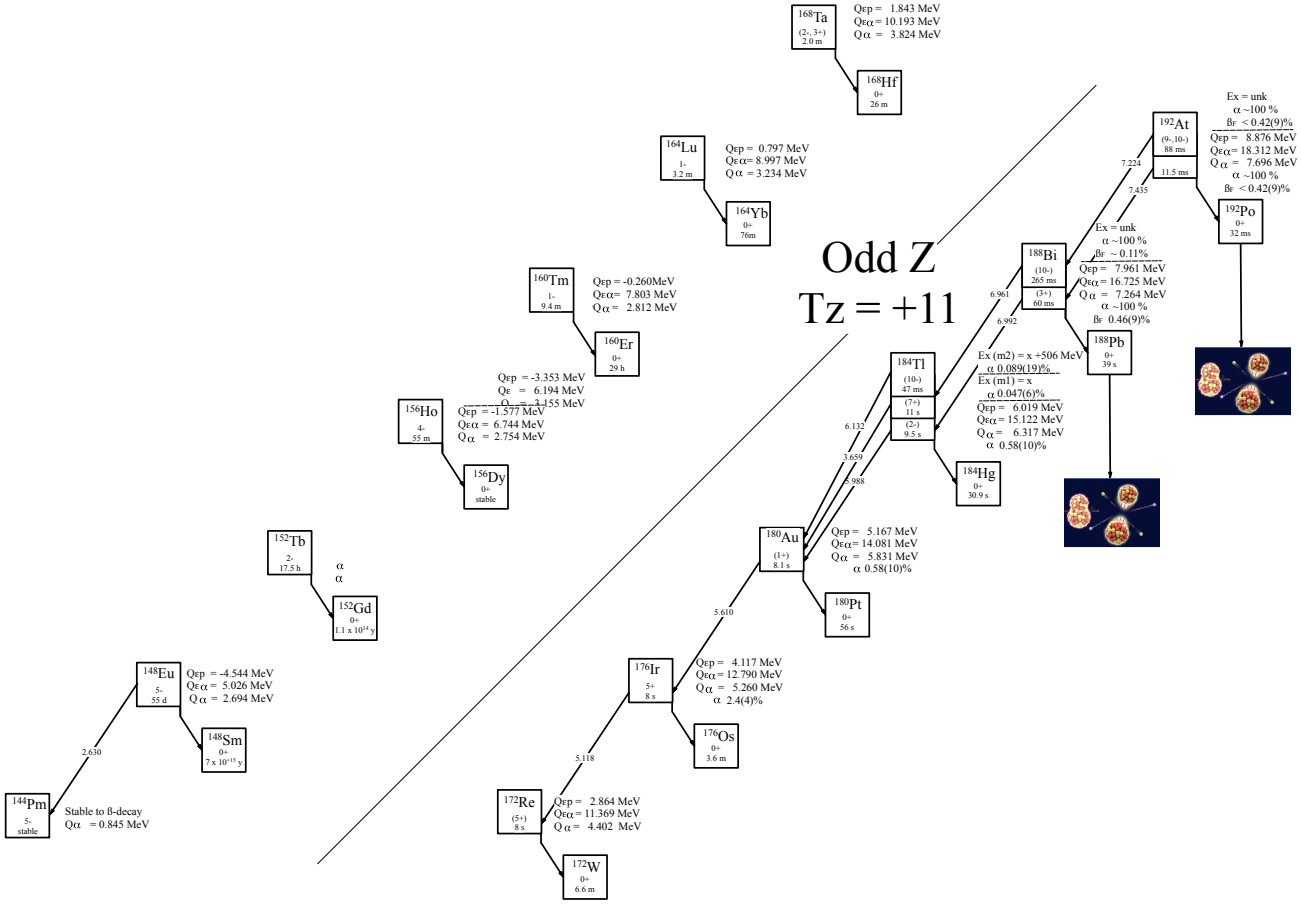

Fig. 1: Known experimental values for heavy particle emission of the odd-Z T_z= +11 nuclei.

