# You too, electron?

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**Abstract**. A new precise measurement of the fine-structure constant reveals a tension in the electron $(g-2)_e$. Interestingly, this deviation from the Standard Model value goes in the opposite direction of that for the muon $(g-2)_\mu$ anomaly, challenging many Beyond the Standard Model scenarios.

The strength of the electromagnetic interaction, characterized by the fine-structure constant $\alpha$, is one of the fundamental parameters in the description of particle interactions. Historically, several methods have been used to measure this quantity, finding good agreement among them as can be seen in Fig. 1. This is, indeed, a very good test of the Standard Model (SM) of particle physics. At the same time, the errors have become smaller and smaller, being the most precise value the one extracted from the electron anomalous magnetic dipole moment (codified in the quantity $(g-2)_e$). Or at least it was.

Now, a new precise measurement of $\alpha$ has been presented in a recent paper [1]. This result is important for the particle physics community mainly for two reasons. First, because it is the most precise measurement up to now. And second, because it has been obtained using a method which does not depend on the electron $(g-2)_e$ and thus, it can be used to test the SM prediction of the electron anomalous magnetic dipole moment. Interestingly, the electron $(g-2)_e$ reconstructed with this new measured value of $\alpha$ seems to be smaller than what the SM predicts.

In statistical terms, the discrepancy between the new and the previous measurements of $\alpha$ is of $2.5\sigma$. This number does not mean that the SM is in big trouble, although it is a bit suspicious. Even more if we compare this results with the homologous one for the muon, where there could also be a hint for new physics. The well-known $(3-4)\sigma$ discrepancy in the muon $(g-2)_\mu$ indicates that its value could be larger than the SM prediction. Since the electron and muon $(g-2)$ anomalies have opposite directions, any model beyond the SM trying to explain why the muon $(g-2)_\mu$ is larger than in the SM will also have to explain now why the electron one is smaller. This is not an easy task, and actually many new physics models could be in tension with this result. In particular, Ref. [1] shows that the dark photon hypothesis which was proposed to explain the muon $(g-2)_\mu$ anomaly, would be now rejected at 99.5% CL (see Fig. 2).

If these two anomalies were confirmed with more than $5\sigma$, theoretical physics would have a challenging (although interesting) time trying to explain this new scenario. Nevertheless, future experimental results (such as the experiment Muon g-2 at Fermilab [2]) will shed light on this situation.

[1] Parker et al., Science 360, 191-195 (2018) [arXiv: 1812.04130]

[2] http://muon-g-2.fnal.gov

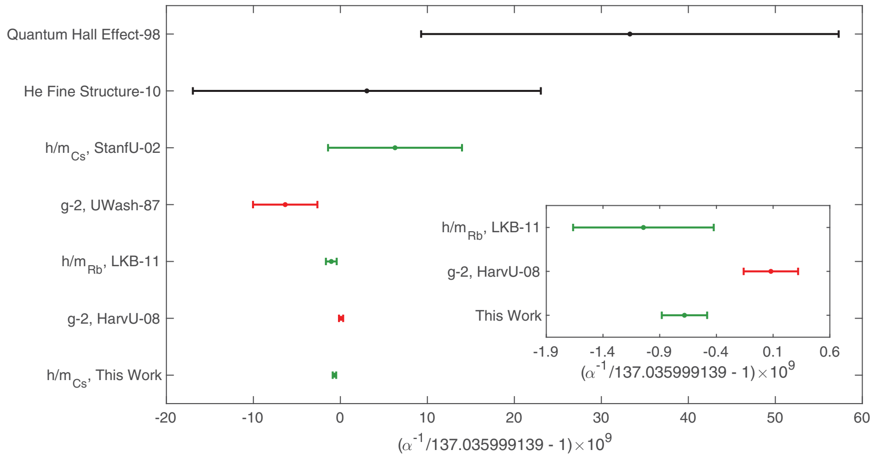


FIG. 1: Different measurements of $\alpha$. Figure from [1].

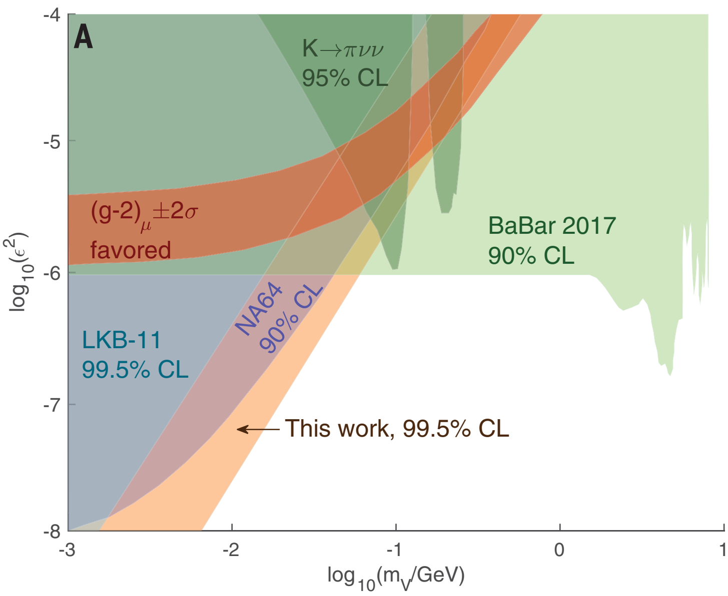


FIG. 2: Exclusions for a model with a dark-photon of mass $m_V$ and mixing $\epsilon$ to the standard photon. The dark orange band would solve the muon $g-2$ anomaly, however it is in conflict with the new measurement of $\alpha$. Figure from [1].