Contribution ID: **16** Type: **Invited Talk**

Searching for New Particles and Forces with Polyatomic Molecules

Monday 21 October 2019 11:05 (30 minutes)

The fact that the universe is made entirely out of matter, and contains no free anti-matter, has no physical explanation. While we cannot currently say what process created the matter in the universe, we know that it must violate a number of fundamental symmetries, including those that forbid the existence of certain electromagnetic moments of fundamental particles. We can search for signatures of these electromagnetic moments via precision measurements in polar molecules, whose extremely large internal electromagnetic fields can significantly amplify these moments. These effects would arise from physics beyond the Standard Model, which enables tabletop searches for new, symmetry-violating particles and forces. With modern, quantum science techniques to control polar molecules, these searches can currently reach into the TeV scale, and offer many routes to even higher scales. In this talk, I will discuss our lab's approach to performing these tabletop measurements with polyatomic molecules, whose complex structure offers a unique opportunity to combine robust precision measurement techniques with laser cooling and trapping. This allows us to build experiments with sensitivity to a variety of new physics sectors, and a route to exploring the PeV scale.

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Session Classification: Session