Reflections of the resonant wave functions in cut-off potentials

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Abstract

The probability of the scattering of nuclear particles on atomic nuclei is controlled by the S-matrix. The poles of the S-matrix on the complex wave number plane determine the resonances. The location of the resonances depends on the nuclear potential.

The most common phenomenological nuclear potentials are the Woods-Saxon potential (WS) and the generalized Woods-Saxon potential (GWS). The solution of the radial Schroedinger equation (a second order differential equation) can be expressed by closed analytical form only for the zero value of the orbital angular momentum, in the other cases we solve the radial equation by numerical integration. However, the WS and GWS potentials have radial shapes which become to zero only at infinity, which means we have to use a cut-off version of them in order to calculate the S-matrix elements. Cutting off the tail of the potentials changes the distribution of the broad resonances considerably. We modified the cut-off generalized Woods-Saxon (GWS) and cut-off generalized Woods-Saxon (CGWS) potentials by attaching polynomial tails to them beyond the cut in order to bring the positions of the resonances closer to that of the WS potential without cut. The polynomial tails continue the CWS and CGWS forms more or less smoothly, and at the finite range of the potential they reach the zero value more or less smoothly, too. The distributions of the resonant poles are influenced by the distances where reflections of the resonant wave function take place. We observed that reflections from the cut-off distance can always happen. We tested the effect of using different tails by our computer code written in FORTRAN-90.

Keywords: resonance, finite range potential

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