α-decay chain of ^{297}Og

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Since the discovery of α-decay [1], it has contributed immensely to the understanding of nuclear physics. Being a dominant mode of decay in superheavy nuclei, α-decay is of pronounced importance for the experimental studies. The heaviest element with proton number Z=118 (^{297}Og) was experimentally synthesized [2] through the α-decay process, and many more efforts are going on along this direction. In this regard, the already known experimental observation of decay chain of ^{293}Lv [4] and theoretical speculation of α-decay from ^{297}Og by Deng *et al.* [3] manifest the possibility of detection of nucleus ^{297}Og.

In this work, we have probed the α-decay from ^{297}Og by using new modified Horoi formula (NMHF), new modified Sobiczewski formula (NMSF), and new modified Manjunatha formula (NMMF) from the recent work [5]. We have calculated the half-lives of α-decay for the decay chain of ^{297}Og for which disintegration energy (Q-value) are picked up from WS4 mass model [6]: the model resulting more precise Q-value while compared with few other theories [7]. The available experimental Q-values are taken from Ref. [4].

The used formulas are given by:

$$log_{10}T_{1/2}^{NMHF} = (a\sqrt{\mu}+b)[(Z_\alpha Z_d)^{0.6}Q_\alpha^{-1/2} - 7] + (c\sqrt{\mu}+d) + eI + fI^2 + gl(l+1) \quad (1)$$

$$log_{10}T_{1/2}^{NMSF} = aZ\sqrt{\mu}(Q_\alpha - \overline{E}_i)^{-1/2} + bZ\sqrt{\mu} + c + dI + eI^2 + fl(l+1) \quad (2)$$

$$log_{10}T_{1/2}^{NMMF} = a\sqrt{\mu}(Z_d^{0.4}/\sqrt{Q_\alpha})^2 + b\sqrt{\mu}(Z_d^{0.4}/\sqrt{Q_\alpha}) + c + dI + eI^2 + fl(l+1) \quad (3)$$

In the above equations, all the half-lives are in the unit of second. μ is the reduced mass which is given by $A_dA_\alpha/(A_d + A_\alpha)$, where A_d and A_α are the mass numbers of daughter nucleus and α-particle, respectively. Likewise, Z, Z_d and Z_α represent atomic numbers of parent nucleus, daughter nucleus and α-particle, respectively. Q_α (in MeV) is the energy released in ground-state to ground-state α-decay. I (=(N-Z)/A) is the nuclear isospin asymmetry. The coefficients $(a, b, c, d, e, f, g,$ and $\overline{E}_i$) are given in Ref. [5]

The spontaneous fission half-lives are calculated using the modified version of Bao formula (MBF) [8], which is given by:

$$log_{10}T_{1/2}^{SF}(s) = c_1 + c_2\left(\frac{Z^2}{(1-kI^2)A}\right) + c_3\left(\frac{Z^2}{(1-kI^2)A}\right)^2 + c_4E_{s+p} \quad (4)$$

Here k=2.6 and other coefficients are c_2=−37.0509, c_3=0.3740, c_4=3.1105. The values of c_1(e-o) is 895.4154.

Using the NMHF, NMSF and NMMF formulas [5], we have predicted the α-decay half-lives for the decay chain of ^{297}Og, which are tabulated in Table I and also shown in Fig. 1. For the possible decay modes, we have also calculated half-lives for SF using modified Bao formula [8] and shown in the tenth column in Table I. The comparison between predicted decay modes with the experimental decay modes are shown in the Table I. The ($\star$)

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TABLE I: Prediction of decay chain from NMHF, NMSF and NMMF formulas for ^{297}Og (See the text for details).

Nucleus	Expt.					$\log_{10}T_{1/2}$(s)				Decay Modes	
	Q (MeV)	j_p^π	j_d^π	l_{min}	$\log_{10}T_{1/2}$(s)	NMHF (α)	NMSF (α)	NMMF (α)	MBF (SF)	Predicted	Expt.
^{297}Og	12.10*	$1/2^+$	$1/2^+$	0	-	-3.39	-4.54	-5.08	15.81	α	-
^{293}Lv	10.71	$1/2^+$	$3/2^+$	2	-1.24	-0.85	-1.89	-2.22	15.59	α	α
^{289}Fl	9.98	$3/2^+$	$5/2^+$	2	0.28	0.23	-0.67	-1.15	13.50	α	α
^{285}Cn	9.32	$5/2^+$	$15/2^-$	5	1.45	1.55	0.71	0.46	9.05	α	α
^{281}Ds	8.85	$15/2^-$	$3/2^+$	7	1.10	2.17	1.45	1.09	5.67	α	SF
^{277}Hs	9.05	$3/2^+$	$3/2^+$	0	-2.52	1.08	0.41	0.23	4.81	α	SF

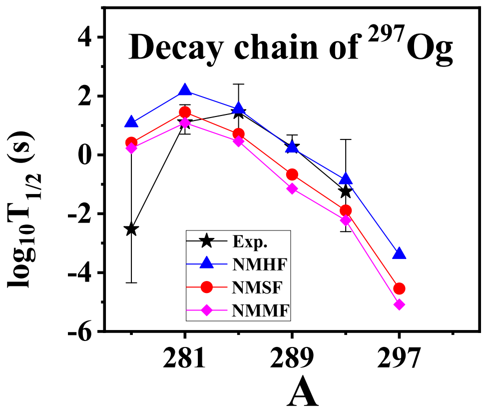

FIG. 1: α-decay half-lives for decay chain of ^{297}Og. The experimentally data are taken from [4].

value of Q is taken from WS4 mass model [6]. For l_{min} (minimum angular momentum), spin and parities are taken from NUBASE2020 [9] or P. Möller [10]. The all three considered formulas reproduce experimental data quite precisely and within the experimental uncertainty [4] as can be ascertained from Fig. 1. Conclusively, as an important outcome, the half-life of unknown nucleus ^{297}Og is found within the experimental reach in addition to the α-particle emission as a probable mode while compared to SF which can be seen from the Table I. It is noticeable that there are indeed certain chances of production of ^{297}Og in near future as speculated by JINR-Dubna laboratory [11].

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