



Fig. 1: Known experimental values for heavy particle emission of the even-Z $T_z = +15$ nuclei.

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Table 1

Observed and predicted β -delayed particle emission from the even- Z , $T_z = +15$ nuclei. Unless otherwise stated, all Q-values are taken from [2021Wa16] or deduced from values therein.

Nuclide	J^π	$T_{1/2}$	Q_ϵ	$Q_{\epsilon p}$	$Q_{\epsilon\alpha}$	Experimental
^{162}Dy	0^+	stable	-2.302(2)	—	—	
^{166}Er	0^+	stable	-1.853(1)	—	—	
^{170}Yb	0^+	stable	-0.969(1)	—	—	
^{174}Hf	0^+	$2.0(4) \times 10^{15}$ y	-0.274(2)	—	—	[1961Ma05]
^{178}W	0^+	21.7(4) d*	0.190(50)#	-4.815(15)	2.738(15)#	[1964Sa16, 1963Ra14]
^{182}Os	0^+	21.9(1) h	0.840(100)	-3.664(22)	3.565(57)	[1958Fo47]
^{186}Pt	0^+	2.10(5) h	1.308(27)	-2.348(22)	5.157(104)	[1991Be25]
^{190}Hg	0^+	19.9(4) m**	1.463(16)	-2.190(19)	5.377(23)	[1964Ja05, 1961An02]
^{194}Pb	0^+	12.0(5) m	2.730(22)	-0.435(23)	6.201(18)	[1987El09]
^{198}Po	0^+	107(2) s***	3.900(30)	1.983(18)	9.039(22)	[1994Wa13, 1971Ho01, 1967Si09]
^{202}Rn	0^+	9.7(2) s@	4.320(30)	2.958(18)	10.674(33)	[1992Wa29, 1971Ho01]
^{206}Ra	0^+	244(13) ms@@	4.810(30)	3.986(19)	11.736(33)	[2021Ni08, 1987He10]
^{210}Th	0^+	15.1(27) ms@@@	5.300(70)	4.912(20)	12.881(34)	[2023Ch23, 2010He25]
^{214}U	0^+	520^{+950}_{-210} μs	5.721(84) ^a	5.772(28) ^a	13.996(65) ^a	[2021Zh22]

* Weighted average of 21.4(5) d [1964Sa16] and 22.0(5) d [1963Ra14].

** Weighted average of 20.0(5) m [1964Ja05] and 19.8(6) m [1961An02].

*** Weighted average of 105(3) s [1994Wa13], 107(3) s [1971Ho01] and 1.80(5) s [1967Si09].

@ Weighted average of 9.5(2) s [1992Wa29], and 9.7(2) s [1971Ho01].

@@ Weighted average of 248(18) ms [2021Ni08], and 240(20) ms [1987He10].

@@@ Weighted average of 14(4) ms [2023Ch24], and 16.0(36) ms [2010He25].

^a From Q_α of ^{214}U and daughter values from [2021Wa16].

Table 2

Particle separation, Q-values, and measured values for direct particle emission of the even- Z , $T_z = +15$ 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
^{162}Dy	8.008(1)	14.817(1)	0.084(1)		
^{166}Er	7.315(1)	13.534(1)	0.832(1)		
^{170}Yb	6.778(1)	12.353	1.735(0)		
^{174}Hf	6.253(2)	11.167(2)	2.494(2)	100%	[1961Ma05, 2020Ca15, 2021Br09, 1960Ma29, 1959Ri34]
^{178}W	5.981(15)	10.409(15)#	3.013(15)		
^{182}Os	5.381(25)	9.551(22)	3.373(27)		
^{186}Pt	4.818(35)	8.190(22)	4.320(18)	$\approx 1.4 \times 10^{-4}\%$	[1963Gr08]
^{190}Hg	5.078(26)	8.128(17)	4.069(27)	$< 3.4 \times 10^{-7}\%$	
^{194}Pb	4.020(19)	6.774(23)	4.738(17)	$7.3(29) \times 10^{-6}\%$	[1987El09]
^{198}Po	3.075(19)	4.703(19)	6.310(1)	58(2)%*	[1998Bo14, 1996Ta18, 1994Wa03, 1993Wa04, 1971Ho01, 1967Si09, 2022We04, 2015We13, 2015We16, 2014Ma66, 1993WaZO, 1989De18, 1984Da14, 1982Bo04, 1967Le21, 1967Tr04, 1967Tr06, 1965Br17, 1965Si22, 1964Br23]
^{202}Rn	2.774(19)	3.911(19)	6.774(2)	78(8)%	[2000Va34, 1992Wa29, 1987He10, 2015We16, 1996Ta18, 1993Wa04, 1992WaZV, 1991Wa29, 1971Ho01, 1969Ha03, 1967Va07, 1967Va17, 1965Nu04]
^{206}Ra	2.414(20)	3.042(19)	7.415(4)	$\approx 100\%^{**}$	[1996Le09, 1987He10, 1967Va22, 2021Ni08, 2021NiZW, 1995Le41, 1968Lo15]
^{210}Th	2.074(59)	2.246(21)	8.069(6)	$\approx 100\%^{**}$	[2023Ch23, 2010He25, 1995Le15, 1995Le41, 1995Uu01]
^{214}U	1.758(65)***	1.508(28)***	8.696(18)***	100%	[2021Zh22]

* Weighted average of 59(3)% [1998Bo04] and 57(2)% [1994Wa13, 1993Wa04].

