DAMOP11-2011-020086

Abstract for an Invited Paper
for the DAMOP11 Meeting of
the American Physical Society

Improved Measurement of the Electron EDM[1]

E.A. HINDS, Imperial College London

The electron is predicted to be slightly aspheric,[2] though no experiment has ever observed this deviation. Comparing the measured and predicted shape provides a powerful test of the standard model of particle physics. The shape is also intimately related to one of the largest outstanding questions in cosmology: why is the universe almost entirely devoid of antimatter? The electron's shape can be characterised by its electric dipole moment (EDM), d_e, which measures the deviation of its electric interactions from purely spherical. According to the standard model, this EDM is $d_e \approx 10^{-38}$ e.cm – some eleven orders of magnitude below the current experimental limit. Most extensions to the standard model predict much larger values, potentially accessible to measurement.[3] Hence, the search for the electron EDM is a search for physics beyond the standard model. Moreover, a non-zero breaks time-reversal symmetry which, in many models of particle physics, is equivalent to breaking the symmetry between matter and antimatter, known as CP symmetry. New CP-breaking physics is thought to be needed to explain the existence of a material universe.[4] We have used cold, polar molecules to measure the electron EDM, obtaining the result $d_e = (-2.4 \pm 5.7_{stat} \pm 1.5_{syst}) \times 10^{-28}$ e.cm. We set a new upper limit of with 90% confidence. Our result, consistent with zero, indicates that the electron is spherical at this improved level of precision. Our measurement, of atto-eV energy shifts in a molecule, probes new physics at the tera-eV energy scale. Many extensions to the standard model, such as the minimal supersymmetric standard model, naturally predict large EDMs and our measurement places significant constraints on the parameters of these theories.[5]

[1]In collaboration with J.J. Hudson, D. M. Kara, I. J. Smallman, B. E. Sauer, and M. R. Tarbutt, Centre for Cold Matter, Blackett Laboratory, Imperial College London, UK.

[2]I. B. Khriplovich, S. K. Lamoreaux, CP Violation Without Strangeness (Springer, New York, 1997).

[3]E. D. Commins, Electric dipole moments of leptons, in Advances in Atomic, Molecular, and Optical Physics, Vol. 40, B. Bederson and H.Walther (Eds.), Academic Press, New York, pp. 1-56 (1999).

[4]A. D. Sakharov, Violation of CP invariance, C asymmetry, and baryon asymmetry of the universe, Pis'ma ZhETF 5, 32 (1967). *Sov. Phys. JETP Lett. 5, 24 (1967).]

[5]E. D. Commins and D. DeMille, "The electric dipole moment of the electron," Chapter 14 in Lepton Dipole Moments Eds. B. L. Roberts and W. J. Marciano, (World Scientific, Singapore 2010).