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Measuring the electron electric dipole moment using ultracold YbF molecules

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The Standard Model of Particle Physics is a versatile and well-tested theory. However, it does not explain the extreme imbalance of matter over antimatter observed in our Universe. A possible mechanism that could explain this asymmetry includes new sources of CP violation, which could result in the existence of a permanent electric dipole moment in fundamental particles such as the electron.
The most precise measurements of the electron electric dipole moment (eEDM) all use molecules [1,2]. The molecules are spin-polarized, and the eEDM is determined by measuring the spin precession frequency in an applied electric field. At Imperial's Centre for Cold Matter, we have set up an experiment to measure the electron EDM using ultracold YbF molecules [3,4]. The electron is exposed to an exceptionally large effective electric field due to the heavy polar nature of the YbF molecule. To reach high sensitivity, the molecules are laser cooled in the two transverse directions [5], and the spin precession frequency is measured as the molecules fly through a beamline setup. This experiment is currently operational, and I will present the sensitivity that we reach and our efforts to control systematic effects.
[1] V. Andreev et al., Nature 562, 355 (2018)
[2] T. S. Roussy et al., Science 381, 46 (2023)
[3] N. J. Fitch et al., Quantum Sci. Technol. 6, 014006 (2021)
[4] Collings F. et al,arXiv:2503.21725v1 (2025)
[5] Alauze X. et al, Quantum Sci. Technol., 6, 044005 (2021)

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