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Table 1
Observed and predicted β-delayed particle emission from the odd-Z, T_z = +11 nuclei. Unless otherwise stated, all Q-values are taken from [2021Wa16] or deduced from values therein. J^π values for ^{144}Pm, ^{148}Eu, ^{152}Tb, ^{156}Ho, ^{160}Tm, ^{164}Lu, ^{168}Ta, ^{172}Re are taken from ENSDF.

Nuclide	Ex	J^π	$T_{1/2}$	Q$_\varepsilon$	$Q_{\varepsilon p}$	$Q_{\varepsilon\alpha}$	BR$_{\beta F}$	Experimental
^{144}Pm		5^-	363(14) d*	0.550(3)	-5.637(2)	4.233(3)		[**1963Pa21, 1964Bu13**
^{148}Eu		5^-	55.6(2) d	3.039(10)	-4.544(10)	5.026(10)		[**1980Ho33**]
^{152}Tb		2^-	17.5(1) h	3.990(40)	-3.353(40)	6.194(40)		[**1967Gr12**]
^{156}Ho		4^-	55(1) m	4.990(40)	-1.577(40)	6.744(38)		[**1966La11**]
^{160}Tm		1^-	9.4(4) m*	5.760(40)	-0.260(33)	7.803(33)		[**1970De13, 1975St12**]
^{164}Lu		1^-	3.15(3) m**	6.370(30)	0.797(28)	8.997(37)		[**1984Ad09, 1983Ge08, 1977Hu02**]
^{168}Ta		$(2^-, 3^+)$	2.0(1) m	6.970(40)	1.843(47)	10.193(32)		[**1989Hi04**]
^{172}Re		(5^+)	15(3) s	7.530(50)	2.864(45)	11.369(45)		[**1977Be66**]
^{176}Ir		5^+	8(1) s	8.249(14)	4.117(29)	12.790(29)		[**1967Si02**]
^{180}Au		(1^+)	8.1(3) s	8.804(11)	5.167(11)	14.081(12)		[**1977Hu05**]
^{184}Tl***	y	(2^-)	9.5(2) s	9.461(14)+y	6.019(14)+y	15.122(14)+y		[**2016Va01**]
^{184m1}Tl***	x	(7^+)	11(1) s	9.461(14)+x	6.019(14)+x	15.122(14)+x		[**2016Va01, 1976CoZH**]
^{184m2}Tl	x +0.506	(10^-)	47.1(7) ms	9.967(14)+x	6.525(14)+x	15.628(14)+x		[**2015Va10**]
^{188}Bi		(3^+)	60(3) ms	10.616(15)	7.961(14)	16.725(15)	0.46(9)%	[**2020An12, 2003An26**, 2013La02, 1993LaZT]
^{188m}Bi	x	(10^-)	265(10) ms	10.616(15)+x	7.961(14)+x	16.725(15)+x	≈0.11%	[**2020An12, 2003An26**, 2013La02, 1993LaZT]
^{192}At	y		11.5(6) ms	10.992(30)	8.876(29)	18.312(30)	0.42(9)%[@]	[**2006An04, 2013An03**]
^{192m}At	x	$(9^-, 10^-)$	88(6) ms	10.992(30)+x	8.876(29)+x	18.312(30)+x	0.42(9)%[@]	[**2006An04, 2013An03**]

* Weighted average of 377(16) d [1963Pa21] and 349(16) d [1964Bu13].
* Weighted average of 9.2(4) m [1970De13] and 9.5(4) m [1975St12].
** Weighted average of 3.12(3) m [1984Ad09], 3.15(8) m [1983Ge08] and 3.17(3) m [1977Hu02].
*** The ordering of the isomers is uncertain.
[@] [2013An03] state that the measured BR$_{\beta F}$ is likely from the 88-ms isomer.

Table 2
Particle separation, Q-values, and measured values for direct particle emission of the odd-Z, T_z = +11 nuclei. Unless otherwise stated, all S and Q-values are taken from [2021Wa16] or deduced from values therein.

