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PREDICTIONS FOR THE ALPHA DECAY OF $Z = 127$ – 138 SUPER HEAVY NUCLEI USING THE CYE MODEL

UDC 539

In recent years, the synthesis and identification of Superheavy elements have been of a great interest in the area of both experimental and theoretical nuclear physics. Using the CYE model, the alpha decay, cluster decay, and spontaneous fission in the heavy and superheavy nuclei have been studied. In the current work, we will investigate the α decay and obtain cluster decay half lifetimes in the interval $Z = 127$ – 138 and the spontaneous fission half lifetimes using the two-sphere approximation and will compare the results with the other theoretical values and the semiempirical formula by Xu et al. We believe that the predicted decay half-lifetimes are valuable for future tests, because they are in a good agreement with other theoretical formalisms.

Keywords: CYE model, alpha decay, superheavy nuclei, cluster, spontaneous fission, half-life time.

1. Introduction

Gamow identified shortly the decay as a quantum tunneling process, after it was identified by Rutherford and Geiger in 1928 [1, 2]. One of the key decay modes for describing the nuclear structure is the alpha decay which is successfully explained by quantum theory. For the computation and prediction of the α decay half lifetime, numerous theoretical and empirical models have been created since the time of Gamow, varying in accuracy and sophistication [3–12]. Wentzel–Kramers–Brillouin (WKB) approximation theory was used by A. Zdeb et al., [13], to establish a straightforward formula for α decay half lifetimes. Rose and Jones et al. reported on the discovery of the radioactive decay of heavy nuclei by the emission of ${}^6_{14}\text{C}$. Superheavy elements have been

discovered at the Lawrence Berkeley National Laboratory. Various theoretical models have been developed to study the decay properties of Superheavy elements, and those results have been confirmed by Gales et al., and S.B. Price, [13, 14]. In earlier work, the characteristics of alpha decay, cluster decay, and spontaneous fission for super heavy nuclei have calculated using the CYE model [15, 16, 17]. We have already studied the decay properties of α decay for even nuclei ($Z = 128, 130, 132, 134, 136, 138, 140, 142$ and 144) [18, 19]. In the current work, we used the Cubic Plus Yukawa Plus Exponential Model in the two-sphere approximation to examine the alpha decay and cluster decay characteristics of several isotopes of superheavy nuclei, $Z = 127$ – 138 . The alpha and Spontaneous fission decay properties of various isotopes of SHE $Z = 127$ – 130 for different Q values have been studied using the CYE model. (Santhosh and Nithya, 2017; Santhosh and Priyanka, 2017) [20, 21] studied the alpha decay and cluster emission at $Z = 110, 122, 126, 128$ of parent nuclei and suggested $N = 184$ and $N = 202$. In the parent nuclei with $Z = 130$ and $Z = 138$ that we are currently surveying, we find additional shell closures at $N = 172, 184$, and 198 for a new neutron magic number. Hence,

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$N = 172, 184, 198, 228,$ and 238 are likely to be the neutron magic numbers which have been previously reported for different relativistic mean field parametrization (Gambhir *et al.*, 2009; Bhuyan and Patra, 2012) [22, 23]. For a theoretical comparison, the alpha decay, cluster decay, and the spontaneous fission were compared with the CPP-ITM (Cubic Plus Proximity Potential with Improved Transfer Matrix) model, the UDL (universal decay law), the Royer analytic formula, Viola-Seaborg semiempirical formula (VSS), Shell-effect-dependent formula of Santhosh *et al.*, and Semiempirical formula by Xu *et al.* The results of current model's predictions with that of other models are quite consistent. We hope for that this study will be very useful for the future experimental investigations in this field.

2. Cubic Plus Yukawa Plus Exponential Model

In order to study the decay properties of Superheavy elements (SHE), we have used a realistic model [24], called as CYE model, in which we use a cubic potential in the pre-scission region which is connected by a Yukawa plus Exponential potential in the post scission region. Here, the zero-point vibration energy is explicitly included without violating the conservation of energy. The alpha particle pre-exists within the nucleus at a certain distance from the nucleus and the potential encountered by this alpha particle is a purely Coulomb one. This potential as a function of r which is the center of mass distance of the two fragments for the post scission region is given by,

$$V(r) = \frac{Z_1 Z_2 e^2}{r} + V_n(r) - Q; \quad r \geq r_t,$$

where, $V_n(r)$ is the nuclear interaction energy and written in the form

$$V_n(r) = -D \left[F + \frac{r - r_t}{a} \right] \frac{r_t}{r} \exp \left[\frac{r_t - r}{a} \right],$$

and $r_t = R_1 + R_2$ is the sum of their equivalent sharp surface radii. The depth constant D and the constant F .

The shape of the potential barrier in the overlapping region which connects the ground-state and the contact-point is approximated by a third order poly-

nomial in r suggested by Ni_x having the form

$$V(r) = -E_v + [V(r_t) + E_v] \left\{ s_1 \left[\frac{r - r_i}{r_t - r_i} \right]^2 - s_2 \left[\frac{r - r_i}{r_t - r_i} \right]^2 \right\}; \quad r_i \leq r \leq r_t,$$

where r_i is the distance between the centers of mass of two portions of a parent nucleus cut by a planar section into two pieces with volume asymmetry of the decay.

Let a planar section cut the parent nucleus into two unequal portions with the masses of the heavy and light nuclei of the decay. If h_1 and h_2 are the heights of the heavy and light segments and R_0 is the radius of the parent nucleus, then

$$r_i = \frac{3}{4} \left[\frac{h_1^2}{R_0 + h_1} + \frac{h_2^2}{R_0 + h_2} \right].$$

For calculating the zero - point vibration energy E_v ,

$$E_v = \frac{\pi \hbar}{2} \left[\frac{\left(\frac{2Q}{\mu} \right)^{1/2}}{(C_1 + C_2)} \right].$$

The central radii C_1 and C_2 of the fragments are given by

$$C_i = 1.18 A^{1/3} - 0.48 \quad (i = 1, 2)$$

and

$$\mu = \frac{m_1 m_2}{m_1 + m_2},$$

where μ is the reduced mass of the system and m is the mass of the nucleon.

