Evidence from CDF II and Muon $g-2$ for a new particle at $80.4287(22)\ \mathrm{GeV}/c^2$

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The CDF II collaboration at Fermilab reports a W boson mass of $80.4335(94)\ \mathrm{GeV}/c^2$, at significant ($6.9\,\sigma$) tension with the Standard Model [1]. Likewise, the Muon $g-2$ experiment at Fermilab is also in tension with the Standard Model at $4.2\,\sigma$ [2]. Both of these measurements are in excellent agreement with a specific preon model in which the usual W boson [predicted mass $80.3785(22)\ \mathrm{GeV}/c^2$, tension with global average $0.04\,\sigma$] is supplemented by coloured counterparts [predicted mass $80.4287(22)\ \mathrm{GeV}/c^2$, tension with CDF II $0.49\,\sigma$], with the latter species appearing only in colour-rich environments. Incorporating virtual coloured W and Z bosons in the calculation of the muon gyromagnetic anomaly yields $a_\mu = 116592042(86)\times 10^{-11}$, with tension of only $0.20\,\sigma$ when compared with the experimental value $a_\mu^{\mathrm{EXP}} = 116592061(41)\times 10^{-11}$. If CDF II has detected coloured W bosons, this would represent the first experimental identification of these particle species, with a most rewarding level of agreement between theory and experiment. Confirmation may be obtained by seeking the coloured Z counterparts at $91.2446(35)\ \mathrm{GeV}/c^2$—these bosons do not contaminate the usual two-lepton signals $Z\to\ell\bar{\ell}$ since only one member from each pair may escape confinement, so a dedicated search may be required.

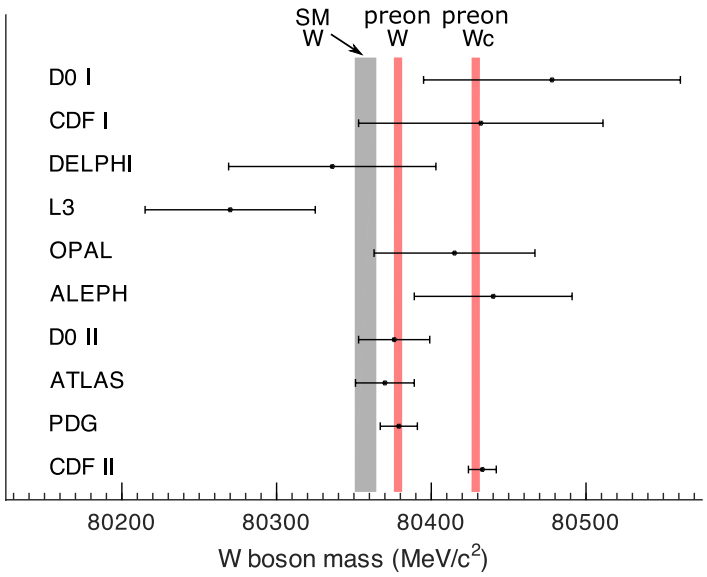

Fig.1: Comparison of W boson mass measurements with predictions for the Standard Model W boson (SM W), the preon model W boson (preon W), and the preon model coloured W boson (preon Wc).

In addition to the prediction of the W mass noted above, the preon model also yields first-principles calculations for the masses of the Z and Higgs bosons, which likewise give satisfactory results.

[1] T. Aaltonen *et al.*, *Science* **376**(6589), 170 (2022). https://doi.org/10.1126/science.abk1781

[2] B. Abi *et al.*, *Phys. Rev. Lett.* **126**, 141801 (2021). https://doi.org/10.1103/PhysRevLett.126.141801