnetometers in diatomic molecules. However, polyatomic molecules (with at least three atoms) have mechanical modes that can be used to realize internal co-magnetometer states, while still offering the electronic structure required for laser-cooling [1]. Polyatomic molecules such as YbOH and YbOCH3 are therefore candidates for long coherence time precision measurements of CP-violation at the PeV scale with laser-cooling, trapping, and internal co-magnetometers. We will discuss the interesting physics of laser cooling and polyatomic molecules that makes this possible, and present an update on experimental progress.

[1] I. Kozyryev and N. R. Hutzler, Phys. Rev. Lett. 119, 133002 (2017)

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