** Based on short half-life.

*** From Q_α of ^{214}U and daughter values from [2021Wa16].

Table 3direct α emission from $^{174}\text{Hf}^*$, $J_i^\pi = 0^+$, $T_{1/2} = 2.0(4) \times 10^{15}$ y, $BR_\alpha = 100$ %.

E_α (c.m.)	E_α (lab)	I_α (abs)	J_f^π	$E_{daughter}(^{170}\text{Yb})$	coincident γ -rays	R_0 (fm)	HF
2.559(30)	2.500(30)	100 %	0^+	0.0	—	1.4833(91)	0.23(5)**

* All values from [1961Ma05].

** This unphysically low value may indicate that the actual half-life is longer than reported in [1961Ma05]. Using a value of 9×10^{15} y gives a HF = 1.0.**Table 4**direct α emission from $^{186}\text{Pt}^*$, $J_i^\pi = 0^+$, $T_{1/2} = 2.10(5)$ h**, $BR_\alpha = \approx 1.4 \times 10^{-4}$ %.

E_α (c.m.)	E_α (lab)	I_α (abs)	J_f^π	$E_{daughter}(^{182}\text{Os})$	coincident γ -rays	R_0 (fm)	HF
4.323(20)	4.230(20)	$\approx 1.4 \times 10^{-4}$ %	0^+	0.0	—	1.536(30)	≈ 1.3

* All values from [1963Gr08], except where noted.

** [1991Be25].

Table 5direct α emission from $^{194}\text{Pb}^*$, $J_i^\pi = 0^+$, $T_{1/2} = 12.0(5)$ m, $BR_\alpha = 7.3(29) \times 10^{-6}$ %.

E_α (c.m.)	E_α (lab)	I_α (abs)	J_f^π	$E_{daughter}(^{190}\text{Hg})$	coincident γ -rays	R_0 (fm)	HF
4.738(20)	4.640(20)	$7.3(29) \times 10^{-6}$ %	0^+	0.0	—	1.437(24)	$1.1^{+0.8}_{-0.4}$

* All values from [1987El09].

Table 6direct α emission from ^{198}Po , $J_i^\pi = 0^+$, $T_{1/2} = 107(2)$ s*, $BR_\alpha = 58(2)$ %**.

E_α (c.m.)	E_α (lab)	I_α (abs)	J_f^π	$E_{daughter}(^{194}\text{Pb})$	coincident γ -rays	R_0 (fm)	HF
6.309(1)	6.182(1)	58(2) %**	0^+	0.0	—	1.4962(19)	0.99(4)

* Weighted average of 105(3) s [1994Wa13], 107(3) s [1971Ho01] and 1.80(5) s [1967Si09].

** Weighted average of 59(3) % [1998Bo04] and 57(2) % [1994Wa13, 1993Wa04].

Table 7direct α emission from ^{202}Rn , $J_i^\pi = 0^+$, $T_{1/2} = 9.7(2)$ s*, $BR_\alpha = 78(8)$ %**.

E_α (c.m.)	E_α (lab)	I_α (rel)	I_α (abs)	J_f^π	$E_{daughter}(^{198}\text{Po})$	coincident γ -rays	R_0 (fm)	HF
5.954(5)	5.836(5)**	$1.8(6) \times 10^{-3}$ %***	$1.4(5) \times 10^{-3}$ %	0^+	0.816	0.211, 0.605	1.5106(49)	21^{+12}_{-6}
6.775(1)	6.641(1)@	100%	78(8) %**	0^+	0.0	—	1.5106(49)	1.0(1)

* Weighted average of 9.5(2) s [1992Wa29], and 9.7(2) s [1971Ho01].

** [1987He10].

*** [1992Wa29].

@ [2000Va34].

Table 8direct α emission from ^{206}Ra , $J_i^\pi = 0^+$, $T_{1/2} = 244(13)$ ms*, $BR_\alpha = \approx 100$ %.

E_α (c.m.)	E_α (lab)	I_α (abs)	J_f^π	$E_{daughter}(^{202}\text{Rn})$	coincident γ -rays	R_0 (fm)	HF
7.414(4)	7.270(4)**	≈ 100 %	0^+	0.0	—	1.5287(42)	1.00(5)

* Weighted average of 248(18) ms [2021Ni08], and 240(20) ms [1987He10].

** Weighted average of 7.268(10) MeV [1996Le09], 7.270(10) MeV [1987He10] and 7.270(5) MeV [1967Va22].

Table 9

direct α emission from ^{210}Th , $J_i^\pi = 0^+$, $T_{1/2} = 15.1(27)$ ms*, $BR_\alpha = \approx 100\%$.

E_α (c.m.)	E_α (lab)	I_α (abs)	J_f^π	$E_{daughter}(^{206}\text{Ra})$	coincident γ -rays	R_0 (fm)	HF
8.071(6)	7.917(6)	$\approx 100\%$	0^+	0.0	—	1.507(11)	0.97(17)

* Weighted average of 14(4) ms [2023Ch24], and 16.0(36) ms [2010He25].

* [2010He25].

Table 10

direct α emission from $^{214}\text{U}^*$, $J_i^\pi = 0^+$, $T_{1/2} = 520_{-210}^{+950}$ μs , $BR_\alpha = 100\%$.

E_α (c.m.)	E_α (lab)	I_α (abs)	J_f^π	$E_{daughter}(^{210}\text{Th})$	coincident γ -rays	R_0 (fm)	HF
8.696(18)	8.533(18)	$\approx 100\%$	0^+	0.0	—		

* All values from [2021Zh22].

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