

Even Z $T_z = +10$

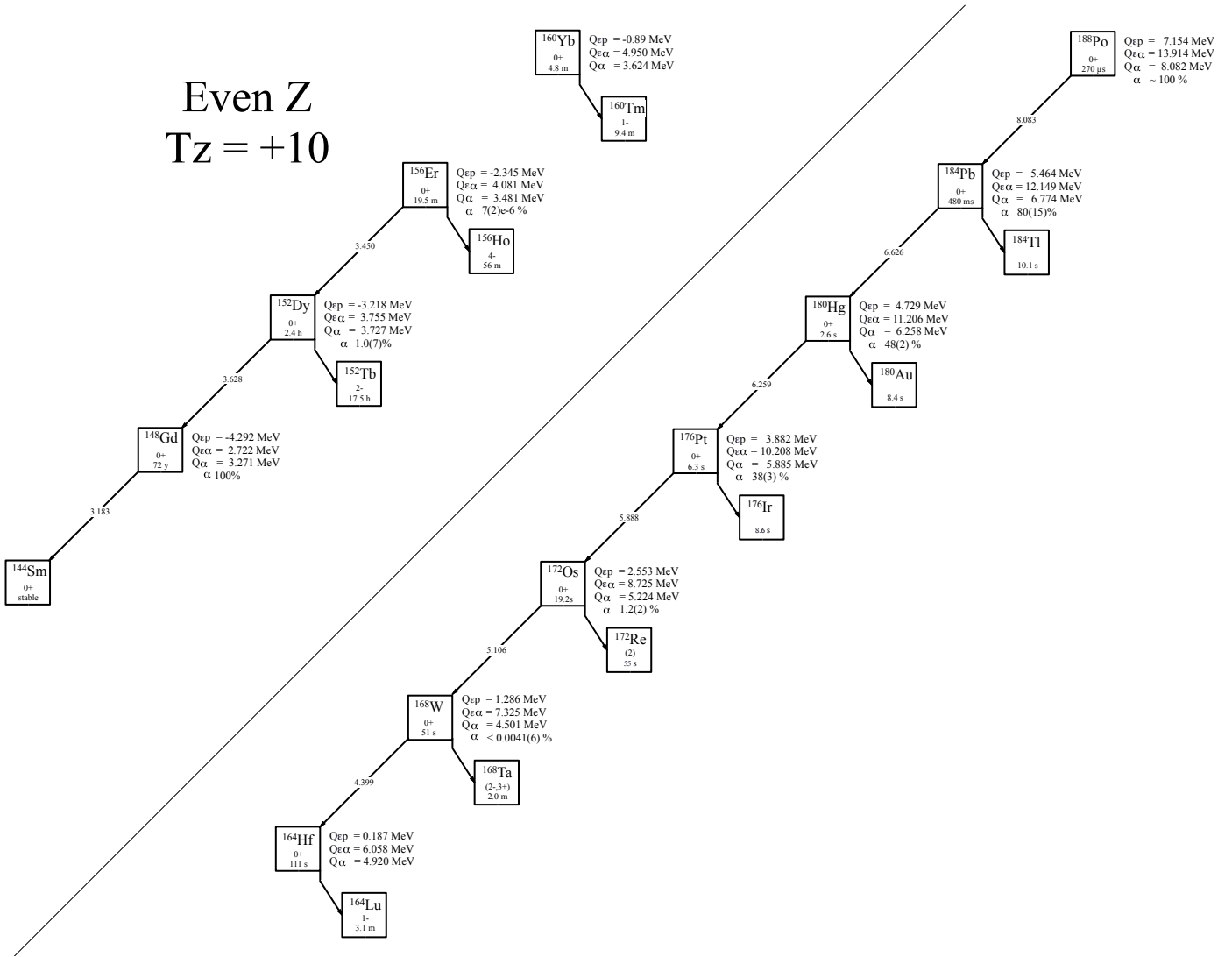


Fig. 1: Known experimental values for heavy particle emission of the even-Z $T_z = +10$ nuclei.

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Table 1

Observed and predicted β -delayed particle emission from the even- Z , $T_z = +10$ nuclei. Unless otherwise stated, all Q -values are taken from [2021Wa16] or deduced from values therein.

