A study of Strutinsky Shell Correction for Z=122&128

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Introduction

The superheavy nuclei (SHN) are charecterized by the extreme value of proton number Z and thier long lived existence is described with the help of strong shell stabilization [1, 2]. A number of various experimental facilities have done for synthesization of SHN with Z=112 and Z=117 with different approaches [3, 4] at GSI. Recently the nuclei of mass region A=266-294 with Z=104-118 have been detected at Dubna [5]. Still the predicted island of stability inferred by theoretical models is not reached by experimental facilities. The classical liquid drop model suggests the idea of instant fission of SHN due to large electric charge. This puzzle of stabilization of SHN is seem to be solved with the importance of shell correction energy [6]. Strutinsky shell correction (SSC) scheme is robust tool to quantify the shell effect in nuclei. In this work, we obtain the neutron shell closure with SSC scheme along with ground state properties using Covariant Energy Density Functionals (CEDFs) with DD-ME2 [7] and DD-PC1 [8]. An excellent forecast and successful results have been achieved using these two parameters in earlier study. We have covered the isotopic series of Z=122 and Z=128 for neutron number varying from 158 to 218, and 162 to 212, respectively.

Results and Discussion

Strutinsky averaging method is described by the difference between the total single-particle energy E and the smoothed sum of single-particle energy $\bar{E}$.

$$E_{shell} = E - \bar{E} = \sum_{i=1}^{N(z)} e_i - 2\int_{-\infty}^{\bar{\lambda}} e\bar{g}(e)de.$$

Where $N(Z)$ denotes for particle number. The single-particle energy, smoothed Fermi level and smoothed level density between e and $e + de$ is represented by e_i, $\bar{\lambda}$, and $\bar{g}(e)$ respectively. It is to note that large negative shell correction to the energy at particular point indicates for shell closure at that point. The neutron, proton and total shell correction to the energies are calculated through Strutinsky averaging method for both the isotopic series (Z=122 and Z=128) which are presented in Fig. 1 and Fig. 2, respectively. The upper portion of both the figures contains the results for neutron and proton shell correction while the lower pannel represnt the total shell correction to energy. The results from both the force parameter (DD-ME2 and DD-PC1) follow almost the same trends except at very few points. Due to constant value of proton number, the shell correction corresponding to proton has less fluctuation in comparison to neutron shell correction to energy. From lower pannel of Fig. 1, it is clear that minima are obtained around N=168, 174, 178, and 184 for both the force parameter. At N=172, minima is predicted only by DD-ME2. So, the shell closure can be reported for these neutron numbers for the isotopic series of Z=122. In our structural calculation which is not presented here, these nucleus are found to be oblately deformed ($\beta_2 < 0$). Therefore, these numbers in SH region can be reffered as deformed neutron magic numbers except N=184. At N=184 the system is reported as

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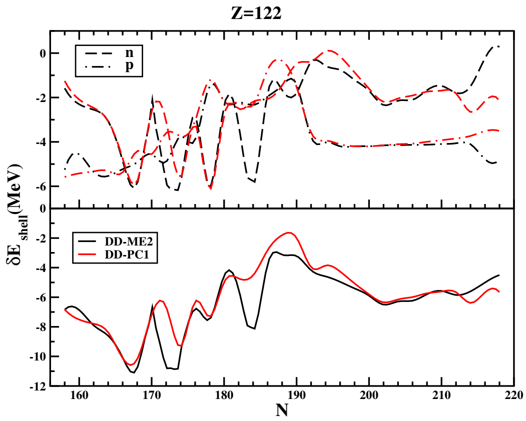

FIG. 1: Neutron, proton, and total shell correction to the energy of the isotopic series of Z=122 at their ground state.

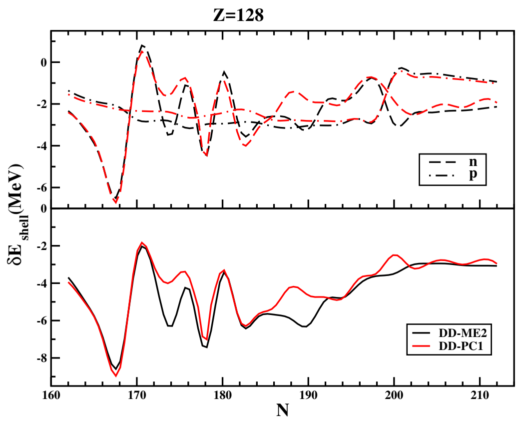

FIG. 2: Same as Fig. 1. but for Z=128.

exactly spherical for both the force parameter in our structural calculation. So, we can say that spherical neutron magicity is obtained at N=184 for this isotopic series.

The results for shell correction energy for isotopic series of Z=128 is presented in Fig. 2. We are getting same behavior from both the force parameter. From the figure, it is clear that minima is obtained at N=168, 174, and 178 for both the relativistic interaction (DD-ME2, DD-PC1). These three minima are common in isotopic series of Z=122. The nuclei corresponding to these neutron number are found to be oblately deformed in our calculation. So these numbers (168, 174, and 178) may be reported as deformed neutron magic for the isotopic series of Z=128. Here, we have not found the spherical neutron magic like previous one. There is one prominent minimum observed around N=182 for both the interaction. DD-ME2 calculation show another flat minima around N=190 but these two numbers can not be confirmed as neutron magic because we are not getting extrastability behavior from the result of two neutron separation energy and neutron pairing energy in our structural caculations.

conclusion

In the present work, we have attempted to locate the neutron shell closure in superheavy region using Strutinsky shell correction scheme. We have found deformed neutron magic at N=168, 174, and 178 for both the isotopic series. Spherical magicity is obatined at N=184 only in isotopic series of Z=122 with DD-ME2 which supports earlier study regarding this neutron magic number.

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