Compositeness of near-threshold s-wave resonances

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The observations of the exotic hadrons in the near-threshold energy region motivate many studies for investigating the internal structure of the near-threshold states. The nature of the near-threshold states can be quantitatively characterized by the compositeness as the probability to find the molecular component in the wavefinction. From the viewpoint of the compositeness, it has been shown that the shallow bound states below the threshold are composite dominant because of the low-energy universality [1, 2, 3]. However, we cannot directly apply the same idea with the compositeness for resonances above the threshold, because the compositeness of resonances is complex value by definition and the probabilistic interpretation is impossible.

In this study, we propose a new probabilistic interpretation of the complex compositeness and pin down the nature of near-threshold resonances with the new interpretation. We consider the near-threshold resonances whose pole position is described by the effective range expansion (ERE), and discuss the nature of the resonances from the viewpoint of the low-energy universality. We propose a probabilistic interpretation of the complex compositeness with a new classification of the internal structure of resonances, which is based on the uncertainty of the unstable states. The interpretation is applied to the resonances in ERE, and we finally show the near-threshold resonances are not composite dominant in contrast to the shallow bound states.

References

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