Nuclide	J^π	$T_{1/2}$	Q_ϵ	$Q_{\epsilon p}$	$BR_{\beta p}$	$Q_{\epsilon\alpha}$	Experimental
^{148}Gd	0^+	72.1(10) y*	0.028(10)	-4.292(1)	—	2.722(3)	[2023Ch23, 2003Fu10, 1981Pr06, 2023ChXZ]
^{152}Dy	0^+	2.37(2) h	0.600(40)	-3.218(5)	—	3.755(11)	[1965Ma14]
^{156}Er	0^+	19.5(10) m	1.330(50)	-2.345(26)	—	4.081(47)	[1975Al26]
^{160}Yb	0^+	4.8(2) m	2.140(30)	-0.891(7)	—	4.950(39)	[1969NeZW]
^{164}Hf	0^+	111(8) s	2.820(30)	0.187(22)	—	6.058(36)	[1989Hi04]
^{168}W	0^+	51(2) s**	3.500(30)	1.286(31)	—	7.325(31)	[1992HeZV, 1991Me05, 1990Me12]
^{172}Os	0^+	19.2(9) s	4.320(40)	2.553(31)	—	8.725(31)	[1995Hi02]
^{176}Pt	0^+	6.33(15) s	4.948(15)	3.882(17)	—	10.208(38)	[1973Ga08]
^{180}Hg	0^+	2.56(2) s	5.375(14)	4.729(15)	—	11.206(15)	[1993Wa03]
^{184}Pb	0^+	480(25) ms	5.832(16)	5.464(15)	—	12.149(14)	[1999To11]
^{188}Po	0^+	270(30) μs	6.650(23)	7.154(21)	—	13.914(22)	[2003Va16]

* Weighted average of 86.9(39) y [2023Ch23], 70.9(10) y [2003Fu10], and 74.6(30) y [1981Pr06].

** Weighted average of 47(3) s [1992HeZV], 49(5) s [1991Me05] and 53(2) s [1990Me12].

Table 2

Particle separation, Q -values, and measured values for direct particle emission of the even- Z , $T_z = +10$ 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
^{148}Gd	6.014(2)	9.851(3)	3.271(1)	100%	[1973Go29, 2023Ch23, 2023ChXZ, 2003Fu10, 2002FuZW, 2001FuZY, 1981Pr06, 1973MiZU, 1966Fr11, 1962Si14, 1957SuXX, 1953Ra02]
^{152}Dy	5.783(6)	8.932(7)	3.727(4)	0.100(7)%*	[1974To07, 1967Go32, 1965Ma14, 1962Si14, 1975ToZT, 1974PeZS, 1974ToZN, 1974ToZQ, 1964Ma19, 1964Ma42, 1960To05]
^{156}Er	5.461(30)	8.396(26)	3.541(10)**	$7(2) \times 10^{-6}\%***$	[2002KaZR, 1996ByZY, 1995KaZS, 2002KaZO, 1992KaZP, 1989KaYU, 1978BiZF]
^{160}Yb	4.882(28)	7.437(26)	3.624(25)		
^{164}Hf	4.316(32)	6.575(22)	3.920(17)		
^{168}W	3.831(31)	5.612(31)	4.501(11)	$<4.1(6) \times 10^{-3}\%$	[1991Me05, 1992HeZV]
^{172}Os	3.282(31)	4.531(18)	5.224(7)	1.2(2)% [@]	[2004GoZZ, 1996Pa01, 1995Hi02, 1971Bo06]
^{176}Pt	2.828(18)	3.516(16)	5.885(2)	38(3)% ^{@@}	[1996Pa01, 1982De11, 1979Ha10, 1974Ho26, 1973Ga08, 1982Bo04, 1966Si08]
^{180}Hg	2.551(17)	2.831(16)	6.258(2)	48(2)%	[1999To11, 1993Wa03, 2010An13, 1996Pa01, 1993WaZO, 1987La23, 1986Si19, 1982HeZM, 1979Ha10, 1977Hu05, 1974Ho26, 1970Ha18, 1969NaZT, 1969NaZU, 1968De01]
^{184}Pb	1.753(16)	2.053(16)	6.774(3)	80(15)%	[2004An07, 1999To11, 2001Po05, 1998Co27, 1998ToZW, 1987To09, 1982HeZM, 1980Du02, 1980Sc09]
^{188}Po	1.450(22)	0.441(23)	8.082(15)	100% ^{@@@}	[2003Va16, 1999An52, 2002VaZZ, 2000AnZZ]

* Weighted average of 0.94(9)% and 1.08(11)% [1974To07].

