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Decay modes of Uranium in the range 203 <A<299

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In the present work, we have considered the total potential as the sum of the coulomb and proximity potential. We have used the recent proximity function to calculate the nuclear potential. The calculated logarithmic half-lives correspond to fission, cluster and alpha decay are compared with that of experiments. We also identified the most probable decay mode by studying branching ratios of these different decay modes. The competition between different decay modes such as fission, cluster radioactivity and alpha decay finds an important role in nuclear structure.

Keywords: Nuclear potential, Cluster radioactivity, Alpha decay, Spontaneous fission

1 Introduction

It is important to study the alpha decay properties of superheavy nuclei. Most of the superheavy nuclei are identified through alpha decay process only. Many researchers in the nuclear physics field predicted alpha decay half-lives for the superheavy nuclei[1-10]. Superheavy nuclei can be synthesized using fusion reaction through the compound nucleus formation. The compound nucleus formed during the fusion reaction undergoes different decay modes such as alpha decay, spontaneous fission and cluster radioactivity, etc. It is important to study the competition between different decay modes. Manjunatha and Sowmya[11] studied the competition between spontaneous fission, ternary fission, cluster decay and alpha decay in the super heavy nuclei of Z=126. It finds importance to construct a simple and accurate semi empirical formula for the prediction of alpha decay and cluster radioactivity. Earlier researchers proposed different formulae for the evaluation of alpha decay half lives[12-15]. Poenaru[16] *et al.* evaluated the deviations of the formulae proposed by the earlier workers[13-15]. Earlier workers [17] shown that preformed-cluster models are equivalent with fission models, used to describe in a unified way cluster radio activities and alpha decay. Parkhomenko *et al*.[18] studied the alpha decay properties for odd mass number superheavy nuclei. Poenaru *et al*.[19] improved the formula for alpha decay halflives around magic numbers by using the SemFIS formula. Sobiczewski *et al*. [20] reviewed the theoretical studies on alpha decay of superheavy nuclei, which are based on both traditional macroscopic–microscopic, and purely microscopic and self-consistent approaches.

Ni *et al*.[21] proposed a general formula of half-lives for α decay and cluster radioactivity. Poenaru *et al*.[22-24] formulated the expression for half-lives of heavy-particle radioactivity (HPR) and alpha decay using the WKB approximation. Poenaru *et al*.[25,26] studied the alpha decay half-lives and cluster radioactivity of superheavy nuclei. A study of alpha and cluster decay is important to predict the decay mode of superheavy nuclei[27,28]. Hourani[29] measured the cluster radioactivity in heavy elements. Nuclei in the actinide region are unstable and exhibiting alpha, cluster radioactivity and spontaneous fission. Heavy nuclei may decay through the different decay modes such as spontaneous fission, cluster and alpha decay. We have studied the different decay modes such as cluster, alpha decay, β^- decay, β^+ decay and spontaneous fission of Uranium in the range 203 <A<299. The aim of present work is also to identify the prominent decay modes of uranium in the range 203 <A<299.

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2 Theory

2.1 Cluster radioactivity and alpha decay process

The interacting potential between two nuclei is the sum of the Coulomb potential and proximity potential. We have used Denisov nuclear potential Vp(r)[30] to study the binary and ternary fission, is given by

$$V_P(r) = -1.989843\frac{R_1R_2}{R_1+R_2}\varphi(r-R_1-R_2-2.65)\times \left[1+0.0035251399\left(\frac{A_1}{A_2}+\frac{A_2}{A_1}\right)^{3/2}-0.4113263(I_1+I_2)\right] \quad \ldots (1)$$

Where effective nuclear radius is given by

$$R_i = R_{ip}\left(1-\frac{11.65415}{R_{ip}}\right)+1.284589\left(I_i-\frac{0.4A_i}{A_i+200}\right)(i=1,2) \quad \ldots (2)$$

