

Even Z
 $T_z = +19/2$

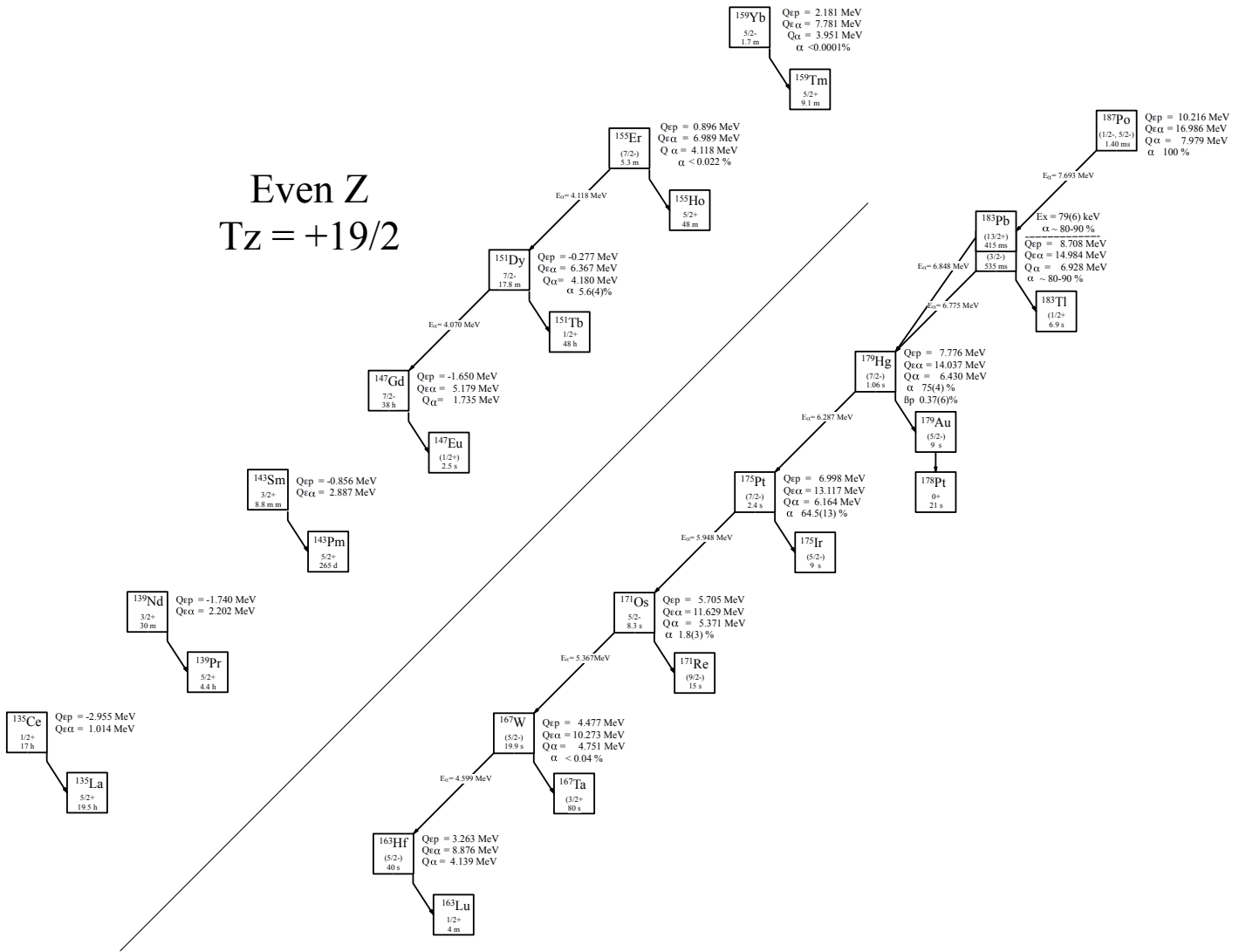


Fig. 1: Known experimental values for heavy particle emission of the even-Z $T_z = +19/2$ nuclei.

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Table 1

Observed and predicted β -delayed particle emission from the even- Z , $T_z = +19/2$ nuclei. Unless otherwise stated, all Q-values are taken from [2021Wa16] or deduced from values therein. J^π values for ^{135}Ce , ^{139}Nd , ^{143}Sm , ^{147}Gd , ^{159}Yb , ^{163}Hf are taken from ENSDF.