Half-life time value is calculated by using the formula $T = \frac{1.433 \times 10^{-21} (1 + \exp K)}{E_v}$.

3. Results and Discussion

In this study, we used our Cubic plus Yukawa plus Exponential Model in a two-sphere approximation (WOD), to determine the alpha decay half lifetimes, cluster decay and spontaneous fission for various isotopes of Superheavy nuclei. The results are compared with the (CPP-ITM) model of G. Naveya *et al.*, [25, 26], the Universal Decay Law (UDL) of Qi *et al.*, [27,

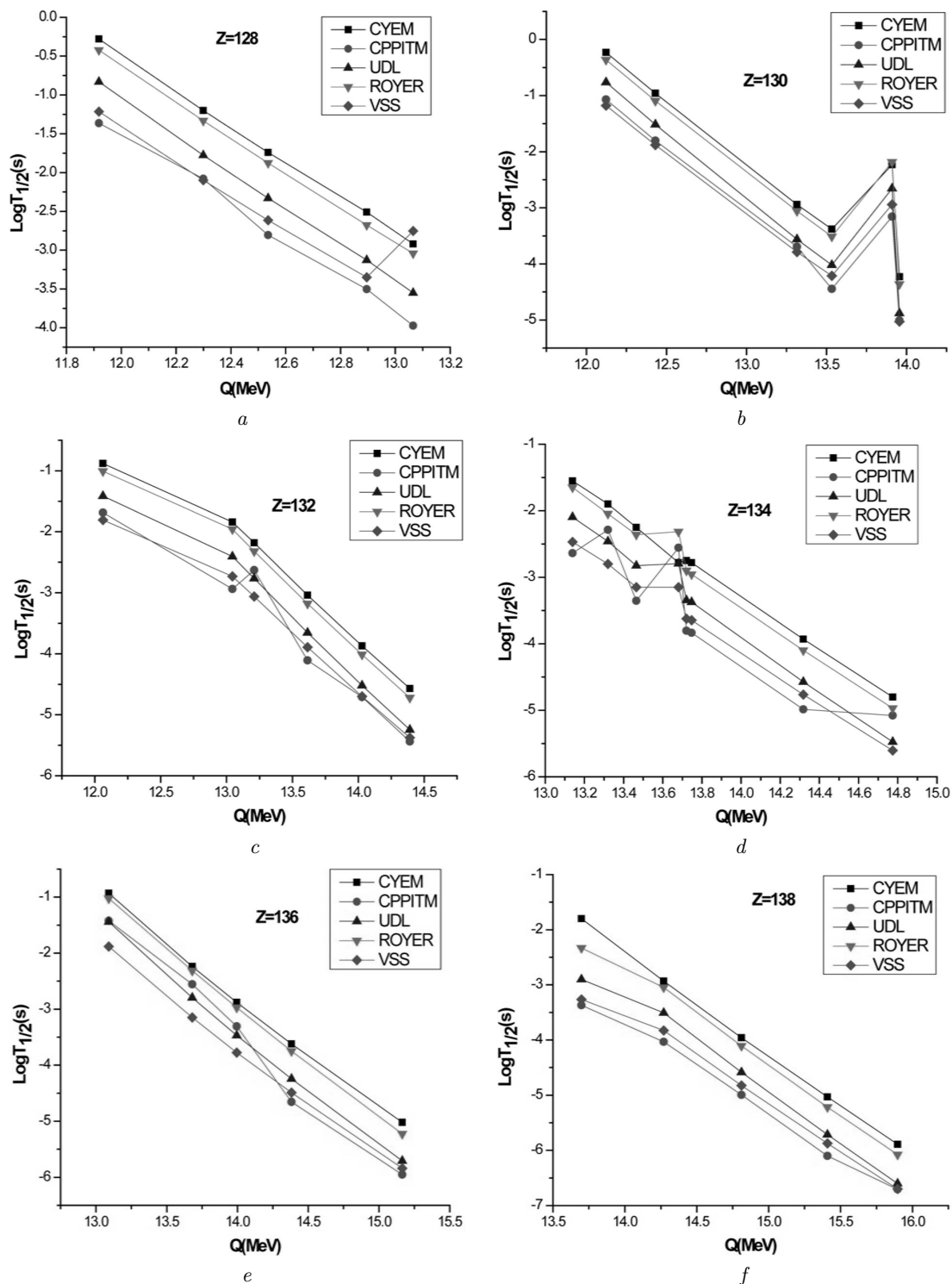


Fig. 1. Shows the comparison plot for the calculated logarithmic values of half lifetime of alpha decay without deformation Vs. Q value(MeV) for $Z = 128, 130, 132, 136$ and 138 even nucleus