Where R_{ip} is given by

$$R_{ip} = 1.24A_i^{3/2}\left[1+\frac{1.646}{A_i}-0.191\left(\frac{A_i-2Z_i}{A_i}\right)\right] \text{ with}$$

$$\boldsymbol{I_i} = \frac{\boldsymbol{N_i - Z_i}}{\boldsymbol{A_i}} \quad \ldots (3)$$

The universal function $\phi(s=r-R_1-R_2-2.65)$ is given by

$$\Phi(\xi) = \begin{cases} 1 - s/0.7881663 + 1.229218S^2 - 0.2234277S^3 - 0.1038769S^4 \\ -\frac{R_1R_2}{R_1+R_2}\left(0.1844935S^2 + 0.07570101S^3\right) + (I_1+I_2) \\ \left(0.04470645S^2 + 0.03346870S^3\right) \qquad \text{for } -5.65 \le S \le 0 \\ 1 - S^2\left[0.05410106\frac{R_1R_2}{R_1+R_2}\exp\left(-\frac{S}{1.760580}\right)\right] \\ -0.5395420(I_1+I_2)\exp\left(-\frac{S}{2.424408}\right)\times\exp\left(-\frac{S}{0.7881663}\right) \\ \qquad \text{for } S \ge 0 \end{cases}$$

We have used Coulomb potential $V_c(R)$, to study the cluster decay and alpha decay, is given by:

$$V_C(R) = Z_1Z_2e^2\begin{cases}\frac{1}{R} & (R > R_C) \\ \frac{1}{2R_c}\left[3-\left(\frac{R}{R_c}\right)^2\right] & (R < R_C)\end{cases} \quad \ldots (4)$$

where $R_C = 1.24\times(R_1+R_2)$, R_1 and R_2 are the radii of the emitted alpha/cluster and daughter nuclei, respectively. Z_1 and Z_2 are the atomic numbers of the daughter and emitted cluster. We have used the proximity function defined specially for cluster/alpha decay and it is given by[31]

$$\Phi(\varepsilon) = \frac{p_1}{1+exp\left(\frac{s_0+p_2}{p_3}\right)} \quad \text{with}$$

$$s_0 = \frac{R-R_1-R_2}{b} \quad \ldots (5)$$

Previous researchers evaluated the proximity function for the density-dependent nucleon-nucleon interaction using the double folding model and fitted the equation for the evaluated proximity function values. The fitting parameters p_1, p_2 and p_3 defined by the previous researchers[32] are -7.65, 1.02 and 0.89, respectively.

For all the four decays such as spontaneous fission, alpha ternary fission, cluster decay and alpha decay, the barrier penetrability *P* is given as:

$$P = \exp\left\{-\frac{2}{\hbar}\int_a^b\sqrt{2\mu(V-Q)}dz\right\} \quad \ldots (6)$$

Here $\mu = mA_1A_2/A$, where *m* is the nucleon mass and A_1, A_2 are the mass numbers of daughter and emitted clusters, respectively. The equation, $V(a)=V(b)=Q$ gives the turning points "*a*" and "*b*" for cluster/alpha decay. For fission process, first turning point is determined from the equation V(a)=Q and second turning point b=0. The above integral can be evaluated numerically or analytically, and the half-life time is given by:

$$T_{1/2} = \frac{\ln 2}{\lambda} = \frac{\ln 2}{\upsilon P} \quad \ldots (7)$$

where $\upsilon = \frac{\omega}{2\pi} = \frac{2E_\upsilon}{h}$ represent the number of assaults on the barrier per second and λ the decay constant. E_v, the empirical vibration energy, is given as:

$$E_\upsilon = Q\left\{0.056+0.039exp\left[\frac{4-A_2}{2.5}\right]\right\} \text{ for } A_2 \ge 4 \quad \ldots (8)$$

2.2 Proton emission half-lives

We have evaluated the proton decay half-lives using expression given by the previous researcher[33]:

$$\log(T_{1/2}) = a + bA^{1/6}Z^{1/2} + cZQ^{-1/2} + d_2|\beta_2|^{p_2} + d_4|\beta_4|^{p_4} \qquad \dots (9)$$

where Z and A are charge and mass number of parent nucleus, respectively. Where a, b, c, d_2, p_2, d_4 and p_4 are constants [33]. β_2 and β_4 are quadrupole and hexadecapole deformation parameters.