Nuclide	Ex	J^π	$T_{1/2}$	Q_ϵ	$Q_{\epsilon p}$	$\text{BR}_{\beta p}$	$Q_{\epsilon\alpha}$	Experimental
^{135}Ce		$1/2^+$	17.8(3) h	2.027(5)	-2.955(10)		1.014(10)	[1976Ge10]
^{139}Nd		$3/2^+$	29.7(5) m	2.812(28)	-1.740(28)		2.202(29)	[1967La19]
^{143}Sm		$3/2^+$	8.83(1) m	3.444(4)	-0.856(2)		2.887(5)	[1968Bi13]
^{147}Gd		$7/2^-$	38,06(12) h	2.188(3)	-1.650(3)		5.179(3)	[1969Ch32]
^{151}Dy		$7/2^-$	17.8(2) m*	2.871(5)	-0.277(7)		6.367(4)	[1978MoZH, 1973Bi06, 1965Ma51, 1964Ma19]
^{155}Er		$(7/2^-)$	5.3(3) m	3.831(18)	0.896(9)		6.989(7)	[1969To06]
^{159}Yb		$5/2^-$	1.72(10) m	4.740(30)	2.181(31)		7.781(25)	[1993Al03]
^{163}Hf		$(5/2^-)$	40.0(6) s	5.520(40)	3.263(30)		8.876(38)	[1982Sc15]
^{167}W		$(5/2^-)$	19.9(5) s	6.260(30)	4.477(34)		10.273(34)	[1989Me02]
^{171}Os		$5/2^-$	8.3(2) s	6.950(30)	5.705(23)		11.629(33)	[1995Hi02]
^{175}Pt		$(7/2^-)$	2.43(4) s	7.686(22)	6.998(21)		13.117(34)	[2014Pe02]
^{179}Hg		$(7/2^-)$	1.06(4) s	8.060(30)	7.776(30)	0.37(6)%***	14.037(31)	[2002Ko09, 2002Ro17, 1971Ha03, 1971Ho07]
^{183}Pb		$(3/2^-)$	535(30) ms	9.010(30)	8.708(31)		14.984(31)	[2002Je09]
^{183m}Pb	0.079(6)	$(13/2^+)$	415(20) ms	9.089(30)	8.787(31)		15.063(31)	[2002Je09]
^{187}Po		$(1/2^-, 5/2^-)$	1.40(25) ms	9.210(30)	10.216(34)		16.986(34)	[2006An11]

* Weighted average of 17.5(5) m [1978MoZH], 16.9(5) m [1973Bi06], 17.7(5) m [1965Ma51] and 18.0(2) m [1964Ma19].

** Weighted average of 1.00(5) s [2002Ko09], 1.08(9) s [2002Ro17], and 1.09(4) s [1971Ha03].

*** [1971Ho17] reports $I_{\beta p}/I_\alpha = 0.28(4)\%$. Combining this value with $\text{BR}_\alpha = 75(4)\%$ [2012Ve04] results in $\text{BR}_{\beta p} = 0.37(6)\%$

Table 2

Particle separation, Q-values, and measured values for direct particle emission of the even- Z , $T_z = +19/2$ 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
^{135}Ce	6.687(22)	11.641(10)	-0.362(10)		
^{139}Nd	6.177(29)	10.676(28)	0.174(29)		
^{143}Sm	5.665(24)	9.904(4)	0.075(28)		
^{147}Gd	5.528(6)	9.283(1)	1.735(2)		
^{151}Dy	4.936(8)	8.203(4)	4.180(3)	5.6(4)%	[1974To07, 1982Bo04, 1978MoZH, 1973Bi06, 1965Ma51, 1964Ma19, 1990KaZM, 1989KaYU, 1988KaZK, 1987KaZL, 1985Ne09, 1982De11, 1981HoZM, 1979Ho10, 1978AfZZ, 1975ToZT, 1974ToZN, 1974ToZQ, 1973BoXL, 1972OkZZ, 1968Go13, 1967Go32, 1960Ma47]
^{155}Er	4.859(10)	7.644(7)	4.118(5)	<0.022(7)%	[1974To07, 1990Po13, 1990KaZM, 1978AfZZ, 1975ToZT, 1974PeZS, 1970Ma23, 1969To06]
^{159}Yb	4.419(31)	6.998(32)	3.951(18)	<0.0001%***	[1995Hi12]
^{163}Hf	3.727(79)	6.013(30)	4.139(31)		
^{167}W	3.284(34)	5.036(34)	4.751(30)	<0.04(1)%	[1991Me05, 1989Me02]
^{171}Os	2.682(22)	3.957(24)	5.371(4)	1.8(3)%*	[1995Hi02, 1979Ha10, 2004GoZZ, 1996Pa01, 1978Sc26, 1976HoZD, 1972To06, 1972ToZC, 1972ToZL, 1972ToZO, 1972ToZW]
^{175}Pt	2.212(22)	2.848(24)	6.164(4)	64.5(13)%	[2014Pe02, 1979Ha10, 2004GoZZ, 2002Ko09, 1996Pa01, 1986Ke03, 1982De11, 1981DeZA, 1981DeZL, 1976HoZD, 1973Ga08, 1971Ha03, 1970Ha18, 1966Si08]
^{179}Hg	1.919(30)	2.140(33)	6.430(4)**	75(4)%	[2012Ve04, 2002Ko09, 1979Ho10, 2002Ro17, 1996Pa01, 1982HeZM, 1971Ha03, 1971Ho17, 1970Ha18, 1969NaZT, 1968De01]
^{183}Pb	1.542(31)#	1.497(33)#	6.928(7)	obs [@]	[2002Je09, 1989To01, 2012Ve04, 1987To09, 1986Ke03, 1980Sc09]
^{183m}Pb	1.463(31)#	1.418(33)#	7.007(9)	obs [@]	[2002Je09, 1989To01, 1987To09, 1986Ke03, 1984ScZQ, 1980Sc09]
^{187}Po	1.320(37)	0.213(36)	7.979(15)	100%	[2006An11, 2007An19, 2005An17, 2005AnZY]

