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The role of nonperturbative dynamics in D-meson mixing

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The theoretical predictions for the $D - \bar{D}$ mixing parameters fall significantly short of experimental measurements, with discrepancies spanning several orders of magnitude. This divergence is largely attributed to the Glashow–Iliopoulos–Maiani (GIM) mechanism, which suppresses leading-order contributions. However, higher-order corrections and nonperturbative effects have the potential to mitigate this suppression, particularly through flavor SU(3) symmetry breaking. In this work, we explore the long-distance contributions arising from nonlocal QCD condensates, incorporating for the first time the impact of mixed condensates within multiple models. Our results demonstrate an improvement in the predicted values of $D - \bar{D}$ mixing parameters by an order of magnitude, providing insights into the role of nonperturbative QCD dynamics. While the theoretical estimates remain below experimental values, this study represents a crucial step toward bridging the gap between theory and observation, highlighting the importance of nonlocal QCD effects in understanding $D - \bar{D}$ mixing.

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