2.3 Spontaneous fission

The generalised spontaneous fission including pairing, shell model calculations and valence nucleons, Ren *et al*.[34] constructed a semi-empirical formula for spontaneous fission half-lives and is given by:

$$log_{10}[T_{1/2}(yr)] = 21.08 + c_1\frac{Z-90-\upsilon}{A} + c_2\frac{(Z-90-\upsilon)^2}{A} + c_3\frac{(Z-90-\upsilon)^3}{A} + c_4\frac{(Z-90-\upsilon)}{A}(N-Z-52)^2 \qquad \dots (10)$$

where $c_1 = -548.825021$, $c_2 = -5.359139$, $c_3 = 0.767379$, $c_4 = -4{,}28222$ and υ =0 for even-even nuclei and υ =2 for odd-A nuclei.

2.4 β⁻ decay formula

β^- decay process occurs in proton rich nuclei. Zhang *et al*.[35] constructed a semi-empirical formula for β^- decay half-lives and it is expressed as:

$$log_{10}T_{1/2} = (c_1Z + c_2)N + c_3Z + c_4 + shell(Z,N) \qquad \dots (11)$$

where shell correction term is expressed as:

$$shell(Z,N) = c_5\begin{pmatrix} e^{-(N-29)^2/15} + e^{-(N-50)^2/37} \\ + e^{-(N-85)^2/9} + e^{-(N-131)^2/3} \end{pmatrix} + c_6 e^{-\left[(Z-51.5)^2 + (N-80.5)^2\right]/1.9} \qquad \dots (12)$$

Z and N are the proton and neutron number of the parent nuclei, respectively. $T_{1/2}$ is the half-life of β^- decay. The parameters are $c_1 = 3.37\times10^{-4}$, $c_2 = -0.2558$, $c_3 = 0.4028$, $c_4 = -1.01$, $c_5 = 0.9039$ *and* $c_6 = 7.7139$.

2.5 β⁺ decay formula

Zhang *et al*.[40] proposed semi empirical formula for β^+ decay and it is expressed as:

$$log_{10}T_{1/2} = (c_1Z + c_2)N + c_3Z + c_4 \qquad \dots (13)$$

Z and N are the proton and neutron number, respectively. The parameters c_1, c_2, c_3 and c_4 are different for different orders. The first and second forbidden transition for β^+ decay and the different parameters are explained in detail[36]. The even-odd effects are also considered in the above equation.

3 Results and Discussion

The amount of energy released during distinct fission process is studied from the following equation:

$$Q = \Delta M(A,Z) - \sum_i^n \Delta M(A_i, Z_i) \qquad \dots (14)$$

where $\Delta M(A, Z)$ and $\Delta M(A_i,Z_i)$ are mass excess of the parent and daughter nuclei respectively. These mass excess values are taken from [37-42]. The variation of energy released (Q) in different decay modes (cluster radioactivity, alpha decay, spontaneous fission, β-decay and β+ decay) for isotopes of uranium is as shown in Fig. 1. To identify the dominant decay mode, we have studied the competition between different decay modes. Figure 2 shows the variation of logarithmic half-lives of cluster radioactivity, alpha decay, beta decay and spontaneous fission for different isotopes of uranium.