* Weighted average of 1.9(3)% [1995Hi02] and 1.7(3)% [1979Ha10].

** Deduced from α energy, 6.351(31) in [2021Wa16].

*** Not observed.

@ Not measured, expected to be 80-90% based on half-life.

Table 3
direct α emission from ^{151}Dy , $J^\pi = 7/2^-$, $T_{1/2} = 17.8(2)$ m*, $BR_\alpha = 5.6(4)**$.

E_α (c.m.)	E_α (lab)	I_α (abs)	J_f^π	$E_{daughter}$ (^{147}Gd)	coincident γ -rays	R_0 (fm)	HF
4.184(3)	4.070(3)***	5.6(4)**	$7/2^-$	0.0	—	1.5706(33)	1.92(20)

* Weighted average of 17.5(5) m [1978MoZH], 16.9(5) m [1973Bi06], 17.7(5) m [1965Ma51] and 18.0(2) m [1964Ma19].

** [1974To07].

*** From 4.67(3) MeV [1982Bo04], adjusted to 4070(3) in [1991Ry01].

Table 4
direct α emission from ^{155}Er *, $J^\pi = (7/2^-)$, $T_{1/2} = 5.3(3)$ m**, $BR_\alpha = <0.022(7)\%$.

E_α (c.m.)	E_α (lab)	I_α (abs)	J_f^π	$E_{daughter}$ (^{151}Dy)	coincident γ -rays	R_0 (fm)	HF
4.118(5)	4.012(5)	$<0.022(7)\%$	$7/2^-$	0.0	—	1.546(21)	>2.9

* All values from [1974To07], except where noted.

** [1969To06].

Table 5
direct α emission from ^{167}W *, $J^\pi = (5/2^-)$, $T_{1/2} = 19.9(5)$ s, $BR_\alpha = <0.04(1)\%$.

E_α (c.m.)	E_α (lab)	I_α (abs)	J_f^π	$E_{daughter}$ (^{163}Hf)	coincident γ -rays	R_0 (fm)	HF
4.671(13)	4.559(13)**	0.04(1)%	$(5/2^-)$	***		1.548(28)	$0.9^{+1.3}_{-0.6}$ @

* All values from [1989Me02], except where noted.

** [1991Me05].

*** Assumed to feed the ground state of ^{163}Hf in [1989Me02]. However, using the Q_α from this value gives a HF value of 0.16, indicating that it likely feeds an excited state or the value for BR_α is much smaller.

@ Calculated using 4.751(30) MeV [2021Wa16] for Q_α .

Table 6
direct α emission from ^{171}Os *, $J^\pi = 5/2^-$, $T_{1/2} = 8.3(2)$ s, $BR_\alpha = 1.8(3)\%$.

E_α (c.m.)	E_α (lab)	I_α (abs)	J_f^π	$E_{daughter}$ (^{167}W)	coincident γ -rays	R_0 (fm)	HF	
5.290(10)	5.166(10)	7.0%***	$(7/2^-)$	0.12(3)%	0.079	0.079***	1.5721(95)	$7.7^{+3.0}_{-2.1}$
5.367(7)	5.241(7)	100%***	$(5/2^-)$	1.68(3)%	0.0	—	1.5721(95)	$1.3^{+0.4}_{-0.3}$

* All values from [1995Hi02], except where noted.

** Weighted average of 1.9(3)% [1995Hi02] and 1.7(3)% [1979Ha10].

*** Uncertainties not given in [1995Hi02].

Table 7
direct α emission from ^{175}Pt *, $J^\pi = (7/2^-)$, $T_{1/2} = 2.43(4)$ s, $BR_\alpha = 64.5(13)\%$.

