New proposal for dark photon searches: parity-violating electron scattering

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Given advances in experimental capabilities in recent years, the parity-violating electron scattering (PVES) offers the chance to discover new physics in the near future. In our work [1], we proposed that PVES can be applied to probe the hypothetical dark photon, and explored the sensitivity of PVES asymmetry to the dark photon parameters.

We calculated the dark photon contributions to PVES asymmetries in both elastic and deep-inelastic scatterings (DIS). These contributions are characterized by the corrections to the standard model couplings C_{1q}, C_{2q}, and C_{3q}. For elastic scattering we showed that there could be a relatively large correction to the neutron radius of the Pb nucleus deduced from the PVES measurement of PREX. On the other hand, the allowed changes are sufficiently small that they have no effect on the interpretation of the Qweak experiment. In DIS at very high Q^2, of relevance to HERA or the EIC, the dark photon could induce substantial corrections to the parton distribution functions deduced from the DIS data. Finally, the electron-positron asymmetry in DIS offers direct access to the combination $2C_{3u} - C_{3d}$, where effects as large as 5% are possible.

In a following work [2], we extracted the favoured region of dark photon parameters by fitting the parity-violation data and the latest W-mass anomaly. While both fits prefer a heavy dark photon with mass above the Z-boson mass, other sources of new physics beyond the standard model would also be expected.

[1] A.W. Thomas, X.G. Wang, A.G. Williams, *Phys. Rev. Lett.* **129**, 011807 (2022).

[2] A.W. Thomas, X.G. Wang, arXiv: 2205.01911 [hep-ph].