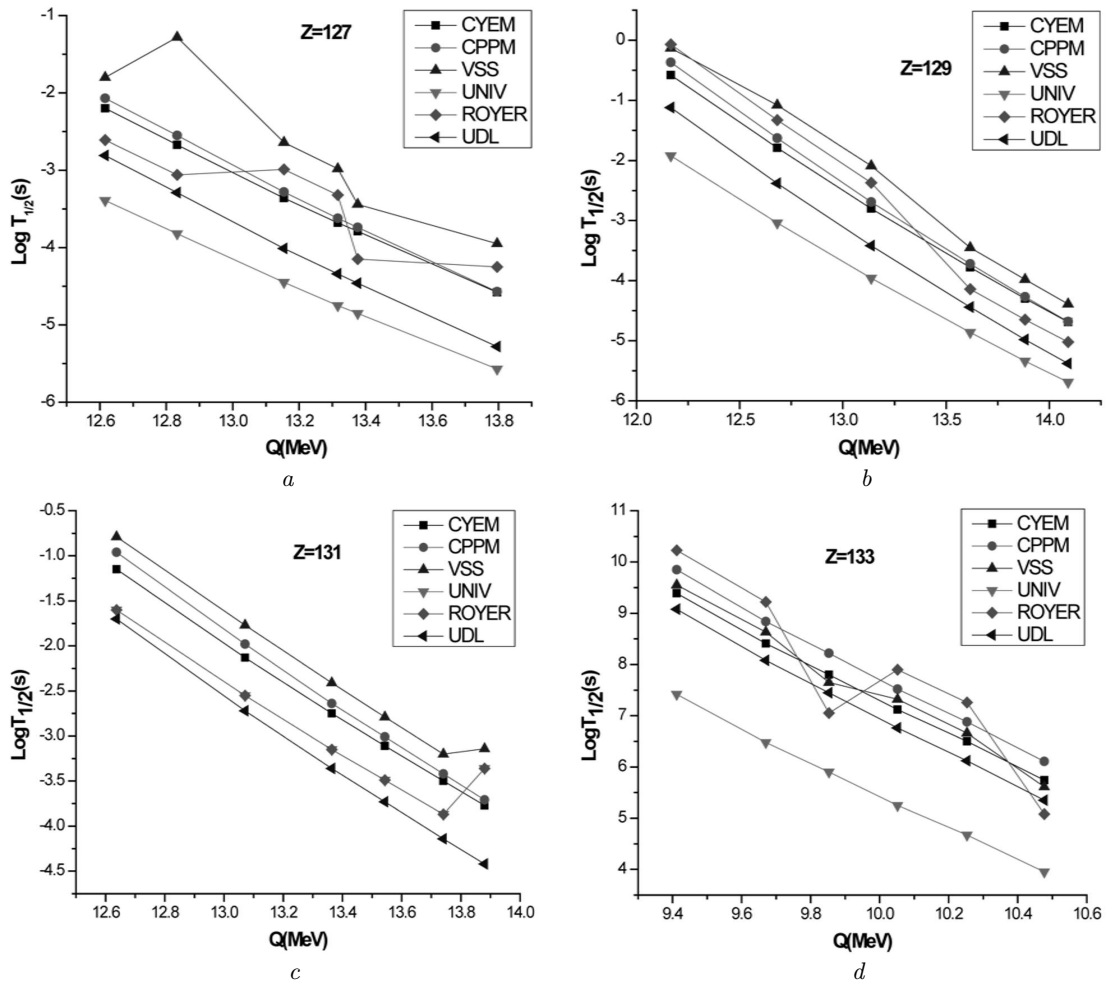


Fig. 2. Shows the comparison plot for the calculated logarithmic values of half lifetime of alpha decay without deformation Vs. Q value (MeV) for $Z = 127, 131$ and 133 odd nucleus

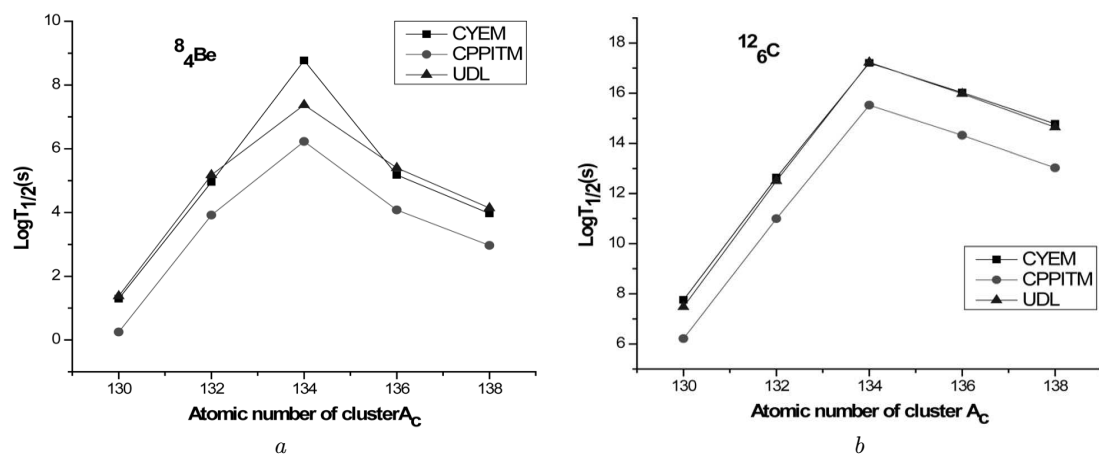


Fig. 3. Shows the comparison plot for the Q -value and the half lifetimes for cluster emission of ${}^8_4\text{Be}$, ${}^{12}_6\text{C}$ for $Z = 130-138$ even-even isotopes