The branching ratios are studied using the corresponding decay constants of binary fission,

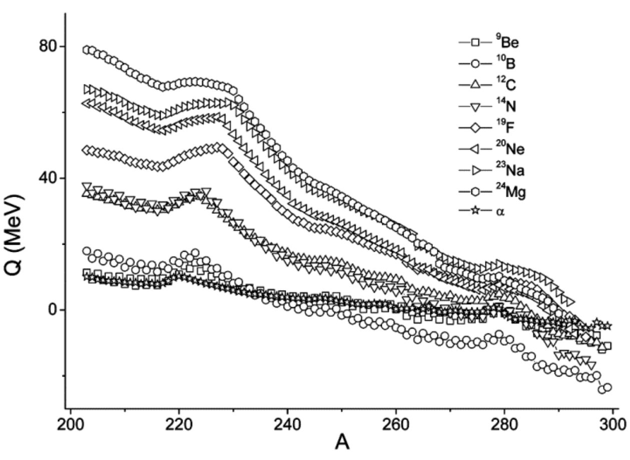

Fig. 1 — Variation of energy released (Q) in different decay modes for different isotopes of uranium

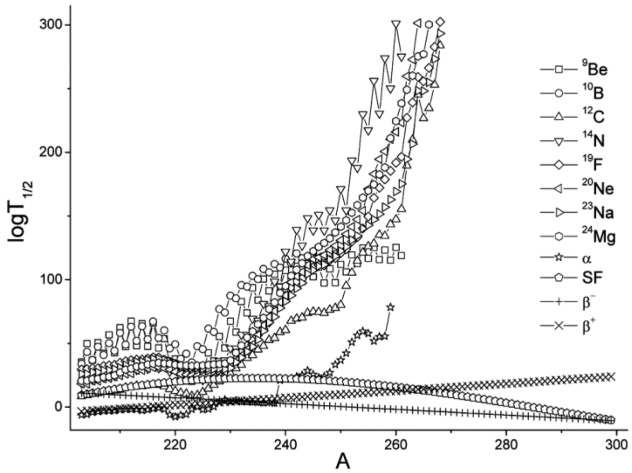

Fig. 2 — Variation of logarithmic half-lives of cluster radioactivity, alpha decay, beta decay and spontaneous fission for different isotopes of uranium.

ternary fission, cluster radioactivity and alpha decay. The branching ratio of alpha decay to the different decay modes are defined by:

$$BR = \frac{\lambda_\alpha}{\lambda_{BF,TF,CR}} \quad \dots (15)$$

where λ_α and $\lambda_{BF,TF,CR}$ are decay constants corresponding to alpha, binary fission, ternary fission and cluster decay, respectively. Figure 3 shows the variation of branching ratios with respect to alpha decay for different decay modes such as cluster radioactivity, beta decay and spontaneous fission as a function of mass number.

The comparison of alpha decay half-lives with that of other decay modes are shown in Table 1. The half-lives

Table 1 — The half-lives corresponding to cluster radioactivity, alpha decay, spontaneous fission, β- decay and β+ decay of $^{203-299}$U.

