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Multi-level computation of the hadronic vacuum polarization contribution to $(g_\mu - 2)$

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The first results from the Fermilab E989 experiment have confirmed the long-standing tension between the experimental determination of the muon anomalous magnetic moment $a_\mu = (g_\mu - 2)/2$ and its SM determination using the dispersive approach. In order to match the expected final precision from E989, the current uncertainty on ab initio determinations using lattice QCD must be decreased by a factor 5-15, a goal which is hampered by the signal-to-noise ratio problem of the electromagnetic current correlator. Multi-level Monte Carlo integration with fermions is a method which reduces the variance of correlators exponentially in the distance of the fields. Here we demonstrate that the variance reduction in a realistic two-level simulation with a pion mass of 270 MeV, linear size of 3 fm and lattice spacing around 0.065 fm is sufficient to compute the tail of the current correlator with the statistical accuracy required for the hadronic vacuum polarization contribution to a_μ. An efficient estimator is also employed for computing the disconnected contribution.

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