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A New Limit on the Permanent Electric Dipole Moment (EDM) of ^{199}Hg ¹

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A finite permanent electric dipole moment (EDM) of a particle or atom would violate time reversal symmetry (T), and would also imply violation of the combined charge conjugation and parity symmetry (CP) through the CPT theorem. EDMs are suppressed in the standard model of particle physics (SM), lying many orders of magnitude below current experimental sensitivity. It is generally accepted, however, that extra sources of CP violation are needed to account for baryogenesis and many theories beyond the SM, such as supersymmetry, naturally predict EDMs within experimental reach. To date, EDM searches have yielded null results. The most precise and significant limits have been set on the EDM of the neutron², the electron³, and the ^{199}Hg atom⁴, leading to tight constraints on supersymmetric extensions of the SM. I will describe the results from a new experimental search for the EDM of ^{199}Hg . We find $d(^{199}\text{Hg}) = (0.49 \pm 1.29_{stat} \pm 0.76_{syst}) \times 10^{-29} e \text{ cm}$, and interpret this as a new upper bound, $d(^{199}\text{Hg}) < 3.1 \times 10^{-29} e \text{ cm}$ (95% C.L.)⁵. This result improves our previous ^{199}Hg limit by a factor of 7 and offers a yet more exacting probe of possible new sources of CP violation. The experiment utilizes a stack of four spin-polarized Hg vapor cells in a common B -field. The middle two cells have oppositely directed E -fields, resulting in EDM-sensitive Larmor shifts of opposite sign; the outer two cells, enclosed by the high voltage (HV) electrodes and thus placed at $E = 0$, are free of EDM effects and instead allow cancelation of B -field gradient noise and checks for spurious HV-correlated B -field shifts. The dataset consists of 166 runs, with each run lasting roughly 24 hours and comprising several hundred E -field reversals. Measurements were performed for nine different vapor cells, four electrodes, two cell-containing vessels, and multiple vapor cell and electrode orientations. An unknown, HV-correlated, EDM-mimicking offset was added to the fitted values of the middle cell precession frequencies. This fixed blind offset masked the measured EDM and was revealed only after the data collection, data cuts, and error analysis were complete. In addition to experimental results, I will briefly outline the resulting new upper bounds on fundamental CP violating parameters.

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³B.C. Regan, *et al.*, Phys. Rev. Lett. **88**, 071805 (2002).

⁴M.V. Romalis, *et al.*, Phys. Rev. Lett. **86**, 2505 (2001).

⁵W.C. Griffith, *et al.*, ArXiv:0901.2328v1.