Neutron skin in Osmium isotopes

Nithu Ashok[1],* Antony Joseph[1], and Deepthy Maria Joseph[1]
[1]*Department of Physics, University of Calicut, Malappuram - 673635, INDIA*

Introduction

With the development of experimental facilities like Radioactive Ion Beams, research in nuclear structure have entered into a new era. They enable us to study the wide range of nuclei in the chart of nuclides. The study of nuclei far from stability line is an interesting field nowadays. Experimental data are available only for light nuclei. So studies on heavy nuclei in this region mostly rely on theoretical models. As the asymmetry between the number of proton and neutron increases, new phenomena like neutron skins, halos etc arises[1]. Here we have made an attempt to calculate neutron skin thickness in rare earth even-even osmium isotopes. The selected isotopes ranges from 2-p to 2-n drip line. Neutron skin is an important feature of neutron rich nuclei[2]. The ground state proton and neutron rms radii [3]have been calculated using HFB approximation. A comparison of calculated radii have been done by using two different Skyrme parametrizations and two different basis.

Theory

The calculations have been done using Skyrme Hartree Fock Bogoliubov (HFB) theory[4]. The matrix form of HFB equations are given by,

$$\begin{pmatrix} h-\lambda & \Delta \\ -\Delta^* & -h^*+\lambda \end{pmatrix} \begin{pmatrix} U_n \\ V_n \end{pmatrix} = E_n \begin{pmatrix} U_n \\ V_n \end{pmatrix} \quad (1)$$

HFB equations have been solved using cylindrically symmetric deformed harmonic oscillator (HO) and transformed harmonic oscillator (THO)[5] basis. In the particle-hole channel effective Skyrme interactions, SKP and SLY5 have been used and in the particle-particle channel density dependent delta interaction (DDDI) in its mixed[6] form is used. i.e,

$$V_\delta^{n/p}(\vec{r_1},\vec{r_2}) = V_0^{n/p}[1-\frac{1}{2}(\frac{\rho(\vec{r_1}+\vec{r_2})}{\rho_0})^\alpha]\delta(\vec{r_1}-\vec{r_2}) \quad (2)$$

Neutron skin [7]is defined as the difference be-

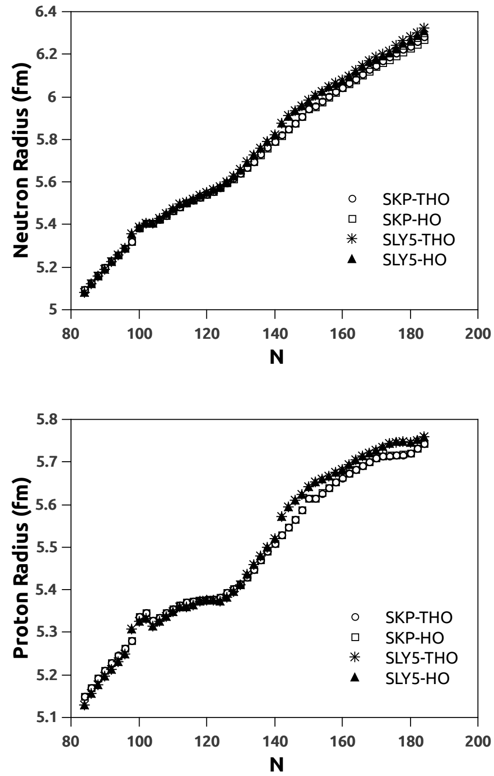

FIG. 1: A plot of neutron radius (top) and proton radius (bottom) against neutron number.

*Electronic address: `nithu.ashok@gmail.com`

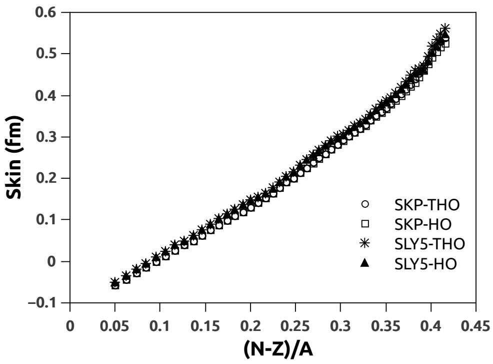

FIG. 2: A plot of neutron skin against (N-Z)/A.

tween neutron and proton rms radii,

$$\Delta R \equiv < r_n^2 >^{1/2} - < r_p^2 >^{1/2} \qquad (3)$$

Results and Discussion

Drip line nuclei have been found out using the binding energies[8]. ^{162}Os and ^{258}Os are respectively 2-p and 2-n drip line nuclei. Calculated neutron and proton rms radii are given in fig(1). It is found that both rms radii obtained by the force SKP underestimates slightly SLY5 towards the drip line.

Neutron skin calculated using eqn(3) are given in fig(2) as a function of asymmetry parameter. As the asymmetry between neutron and proton numbers increases difference between rms radii also increases. Usually this difference is about 0.1 to 0.2 fm. The increase of this difference shows the formation of neutron skin. From the figure we find that neutron skin in the case of SKP underestimates SLY5 slightly, but the pattern of radii and skin in case of both the forces follow each other. The change of basis does not produce any significant difference in any of the calculated value.

These results show that the rms radii and skin depend on the type of effective interaction used.

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