A	$logT_{1/2}$												Decay mode
	Cluster decay								Alpha decay	SF	β- decay	β+ decay	
	^{9}Be	^{10}B	^{12}C	^{14}N	^{19}F	^{20}Ne	^{23}Na	^{24}Mg					
203	35.46	33.92	8.65	18.89	29.55	18.26	25.97	20.74	-6.05	9.44	11.10	-3.32	α
204	49.83	43.30	9.40	23.55	29.83	18.21	26.04	20.85	-5.66	10.28	10.87	-3.04	α
205	36.92	36.96	10.60	21.50	30.60	20.60	27.44	22.01	-4.08	11.10	10.65	-2.76	α
206	50.56	47.40	11.00	24.89	30.52	20.60	27.29	22.23	-3.50	11.89	10.42	-2.47	α
207	42.19	40.88	12.31	23.25	32.25	22.43	28.89	23.49	-2.86	12.66	10.20	-2.19	α
208	56.72	50.20	12.18	27.71	32.66	22.65	29.04	23.91	-2.88	13.40	9.97	-1.91	α
209	42.73	44.12	13.01	24.50	33.14	23.96	29.80	25.05	-2.79	14.11	9.75	-1.63	α
210	62.33	58.23	13.65	30.69	34.86	24.72	30.89	27.13	-2.01	14.79	9.52	-1.34	α
211	47.36	49.04	15.35	27.68	36.05	26.05	32.99	29.43	-1.67	15.44	9.30	-1.06	α
212	67.42	62.98	15.90	33.63	36.76	26.52	34.11	30.34	-1.63	16.07	9.07	-0.78	α
213	48.21	52.04	16.78	29.31	37.42	28.93	35.59	31.76	-1.77	16.66	8.85	-0.50	α
214	65.35	63.43	16.48	34.21	37.42	28.95	35.73	32.12	-2.61	17.23	8.62	-0.21	α
215	47.73	53.26	17.32	30.11	38.00	30.46	36.98	33.48	-2.05	17.77	8.40	0.07	α
216	66.02	67.25	17.61	35.83	39.05	31.00	37.81	34.13	-1.25	18.28	8.17	0.57	α
217	46.49	54.30	17.47	30.61	38.95	31.41	38.02	34.82	-0.64	18.77	7.95	0.63	α
218	53.87	60.18	16.25	33.85	37.27	30.46	37.05	34.32	-1.69	19.22	7.72	1.13	α
219	34.69	46.13	14.21	27.84	35.67	29.55	35.90	34.14	-5.94	19.65	7.50	1.20	α
220	37.71	49.31	12.70	29.33	33.91	27.71	34.58	33.28	-7.60	20.04	7.32	1.69	α
221	24.43	37.95	11.31	23.74	31.69	26.06	32.86	32.87	-6.26	20.41	7.29	1.76	α
222	28.10	41.93	10.59	26.17	30.17	25.54	31.53	32.65	-5.58	20.76	7.47	2.26	α
223	20.21	35.11	8.74	22.01	29.12	25.00	30.83	32.41	-1.70	21.07	7.50	2.33	α
224	32.25	47.67	9.47	23.85	28.64	24.69	30.75	32.55	0.22	21.36	7.02	2.82	α
225	27.44	45.55	11.86	21.28	27.57	24.22	30.11	32.71	-1.89	21.62	6.39	2.89	α
226	42.51	61.54	14.40	27.98	27.54	24.20	30.38	33.09	-1.39	21.85	5.97	3.39	α
227	36.20	59.01	17.43	28.67	26.60	23.66	29.97	33.50	0.33	22.06	5.70	3.46	α
228	55.37	76.83	20.27	36.17	27.25	24.26	30.31	33.89	3.94	22.24	5.48	3.95	α
229	46.44	74.21	23.25	36.79	29.54	27.95	29.72	34.33	5.77	22.39	5.25	4.02	β+
230	67.45	87.36	26.57	46.25	35.19	32.29	30.68	36.74	4.32	22.52	5.03	4.52	α
231	58.83	85.41	30.60	46.06	37.88	36.38	35.23	42.69	5.02	22.62	4.80	4.59	β+
232	82.89	95.70	33.29	56.81	43.41	40.57	38.95	48.38	4.40	22.69	4.58	5.08	α

(*Contd.*)

Table 1 — The half-lives corresponding to cluster radioactivity, alpha decay, spontaneous fission, β- decay and β+ decay of $^{203-299}U$.

(*Contd.*)

