Ultracold molecules - a testbed for physics beyond the Standard Model

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The Standard Model of Particle Physics (SM) provides a good description of matter, radiation, and their interactions. Unfortunately, there are still open questions in science where SM cannot accurately describe observed phenomena such as the matter-antimatter imbalance. A promising approach to uncovering physics beyond the SM is to identify novel sources of combined charge and parity ($\mathcal{CP}$) violation. The presence of $\mathcal{P}, \mathcal{T}$-odd forces and permanent electric dipole moments of elementary particles may induce a non-zero molecular dipole moment of the entire system, leading to subtle shifts in the molecule's energy structure [1]. In this work, we propose a new class of molecular systems – ultracold high-spin Σ-state polar molecules, such as YbCr and RaCr – as sensitive platforms to study $\mathcal{CP}$ violation in the hadronic and leptonic sectors. We theoretically modeled the formation of these molecules from ultracold high-spin spherically symmetric atoms with closed-shell atoms. We found that these systems can be easily polarized due to the presence of Ω doubling and used for precision measurements. We analyzed their molecular properties using relativistic *ab initio* quantum chemical methods. We carefully investigated enhancement factors describing the sensitivity of molecules to the $\mathcal{CP}$-odd nuclear magnetic quadrupole moment, electron electric dipole moment and electron-nucleon scalar-pseudoscalar interactions [2]. Possibility of the formation of YbCr [3] or RaCr in ultracold temperatures makes them great for high-precision experiments due to enhanced sensitivity of an experiment. In this manner, we want to pave the way for a new class of very promising systems for the next generation of SM-physics searches at the low-energy frontier.

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