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Hadronic vacuum polarisation contribution to the muon anomaly from first principles to an accuracy of 4.6 per mil

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The anomalous magnetic moment of the muon, as a low energy precision observable, has long served as a test of the Standard Model (SM) of particle physics. The latest muon $g-2$ measurements at Fermilab confirm the previous BNL result, hence emphasizing, up to 5.1 standard deviations, the discrepancy between the experimental world average value and the reference SM prediction. The uncertainty of the latter is dominated by the hadronic vacuum polarisation (HVP) contribution, which is traditionally evaluated using dispersion integrals and experimental hadronic cross section data. However, recent independent HVP evaluations based on lattice QCD calculations and on a new measurement of the $e^+e^- \to \pi^+\pi^-$ cross section are providing hints for a significantly reduced tension with the direct experimental determination. In this invited talk, after briefly reviewing the status of lattice calculations in the field, we present the new result from first principles by the BMW Collaboration at the remarkable precision of 0.32 ppm, with a particular focus on our evolving understanding of the HVP contribution and implications for indirect searches of new physics.

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