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Encounters with dibaryons - have they finally become true?

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Collaboration

Abstract content

The long history of dibaryon searches dating back to the fifties has been a very changeful one - with many ups and downs. After Gell-Mann's famous paper on the quark model Dyson and Xuong were the first to correlate this topic with SU(6) and six quark systems – still in the year 1964. But it was not until Jaffe's note in 1977 about a bound $\Lambda\Lambda$ system, the H-dibaryon, when a real rush for dibaryons started – both theoretically and experimentally. As a result there were predictions of a vast number of dibaryon states and endless experimental claims, but finally none survived careful experimental investigations. Despite their long painful history dibaryon searches have recently received renewed interest, in particular by the recognition that there are more complex quark configurations than just the familiar $q\bar{q}$ and qqq systems. Recently two groups announced that lattice QCD calculations provide evidence for a bound H-dibaryon - though any experimental evidence is still pending. However, recently the WASA-at-COSY collaboration has found that the double-pionic fusion reaction $pn \to d\pi^0\pi^0$ proceeds dominantly via a resonance structure observed in the total cross section at $\sqrt{s} = 2.37$ GeV with $\Gamma \approx 70$ MeV and $I(J^P) = 0(3^+)$. Meanwhile nearly all possible decay channels have been investigated, in particular also the one into the elastic np channel. And, indeed, new data on polarized np scattering in the region of interest produce a resonance pole in the coupled ${}^3D_3 - {}^3G_3$ partial waves in accordance with the resonance hypothesis. This is the first solid evidence that dibaryons really exist. Since this resonance is observed to decay predominantly via an intermediate $\Delta\Delta$ system, it constitutes asymptotically a $\Delta\Delta$ system bound by nearly 100 MeV - as predicted by Dyson and lateron also by Goldman et al., who called it the "inevitable dibaryon". Most recent relativistic three-body calculations based on hadron dynamics as well as quark model calculations succeeded to predict properly important characteristics of this resonance. In addition they predict a number of further dibaryon states. Is it just a matter of time, until those are discovered, too?

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