Study of single particle energy levels by using Woods-Saxon potential and its approximate solution in harmonic oscillator basis

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Abstract

In this investigation, the approximate solution of Schrodinger equation with mean field Woods-Saxon potential in harmonic oscillator basis has been presented. The energy eigenvalue and corresponding eigenfunction of bound neutron and proton single-particle energy levels were determined for some light, medium weight, and heavy nuclei. The obtained results were compared with the numerical solution of Schrodinger equation, and good agreements were observed between the two methods. The exact analytical solutions of Schrodinger equation with Woods-Saxon potential have been represented for neutron single-particle S-state using Nikiforov-Uvarov (NU) method and considering boundary conditions. The energy levels of S-state were calculated for some light, medium weight, and heavy nuclei. The results showed that the value of energy levels strongly depends on the adjustable parameters of Woods-Saxon potential and the method of calculation. Thus, by increasing the atomic number and principal quantum number, the discrepancy between the calculated data using numerical solution and analytical solution increased for different set of adjustable parameters.

Keywords: Woods-Saxon potential, harmonic oscillator, mean-field

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