S-matrix poles and determination of the bound, virtual and resonance parameters for the light nuclei

B. F. Irgaziev,[1] V. Z. Goldberg, A. M. Mukhamedzhanov, Yu. V. Orlov,[2] and I. Qazi[1]
[1]*GIK Institute of Engineering Sciences and Technology,Topi, District Swabi, N.W.F.P.,Pakistan*
[2] *Skobeltsyn Institute of Nuclear Physics, Moscow State Universit, Moscow, Russia*

A general method is developed for determination of the *S*-matrix pole parameters for bound, virtual and resonance states based on numerical solutions with high precision of the Schrödinger equation. This method is well-known for the bound state. In this work we generalize it for the case of the Gamov resonance and virtual states in spite of the fact that the corresponding solutions increase exponentially at $r\to\infty$. The specific calculations are performed for the virtual states of the ^{2}He and triton. The results obtained for the virtual ^{2}H and triton are in good agreement with those found using the Lippmann–Schwinger integral equations analytically continued to the unphysical energy sheet. The normalization method for the Gamov state wave function is also considered.

Using the developed method we investigated the resonance states ($1/2^+$, $5/2^+$) in ^{15}F and its ground state which is the subthreshold resonance. We analyzed also the bound $3/2^+$ state of ^{14}N, the low-lying states $1/2^+$(gr.st.) and the excited states $1/2^-$ and doublet $(5/2^+, 3/2^-)$ in mirror nuclei ^{11}Be and ^{11}N. Our two-body (nucleon-target) approach allows one to treat on the equal foot both bound and virtual states and resonances. In particular, we are able to determine the pole of the S matrix for the broad resonance $s^+_{1/2}$ in ^{11}N, when the phase shift does not reveal resonance behavior.