** From α energy, 3.481(25) MeV in [2021Wa16].

*** Weighted average of $1.2(3) \times 10^{-5}\%$ [1996ByZY], and $5(2) \times 10^{-6}\%$ [1995KaZS].

@ Weighted average of 1.1(2)% [1995Hi02] and 1.4(3)% [2004GoZZ].

@@ Weighted average of 42(4)% [1996Pa01] and 438(3)% [1979Ha10].

@@@ Deduced from short half-life.

Table 3

direct α emission from ^{148}Gd , $J^\pi = 0^+$, $T_{1/2} = 72.1(10)$ y*, $BR_\alpha = 100\%**$.

$E_\alpha(\text{c.m.})$	$E_\alpha(\text{lab})$	$I_\alpha(\text{abs})$	J_f^π	$E_{\text{daughter}}(^{144}\text{Sm})$	coincident γ -rays	R_0 (fm)	HF
3.271198(24)	3.182787(24)***	100%**	0^+	0.0	—	1.5695(23)	0.961(13)

* Weighted average of 86.9(39) y [2023Ch23], 70.9(10) y [2003Fu10], and 74.6(30) y [1981Pr06].

** Only decay channel open.

*** 3.182787(24) MeV in [1973Go29], adjusted to 3.182680(24) MeV in [1991Fy01].

Table 4
direct α emission from ^{152}Dy , $J^\pi = 0^+$, $T_{1/2} = 2.37(2)$ h*, $BR_\alpha = 0.100(7)\%$ **.

E_α (c.m.)	E_α (lab)	I_α (abs)	J_f^π	$E_{daughter}$ (^{148}Gd)	coincident γ -rays	R_0 (fm)	HF
3.726(4)	3.628(4)***	1.0(7)%**	0^+	0.0	—	1.5796(54)	0.98(7)

* [1965Ma14].

** Weighted average of 0.94(9)% and 1.08(11)% [1974To07].

*** Weighted average of 3.627(8) MeV [1965Ma14] (adjusted to 3.630(8) MeV in [1991Ry01]), and 3.630(5) MeV [1965Ma14] (adjusted to 3.628(5) MeV in [1991Ry01]).

Table 5
direct α emission from ^{156}Er , $J^\pi = 0^+$, $T_{1/2} = 19.5(10)$ m*, $BR_\alpha = 7(2)\times 10^{-6}\%$ **.

E_α (c.m.)	E_α (lab)	I_α (abs)	J_f^π	$E_{daughter}$ (^{152}Dy)	coincident γ -rays	R_0 (fm)	HF
3.541(10)	3.450(10)***	$7(2)\times 10^{-6}\%$ **	0^+	0.0	—	1.531(25)	$1.2^{+0.7}_{-0.4}$

* [1975Al26].

** Weighted average of $1.2(3)e^{-5}\%$ [1996ByZY], and $5(2)e^{-6}\%$ [1995KaZS].

*** [2002KaZR].

Table 6
direct α emission from $^{168}\text{W}^*$, $J^\pi = 0^+$, $T_{1/2} = 51(2)$ s*, $BR_\alpha = <4.1(6)\times 10^{-3}\%$.

E_α (c.m.)	E_α (lab)	I_α (abs)	J_f^π	$E_{daughter}$ (^{164}Hf)	coincident γ -rays	R_0 (fm)	HF
4.506(12)	4.399(12)	$<4.1(6)\times 10^{-3}\%$	0^+	0.0	—	1.580(35)	>0.86

* All values from [1991Me05], except where noted.

** Weighted average of 47(3) s [1992HeZV], 49(5) s [1991Me05] and 53(2) s [1990Me12].

Table 7
direct α emission from ^{172}Os , $J^\pi = 0^+$, $T_{1/2} = 19.2(9)$ s*, $BR_\alpha = 1.2(2)\%$ **.

E_α (c.m.)	E_α (lab)	I_α (abs)	J_f^π	$E_{daughter}$ (^{168}W)	coincident γ -rays	R_0 (fm)	HF
5.227(5)	5.106(5)***	1.2(2)%	0^+	0.0	—	1.583(13)	$1.14^{+0.29}_{-0.21}$

* [1995Hi02].