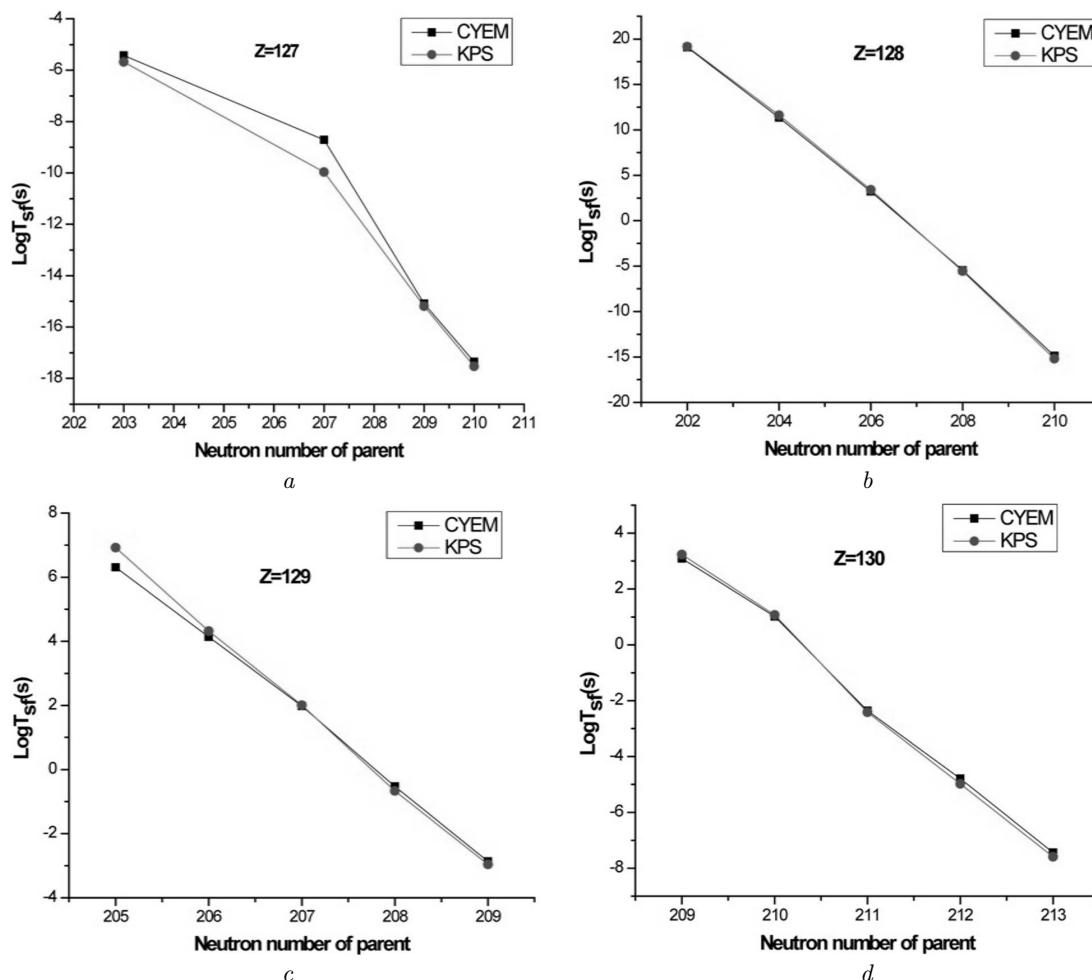


Fig. 4. Shows the comparison plot of SF half lifetimes for the Neutron number of parent nuclei versus $\text{Log}T_{1/2}(s)$

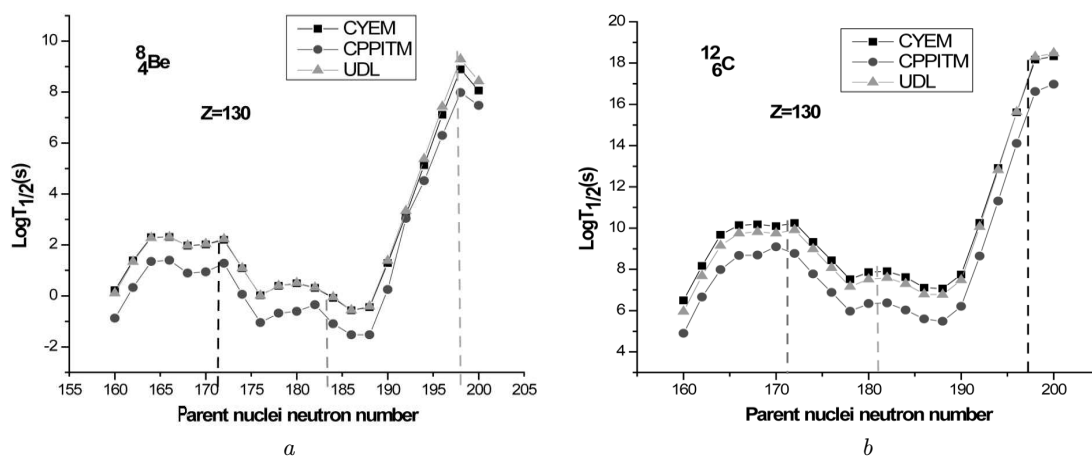


Fig. 5. Half lifetimes for ${}^8_4\text{Be}$ and ${}^{12}_6\text{C}$ emission against neutron number of daughter nuclei for $Z = 130$

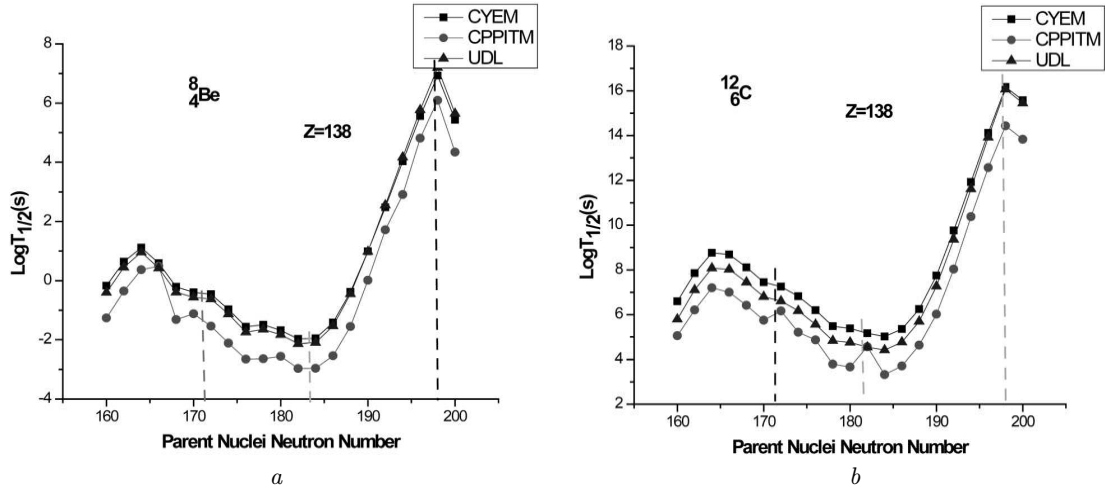


Fig. 6. Half lifetimes for ${}^8_4\text{Be}$ and ${}^{12}_6\text{C}$ emission against neutron number of parent nuclei for $Z = 138$