Nuclide	S_p	S_{2p}	Q$_\alpha$	BR$_\alpha$	Experimental
^{144}Pm	4.703(3)	12.208(3)	0.845(7)		
^{148}Eu	4.320(10)	11.421(11)	2.694(10)	$9.4(28)\times10^{-7}$%	[**1964To04**]
^{152}Tb	3.817(40)	10.503(41)	3.155(41)		
^{156}Ho	3.671(40)	9.960(60)	2.754(55)		
^{160}Tm	3.029(33)	8.692(42)	2.812(50)		
^{164}Lu	2.637(32)	7.743(38)	3.234(43)		
^{168}Ta	2.215(40)	6.951(41)	3.824(40)		
^{172}Re	1.770(45)	6.007(45)	4.402(45)		
^{176}Ir	1.066(14)	4.787(29)	5.260(36)	2.4(4)%*	[**1967Si02, 1990Bo19, 1986Ke03**]
^{180}Au	0.646(9)	3.949(19)	5.831(7)	0.58(10)%	[**2020Ha24**] 2020Cu02,1993Wa03, 1986Ke03]
^{184}Tl	0.368(12)-y	3.157(21)-y	6.317(9)+y	1.22(30)%	[**2016Va01**, 1978CoYS, 1977ToZS, 1976Co24, 1976To06, 1976WoZJ]
^{184m1}Tl	0.368(12)-x	3.157(21)-x	6.317(9)+x	0.047(6)%	[2016Va01, 1976CoZH, 1978CoYS]
^{184m2}Tl	-0.138(12)+x	2.651(21)-x	6.823(9)+x	0.089(19)%	[**2016Va01, 2015Va10**]
^{188}Bi	-0.503(12)	1.890(24)	7.264(5)	≈100%**	[**2003An26**, 2006An04, 2003AnZZ, 1997Wa05, 1993An19, 1984ScZQ]
^{188m}Bi	-0.503(12)-x	1.890(24)-x	7.264(5)+x	≈100%**	[**2003An26**, 2006An04, 2003AnZZ, 1997Wa05, 1993An19, 1984ScZQ]
^{192}At	-0.706(29)	1.056(35)	7.696(26)	≈100%**	[**2006An04**, 2005AnZY]
^{192m}At	-0.706(29)-x	1.056(35)-x	7.696(26)+x	≈100%**	[**2006An04**, 2005AnZY]

* Weighted average of 3.1(6)% [1990Bo19], and 2.1(4)% [1986Ke03].
** Based on short half-life.

Table 3
direct α emission from ^{148}Eu*, $J^\pi = 5^-$, $T_{1/2}$ = 55.6(2) d**, BR_α =9.4(28)$\times 10^{-7}$%.

E_α(c.m.)	E_α(lab)	I_α(abs)	J_f^π	$E_{daughter}$(^{144}Pm)	coincident γ-rays	R_0 (fm)***	HF
2.703(30)	2.630(30)	9.4(28)$\times 10^{-7}$%	5^-	0.0	——	1.584(11)	4^{+5}_{-3}

* All values from [1964To04], except where noted.
** [1980Ho33].
*** Interpolated between 1.5930(74) fm ^{146}Sm and 1.5748(86) ^{150}Gd.

Table 4
direct α emission from ^{176}Ir*, $J^\pi = 5^+$, $T_{1/2}$ = 8(1) s, BR_α =2.4(4)%**.

E_α(c.m.)	E_α(lab)	I_α(abs)	J_f^π	$E_{daughter}$(^{172}Re)	coincident γ-rays	R_0 (fm)***	HF
5.237(10)	5.118(10)	2.4(4)%***	(5^+)	0.0	——	1.556(34)	$0.06^{+0.06\,@}_{-0.03}$

* All values from [1967Si02], except where noted.
** Weighted average of 3.1(6)% [1990Bo19], and 2.1(4)% [1986Ke03].
*** Interpolated between 1.540(34) fm ^{174}Os and 1.5708(31) ^{178}Pt.
@ The reason for this un-physically low HF value is unknown. A likely possibility is the observed peak at 5.118 MeV is an unresolved multiplet consisting of multiple α transitions and conversion electron summing.

Table 5
direct α emission from ^{180}Au*, $J^\pi = (1^+)$, $T_{1/2}$ = 8.1(3) s**, BR_α =0.58(10)%.

