

Contribution ID: **197** Type: **Poster**

QED and hadronic contributions to the muon anomalous magnetic moment: from the Schwinger term to the two-pion channel

The anomalous magnetic moment of the muon, $a_\mu = (g-2)/2$, is one of the most demanding precision tests of the Standard Model, and the uncertainty of its theoretical prediction is dominated by the hadronic vacuum polarization (HVP) contribution.

We start from the Dirac Lagrangian, which predicts $g = 2$ at tree level. Quantum fluctuations shift g away from this value, and we derive the first-order QED radiative correction in the fine-structure constant, the Schwinger term $\alpha/2\pi$, which we verify by Monte Carlo integration. We then include the higher-order QED corrections using coefficients from the literature, and with these values we analyze the contribution of each order and the total of the QED series.

We also consider the contribution of the $\pi^+\pi^-$ channel to the HVP. We compute it numerically through the dispersion relation, using a model of the pion form factor as input, and we analyze the sensitivity of the result to the model parameters. Finally, we compare the computed value with published reference values and estimate the fraction it represents of the experimental value and of the current theoretical prediction of a_μ.

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Session Classification: Posters & Empanadas

Track Classification: Electroweak, Top and Higgs physics