

Double-mixing CP violation

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We propose a new kind of CP violation effect — the double-mixing CP asymmetry — in a type of cascade decays that involves at least two mixing neutral mesons in the decay chain. It is induced by the interference between different oscillation paths of the neutral mesons in the decay process. The double-mixing CP asymmetry is of critical importance for phenomenology, providing opportunities for clean determination of CKM phase angles free of uncertainties induced by the strong dynamics. To illustrate this point, we perform a phenomenological analysis on two examples: $B_s^0 \rightarrow \rho^0 K \rightarrow \rho^0(\pi^- \ell^+ \nu_\ell)$ and $B^0 \rightarrow D^0 K \rightarrow D^0(\pi^+ \ell^- \bar{\nu}_\ell)$. Our results demonstrate that the double-mixing CP asymmetry can be numerically significant in the absence of strong phases, as shown by the former example. Additionally, the latter example showcases the direct extraction of weak and strong phases from data, without the need for theoretical inputs.

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