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Implications of cascade topologies for rare charm decays and CP violation

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The CP violation observed in the hadronic decays of charmed mesons remains a puzzling open question for theorists. Calculations relying on the assumption of inelastic final-state interactions occurring between pairs of pions and kaons fall short of the experimental value. It has been pointed out that a third channel of four pions can leave imprints on the CP asymmetries of the two-body decays. At the same time, plenty of data are available for the 4π decays of charmed mesons, as well as for the rare decays $D^0 \rightarrow \pi^+\pi^-\ell^+\ell^-$. With this motivation, we study the cascade topology $D^0 \rightarrow a_1^+(1260)\pi^-$, which has been measured to contribute significantly to the 4π decays, and estimate its effect on the branching ratio and angular observables of the rare decays. We also explore the possibility of this “intermediate” state contributing to the decay amplitude of $D^0 \rightarrow \pi^+\pi^-$ and by extension to the related CP asymmetry.

Author: SOLOMONIDI, Eleftheria (University of Valencia)

Presenter: SOLOMONIDI, Eleftheria (University of Valencia)

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