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Measuring the electric dipole moment of the electron using polar molecules in a parahydrogen matrix

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The electron electric dipole moment (eEDM) is a sensitive probe to investigate new physics beyond the Standard Model. We propose a novel experimental method to measure the eEDM using polar molecules (BaF) embedded in a cryogenic matrix of parahydrogen. This approach could improve the current eEDM limits, offering valuable insights into CP violation sources and the origin of matter-antimatter asymmetry in the universe. Additionally, the experiment may indirectly shed light on the nature of dark matter as many extensions of the Standard Model that account for dark matter predict an eEDM within the sensitivity range of our experiment.
Our experimental strategy consists of aligning BaF molecules with an external electric field and then measuring the electron spin precession frequency in a magnetic field for two opposing electric field orientations. We employ laser-induced fluorescence spectroscopy and microwave techniques to determine the precession frequencies. Any difference in frequency between the two configurations would indicate a non-zero eEDM.
The principal advantage of our approach is that the parahydrogen matrix is expected to increase the spin coherence time of BaF molecules by reducing the environmental disturbances that cause decoherence. In addition, our approach leverages the large internal molecular field available in BaF molecules and the efficient cooling and large concentrations of molecules enabled by the parahydrogen matrix.
We will discuss the experimental setup we developed to produce parahydrogen and grow cryogenic crystals alongside the necessary steps for creating and integrating BaF molecules into these matrices.

Collaboration

Phydes

Role of Submitter

I am the presenter

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