E_α (c.m.)	E_α (lab)	I_α (rel)	I_α (abs)	J_f^π	$E_{daughter}$ (^{171}Os)	coincident γ -rays	R_0 (fm)	HF
5.950(4)	5.814(4)	7.3(16)%	4.0(9)%	$(7/2^-, 9/2^-)$	0.2112(5)	0.2112(5), 0.1341(4), 0.0767(3)	1.5574(37)	$6.6^{+2.1}_{-1.4}$
5.955(4)	5.819(4)	1.3(4)%	0.7(2)%	$(9/2^-)$	0.2079(5)	0.2079(5), 0.1308(4), 0.0767(3)	1.5574(37)	38^{+16}_{-9}
6.087(4)	5.948(4)	100(1)%	55.0(5)%	$(7/2^-)$	0.0767(3)	0.0767(3)	1.5574(37)	1.71(15)
6.162(4)	6.021(4)	8.7(15)%	4.8(8)%	$(5/2^-)$	0.0	—	1.5574(37)	40^{+9}_{-7}

* All values from [2014Pe02], except where noted.

Table 8
direct α emission from ^{179}Hg , $J^\pi = (7/2^-)$, $T_{1/2} = 1.06(4)$ s*, $BR_\alpha = 75(4)\%^{**}$.

E_α (c.m.)	E_α (lab)	I_α (abs)	J_f^π	$E_{daughter}(^{175}\text{Pt})$	coincident γ -rays	R_0 (fm)	HF
6.430(4)	6.287(4)	75(4)%**	(7/2 ⁻)		0.0	—	1.5367(27) 1.26(12)

* Weighted average of 1.00(5) s [2002Ko09], 1.08(9) s [2002Ro17], and 1.09(4) s [1971Ha03].

** [2112Ve04].

Table 9
direct α emission from ^{183}Pb *, $J^\pi = (3/2^-)$, $T_{1/2} = 535(30)$ ms, $BR_\alpha = \text{obs}^{**}$.

E_α (c.m.)	E_α (lab)	I_α (rel)	I_α (abs)	J_f^π	$E_{daughter}(^{179}\text{Hg})$	coincident γ -rays	R_0 (fm)	HF
6.717(10)	6.570(10)	39(6)%	(3/2 ⁻)		0.217	0.217	1.5067(87)	1.7 ^{+0.5} _{-0.4} **
6.926(7)	6.775(7)	100(7)%	(7/2 ⁻)		0.0	—	1.5067(87)	3.9 ^{+0.9} _{-0.8} **

* All values from [2002Je01], except where noted.

** Not measured, expected to be 80-90% based on half-life.

*** Value based on a 100% α branching ratio for ^{183}Pb .

Table 10
direct α emission from ^{183m}Pb *, $E_x = 79(6)$ keV, $J^\pi =$, $T_{1/2} = 415(20)$ ms, $BR_\alpha = \text{obs}^{**}$.

E_α (c.m.)	E_α (lab)	I_α (rel)	I_α (abs)	J_f^π	$E_{daughter}(^{179}\text{Hg})$	coincident γ -rays	R_0 (fm)	HF
6.848(5)	6.698(5)	100(6)%	(13/2 ⁺)		0.172	0.0061, 0.111	1.5067(87)	1.12 ^{+0.24} _{-0.20} **
7.013(11)	6.860(11)	3(1)%	(7/2 ⁻)		0.0	—	1.5067(87)	140 ⁺⁹⁰ ₋₅₀ **

* All values from [2002Je01], except where noted.

** Not measured, expected to be 80-90% based on half-life.

*** Value based on a 100% α branching ratio for ^{183}Pb .

Table 11
direct α emission from ^{187}Po *, $J^\pi = (1/2^-, 5/2^-)$, $T_{1/2} = 1.40(25)$ ms, $BR_\alpha = 100\%^{***}$.

E_α (c.m.)	E_α (lab)	I_α (rel)	I_α (abs)	J_f^π	$E_{daughter}(^{183}\text{Pb})$	coincident γ -rays	R_0 (fm)	HF
7.693(15)	7.528(15)	100%	100%	(1/2 ⁻)	0.286(1)	0.286(1)	1.487(13)	0.29 ^{+0.11} _{-0.09} @
	7.979	<2%**	<2%**	(3/2 ⁻)	0.0	—	1.487(13)	>100

* All values from [2006An11].

** A single event at this energy was observed.

*** Inferred from half-life.

@ The very low value for HF may indicate that the decay of ^{187}Po has other unobserved transitions.

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