



Fig. 1: Known experimental values for heavy particle emission of the even-Z $T_z = +33/2$ nuclei.

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Table 1

Observed and predicted β -delayed particle emission from the even- Z , $T_z = +33/2$ nuclei. J^π values for ^{169}Er , ^{173}Yb , ^{177}Hf , ^{181}W , ^{185}Os , ^{189}Pt , ^{193}Hg , ^{197}Pb and ^{201}Po are taken from ENSDF. Unless otherwise stated, all Q-values are taken from [2021Wa16] or deduced from values therein.

Nuclide	Ex	J^π	$T_{1/2}$	Q_ϵ	$Q_{\epsilon p}$	$Q_{\epsilon\alpha}$	Experimental
$^{169}\text{Er}^*$		$1/2^-$	9.36(4) d	-2.125(20)	—	—	[2004Sc04]
^{173}Yb		$5/2^-$	stable	-1.295(4)	—	—	
^{177}Hf		$7/2^-$	stable**	-0.497(1)	—	—	
^{181}W		$9/2^+$	120.95(2) d	0.205(2)	-5.743	1.725(2)	[1973My02]
^{185}Os		$1/2^-$	92.95(9) d	1.013(1)	-4.389(1)	3.208(2)	[2012Kr05]
^{189}Pt		$3/2^-$	10.87(12) h	1.980(14)	-2.621(10)	4.925(10)	[1964Le07]
^{193}Hg		$3/2^-$	3.80(15) h	2.343(14)	-2.063(16)	4.963(20)	[1974ViZS]
^{197}Pb		$3/2^-$	7.2(10) m***	3.609(14)	-0.208(6)	6.235(10)	[1980Hi04, 1979Ra04]
^{201}Po		$3/2^-$	15.8(3) m	4.908(13)	2.441(11)	9.408(14)	[1965Br17, 1967Le21]
^{201m}Po	0.4234(2) [@]	$13/2^+$	9(2) m	5.331(13)	2.864(11)	9.831(14)	[1965Br17, 1967Le21]
^{205}Rn		$5/2^-$	170(4) s	5.275(13)	3.342(11)	11.294(13)	[1971Ho01]
^{209}Ra		$5/2^-$	4.9(2) s ^{@@}	5.640(13)	4.225(12)	12.418(13)	[2008Ha12, 1967Va22]
^{213}Th		$5/2^-$	86(10) ms ^{@@@}	5.979(15)	5.030(14)	13.477(15)	[1980Ve01, 1968Va18]
^{217}U			15.6 ^{+21.3} _{-5.7} ms	5.920(80)#	5.383(81)#	14.405(81)#	[2000Ma65]
^{221}Pu				6.02(36)#	5.63(32)#	16.45(30)#	

* 100% β^- emitter.

** $T_{1/2}$ reported as $\geq 7.5 \times 10^{16}$ y [2020Ca15], due to non observation of α decays from this nucleus.

*** Weighted average of 10(2) m [1979Ra04] and 6.2(12) m [1980Hi04].

@ [2023Ko01].

@@ Weighted average of 5.1(2) s [2008Ha12] and 4.7(2) s [1967Va22].

@@@ Weighted average of 80(10) ms [1980Ve01] and 125(25) ms [1968Va18].

Table 2

Particle separation, Q-values, and measured values for direct particle emission of the even- Z , $T_z = +33/2$ nuclei. Unless otherwise stated, all S and Q-values are taken from [2021Wa16] or deduced from values therein.

Nuclide	S_p	S_{2p}	Q_α	BR_α	Experimental
^{169}Er	8.151(30)	15.588(4)	0.266(1)		
^{173}Yb	7.467(5)	14.411(1)	0.945		
^{177}Hf	6.787(1)	12.763(1)	2.246(1)		
^{181}W	6.589(2)	12.349	2.222		
^{185}Os	5.875(4)	11.018(1)	3.003(2)		
^{189}Pt	5.413(14)	9.828(10)	3.912(10)		
^{193}Hg	5.579(22)	9.942(16)	2.982(18)		
^{197}Pb	4.538(13)	8.310(24)	3.892(16)		
^{201}Po	3.440(23)	5.867(8)	5.799(2)	1.15(1)%	[1965Br17, 1967Le21, 1968Go12, 1993Wa04, 1986Br28, 1970DaZM, 1970Jo26, 1970Ra14, 1967Le08, 1967Ti04, 1967Tr04, 1967Tr06, 1963Ho18, 1962Be26, 1961Be25, 1961Fo05, 1954Ro39]
^{201m}Po	3.440(23)	5.867(8)	5.799(2)	2.9(2)%	[1965Br17, 1967Le21, 1968Go12, 2015We13, 1993Wa04, 1986Br28, 1970Jo26, 1970Ra14, 1967Le08]
^{205}Rn	3.123(23)	4.977(7)	6.386(2)	26(1)%*	[1993Wa04, 1971Ho01, 1967Va17, 1971Jo19, 1967Va07, 1965Nu04]
^{209}Ra	2.766(13)	4.085(7)	7.143(3)	$\approx 100\%^{**}$	[2003He06, 2008Ha12, 2001HeZY, 1997Mi03, 1968Lo15, 1967Va22]
^{213}Th	2.468(24)	3.290(10)	7.837(7)	100%*	[1980Ve01, 1968Va18, 2000Ma65]
^{217}U	2.142(84)	2.529(81)	8.426(80)	100%*	[2000Ma65, 2022Zh45, 2012WaZX, 2005Le42]
^{221}Pu	1.83(30)#	1.94(30)#	10.53(31)#		

* Weighted average of 25(1)% [1993Wa04] and 35(3)% [1971Ho01].

