

Likely existence of bound states and the Efimov effect in the triple- J/ψ system

The ground-breaking discovery of the first fully charmed tetraquark state $X(6900)$ in the $J/\psi J/\psi$ invariant mass distribution by the LHCb collaboration has inspired intensive theoretical studies. Various interpretations, such as molecular states, compact tetraquark states, and coupled-channel effects, have been proposed for these states. Of particular interest is the ongoing search for the triple- J/ψ state—a fully-charmed hexaquark state. To deepen our understanding of the triple- J/ψ state and to guide future experimental searches, we study the triple- J/ψ system in this work employing the Gaussian expansion method and with the $J/\psi J/\psi$ potential parameterized to yield a shallow bound state, as suggested in several theoretical works. Our results support a triple- J/ψ bound state, even in cases where the attractive interaction between the two J/ψ mesons is very weak. Moreover, our analysis implies the Efimov effect in the triple- J/ψ system. In addition, we extend our investigation to the triple- $\Upsilon(1S)$ system and obtain results similar to those for the triple- J/ψ system.

Field of Research

Hadrons

Experiment/Theory

Theory

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Session Classification: Aug. 6 afternoon