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New BABAR studies of high-order radiation and the new landscape of data-driven hadronic vacuum polarization predictions of the muon g-2

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A dedicated measurement of additional radiation in $e^+e^- \to \mu^+\mu^-\gamma$ and $e^+e^- \to \pi^+\pi^-\gamma$ initial-state-radiation events is presented using the full $BABAR$ data sample. For the first time results are presented at next-to-leading and next-to-next-to-leading order, with one and two additional photons, respectively, for radiation from the initial and final states. The comparison with predictions from Phokhara and AfkQed Monte Carlo generators reveals discrepancies for the former in the one-photon rates and angular distributions. While this disagreement has a negligible effect on the $e^+e^- \to \pi^+\pi^-(\gamma)$ cross section measured by $BABAR$, the impact on the KLOE and BESIII cross-section measurements is estimated and found to be indicative of systematic effects larger than uncertainties assigned. The new situation also warrants a reappraisal of the independent information provided by hadronic $/tau$ decays, including state-of-the-art isospin-breaking corrections. The findings shed a new light on the longstanding deviation between the muon $g-2$ measurement and the Standard Model prediction using the data-driven dispersive approach, and the comparison with lattice QCD calculations.

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