E_α(c.m.)	E_α(lab)	I_α(rel)	I_α(abs)	J_f^π	$E_{daughter}$(^{176}Ir)	coincident γ-rays	R_0 (fm)	HF
5.476(20)	5.354(20)	0.51(26)%	0.0012(6)%		0.338(20)		1.5442(51)	180^{+230}_{-80}
5.548(20)	5.425(20)	2.3(8)%	0.005(2)%		0.2648(9)	0.0365, 0.0415, 0.1778, 0.2188	1.5442(51)	90^{+60}_{-30}
5.610(10)	5.485(10)	100(10)%	0.23(5)%	(1^+)	0.2052(9)	0.0365, 0.0415, 0.1089, 0.1180, 0.1599, 0.1957, 0.2052	1.5442(51)	4.0^{+14}_{-10}
5.637(15)	5.512(15)	8.5(18)%	0.019(4)%		0.1766(9)	0.0365, 0.0415, 0.0891, 0.1033	1.5442(51)	64^{+27}_{-18}
5.725(8)	5.598(8)	60.5(87)%	0.14(3)%		0.0875(8)	0.0365, 0.0415,	1.5442(51)	23^{+8}_{-6}
5.767(7)	5.639(7)	85(12)%	0.19(4)%		0.0460(7)	0.0365	1.5442(51)	25^{+8}_{-6}
≈5.804	≈5.675	<1.3%	<0.0029%		0.0095(7)		1.5442(51)	>2400
≈5.815	≈5.686	<1.3%	<0.0029%	5^+	0.0	——	1.5442(51)	>2700

* All values from [2020Ha24], except where noted.
** [1977Hu05].
*** Interpolated between 1.5708(31) ^{178}Pt and 1.5176(41) fm ^{182}Hg.

Table 6
direct α emission from ^{184}Tl*, $J^\pi = (2^-)$, $T_{1/2}$ = 9.5(2) s, BR_α =1.22(30)%.

E_α(c.m.)	E_α(lab)	I_α(rel)	I_α(abs)	J_f^π	$E_{daughter}$(^{180}Au)	coincident γ-rays
5.876(12)	5.748(12)	<0.4%	<0.0024%		x + 0.426	0.4260(5)
5.935(12)	5.810(12)	6.0(4)%	0.037(9)%		x + 0.365	0.3651(2), 0.3151(2), 0.2728(3), 0.1984(9)
6.097(13)	5.964(13)				x + 0.224	0.2243(3)
6.121(12)	5.988(12)	100%	0.61(15)%		x + 0.201	0.2013(3), 0.1842(1), 0.1785(1), 0.1263(1)
6.298(10)	6.161(10)	93(1)%	0.57(14)%		x + 0.017	

* All values from [2016Va01].

Table 7
direct α emission from ^{184m1}Tl*, $J^\pi = (7^+)$, $T_{1/2}$ = 11(1) s**, BR_α =0.047(6)%.

E_α(c.m.)	E_α(lab)	I_α(abs)	J_f^π	$E_{daughter}$(^{180}Au)	coincident γ-rays
5.785(5)	5.659(5)	0.047(6)%		z + 0.183	0.3633(6), 0.2618(3), 0.2577(3), 0.1757(3)

* All values from [2016Va01], except where noted.
** [1976CoZH].

Table 8
direct α emission from ^{184m2}Tl*, J^π = (10^-), $T_{1/2}$ = 47.1(7) ms**, BR_α =0.089(19)%.

E_α(c.m.)	E_α(lab)	I_α(abs)	J_f^π	$E_{daughter}$(^{180}Au)	coincident γ-rays
6.268(19)	6.132(19)	0.089(19)%		z + 0.206	0.2059(2), 0.1626(1), 0.1079(2), 0.1013(6)

* All values from [2016Va01], except where noted.
** [2015Va10].

Table 9
direct α emission from ^{188}Bi*, J^π = (3^+), $T_{1/2}$ = 60(3) ms, BR_α =≈100%.

