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Extracting properties of the $T_{cc}(3875)$ state from lattice QCD

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Exploring the light-quark mass dependence of near-threshold exotic states provides insights into their internal structure. In this talk, we introduce a novel approach based on chiral effective field theory to extract the properties of such states from lattice energy levels [1]. This approach benefits from the incorporation of left-hand cuts originating from long-range interactions, thereby extending beyond the well-known Lüscher method. Also, the presence of the left-hand cuts in the vicinity of the threshold restricts the effective range expansion, commonly used for analyzing infinite volume phase shifts, to a very narrow energy range [2].

The proposed approach is applied to systematically extract, for the first time, the properties of the T_{cc} state, particularly the pole position and the low-energy parameters, from recent lattice data for DD^* scattering at $m_{\pi}=280$ MeV [3], accounting for the left-hand cut contribution from the one-pion exchange [1]. The one-pion exchange is shown to have a significant impact on S-wave and P-wave phase shifts as well as the T_{cc} pole position. Consequences for the structure of the T_{cc} are discussed.

[1] L.-Meng, V.-Baru, E.-Epelbaum, A.-A.-Filin and A.-M.-Gasparyan, "Solving the left-hand cut problem in lattice QCD: $T_{cc}(3875)^+$ from finite volume energy levels," [arXiv:2312.01930 [hep-lat]], accepted for publication in Physics Review D (letter).

[2] M.-L.-Du, A.-Filin, V.-Baru, X.-K.-Dong, E.-Epelbaum, F.-K.-Guo, C.-Hanhart, A.-Nefediev, J.-Nieves and Q.-Wang, "Role of Left-Hand Cut Contributions on Pole Extractions from Lattice Data: Case Study for $T_{cc}(3875)^+$," Phys. Rev. Lett. **131** (2023), 131903

[3] M.-Padmanath and S.-Prelovsek, "Signature of a Doubly Charm Tetraquark Pole in DD^* Scattering on the Lattice," Phys. Rev. Lett. **129** (2022), 032002

session

B. Hadron Spectroscopy

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