A	$\log T_{1/2}$												Decay mode
	Cluster decay								Alpha decay	SF	β- decay	β+ decay	
	^{9}Be	^{10}B	^{12}C	^{14}N	^{19}F	^{20}Ne	^{23}Na	^{24}Mg					
233	73.99	94.50	38.65	56.72	48.12	45.47	43.65	54.72	4.13	22.74	4.35	5.15	α
234	93.79	102.92	40.92	69.46	51.97	49.18	47.37	59.39	4.01	22.77	4.13	5.65	α
235	84.05	100.43	45.32	67.89	56.77	56.59	52.95	65.06	3.78	22.77	3.90	5.72	α
236	100.62	108.36	47.99	81.01	61.34	64.28	59.82	70.02	3.37	22.75	3.68	6.21	α
237	91.25	105.79	52.83	79.30	66.37	70.89	66.38	76.98	3.86	22.70	3.45	6.28	β-
238	104.36	112.25	54.28	98.47	75.87	75.36	70.84	82.24	3.09	22.63	3.23	6.78	α
239	94.46	109.49	58.94	94.71	81.80	82.45	77.72	89.54	21.18	22.54	3.00	6.84	β-
240	107.32	116.41	60.52	122.04	87.40	87.58	82.93	94.95	22.22	22.42	2.78	7.34	β-
241	98.39	112.78	67.79	114.14	94.03	98.12	87.64	103.03	22.50	22.28	2.55	7.41	β-
242	110.45	120.66	69.42	139.17	98.76	102.65	93.16	107.84	23.92	22.12	2.33	7.91	β-
243	98.56	116.74	70.29	126.81	100.82	105.99	97.49	112.96	25.09	21.94	2.10	7.97	β-
244	112.56	-	73.97	148.30	107.25	111.44	104.50	118.59	28.63	21.73	1.88	8.47	β-
245	102.25	119.62	74.94	138.68	109.76	116.20	107.48	122.42	25.62	21.51	1.65	8.54	β-
246	109.79	-	74.71	150.77	111.47	117.60	110.51	125.74	23.02	21.26	1.43	9.04	β-
247	97.40	118.52	74.01	138.74	111.31	119.29	111.74	128.78	24.04	20.99	1.20	9.10	β-
248	108.53	-	76.54	154.42	115.31	123.41	115.80	132.45	27.08	20.70	0.98	9.60	β-
249	97.74	120.03	77.90	146.40	116.98	126.52	118.48	137.07	33.37	20.40	0.75	9.64	β-
250	111.86	-	80.30	171.14	120.94	130.92	122.63	141.63	36.86	20.07	0.53	9.95	β-
251	106.12	-	95.24	154.46	123.95	135.82	125.86	146.68	42.41	19.72	0.31	10.21	β-
252	119.42	-	105.56	193.62	129.99	141.48	131.05	152.51	50.94	19.36	0.08	10.52	β-
253	112.67	-	114.77	187.81	133.43	147.20	134.48	158.51	56.31	18.98	-0.14	10.77	β-
254	124.80	-	121.37	229.81	140.31	154.08	140.11	164.45	59.49	18.58	-0.37	11.08	β-
255	116.67	-	126.24	217.17	149.60	171.16	142.72	169.75	57.84	18.16	-0.59	11.34	β-
256	125.22	-	128.32	256.02	164.26	182.95	147.21	174.71	51.94	17.72	-0.82	11.64	β-
257	115.80	-	135.24	230.41	172.12	194.46	151.49	182.54	55.33	17.27	-1.04	11.90	β-
258	123.28	-	134.34	273.84	178.69	200.68	156.96	188.13	55.61	16.80	-1.27	12.21	β-
259	115.25	-	143.43	250.06	185.46	210.15	162.90	211.08	78.29	16.32	-1.49	12.47	β-
260	125.31	-	147.32	301.04	191.80	215.98	169.26	224.42	220.33	15.82	-1.72	12.77	β-
261	118.95	-	155.43	275.10	196.45	223.24	175.24	238.46	195.41	15.31	-1.94	13.03	β-
262	-	-	189.67	-	227.12	259.66	194.61	249.08	160.94	14.78	-2.17	13.34	β-
263	-	-	209.81	-	239.09	272.79	206.58	260.09	142.80	14.24	-2.39	13.60	β-
264	-	-	245.12	-	259.09	301.33	248.25	275.32		13.68	-2.62	13.90	β-
265	-	-	226.77	-	255.65	-	248.13	277.00	235.88	13.11	-2.84	14.16	β-
266	-	-	234.65	-	266.26	-	254.86	300.25	85.06	12.53	-3.07	14.47	β-
267	-	-	252.91	-	282.79	-	273.22	-	-	11.93	-3.29	14.73	β-
268	-	-	283.75	-	302.40	-	293.22	-	-	11.33	-3.52	15.03	β-
269	-	-		-19.42	-	-	-	-	-	10.71	-3.74	15.29	β-
270	-	-	274.95		-	-	-	-	-	10.08	-3.97	15.60	β-
271	-	-		-19.60	-	-	-	-	-	9.45	-4.19	15.86	β-
272	-	-			-	-	-	-	-	8.80	-4.42	16.16	β-
273	-	-			-	-	-	-	-	8.14	-4.64	16.42	β-
274	-	-			-	-	-	-	-	7.47	-4.87	16.73	β-
275	-	-			-	-	-	-	-	6.80	-5.09	16.99	β-
276	-	-			-	-	-	-	-	6.12	-5.31	17.29	β-
277	-	-		226.12	-	-	-	-	123.00	5.43	-5.54	17.55	β-
278	-	-	287.74		-	-	-	-	119.25	4.74	-5.76	17.86	β-
279	150.06		256.66	215.31	-	-	-	-	178.85	4.03	-5.99	18.11	β-