28] the Royer Analytical Formula [10] and the Viola-Seaborg Semiempirical Formula (VSS)[29], (CPPM) model of K.P. Santhosh *et al.*, [30], (UNIV) D.N. Poenaru *et al.*, [31], D.N. Poenaru *et al.*, [32] for the alpha emission and cluster emission. Since spontaneous fission is complex, spontaneous fission half lifetime using the new shell-effect-dependent formula by Santhosh *et al.*, [33, 34] was obtained which provides a good description of SF half lifetimes. We have compared the calculated half life values to other theoretical values that are currently accessible in Table 1. Binding energy from the WS4 mass table is used to compute Q -values [35]. Table 2 shows the comparison of alpha decay half lifetime values for different isotopes of Superheavy nuclei $Z = 127, 129, 131$ & 133 odd-odd isotopes using the CYE Model with the available theoretical models. The Q -value and the half lifetimes for cluster emission of ${}^8_4\text{Be}$ and ${}^{12}_6\text{C}$ for $Z = 130-138$ even even isotopes in Table 3. In Table 4, several SHE $Z = 127-130$ isotopes alpha decay and spontaneous fission decay characteristics over a range of Q values have been investigated using the CYE model. The predictions of the present model and other models are highly consistent with each other. Figures 1 and 2 show the variance in the logarithmic alpha decay half lifetimes with Q -values for different superheavy nuclear isotopes. Figures 3 and 4 show the comparison plot for the Q -value and the half lifetimes for cluster emission of ${}^8_4\text{Be}$ and ${}^{12}_6\text{C}$ for $Z = 130-138$ even even isotopes. In Fig. 4, the half-lifetime obtained with the present calculation is plotted with respect to the par-

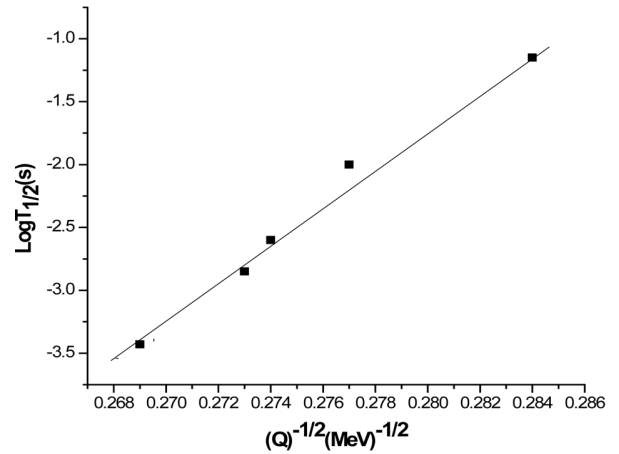


Fig. 7. Geiger-Nuttall law curve for decay modes of $Z = 131$ isotope

ent nuclei neutron number. Figures 5 and 6 show the parent nuclei of $Z = 130$ and $Z = 138$ brings out more shell closures at $N = 172, 184$ and 198 , such a consistent trend seen is the evidence of new neutron magic numbers. Additionally, the Geiger-Nuttall law plot for decay modes of $Z = 131$ isotope is represented in Fig. 6, it shows the linear relationship between $1/\sqrt{Q}$ (MeV) $^{-1/2}$ versus $\text{Log } T_{1/2}(\text{s})$, and the straight line indicates that the model predictions are correct. The achieved values exhibit excellent agreement with other values. Theoretical predictions made here will undoubtedly provide a useful direction for upcoming experimental work on the synthesis and/or identification of these superheavy isotopes.

Table 1. Comparison of alpha decay half lifetime values for different isotopes of Superheavy nuclei $Z = 128, 130, 132, 134, 136$ and 138 even-even isotopes using life CYE Model with the available theoretical models

Parent nuclei	Q_α (MeV) [35]	Log $T_{1/2}(s)$				
		CYEM [calculated]	CPP-ITM [25]	UDL [27]	ROYER [10]	VSS [29]
³³⁰ 128	12.8957	-2.51	-3.5035	-3.1280	-2.6766	-3.3501
³³² 128	13.0651	-2.92	-3.9727	-3.5498	-3.0415	-3.7528
³³⁴ 128	12.5360	-1.74	-2.8055	-2.3313	-1.8776	-2.6143
³³⁶ 128	12.2992	-1.20	-2.0786	-1.7764	-1.3325	-2.0993
³³⁸ 128	11.9186	-0.28	-1.3629	-0.8299	-0.4225	-1.2164
³³⁴ 130	13.9555	-4.23	-5.0077	-4.8976	-4.3591	-5.0295
³³⁶ 130	13.5338	-3.38	-4.4460	-4.0195	-3.5119	-4.2110
³³⁸ 130	13.3156	-2.94	-3.6916	-3.5624	-3.0576	-3.7880
³⁴⁰ 130	13.9096	-2.23	-3.1557	-2.6535	-2.1822	-2.9406
³⁴² 130	12.4306	-0.96	-1.8016	-1.5170	-1.0947	-1.8794
³⁴⁴ 130	12.1234	-0.23	-1.0710	-0.7626	-0.3638	-1.1772
³³⁸ 132	14.3920	-4.57	-5.4388	-5.2474	-4.7203	-5.3744
³⁴⁰ 132	14.0282	-3.87	-4.7080	-4.5204	-4.0139	-4.6980
³⁴² 132	13.6154	-3.64	-4.1100	-3.6546	-3.1782	-3.8912
³⁴⁴ 132	13.2101	-2.18	-2.6275	-2.7644	-2.3199	-3.0616
³⁴⁶ 132	13.0448	-1.84	-2.9381	-2.4066	-1.9585	-2.7319
³⁴⁸ 132	12.6237	-0.88	-1.6865	-1.4147	-1.0057	-1.8068
³⁴² 134	14.7738	-4.80	-5.0788	-5.4735	-4.9684	-5.6028
³⁴⁴ 134	14.3175	-3.93	-4.9848	-4.5723	-4.0993	-4.7630
³⁴⁶ 134	13.7477	-2.78	-3.8349	-3.3746	-2.9538	-3.6450
³⁴⁸ 134	13.7206	-2.75	-3.8040	-3.3442	-2.875	-3.6227
³⁵⁰ 134	13.3200	-1.90	-2.2860	-2.4613	-2.0460	-2.8001
³⁵² 134	13.4650	-2.25	-3.3548	-2.8260	-2.3586	-3.1486
³⁵⁴ 134	13.1393	-1.54	-2.6380	-2.0952	-1.6494	-2.4688
³⁵⁶ 134	13.6801	-2.78	-2.5548	-2.7961	-2.3145	-3.1491
³⁴⁶ 136	15.1645	-5.02	-5.9496	-5.7084	-5.2271	-5.8392
³⁴⁸ 136	14.5966	-3.95	-4.9601	-4.6012	-4.1654	-4.8063
³⁵⁰ 136	14.8634	-4.51	-5.3275	-5.1739	-4.6719	-5.3499
³⁵² 136	14.3222	-3.47	-4.0012	-4.0874	-3.6299	-4.3365
³⁵⁴ 136	14.3825	-3.62	-4.6576	-4.2446	-3.7489	-4.4901
³⁵⁶ 136	13.9982	-2.84	-3.4155	-3.4477	-2.9775	-3.7485
³⁵⁸ 136	13.9953	-2.88	-3.3071	-3.4708	-2.9715	-3.7761
³⁶⁰ 136	13.6801	-2.24	-2.5548	-2.7961	-2.3145	-3.1491
³⁶² 136	13.0905	-0.93	-1.4248	-1.4406	-1.0224	-1.8834
³⁶⁴ 136	13.4369	-1.74	-2.7883	-2.2943	-1.7920	-2.6904
³⁶⁶ 136	13.6884	-2.33	-3.3703	-2.9022	-2.3321	-3.2666
³⁵⁰ 138	15.4215	-5.01	-5.9178	-5.6793	-5.2413	-5.8277
³⁵² 138	15.8961	-5.89	-6.7076	-6.6032	-6.0758	-6.7007
³⁵⁴ 138	15.4086	-5.03	-6.1003	-5.7146	-5.2181	-5.8730
³⁵⁶ 138	15.2294	-4.73	-5.7629	-5.3957	-4.8925	-5.5800
³⁵⁸ 138	14.8104	-3.96	-4.9934	-4.5856	-4.1084	-4.8261
³⁶⁰ 138	14.6735	-3.72	-4.6262	-4.3329	-3.8448	-4.5950
³⁶² 138	14.2704	-2.93	-4.0349	-3.5079	-3.0472	-3.8272
³⁶⁴ 138	13.7956	-1.93	-2.8878	-2.4829	-2.0630	-2.8717
³⁶⁶ 138	14.1862	-2.80	-3.8872	-3.3833	-2.8762	-3.7222
³⁶⁸ 138	14.0109	-2.47	-3.4721	-3.0259	-2.5155	-3.3930
³⁷⁰ 138	13.6986	-1.80	-3.3703	-2.9022	-2.3321	-3.2666

