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Insights into the T_{cc}^+ tetraquark in a constituent quark model picture

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The LHCb collaboration announced in 2021 the discovery of a new tetraquark-like state, named T_{cc}^+ . The T_{cc}^+ is reminiscent of the $X(3872)$, which is a candidate for a loosely-bound $D\bar{D}^*$ +h.c. molecule; however, we are now dealing with an open-charmed state which radically changes its nature and makes it explicitly exotic. In this talk, the recently discovered T_{cc}^+ is evaluated as a DD^* molecular structure in the $J^P = 1^+$ sector [1]. A coupled-channel calculation in the charged basis, considering the D^0D^{*+} , D^+D^{*0} and $D^{*0}D^{*+}$ channels, is carried out in the framework of a constituent quark model that has successfully described other molecular candidates in the charmonium spectrum such as the $X(3872)$. The T_{cc}^+ is found to be a D^0D^{*+} molecule (87%) with a binding energy of $387 \text{ keV}/c^2$ and a width of 81 keV, in agreement with the experimental measurements. The quark content of the state forces the inclusion of exchange diagrams to handle indistinguishable quarks between the D mesons, which are found to be essential for binding the molecule. The $D^0D^0\pi^+$ line shape, scattering lengths and effective ranges of the molecule are also analysed and found to be in agreement with the LHCb analysis. We search for further partners of the T_{cc}^+ in other charm and bottom sectors, finding different candidates. In particular, in the charm sector we find a shallow $J^P = 1^+$ D^+D^{*0} molecule (83%), called T'_{cc} , just 1.8 MeV above the T_{cc}^+ state. In the bottom sector, we find an isoscalar and an isovector $J^P = 1^+$ bottom partners, which are BB^* molecules lying $21.9 \text{ MeV}/c^2$ ($I = 0$) and $10.5 \text{ MeV}/c^2$ ($I = 1$), respectively, below the B^0B^{*+} threshold.

[1] P.G.Ortega, J.Segovia, D.R.Entem and F.Fernandez, "Nature of the doubly-charmed tetraquark T_{cc}^+ in a constituent quark model", Phys. Lett. B 841 (2023), 137918 [arXiv:2211.06118 [hep-ph]].

Consent

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