Two-state structure of the $D_0^*(2400)$ peak: evidence from theory, LQCD, and experiment

Miguel Albaladejo

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The so far only known charmed non-strange scalar meson ($S = 0$, $I = \frac{1}{2}$, $J^P = 0^+$) is dubbed as $D_0^*(2400)$ in the Review of Particle Physics. In this talk we present a strong case for the existence of two different resonances, instead of only one, building up the $D_0^*(2400)$ peak. In Ref. [1] we have used unitarized amplitudes based on chiral and heavy-quark spin symmetries to compute the energy levels in a finite volume for the $D\pi$, $D\eta$, $D_s\bar{K}$ (in S-wave) coupled channel system, in which the $D_0^*(2400)$ peak is seen. We have compared these energy levels with those of a recent LQCD simulation [2] in this sector, finding an excellent agreement. The parameters of the amplitudes in Ref. [1] are fixed from previous works, so no fit is done in that work to achieve a good comparison with Ref. [2]. The amplitudes in Ref. [1] actually present two poles, located in different Riemann sheets continuosly connected with the physical one, which correspond to two different resonances, instead of one, in the mass region close to the $D_0^*(2400)$ peak.

We have also used the amplitudes of Ref. [1], which contain this two-state structure, to compute $D \to \pi/K$ semileptonic scalar form factors by means of the Mushkelishvili-Omnès formalism [3]. We have compared these scalar form factors with different LQCD calculations, finding good agreement. Finally, in Ref. [4] we are using these amplitudes to compute the $D\pi$ spectrum in the reaction $\bar{B} \to D\pi\pi$ recently measured by LHCb [5], in which the $D_0^*(2400)$ peak is seen. Our preliminary results indicate good agreement with the data.

References

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