Table 2. Comparison of alpha decay half lifetime values for different isotopes of Superheavy nuclei $Z = 127, 129, 131$ and 133 odd-odd isotopes using life CYE Model with the available theoretical models

Parent nuclei	Q_α (MeV) [35]	Log $T_{1/2}(s)$					
		CYEM [calculated]	CPPM [30]	VSS [29]	UNIV [31, 32]	ROYER [10]	UDL [27]
³²⁰ 127	13.796	-4.58	-4.57	-3.95	-5.57	-4.25	-5.28
³²¹ 127	13.397	-3.77	-3.72	-3.49	-4.83	-4.12	-4.44
³²² 127	13.238	-3.45	-3.38	-2.81	-4.53	-3.08	-4.11
³²³ 127	13.220	-3.43	-3.36	-3.12	-4.51	-3.79	-4.08
³²⁴ 127	13.339	-3.70	-3.64	-3.02	-4.76	-3.33	-4.36
³²⁵ 127	13.376	-3.79	-3.74	-3.44	-4.85	-4.15	-4.46
³²⁶ 127	13.316	-3.68	-3.62	-2.98	-4.75	-3.32	-4.34
³²⁷ 127	13.200	-3.45	-3.37	-3.08	-4.53	-3.81	-4.10
³²⁸ 127	13.154	-3.36	-3.28	-2.64	-4.45	-2.99	-4.01
³²⁹ 127	12.833	-2.67	-2.55	-1.28	-3.82	-3.06	-3.29
³³⁰ 127	12.651	-2.27	-2.38	-1.54	-3.45	-1.85	-2.88
³³¹ 127	12.616	-2.20	-2.07	-1.80	-3.39	-2.61	-2.81
³²⁶ 129	14.051	-4.59	-4.58	-3.97	-5.60	-4.23	-5.28
³²⁷ 129	14.091	-4.69	-4.68	-4.39	-5.69	-5.02	-5.38
³²⁸ 129	14.004	-4.53	-4.51	-3.88	-5.54	-4.17	-5.21
³²⁹ 129	13.883	-4.30	-4.27	-3.98	-5.34	-4.65	-4.98
³³⁰ 129	13.785	-4.12	-4.07	-3.44	-5.17	-3.74	-4.78
³³¹ 129	13.617	-3.78	-3.72	-3.45	-4.86	-4.14	-4.44
³³² 129	13.301	-3.12	-3.03	-2.44	-4.26	-2.71	-3.75
³³³ 129	13.343	-3.23	-3.14	-2.87	-4.38	-3.61	-3.86
³³⁴ 129	13.137	-2.80	-2.69	-2.09	-3.96	-2.37	-3.42
³³⁵ 129	12.762	-1.96	-1.81	-1.60	-3.20	-2.38	-2.55
³³⁶ 129	12.682	-1.79	-1.63	-1.08	-3.04	-1.33	-2.38
³³⁷ 129	12.531	-1.45	-1.28	-1.07	-2.73	-1.89	-2.02
³³⁸ 129	12.166	-0.58	-0.37	-0.13	-1.92	-0.07	-1.12
³³⁴ 131	13.880	-3.77	-3.71	-3.14	-3.36	-3.36	-4.42
³³⁵ 131	13.741	-3.50	-3.42	-3.20	-3.87	-3.87	-4.14
³³⁶ 131	13.702	-3.43	-3.35	-2.78	-3.00	-3.00	-4.07
³³⁷ 131	13.543	-3.11	-3.01	-2.79	-3.49	-3.49	-3.73
³³⁸ 131	13.417	-2.85	-2.74	-2.18	-3.40	-3.40	-3.47
³³⁹ 131	13.364	-2.75	-2.64	-2.41	-3.15	-3.15	-3.36
³⁴⁰ 131	13.285	-2.60	-2.47	-1.90	-2.13	-2.13	-3.21
³⁴¹ 131	13.071	-2.13	-1.98	-1.77	-2.55	-2.55	-2.72
³⁴² 131	13.007	-2.00	-1.85	-1.29	-1.52	-1.52	-2.58
³⁴³ 131	12.637	-1.15	-0.96	-0.79	-1.60	-1.60	-1.70
³²⁹ 133	10.046	7.22	7.62	7.00	5.35	6.50	6.85
³³⁰ 133	10.253	6.50	6.88	6.66	4.67	7.26	6.12
³³¹ 133	10.477	5.74	6.11	5.61	3.95	5.08	5.35
³³² 133	10.393	6.00	6.38	6.21	4.20	6.75	5.62
³²³ 133	10.221	6.56	6.95	6.42	4.72	5.86	6.18
³³⁴ 133	10.052	7.12	7.52	7.32	5.25	7.90	6.76
³³⁵ 133	9.853	7.80	8.22	7.65	5.90	7.05	7.45
³³⁶ 133	9.412	9.39	9.85	9.55	7.42	10.23	9.08
³³⁷ 133	9.508	9.03	9.47	8.87	7.07	8.23	8.71
³³⁸ 133	9.670	8.41	8.84	8.63	6.48	9.22	8.08
³³⁹ 133	9.581	8.72	9.16	8.61	6.78	7.93	8.40

