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The Muon g-2: New Results, Theoretical Challenges, and the Role of Hadron Physics

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The anomalous magnetic moment of the muon, or muon $g-2$, stands as one of the most precise tests of the Standard Model and a sensitive probe for potential new physics. With the final results from the Fermilab E989 experiment released in June 2025, and the second White Paper of the Muon $g-2$ Theory Initiative published in May 2025, the status of muon $g-2$ has entered a new and critical phase.

The current theoretical prediction is now more precise than ever, yet key challenges remain, as the main source of uncertainty continues to be the hadronic contributions. While recent progress in lattice QCD calculations – now precise enough to serve as a reference – has resolved the long-standing discrepancy between theory and experiment, a new tension has emerged between different theoretical approaches. In particular, data-driven dispersive methods based on measurements of electron–positron annihilation into hadrons show results that are not fully consistent with lattice predictions or among themselves. These discrepancies raise important questions about the interpretation of existing data and the reliability of various experimental inputs.

This talk will review the full current status of the muon $g-2$, with a particular emphasis on the theoretical predictions and the data-driven methods that use cross-section measurements of $e^+e^- \to \text{hadrons}$ to calculate hadronic contributions. I will discuss the sources of the current tensions, the latest developments in the dispersive approach, and what they imply for the overall interpretation of muon $g-2$ as a probe of fundamental physics.

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