(*Contd.*)

Table 1 — The half-lives corresponding to cluster radioactivity, alpha decay, spontaneous fission, β- decay and β+ decay of $^{203\text{-}299}U$.

(*Contd.*)

A	logT$_{1/2}$												Decay mode
	Cluster decay								Alpha decay	SF	β- decay	β+ decay	
	^{9}Be	^{10}B	^{12}C	^{14}N	^{19}F	^{20}Ne	^{23}Na	^{24}Mg					
280	-	-	-	-	-	-	-	-	-	3.33	-6.21	18.42	β-
281	-	-	-	-	-	-	-	-	-	2.62	-6.44	18.68	β-
282	-	-	-	-	-	-	-	-	-	1.90	-6.66	18.99	β-
283	-	-	-	-	-	-	-	-	-	1.18	-6.89	19.24	β-
284	-	-	-	-	-	-	-	-	-	0.46	-7.11	19.55	β-
285	-	-	-	-	-	-	-	-	-	-0.26	-7.34	19.81	β-
286	-	-	-	-	-	-	-	-	-	-0.98	-7.56	20.12	β-
287	-	-	-	-	-	-	-	-	-	-1.71	-7.79	20.37	β-
288	-	-	-	-	-	-	-	-	-	-2.43	-8.01	20.68	β-
289	-	-	-	-	-	-	-	-	-	-3.16	-8.24	21.18	β-
290	-	-	-	-	-	-	-	-	-	-3.88	-8.46	21.25	β-
291	-	-	-	-	-	-	-	-22.13	-	-4.60	-8.69	21.74	α
292	-	-	-	-	-	-	-	-22.14	-	-5.31	-8.91	21.81	α
293	-	-	-	-	-		-22.14	-22.15	-	-6.02	-9.14	22.31	α
294	-	-	-	-	-	-22.15	-22.15	-22.16	-	-6.73	-9.36	22.37	α
295	-	-	-	-	-	-22.16	-22.16	-22.17	-	-7.43	-9.59	22.87	α
296	-	-	-	-	-22.16	-22.17	-22.17	-22.17	-	-8.13	-9.81	22.94	α
297	-	-	-	-22.17	-22.17	-22.18	-22.18	-22.18	-	-8.81	-10.04	23.44	α
298	-	-	-	-22.17	-22.18	-22.18	-22.19	-22.19	-	-9.49	-10.26	23.50	α
299	-	-	-22.19	-22.18	-22.19	-22.19	-22.20	-22.20	-	-10.16	-10.49	24.00	α