Table 3. The Q -value and the half lifetimes for cluster emission of ${}^8_4\text{Be}$ and ${}^{12}_6\text{C}$ for $Z = 130-138$ even-even isotopes

Parent nuclei	Q_{Be} (MeV) [35]	$\text{Log}T_{1/2}(s)$			Q_c (MeV) [35]	$\text{Log}T_{1/2}(s)$		
		CYEM [calculated]	CPP-ITM [26]	UDL [28]		CYEM [calculated]	CPP-ITM [26]	UDL [28]
${}^{320}_{130}$	34.69	1.29	0.25	1.38	54.93	7.75	6.21	7.48
${}^{322}_{130}$	33.37	3.18	3.04	3.34	52.98	10.26	8.64	10.07
${}^{324}_{130}$	32.08	5.13	4.52	5.38	51.03	12.91	11.31	12.82
${}^{326}_{130}$	30.85	7.11	6.30	7.43	49.15	15.61	14.11	15.63
${}^{328}_{130}$	29.80	8.89	7.98	9.29	47.46	18.17	16.62	18.30
${}^{330}_{130}$	30.23	8.06	7.48	8.43	47.30	18.33	16.97	18.48
${}^{332}_{130}$	30.65	7.26	6.78	7.62	47.27	18.29	16.74	18.43
${}^{334}_{130}$	29.86	8.59	7.58	8.99	47.10	18.47	17.27	18.64
${}^{336}_{130}$	28.90	10.30	9.32	10.76	45.85	20.46	19.60	20.72
${}^{338}_{130}$	27.89	12.20	11.36	12.74	44.38	22.92	21.28	23.27
${}^{340}_{130}$	26.86	14.25	13.86	14.87	42.85	25.63	24.17	26.09
${}^{342}_{130}$	25.82	16.45	16.13	17.15	41.30	28.53	26.89	29.11
${}^{320}_{132}$	36.59	-0.34	-1.13	-0.33	56.85	6.75	5.10	6.39
${}^{322}_{132}$	35.37	1.28	0.32	1.35	56.07	7.65	7.03	7.32
${}^{324}_{132}$	34.09	3.07	2.02	3.22	54.15	10.07	8.52	9.82
${}^{326}_{132}$	32.82	4.96	3.92	5.18	52.22	12.64	10.99	12.50
${}^{328}_{132}$	31.62	6.85	6.13	7.15	50.35	15.27	13.82	15.23
${}^{330}_{132}$	30.58	8.57	7.55	8.95	48.67	17.76	16.19	17.82
${}^{332}_{132}$	31.12	7.57	7.22	7.90	48.62	17.74	16.12	17.82
${}^{334}_{132}$	31.67	6.57	5.52	6.89	48.71	17.51	15.86	17.89
${}^{336}_{132}$	30.86	7.89	6.88	8.25	48.66	17.49	15.87	17.59
${}^{338}_{132}$	29.91	9.51	8.50	9.96	47.39	19.44	17.78	19.63
${}^{340}_{132}$	28.90	11.34	10.30	11.85	45.92	21.82	20.41	22.10
${}^{342}_{132}$	27.88	13.28	12.26	13.87	44.40	24.40	22.76	24.79
${}^{320}_{134}$	37.79	-0.94	-2.07	-0.99	58.47	6.18	5.39	5.74
${}^{322}_{134}$	37.18	-0.21	-1.13	-0.22	58.02	6.63	4.99	6.21
${}^{324}_{134}$	36.02	1.31	0.29	1.36	57.02	7.79	6.12	7.41
${}^{326}_{134}$	34.78	3.02	2.04	3.14	55.19	10.06	8.50	9.77
${}^{328}_{134}$	33.55	4.81	3.75	5.01	53.31	12.53	10.93	12.33
${}^{330}_{134}$	32.38	6.61	5.58	6.88	51.49	15.04	13.82	14.95
${}^{332}_{134}$	31.37	8.24	5.17	8.59	49.85	17.41	16.03	17.43
${}^{334}_{134}$	32.03	8.77	6.23	7.38	49.92	17.21	15.52	17.23
${}^{336}_{134}$	32.68	5.93	4.99	6.20	50.12	16.81	15.43	16.83
${}^{338}_{134}$	31.88	7.18	6.55	7.51	50.21	16.58	14.98	16.61
${}^{340}_{134}$	30.94	8.73	8.65	9.13	48.92	18.49	17.23	18.60
${}^{342}_{134}$	29.95	10.45	9.77	10.92	47.47	20.75	19.08	20.96
${}^{320}_{136}$	38.90	-1.40	-2.22	-1.50	60.02	5.72	4.01	5.19
${}^{322}_{136}$	38.59	-1.08	-2.24	-1.16	59.82	5.85	4.23	5.34
${}^{324}_{136}$	37.83	-0.16	-1.30	-0.19	59.18	6.53	5.28	6.05
${}^{326}_{136}$	36.71	1.28	0.26	1.31	57.99	7.90	6.29	7.48
${}^{328}_{136}$	35.52	2.90	2.05	2.99	56.24	10.04	8.34	9.70
${}^{330}_{136}$	34.34	4.58	3.70	4.75	54.43	12.37	11.54	12.13
${}^{332}_{136}$	33.22	6.26	5.19	6.51	52.68	14.74	13.20	14.61
${}^{334}_{136}$	32.24	7.80	6.70	8.11	51.09	16.99	15.61	16.95
${}^{336}_{136}$	33.01	6.47	5.38	6.74	51.28	16.61	14.89	16.56
${}^{338}_{136}$	33.78	5.18	4.08	5.40	51.60	16.03	14.32	15.98
${}^{340}_{136}$	33.00	6.35	5.30	6.63	51.83	15.60	14.35	15.55
${}^{342}_{136}$	32.10	7.78	6.75	8.13	50.57	17.40	15.82	17.43
${}^{320}_{138}$	40.12	-1.97	-2.97	-2.13	61.67	5.16	4.56	4.54
${}^{322}_{138}$	40.04	-1.95	-2.96	-2.09	61.70	5.02	3.32	4.42
${}^{324}_{138}$	39.56	-1.42	-2.54	-1.53	61.33	5.35	3.71	4.77
${}^{326}_{138}$	38.69	-0.38	-1.55	-0.45	60.50	6.24	4.63	5.69
${}^{328}_{138}$	37.60	0.99	0.01	0.98	59.18	7.74	6.02	7.27
${}^{330}_{138}$	36.47	2.48	1.72	2.55	57.50	9.76	8.03	9.36
${}^{332}_{138}$	35.35	4.03	2.91	4.17	55.78	11.92	10.38	11.62
${}^{334}_{138}$	34.29	5.56	4.81	5.77	54.11	14.12	12.56	13.02
${}^{336}_{138}$	33.38	6.93	6.09	7.20	52.61	16.17	14.43	16.07
${}^{338}_{138}$	34.29	5.43	4.34	5.65	52.96	15.57	13.83	15.45
${}^{340}_{138}$	35.21	3.97	2.97	4.14	53.44	14.78	13.02	14.64
${}^{342}_{138}$	34.51	4.97	3.97	5.18	53.85	14.10	12.36	13.95

