The ground state properties of Z=117 and the α-decay chains of ^{293}117 and ^{294}117.

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1. Introduction

Nuclei can survive beyond the macroscopic limit, far into the transuranium region, where the necessary balance between the nuclear and Coulomb force is achived through the shell stabilisation. The next double shell closer, beyond ^{208}Pb, is in the superheavy region, where they may have suprisingly long half-lives, in the order of million of year [1, 2]. Till to-date the heaviest elements Z=118 has been synthesised by heavy ion reactions [3] with a half-life ranging from a few minutes to about a mili-second. The microscopic relativistic mean field calculations have predicted the next magic number, beyond N=126 and Z=82, as N=184 or 172 and Z=120 [4, 5].

Recently, a lot of activity for superheavy nuclei appeared in the literature. Important among them are the finding of Z=122 from natural Th-isotopes in hyperdeformed (HD) and/ or superdeformed (SD) isomeric states [6, 7], the experimental confirmation of Z=118 [3] and the recent discovery of Z=117 [^{294}117 and ^{293}117] at Flerov Laboratory [8] from the reaction $^{48}_{20}$Ca+$^{249}_{97}$Bk$\rightarrow^{297}$117. All these discoveries tempted us to study some of the properties of superheavy element (SHE) theoretically, which may be a direction towards the concept of "Island of Stability" beyond the doubly shell closed spherical magic nucleus ^{208}Pb. In the present report, we have chosen Z=117 as a candidate for our investigation.

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2. Theoretical Framework

We have used the axially deformed relativistic mean field formalism [7] with the successful NL3 parameter set. The pairing effects are also considered here, through the well known BCS approach [9].

3. Calculations and Results

The ground state properties, like binding (BE), two-neutron separation (S_{2n}) and pairing (E_{pair}) energies are evaluated. The quadrupole deformation parameters (β_2), matter rms radii (r_m), charge radii (r_{ch}) and other bulk properties are also calculated by using the RMF formalism for the isotopic chain of Z=117. The predicted results are compared with the Finite Range Droplet Model (FRDM) [9] in TABLE I.

In TABLE II, we illustrate our results of calculations for the α-decay chain, the Q_α energy and the half-life time T_α, for the isotope ^{293}117 (Z=117, N=176), obtained from the RMF(NL3). The predicted results are compared with the FRDM [9], experimental and experimentally extrapolated data [8, 10].

4. Summary and Discussion

Concluding, we have calculated the ground state and excited intrinsic state properties for superheavy Z=117 isotopes in RMF formalism. From the calculated binding energy, we have also estimated the two-neutron separation energy for the isotopic chain. We found a shape change from oblate to prolate deformation with increase of mass number at A=292. Most of the ground-state structures are spherical in shape in agreement with the FRDM calculations. From the binding energy analysis, we found that the most stable isotope

TABLE I: The RMF(NL3) results for binding (BE), two-neutron separation (S_{2n}) and pairing (E_{pair}) energies for Z=117 isotopic chain. The quadrupole deformation parameter (β_2) is also listed. The results are compared with the Finite Range Droplet Model (FRDM) data [9]. The energy is in MeV.

	RMF (NL3) Results				FRDM Results		
Nucleus	BE	S_{2n}	E_{pair}	β_2	BE	S_{2n}	β_2
288	2052.586	14.836	14.698	0.018	2047.09	15.16	0.080
290	2066.138	13.552	14.274	0.017	2061.65	14.56	0.080
292	2079.802	13.664	14.109	-0.017	2075.72	14.07	0.072
294	2092.468	12.775	13.653	0.041	2089.22	13.50	-0.087

TABLE II: The BE, Q_α and T_α, calculated on the RMF(NL3) model, for ^{293}117 nucleus. The results are compared with the FRDM [9] as well as with the experimental and experimentally extrapolated data [8, 10].

		RMF (NL3) Result			FRDM Results			Extrapolated result			Experimental Results	
Nucleus	Z	BE	Q_α	T_α	BE	Q_α	T_α	BE	Q_α	T_α	Q_α	T_α
293	117	2086.602	11.480	-2.71	2083.06	11.68	-2.40				11.03	-1.60
289	115	2069.786	10.552	-0.96	2066.45	10.03	1.26	2063.17	10.57	-1.01	10.31	-0.31
285	113	2052.042	9.765	0.60	2048.18	8.97	3.86	2045.45	9.99	-0.04	9.74	0.67
281	111	2033.511	9.231	1.55	2028.85	9.37	1.90	2027.13	9.69	0.16	9.48	0.78

in the series is ^{288}117, which is close to predicted magic number at N=172. Our predicted α-decay energy Q_α and half-life time T_α match nicely with the vailable extrapolated and experimental data. Considering S_{2n} energy, some shell structure also appear in the isotopic chain at N=172 or 184.

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