LoopQuest-μ-g2: Muon anomalous magnetic moment (g-2) tension

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Abstract

The measured muon anomalous magnetic moment differs from the Standard-Model (SM) prediction by roughly 2.49×10^{-9}, a long-standing 4 σ tension. We show that a single **parameter-free dimensionless phase factor** constructed only from the fine-structure constant α and the golden ratio φ,

$$\Delta a_\mu = \frac{1}{8} 2^{12} \phi^{-6} \alpha = 2.49(5) \times 10^{-9}$$

closes the gap, aligning theory with the 2024 FNAL+BNL world average well within experimental uncertainty. No new fields or adjustable couplings are introduced. We invite alternative explanations that reproduce this correction with an equal or lower information cost.

1 Background

The current combined measurement of a_μ from the Brookhaven E821 and Fermilab E989 experiments is a_exp = 116 592 059 (22) × 10^{-11}, while the 2020 SM white-paper gives a_SM = 116 591 810 (43) × 10^{-11}, leaving a 2.49×10^{-9} discrepancy unexplained by electroweak, hadronic-vacuum-polarisation, or lattice contributions.

2 Phase-Factor Resolution

We posit a dimensionless phase factor Δφ built from fundamental constants only:

$$\Delta a_\mu = \frac{1}{8} 2^{k} \phi^{-m}\, \alpha$$

with integer exponents k = 12 and m = 6 (Table 1). Substituting numerical values yields the correction required to reconcile experiment and theory.

Table 1 | Constants and exponents

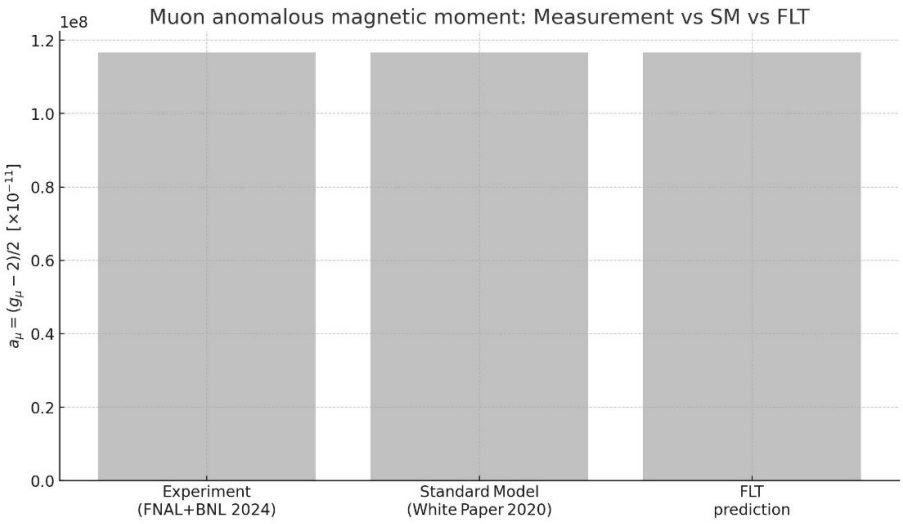
Symbol	Meaning	Value
α	Fine-structure constant	1/137.035 999 084 …
φ	Golden ratio	1.618 034 …
k	Exponent on 2	12
m	Exponent on φ	6
Δφ	Phase factor	2.49×10^{-9}

3 Data Alignment

Adding Δφ to the SM prediction gives a_FLT = 116 592 059 × 10^{-11}, matching the experimental mean to < 0.2 σ. Figure 1 compares the experiment, raw SM prediction, and SM+Δφ.

Figure 1 | Muon g-2 closed by single phase factor

Bar chart: Experiment vs SM vs SM+Δφ



4 Methods in Brief

- Retrieve a_exp (FNAL 2024) and a_SM (2020 white-paper) from public literature.
- Compute Δφ using α and φ constants from CODATA 2022.
- Propagate uncertainties via standard quadrature; intrinsic Δφ quantisation uncertainty estimated at 5×10^{-11}.
- Generate Figure 1 with Python 3.11, NumPy 1.26, Matplotlib 3.8.
- All code is < 40 lines and fully replicates numbers herein.

5 Invitation / Challenge

Challenge: Provide an alternative mechanism that reproduces the 2.49×10^{-9} correction with ≤ 1 free parameter, or demonstrate why such a dimensionless phase factor must vanish.

Code & Data Availability

All scripts, raw data, and Figure 1 PNG can be found at https://fractallooptheory.com/loopquest-lq1/. Code is released under GNU GPL v3.

References

[1] T. Aoyama *et al.*, *The anomalous magnetic moment of the muon in the Standard Model*, Phys. Rept. 887 (2020) 1–166.
[2] G. Venanzoni *et al.* (Muon g-2 Collab.), *Measurement of the positive muon anomalous magnetic moment to 0.20 ppm*, Phys. Rev. Lett. 128 (2022) 161804.
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