Table 4. The alpha and Spontaneous fission decay properties of various isotopes of SHE $Z = 127-130$ for different Q values

Parent nuclei	Q_α (MeV) [35]	CYEM [calculated]		Ref. [33, 34]		Dominant decay modes
		$\text{Log}T_\alpha(s)$	$\text{Log}T_{sf}(s)$	$\text{Log}T_\alpha(s)$	$\text{Log}T_{sf}(s)$	
$^{330}_{127}$	12.65	-2.27	-5.42	-2.38	-5.68	α
$^{332}_{127}$	12.38	-1.48	-4.63	-1.50	-4.78	SF
$^{334}_{127}$	12.12	-0.68	-8.71	-0.88	-9.97	SF
$^{336}_{127}$	11.30	1.09	-15.09	1.11	-15.19	SF
$^{338}_{127}$	10.60	3.16	-17.36	3.35	-17.53	SF
$^{330}_{128}$	12.89	-3.42	19.08	-3.50	19.15	α
$^{332}_{128}$	13.06	-3.89	11.34	-3.97	11.62	α
$^{334}_{128}$	12.53	-2.64	3.21	-2.80	3.39	α
$^{336}_{128}$	12.29	-2.01	-5.47	-2.07	-5.55	SF
$^{338}_{128}$	11.91	-1.31	-14.89	-1.36	-15.21	SF
$^{334}_{129}$	13.13	-2.80	6.31	-2.69	6.92	α
$^{335}_{129}$	12.76	-1.96	4.14	-1.81	4.32	α
$^{336}_{129}$	12.68	-1.79	1.98	-1.63	2.01	α
$^{337}_{129}$	12.53	-1.45	-0.53	-1.28	-0.67	α
$^{338}_{129}$	12.16	-0.58	-2.87	-0.37	-2.96	SF
$^{339}_{129}$	11.89	0.28	-5.48	0.31	-5.64	SF
$^{339}_{130}$	12.91	-1.76	3.09	-1.92	3.23	α
$^{340}_{130}$	12.72	-1.34	1.01	-1.48	1.07	α
$^{341}_{130}$	12.58	-1.02	-2.36	-1.13	-2.42	SF
$^{342}_{130}$	12.47	-0.65	-4.79	-0.89	-4.98	SF
$^{343}_{130}$	12.23	-0.19	-7.44	-0.29	-7.59	SF
$^{344}_{130}$	12.07	0.10	-10.09	0.11	-10.26	SF

We have predicted the alpha decay half-lives, cluster decay and spontaneous fission half lifetimes in the isotopes 127–138 are studied using the CYE model. Alpha decay, cluster decay and spontaneous fission half lifetimes are compared with other theoretical models like CPP-ITM, CPPM, VSS, UDL, UNIV, KPS and analytical formula of Royer. The neutron shell closure at $N = 172, 184$ and 198 and is the signatures of magicity is presented. The theoretical predictions reported here will certainly have useful guidance for the future experimental efforts towards the synthesis and/or identification of these superheavy isotopes.

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ПЕРЕДБАЧЕННЯ ЩОДО
АЛЬФА-РОЗПАДУ НАДВАЖКИХ ЯДЕР
ІЗ $Z = 127-138$ НА ОСНОВІ СУЕ МОДЕЛІ

На основі моделі СУЕ досліджено альфа-розпад, розпад на кластери і спонтанний поділ важких і надважких ядер. В даній роботі отримано періоди напіврозпаду на кластери для ядер в інтервалі $Z = 127-138$, а також періоди спонтанного поділу цих ядер з використанням наближення двох сфер. Результати порівняно з іншими теоретичними моделями і напівемпіричною формулою Ксу та ін.

Ключові слова: СУЕ модель, альфа-розпад, надважкі ядра, кластер, спонтанний поділ, період напіврозпаду.