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Analytic continuation of the finite-volume three-particle amplitudes

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Many hadronic resonances, including the most intriguing ones (Roper, $\pi_1(1600)$, or $T_{cc}^+(3872)$), decay into three or more particles. In principle, one can determine their properties from the multi-body version of the Luscher finite-volume scattering formalism. However, one of the obstacles in specifying their masses from Lattice QCD is the lack of developed three-body amplitude analysis techniques that would allow one to translate a finite-volume output into physically meaningful quantities. In particular, an amplitude obtained from the Lattice QCD calculation must be analytically continued to the complex energy plane, where resonances exist as pole singularities.

In the talk, I will explore the relativistic scattering of three identical scalar bosons interacting via pair-wise interactions. I will describe a general prescription for solving and analytically continuing integral equations describing the three-body process. As an illustration, I will use these techniques to analyze a system governed by a single scattering length leading to a bound state in a two-body sub-channel. I will present the resulting three-body scattering amplitudes for complex energies in the physical and unphysical Riemann sheets. In particular, I will discuss the emergence of three-particle bound states in the system under study that agrees with previous work utilizing relativistic finite-volume formalism. Finally, I will also comment on the obtained numerical evidence of the breakdown of the two-body finite-volume formalism in the vicinity of left-hand cuts.

Topical area

Hadronic and Nuclear Spectrum and Interactions

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