Study Of Some Properties Of Superheavy Nuclei With Z=124

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Introduction

Due to the recent progress in the superheavy element, it became the centre of attraction for both theoreticians and experimentalists in nuclear physics. The recent experiment make it possible to reach proton number Z=120. The new superheavy nuclei (SHN) can be identified with successful experiments along with thier α-decay chains and half life time. It is found that physics of SHNs is more reliable in DFT (Density Functional Theory) framework than in any other approach. DFT plays a key role for understanding the dynamics of the nuclear many body system in terms of Energy Density Functionals.

In this paper, we have reported potential energy surface(PES), separation energy, and α-decay of isotopic chain of Z=124 within the covariant density functional theory (CDFT) for axially symmetric configuration. Treatment of pairing correlation have been taken care of as given in Ref[1]. We have calculated ground state bulk properties which will be presented.

Result and Discussion

A. Potential Energy Surface

The deformation energy curves of the isotopic chain of Z=124 are presented in Fig.1. The interactions DD-ME1, DD-ME2 gives the same PES pattern but DD-PC1 slightly differs from these two interaction. The dashed line gives the actual ground state that we have chosen. It is to be noticed that we have neglected prolate superdeformed (SD) minimum, which is even lower than the spherical or oblate minima because there is no sharp deviation in experimental data (for example spontaneous fusion half-lives or total evaporation-residue cross section) from the expected trend, that could be taken as transition to a SD ground state. The reasons for neglecting second superdeformed minima have been discussed elaborately in Ref.[2].

B. Separation Energy

The sudden fall in the neutron separation energy can estimate the extra stability of certain nuclei. The Fig.2. shows the two neutron separation energy (S_{2n}) and difference of two neutron separation energy for the isotopic chain of Z=124. Fig.2 shows the sudden change at N=172 and 184 which confirms the magicity of these two numbers as predicted in earlier studies. We have also compared our result with FRDM (Finite Range Droplet Model) prediction and it is clearly observed from the figure that an abnormal peak appears at N=194 in FRDM calculation which is not present in our calculations.

C. Q_α energy and decay half life T_α

The superheavy nuclei on β-stability line are generally supposed to be α emitters. Possibility of existence and degrees of stability of nuclei are given by the α-decay mode, thus it is advantageous to investigate the α-decay of nuclei for confirming the magic number corresponding to a particular neutron number and it also gives the information about thier degree of stability and possibility of existence. Here we investigated the α-decay energy of nucleus $^{296}124$ beacause we have found a sharp decrease in two neutron separation energy at this point. In Fig.3 and Fig.4, we have compared the available experimental data with our calculation. The calculated Q_α energy and $T_\alpha^{1/2}(s)$ are found to be in good agreement with Experimental data[3] and FRDM result, which reflects in Fig.3 and

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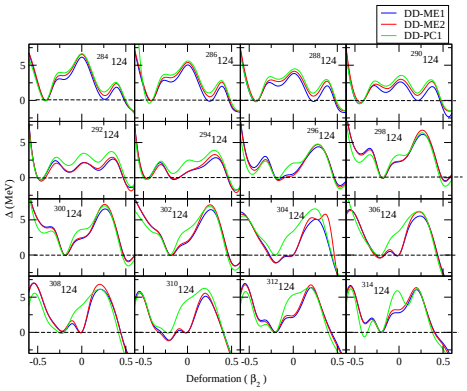

FIG. 1: Potential Energy Curves of $^{284-314}124$.

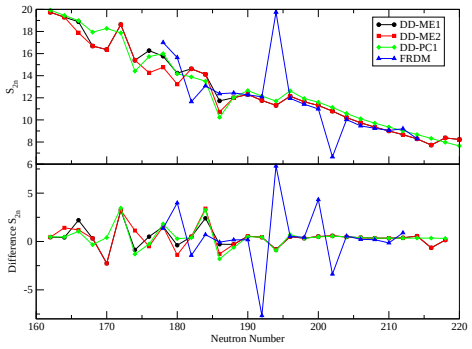

FIG. 2: Two neutron separation energy and difference of two neutron separation energy of Z=124 series.

Fig.4. The equation used for calculating Q_α energy and decay half-life $log_{10}T^{\alpha}_{1/2}(s)$ are given in Ref [4].

Conclusion

In the present study, we examine the properties of isotopic chain of Z=124 using DFT and compared our results with macro-microscopic FRDM predictions and available experimental data. We obtained PES curve, two neutron separation energy, and Q_α energy and decay half life $T_\alpha^{1/2}(s)$ for the isotopic series of $Z = 124$. The calculated results are found to be in good agreement with available experimental data and FRDM results.

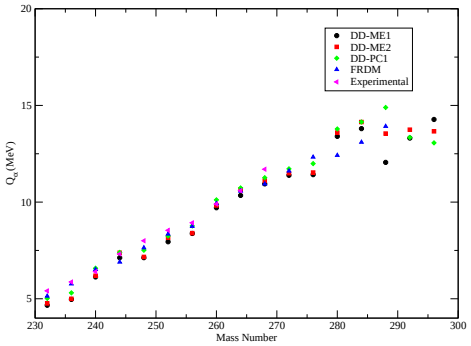

FIG. 3: α-decay (Q_α energy) chain from Z=124 to 92.

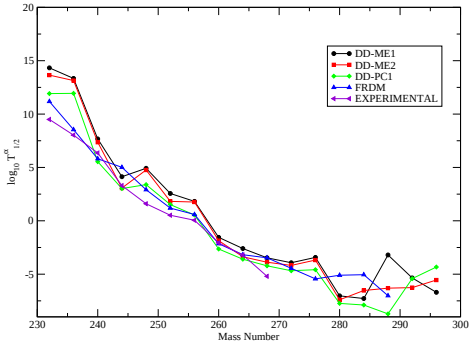

FIG. 4: $T_\alpha^{1/2}$ values of $^{296}124$ series.

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