** Based on half-life.

Table 3

direct α emission from ^{201}Po , $J_i^\pi = (3^-)$, $T_{1/2} = 15.8(3)$ m*, $BR_\alpha = 1.15(1)\%^*$.

E_α (c.m.)	E_α (lab)	I_α (abs)	J_f^π	$E_{\text{daughter}}(^{210}\text{Ac})$	coincident γ -rays	R_0 (fm)	HF
5.799(2)	5.684(2)	1.15(1)%*	(3^-)	0.0	—	1.4762(18)	1.82(9)

* [1965Br17, 1967Le21]

** [1968Go12].

Table 4

direct α emission from ^{201m}Po , Ex. = 423.4(2) keV*, $J_i^\pi = (13^+)$, $T_{1/2} = 9(2)$ m**, $BR_\alpha = 2.9(2)\%$ **.

E_α (c.m.)	E_α (lab)	I_α (abs)	J_f^π	$E_{daughter}(^{197}\text{Pb})$	coincident γ -rays	R_0 (fm)	HF
5.905(2)	5.787(2)	1.15(1)%*	(13 ⁺)	0.3193(1) [@]	0.085, 0.234 [@]	1.4762(18)	1.29(31)

* [2023Ko01].

** [1965Br17, 1967Le21]

*** [1968Go12].

[@] [2005Hu03].

Table 5

direct α emission from ^{205}Rn , $J_i^\pi = (5^-)$, $T_{1/2} = 170(4)$ s*, $BR_\alpha = 26(1)\%$ **.

E_α (c.m.)	E_α (lab)	I_α (abs)	J_f^π	$E_{daughter}(^{201}\text{Po})$	coincident γ -rays	R_0 (fm)	HF
6.3855(25)	6.2609(25)	26(1)%*	(5 ⁻)	0.00561(13) [@]	0.0056	1.4972(20)	1.23(8)

* [1971Ho01].

** Weighted average of 25(1)% [1993Wa04] and 35(3)% [1971Ho01].

*** [1993Wa04].

[@] α -transition assumed to decay to the favored 5/2⁻ state in the ^{201}Po daughter. Energy from [2023Ko01].

Table 6

direct α emission from ^{209}Ra , $J_i^\pi = (5^-)$, $T_{1/2} = 4.9(2)$ s*, $BR_\alpha = \approx 100\%$.

E_α (c.m.)	E_α (lab)	I_α (rel)	I_α (abs)	J_f^π	$E_{daughter}(^{205}\text{Rn})$	coincident γ -rays	R_0 (fm)	HF
6.500(5)	6.376(5)**	0.2%	$\approx 0.2\%$			0.6337(11)	0.6337(11)	1.4945(33) ≈ 2.2
6.754(5)	6.625(5)**	0.5%	$\approx 0.5\%$			0.3870(5)	0.3870(5)	1.4945(33) ≈ 8.8
7.140(10)	7.003(10)**	100%	$\approx 99.3\%$	(5 ⁻)		0.0	—	1.4945(33) ≈ 1.25

* Weighted average of 5.1(2) s [2008Ha12] and 4.7(2) s [1967Va22].

** [2003He06].

Table 7

direct α emission from ^{213}Th , $J_i^\pi = (5^-)$, $T_{1/2} = 86(10)$ ms*, $BR_\alpha = 100\%$.

E_α (c.m.)	E_α (lab)	I_α (abs)	J_f^π	$E_{daughter}(^{209}\text{Ra})$	coincident γ -rays	R_0 (fm)	HF
7.824(10)	7.684(10)	100%	(5 ⁻)	0.0	—	1.5022(41)	0.99(16)

* Weighted average of 80(10) ms [1980Ve01] and 125(25) ms [1968Va18].

** Weighted average of 7.690(10) MeV [1968Va18] and 7.677(10) MeV [1980Ve01].

Table 8

direct α emission from $^{217}\text{U}^*$, $J_i^\pi = (5^-)$, $T_{1/2} = 15.6_{-5.7}^{+21.3}$ ms, $BR_\alpha = 100\%$.

E_α (c.m.)	E_α (lab)	I_α (abs)	J_f^π	$E_{daughter}(^{213}\text{Th})$	coincident γ -rays	R_0 (fm)	HF
8.155(20)	8.005(20)	100%	(5 ⁻)	0.0	—	1.499(24)	0.37 $_{-0.21}^{+0.53}$ **

* All values from [2000Ma65].

** The unphysically low HF value may suggest that the half-life is longer than reported. A $T_{1/2}$ of 42 ms at this energy gives a HF of 1.0.

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