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Anomalous Photon Self-Couplings in Born-Infeld Theory: Implications for the Muon Magnetic Anomaly

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The anomalous magnetic moment of the muon, $a_\mu = (g-2)_\mu/2$, remains a significant discrepancy between theoretical predictions and experimental observations, indicating possible physics beyond the Standard Model. We explore the nonlinear Born-Infeld Lagrangian, characterized by a quartic photon self-interaction, to reconcile these differences. By calculating contributions from light-by-light scattering and vacuum polarization, and adjusting the Born-Infeld parameter using experimental data, we aim to resolve the $4-5\sigma$ anomaly. Our approach not only narrows the gap between theory and experiment but also establishes a strong lower limit for the Born-Infeld parameter β, highlighting its potential to reveal new physics. Furthermore, we emphasize that our obtained lower limit for the Born-Infeld parameter exceeds those found in previous studies and are particularly relevant for certain Beyond Standard Model scenarios, where mass scales are expected to fall within a similar range ($\mathcal{O}$(TeV)).

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