** Weighted average of 1.1(2)% [1995Hi02] and 1.4(3)% [2004GoZZ].

*** Weighted average of 5.109(5) MeV [2004GoZZ], 5.106(10) MeV [1996Pa01], 5.100(7) MeV [1995Hi02] and 5.105(10) MeV [1971Bo06].

Table 8
direct α emission from ^{176}Pt , $J^\pi = 0^+$, $T_{1/2} = 6.33(15)$ s*, $BR_\alpha = 39(3)\%$ **.

E_α (c.m.)	E_α (lab)	I_α (rel)	I_α (abs)	J_f^π	$E_{daughter}$ (^{172}Os)	coincident γ -rays	R_0 (fm)	HF
5.662(10)	5.534(10)***	0.26(13)% [@]	0.10(5)%	2^+	0.2277(10)	0.2277(10)	1.5597(42)	40^{+40}_{-20}
5.888(3)	5.754(3) ^{@@}	100%	39(3)%**	0^+	0.0	—	1.5571(45)	1.05(9)

* [1973Ga08].

** Weighted average of 42(4)% [1996Pa01] and 438(3)% [1979Ha10].

*** Weighted average of 5.537(10) MeV [1979Ha10] (adjusted to 5.536(10) MeV in [1991Ry01]) and 5.528(15) MeV [1974Ho26].

[@] [1979Ha10].

^{@@} Weighted average of 5.753(3) MeV [1982De11] and 5.757(5) MeV [1974Ho26] (adjusted to 5.756(5) MeV in [1991Ry01]).

Table 9direct α emission from $^{180}\text{Hg}^*$, $J^\pi = 0^+$, $T_{1/2} = 2.56(2)$ s, $BR_\alpha = 48(2)\%^{**}$.

E_α (c.m.)	E_α (lab)	I_α (rel)	I_α (abs)	J_f^π	$E_{daughter}(^{176}\text{Pt})^{***}$	coincident γ -rays ^{***}	R_0 (fm)	HF
5.818(5)	5.689(5)	$\approx 0.01\%$	$\approx 0.005\%$	0^+	0.443(1)	0.443(1), 0.2640(3), 0.179(1)	1.5324(24)	≈ 130
6.259(5)	6.120(5)	$\approx 0.05\%$	$\approx 0.024\%$	2^+	0.2640(3)	0.2640(3)	1.5324(24)	≈ 160
6.259(5)	6.120(5)	100%	48(2)% ^{**}	0^+	0.0	—	1.5324(24)	0.99(4)

* All values from [1993Wa03], except where noted.

** [1999To11].

*** [2006Ba16].

Table 10direct α emission from $^{184}\text{Pb}^*$, $J^\pi = 0^+$, $T_{1/2} = 480(25)$ ms^{**}, $BR_\alpha = 80(15)\%$.

E_α (c.m.)	E_α (lab)	I_α (abs)	J_f^π	$E_{daughter}(^{180}\text{Hg})$	coincident γ -rays	R_0 (fm)	HF
6.773(6)	6.626(6)	80(15)%	0^+	0.0	—	1.504(11)	$0.89^{+0.26}_{-0.18}$

* All values from [2004An07], except where noted.

** [1999To11].

Table 11direct α emission from $^{188}\text{Po}^*$, $J^\pi = 0^+$, $T_{1/2} = 270(30)$ μs , $BR_\alpha = 100\%$.

E_α (c.m.)	E_α (lab)	I_α (rel)	I_α (abs)	J_f^π	$E_{daughter}(^{180}\text{Pb})$	coincident γ -rays	R_0 (fm)	HF
7.513(26)	7.353(26) ^{**}	25(5) %	20(4)%	(0^+)	0.570(30)	—	1.4874(76)	$0.08^{+0.04}_{-0.03}$ ^{***}
8.083(13)	7.911(13) [@]	100%	80(4)%	0^+	0.0	—	1.4874(76)	0.99(12)

* All values from [2003Va16], except where noted.

** Weighted average of 7.355(35) MeV [2003Va16] and 7.350(40) MeV [1999An52].

*** The unphysically low value is as yet unexplained.

[@] Weighted average of 7.910(15) MeV [2003Va16] and 7.915(25) MeV [1999An52].**References used in the Tables**

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