E_α(c.m.)	E_α(lab)	I_α(rel)	I_α(abs)	J_f^π	$E_{daughter}$(^{184}Tl)	coincident γ-rays	R_0 (fm)**	HF
7.039(10)	6.889(10)	0.34(1)%		≈0.33	y + 0.216	0.099, 0.1175	1.4985(10)	≈100
7.144(5)	6.992(5)	100%	≈98%	(3^+)	y + 0.1775	0.1175	1.4985(10)	0.46(3)
7.260(5)	7.106(5)	2.1(2)%	≈2.0%	(2^+)	y	1.4985(10)	≈89	

* All values from [2003An26].
** Interpolated between 1.486(10) ^{186}Pb and 1.5114(26) fm ^{190}Po. Note this value is likely too low as Pb is a closed proton shell.

Table 10
direct α emission from ^{188m}Bi*, J^π = (10^-), $T_{1/2}$ = 265(10) ms, BR_α =≈100%.

E_α(c.m.)	E_α(lab)	I_α(rel)	I_α(abs)	J_f^π	$E_{daughter}$(^{184}Tl)	coincident γ-rays	R_0 (fm)**	HF
6.961(5)	6.813(5)	100%	≈91%	(10^-)	0.500		1.4985(10)	≈0.8
7.147(15)	6.995(15)	1.5(5)%	≈1.4%		x + 0.320	0.0705, 0.249, 0.320	1.4985(10)	≈230
7.389(10)	7.232(10)	4.5(1)%	≈4.1%	(6^+)	x + 0.0705	0.0705	1.4985(10)	≈510
7.461(5)	7.302(5)	3.6(1)%	≈3.3%	(7^+)	x		1.4985(10)	≈1050

* All values from [2003An26], except where noted.
** Interpolated between 1.486(10) ^{186}Pb and 1.5114(26) fm ^{190}Po. Note this value is likely too low as Pb is a closed proton shell.

Table 11
direct α emission from ^{192}At*, J^π = , $T_{1/2}$ = 11.5(6) ms, BR_α =≈100%.

E_α(c.m.)	E_α(lab)	I_α(rel)	I_α(abs)	J_f^π	$E_{daughter}$(^{188}Bi)	coincident γ-rays	R_0 (fm)**	HF
7.520(15)	7.363(15)	21(4)%	12(2)%		0.172(29)		1.551(12)	11^{+6}_{-4}
7.593(15)	7.435(15)	100(7)%	56(4)%		0.101(25)	0.036	1.551(12)	$4.0^{+1.7}_{-1.3}$
7.629(15)	7.470(15)	55(7)%	31(3)%		0.065(25)		1.551(12)	19^{+4}_{-3}
7.670-7.721	7.510-7.560	≤1.8(9)%	1.0(5)%	(3^+)	0.0	——		

* All values from [2006An04].
** Interpolated between 1.5114(26) fm ^{190}Po and 1.590(11) ^{194}Pb and Note this value is likely too low as Pb is a closed proton shell.

Table 12
direct α emission from ^{192m}At*, J^π = (9^-, 10^-), $T_{1/2}$ = 88(6) ms, BR_α =≈100%.

E_α(c.m.)	E_α(lab)	I_α(rel)	I_α(abs)	J_f^π	$E_{daughter}$(^{188}Bi)	coincident γ-rays	R_0 (fm)**	HF
7.348(15)	7.195(15)	4.9(4)%	4.0(7)%		x +0.188	0.188	1.551(12)	70^{+40}_{-30}
7.378(15)	7.224(15)	100(4)%	82(3)%	(9^-, 10^-)	x + 0.165	0.165	1.551(12)	$4.2^{+1.9}_{-1.5}$
7.542(15)	7.385(15)	17.1(7)%	14(2)%	(10^-)	x		1.551(12)	80^{+40}_{-30}
7.670-7.721	7.510-7.560	≤1.8(9)%	1.0(5)%	(3^+)	0.0	——		

* All values from [2006An04].
** Interpolated between 1.5114(26) fm ^{190}Po and 1.590(11) ^{194}Pb and Note this value is likely too low as Pb is a closed proton shell.
*** unresolved multiplet.

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