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Inclusion of S-wave dynamics in rare D meson decays and NP tests

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Rare charmed meson decays are a promising canvas for New Physics signatures to appear, being by definition very suppressed in the SM and since previous studies have identified observables that are free from SM contributions. In light of the extended amount of recently released LHCb data, a better control over the SM dynamics is imperative for a comparison to the experimental observables and for disentangling potential NP effects. The mass distributions of the rare decays $D^0 \to \pi^+\pi^-\mu^+\mu^-$ exhibit sharp resonant peaks. In this work we thus examine the aforementioned decays in the SM, using as a starting point the framework of resonance-mediated quasi-two-body topologies, implementing factorisation for the vector resonances. On the other hand, wider intermediate resonances could also give significant contributions, as manifested for instance in the related semileptonic decays of D mesons, where the scalar resonance $f_0(500)$, also known as σ, has been observed by BESIII ; we then include said resonance in our calculation. With the inclusion of σ the differential decay rate sees a dramatic improvement in the comparison to experiment in the region of low invariant mass of the pion pair. Furthermore, we are able to predict a number of angular observables comparable to the LHCb values. Finally, we propose a series of observables that are easy to implement experimentally and would single out the effect of the σ in the SM process, as well as new null tests that can arise from the interference of NP with the σ.

Consent

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