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Dibaryons –Molecule versus Hexaquark

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Whereas exotic states observed in charm and beauty sectors appear as narrow resonances near particle thresholds constituting thus weakly bound systems of molecular character, such systems have to appear in the non-flavored sector as broad resonances, since the decay products themselves constitute very broad resonances. This complicates enormously their detection despite the fact that experiments in the unflavored sector are principally simpler.
The - on the hadronic level - narrow resonance d*(2380) with I(JP) = 0(3+) detected first in the pn⟶dπ0π0 reaction has been so far the only dibaryon resonance observed in all possible hadronic decay channels with evidence also in electromagnetic channels. Both quark model and LQCD calculations predict meanwhile such a hexaquark state decaying asymptotically via a ΔΔ configuration.*
In view of the recently discovered manifold threshold states in the flavored sectors also the longstanding discussion about further dibaryon resonances near the ΔN threshold appears in a new light. Partial-wave analyses based on a wealth of elastic scattering and single-pion production data provided unique results for isovector states with JP = 0-, 2+, 2-, 3- [1].
Recent results from WASA-at-COSY for the isoscalar single-pion production show that its cross section does not grow above threshold as expected conventionally, but rather exhibits a Lorerentzian shape (solid line) suggesting isoscalar states with JP = 1+ and 1- near the NN threshold [2]. Interestingly, a sophisticated NN-interaction model with intermediate dibaryon formation can account for all these states leading to a quantitative description of the corresponding experimental NN-phase-shifts covering the range from 0 up to 1 GeV [3].

[1] for a review see, e.g., H.Clement and T. Skorodko, Chin. Phys. C 45 (2021) 022001 and references therein
[2] H. Clement et al., Phys. Rev. C 106 (2022) 065204
[3] V. I. Kukulin et al., Chin. Phys. C 46 (2022) 114116

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