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ACME Measurement of the Electron Electric Dipole Moment[1]

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The standard model of particle physics (SM) is the great triumph and the great frustration of modern physics. The SM is able to correctly predict the measured size of the electron's magnetic dipole moment to a remarkable 12 significant figures. At the same time, the SM predicts that essentially equal amounts of matter and antimatter should have been created in the big bang, and no explanation comes close to predicting the amount of matter that avoided being annihilated in collisions with the antimatter to form a matter universe. The electric dipole moment of the electron provides a unique opportunity to precisely test the standard model, its fundamental symmetries and many proposed modifications. The SM predicts that the electron has an electric dipole moment (EDM), but that this moment should be much too small to be observed with current methods. In distinct contrast, supersymmetric and other models (proposed as improvements to the standard model) predict that the electron could well have an EDM that is much, much larger. These disparate predictions prompted our ACME collaboration to measure the electron electric dipole moment more than an order of magnitude more precisely than ever before. Despite the greatly increased sensitivity of this ACME generation 1 measurement, a non-zero EDM was not detected. Our order of magnitude lower limit has instead been used in many papers to set many limits – on the masses of postulated new particles, for example. It is worth noting that a measurement done with cold molecules is setting limits whose TeV energy reach is as high and higher than is possible at the largest particle accelerator – CERN's Large Hadron Collider. New ACME apparatus and methods have recently been demonstrated that we expect to increase our EDM sensitivity by more than an additional order of magnitude. An ACME generation 2 measurement is now underway. An overview of the new methods and aspirations will be provided.

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