Analysis of unbound-state contributions in the Borromean systems

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The treatment of the unbound states has been discussed in the many different fields of quantum physics, for example, nuclear physics, atomic and molecular physics, and quantum optics. The essential difference between the bound and unbound states is the boundary condition of the wave function. Among the unbound states, resonant states have divergent behavior in the asymptotic region due to the complex momentum or energy. In order to treat the resonant states on the same footing to the bound states, we employ the complex scaling method (CSM) to transform the matrix element with the resonant wave function as the L^2-integrable. We apply CSM to the Gaussian expansion method [1] (GEM-CS), which is an efficient approach to describe the many-body wave function using the superposition of the Gaussian [2, 3].

There are alternative approaches for the treatment of the unbound states in many-body system. One of the successful approach for including the unbound states is the Gamow shell model (GSM)[4, 5]. In the approach, the basis sets are prepared with eigenstates of the single-particle states including the unbound states by extending the completeness relation. The guiding principle of the extension is to include the resonant poles by changing the contour path on the complex momentum plane.

Two approaches, GEM-CM and GSM are different techniques for describing the many-body wave function in the system, though the goal of both methods might be the same. Therefore, we perform the precise comparison between GEM-CS and GSM [6]. We discuss the results of the comparison and show the other related works [7].

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