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Determining the resonance states 0^+ of the Boron isotope 8B from partial cross-sections using the Jost-matrix approach.

When attempting to extract resonance parameters from the energy-dependent cross-section data, one must fit the data at scattering (real) energies -physical sheet of the Riemann surface- afterwards then perform an analytic continuation to the unphysical sheet where the resonances are located.

When we are dealing with a multi-channel problem that consists of charged particles, the corresponding Riemann surface becomes complicated, i.e. having intricate interconnected sheets. This is due to the square-root and logarithmic branching points at the threshold energy. By using the Jost matrix approach, we can isolate the problematic factors that are responsible for branching, therefore making it easier to explore all the sheets of the Riemann surface. In this way we can accurately locate the resonance parameters. In this approach, the resonance parameters are obtained as zeros of the Jost function (matrix) on the unphysical sheet.

We used the R-matrix and Jost matrix approach to determine the two-channel 0^+resonance state of Boron-8. The R-matrix predicted a single state, while the Jost approach predicted the existence of two nearly overlapping states (one of which matches with the R-matrix result). We believe that the reason why the R-matrix did not pick up the second state is that it has a simplified analytic structure. This is based on the knowledge that it estimates the resonance parameters using only of the real energies, which is not enough to capture the intricate interconnected sheets of the Riemann surface.

In practice, we recommend using the R-matrix to parameterize the data (since it requires fewer parameters), then use the Jost approach to do analytic continuation to the unphysical sheet to determine resonance parameters. By combining these two approaches, it will be able to obtain accurate results.

Notes

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