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Model-independent Padé and D-Log Padé approximants for the hadronic contribution to the muon anomalous magnetic moment

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The hadronic vacuum polarization (HVP) contribution to the muon anomalous magnetic moment, a_μ, remains a key source of uncertainty in precision tests of the Standard Model. The MUonE experiment aims to determine this contribution through measurements of elastic electron–muon scattering, extracting the hadronic component of the running electromagnetic coupling in the spacelike region. However, the limited kinematic range accessible to the experiment requires a reliable extrapolation of the measured quantity over the full integration domain needed to determine $a_\mu^{\mathrm{HVP,LO}}$.

We investigate Padé and D-Log Padé approximants as systematic, model-independent tools for parametrizing and extrapolating the hadronic contribution. These methods exploit the analyticity properties of the underlying vacuum-polarization function to constrain its behavior beyond the directly accessible kinematic region. Their performance is assessed using pseudo-data generated from a model incorporating the expected statistical precision of MUonE. The analysis demonstrates how complementary rational-approximation strategies can provide controlled estimates of the HVP contribution, including conservative upper and lower bounds, while reducing reliance on external theoretical input. These results support the use of analyticity-based approximation methods in the extraction of the hadronic contribution to the muon anomalous magnetic moment and in the assessment of the precision attainable by MUonE.

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