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Short-Distance Matrix Elements for D^0-Meson Mixing from $N_f = 2 + 1$ Lattice QCD

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We calculate in three-flavor lattice QCD the short-distance hadronic matrix elements of all five $\Delta C = 2$ four-fermion operators that contribute to neutral D-meson mixing both in and beyond the Standard Model. We use the MILC Collaboration's $N_f = 2 + 1$ lattice gauge-field configurations generated with asqtad-improved staggered sea quarks. We also employ the asqtad action for the valence light quarks and use the clover action with the Fermilab interpretation for the charm quark. We analyze a large set of ensembles with pions as light as $M_\pi \approx 180$ MeV and lattice spacings as fine as $a \approx 0.045$ fm, thereby enabling good control over the extrapolation to the physical pion mass and continuum limit. We obtain for the matrix elements in the $\overline{MS} - NDR$ scheme using the choice of evanescent operators proposed by Beneke *et al.*, evaluated at 3 GeV. To illustrate the utility of our matrix-element results, we place bounds on the scale of CP-violating new physics in D^0 mixing, finding lower limits of about 10–50 $\times 10^3$ TeV for couplings of $\mathcal{O}(1)$. To enable our results to be employed in more sophisticated or model-specific phenomenological studies, we provide the correlations among our matrix-element results. For convenience, we also present numerical results in the other commonly used scheme of Buras, Misiak, and Urban.

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