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B-Meson Anomalies: Effective Field Theory Meets Machine Learning

Discrepancies between experimental measurements and Standard Model predictions in B-meson decays, especially in lepton flavor universality ratios like $R_{D^{(*)}}$, $R_{J/\psi}$ and branching ratios for processes like $B \to K^*\nu\bar{\nu}$, suggest possible new physics (NP). In this study, we use an effective field theory framework, assuming NP effects only affect a single generation in the interaction basis, leading to non-universal mixing when rotating to the mass basis. We perform a global fit to the current experimental data, exploring three scenarios characterized by different mixing patterns and constraints. Our analysis finds that the best fit involves mixing between the second and third quark generations, with no lepton sector mixing and independent coefficients for singlet and triplet four-fermion operators. To accurately capture the non-Gaussian nature of the resulting parameter distributions, we use a machine learning-based Monte Carlo algorithm, enabling the generation of representative samples that reflect the true underlying distributions. This work highlights the valuable role of machine learning in accurately modeling intricate parameter distributions in particle physics analyses.

Secondary track

T09 - Beyond the Standard Model

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