p -wave Λ-hyperon binding energies of medium heavy Hypernuclei

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Introduction

Though hypernuclei was discovered more than fifty years back, recent experiments have accumulated properties of hundreds of hypernuclei [1, 2]. The enhanced experimental efforts have thus created renewed interest in the theoretical computations of the various properties of hypernuclei [3, 4]. Large number of Λ-hypernuclei and Λ-hyperon binding energies in the ground state as well as p and d-wave excited states are experimentally measured [5]. In this article, we study the binding energy of hypernuclei containing single Λ hyperon in the frame work of non-relativistic Schrodinger equation. We have used Wood-Saxon potential to study binding energy of hyperon and solved Schrodinger equation numerically.

Methodology

We can calculate the Λ particle binding energy in a spherical potential provided by the nuclear core consisting of the protons and neutrons. we can solve non-relativistic Schrodinger equation numerically to find out the binding energy of Λ particle in hypernuclei .

$$\left[-\frac{\hbar^2}{2\mu}\nabla^2 + V(r)\right]\Psi(\vec{r}) = E\Psi(\vec{r}) \qquad (1)$$

where $\mu = m_{core}m_\Lambda/(m_{core}+m_\Lambda)$ is the reduced mass and E is the binding energy. The phenomenological potential is taken in the Woods-Saxon form given by [6]

$$V(r) = V_{cen}(r) + V_{so}(r) \qquad (2)$$

where $V_{cen}(r)$ and $V_{so}(r)$ are the central and spin-orbital potential, respectively.

$$V_{cen}(r) = -\frac{V_0}{[1+exp[\frac{r-R_{cen}}{a_{cen}}]]} \qquad (3)$$

$$V_0 = U_0 + U1\frac{A-2Z}{A} \qquad (4)$$

$$V_{so}(r) = -\frac{2U_{so}}{ra_{so}}[j(j+1) - l(l+1) - s(s+1)] \times \frac{exp[\frac{r-R_{so}}{a_{so}}]}{[1+exp[\frac{r-R_{so}}{a_{so}}]]^2} \qquad (5)$$

where $R_{cen/so} = r_0A^{\frac{1}{3}}$, A represents the nucleon number of the core nuclei in the hypernucleus. Here we have taken the same potential parameter given by [6] as $r_0 = 1.2fm$, $a_{so} = a_{cen}$=0.215 fm, $U_1 = -0.075$ MeV, U_{so}=3.75 MeV and we fix U_0 for the ground state binding energy of Λ-hypernuclei . The potential parameter U_0 for different Λ-hypernuclei are shown in Fig.(1)

Results and Discussion

The computed results for the lowest s-state and p-state binding energies of six different Λ-hypernuclei are listed in table (1). The potential parameter U_0 vs A as shown in Fig.(1) suggests linear like behaviour with A. The potential parameters and the Λ-Hyperon

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TABLE I: Binding Energy ($-B_\Lambda$) of S and P-states Λ Hypernuclei in MeV.

Nuclei	BE for S-State in MeV			BE for P-State in MeV		
	Present	Other	Expt. [5]	Present	Other	Expt. [5]
$^{11}_{\Lambda}B$	10.029	10.163 [6] 10.28 [7]	10.20			
$^{12}_{\Lambda}C$	10.8076	10.928 [6] 10.97 [7]	10.80			
$^{16}_{\Lambda}O$	12.5031	13.243 [6] 13.15 [7]	12.50	5.812	2.544 [6] 1.92 [7]	2.50
$^{28}_{\Lambda}Si$	16.0025	16.930 [6] 16.95 [7]	16.00	7.490	8.099 [6] 6.039 [7] 5.83 [8]	7.00
$^{32}_{\Lambda}S$	17.5251	17.665 [6] 17.77 [7]	17.50	8.220	9.324 [6] 7.047 [7] 7.28 [8]	8.10
$^{40}_{\Lambda}Ca$	18.7022	18.785 [6] 19.09 [7]	18.70	8.780	11.248 [6] 8.718 [7] 9.56 [8]	11.00

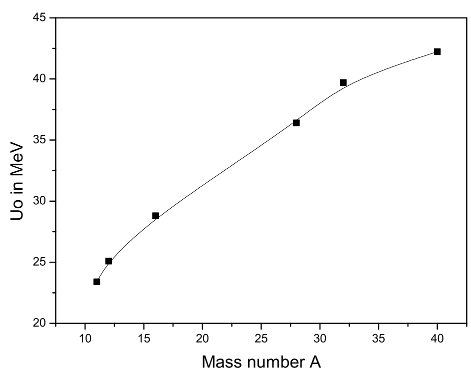

FIG. 1: Variation of potential parameter U_0 with mass number A.

binding energy will be useful to study the decay properties of the hypernuclei. The predicted p-wave binding energy of Λ-hypernuclei are found to be in good agreement with the experimental as well as with other theoretical model predictions.

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