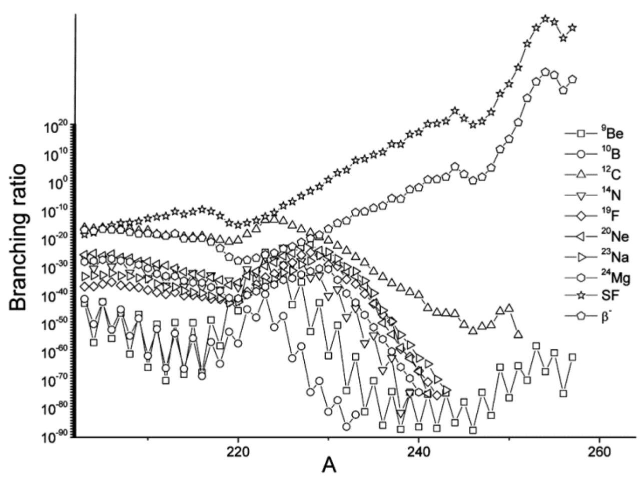

Fig. 3 — Variation of branching ratios with respect to alpha decay for different decay modes such as cluster radioactivity, beta decay and spontaneous fission as a function of mass number.

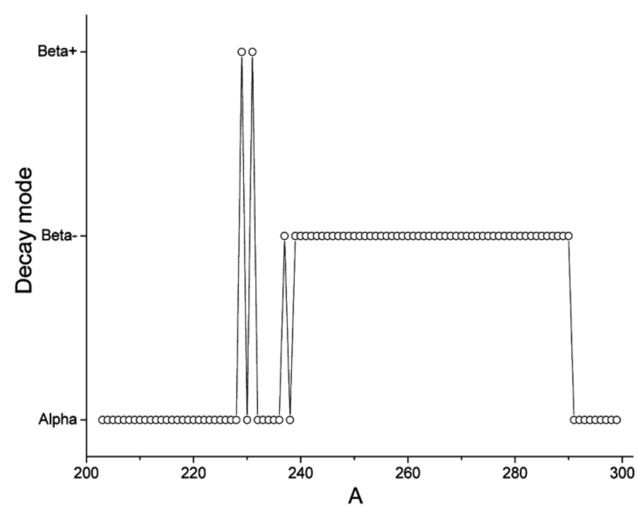

Fig. 4 — Decay modes with mass number.

corresponding to cluster radioactivity, alpha decay, spontaneous fission, β- decay and β+ decay of $^{203\text{-}299}U$ is as shown in Table 1. The decay mode which is having shorter half live is considered as dominant decay mode. We have also identified dominant decay modes for isotopes of uranium of mass number range 203<A<299 and it is shown Table 1. The predicted decay modes for isotopes of uranium is also shown in the Fig. 4. The information of decay modes for isotopes of Uranium in the mass number range 203<A<299 is presented in this figure. To validate the present work, we have compared the alpha decay half-lives with that of the experimental values available in the literature[37] and it is shown in Table 2. From this comparison, it is observed that present work agrees with that of experiments.

Table 2 — Comparison evaluated alpha half-lives with that of the experiments [41].

A	Alpha decay	
	Present Work	Experiment[41]
215	2.35E-04	3.00E-04
216	9.76E-02	4.50E-03
217	1.19E-02	1.60E-02
218	1.78E-04	5.10E-04
219	3.60E-05	4.20E-05
220	3.77E-08	-
221	2.25E-07	6.60E-07
222	2.57E-06	4.70E-06
223	6.87E-05	1.80E-05
224	5.18E-04	8.40E-04
225	3.29E-02	6.90E-02
226	3.40E-01	2.68E-01
227	7.78E+01	6.60E+01
228	6.53E+02	546
229	1.52E+04	-
230	2.50E+06	1.74 E+06
231	3.45E+08	-
232	2.73E+09	2.17283E+18
233	3.31E+12	5.02053E+12
234	7.09E+12	7.74209E+12
235	1.22E+16	2.22013E+16
236	6.90E+14	7.38573E+14
237	2.88E+17	
238	1.47E+17	1.40903E+17
239	2.66E+20	-
240	9.35E+20	-
241	4.33E+23	-
242	4.35E+23	-

4 Conclusions

We have studied the different decay modes such as cluster, alpha decay, β^- decay, β^+ decay and spontaneous fission of Uranium in the range 203 <A<299 using coulomb and recent potential terms. Hence, we have identified the prominent decay modes of uranium isotopes in the mass number range 203 <A<299.

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