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Extracting electroweak observables from atomic parity violation: status and challenges[1]

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Atomic parity violation places powerful constraints on "new physics" beyond the standard model of elementary particles. While the atomic energies are of an eV scale, current results constrain new physics at the TeV mass scale. For example, by combining atomic-structure calculations with measurements in cesium atom, we constrained the mass of the so-far elusive particle - the extra Z boson (Z'). Z' are hypothesized to be carriers of the "fifth force" of Nature, and they are abundant in models of grand unification and string theories. In particular, we raised the lower mass limit previously coming from the direct search at the Tevatron collider. Our raised bound on the Z' mass carves out a lower-energy part of the discovery reach of the Large Hadron Collider. The extraction of electroweak observables from experimental data requires equally accurate calculations. Such calculations are incredibly complex and directly challenge what is possible with existing methods of relativistic atomic many-body physics. In addition to reviewing atomic parity violation, I will discuss the status of such calculations and present an outlook for further advances.

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