Role of Triaxiality in decay chain of $^{298}120$

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Introduction

After the successfull attempts of synthesizing the elements up to $Z \leq 118$, the experimentalists aimed to synthesize the isotope of $Z = 120$ [1]. From the experiment, it is observed that α-decay is the main mode which ultimately terminate with spontaneous fission [2]. The recent experiment report [3] proved that $^{298}120$ preferentially decay through alpha emission, therefore experimental values are also available for Q_α and $T^{\alpha}_{1/2}$. So, it is advantageous to investigate the properties of this decay series. In the present work, we have investigated structural properties of α-decay chain of $^{298}120$ with systematic constrained calculations for axial and triaxial symmetry by using Relativistic Hartree Bogoliubov (RHB) model with density dependent finite range N-N interaction (DD-ME). The pairing correlation is used here in the separable pairing model. The formalism adopted in present calculation is elaborately discussed in Ref. [4].

Results

Potential Energy Surface (PES) is obtained by solving the RHB equation with constraints on the axial and triaxial mass quadrupole moments.

$$\langle \hat{H} \rangle + \sum_{\mu=2,0} C_{2\mu}(\langle \hat{Q}_{2\mu} \rangle - q_{2\mu})^2$$

Where $\langle \hat{H} \rangle$ and $\langle \hat{Q}_{2\mu} \rangle$ denotes total energy and, the expectation value of the mass quadrupole operators, respectevely. $\langle \hat{Q}_{2\mu} \rangle$ is

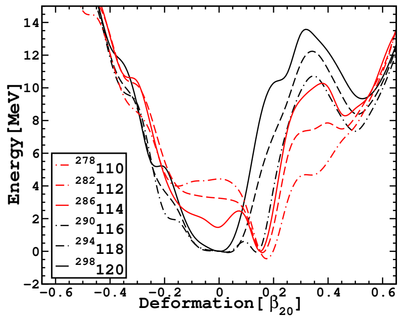

FIG. 1: The axial potential energy surface.

given by

$$\hat{Q}_{20} = 2z^2 - x^2 - y^2,$$

$$\hat{Q}_{22} = x^2 - y^2,$$

$q_{2\mu}$ represent the constrained value of the multipole moment and corresponding stiffness constant is represented by $C_{2\mu}$. Axial PES shown in Fig. 1, suggest the global minimum in spherical and prolate region. For furthur investigation we have gone for PES as function of triaxial mass quadrupole deformation. Fig. 2 represents the triaxial contour plot for nuclei of decay chain of $^{298}120$. By using these PES, we have determined the global minimum of the system. From contour plot it can be concluded that $^{298}120$ and $^{294}118$ have exactly spherical ground state while $^{290}116$, $^{286}114$, $^{282}112$, and $^{278}110$ have prolate ground state which is also reflected in axial PES shown in Fig. 1. In Table. I, we have presnted Binding Energy(BE) for both axial and triaxial symmetric case, quadrupole deformation (β_2), Q_α, $T^{\alpha}_{1/2}$(s) with different semiempirical relationships named as Imsahu [5], SemFis2 [6], Univ2 [6] and spontaneous fission half-lives. The calculated results are more or

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TABLE I: The predicted total binding energy(BE) in MeV, the quadrupole deformation parameter(β_2), Q_α and decay half lives for alpha decay series of $^{298}120$ with DD-ME2 interaction.

					$log_{10}[T^{\alpha}_{1/2}$(s)]				Expt.	
Nuclei	β_2	$BE_{Triaxial}$(MeV)	BE_{axial}(MeV)	Q_α(MeV)	ImSahu	SemFIS2	UNIV2	$log_{10}[T^{\alpha}_{1/2}$(spon)]	Q_α	$log_{10}[T^{\alpha}_{1/2}$(s)]
$^{298}120$	0.00	2094.140	2098.69	11.85	-2.82	-2.47	-3.24	14.48	12.4	-4.52
$^{294}118$	0.00	2077.745	2082.25	11.67	-2.97	-2.67	-3.37	8.46	11.65	-3.05
$^{290}116$	0.15	2060.622	2065.63	11.58	-3.32	-3.08	-3.71	3.79	10.84	-2.15
$^{286}114$	0.15	2044.318	2048.92	10.01	-0.04	0.30	-0.37	0.36	10.19	-0.89
$^{282}112$	0.15	2026.275	2030.64	9.46	0.89	1.21	0.59	-1.90	10.17	3.09
$^{278}110$	0.20	2007.284	2011.81	9.66	-0.34	-0.12	-0.62	-3.90		

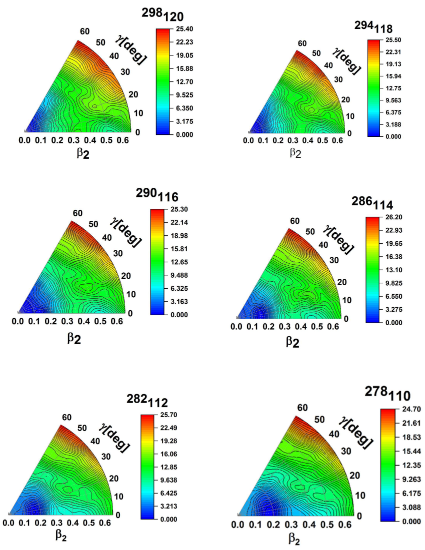

FIG. 2: The triaxial potential energy surface

less agrees with available experimental data which is clearly seen in the Table. I. BE calculated from axial and triaxial symmetric case are very close to each other. We have calculated the spontaneous fission half-lives by the formula given by Xu et al. [7]. Stability of newly synthesize superheavy nuclei can be estimateed through comparison between calculated α-decay half-lives with the spontaneous fission half-lives. Experimental detection of different isotopes within an α-decay chain of superheavy nuclei is also inferred by this comparison. If the isotopes have their α-decay half-lives smaller than the corresponding spontaneous fission half-lives, then, they may be detected experimentally through α-decay. On the basis of these comparison, we can say that system will decay through spontaneous fission after 4α-decay.

Conclusion

We have investigated decay properties of $^{298}120$ using RHB equation for both axial and triaxial symmetric case. Stability of the system against spontaneous fission is also checked. Triaxiality has no role to play in core of α-decay chain of $^{298}120$.

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