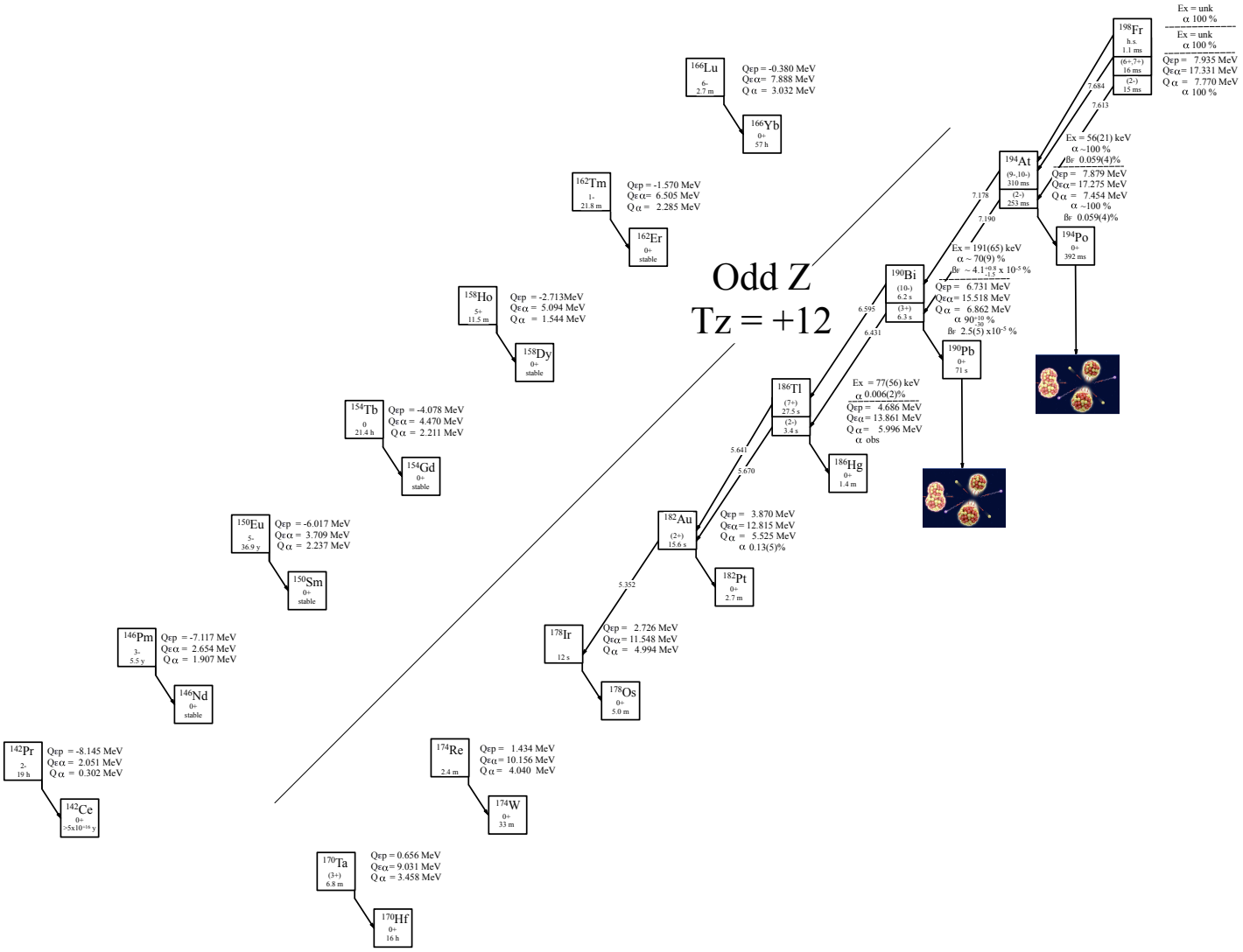

Fig. 1: Known experimental values for heavy particle emission of the odd-Z T_z= +1/2 nuclei.

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Table 1
Observed and predicted β-delayed particle emission from the odd-Z, T_z = +12 nuclei. Unless otherwise stated, all Q-values are taken from [2021Wa16] or deduced from values therein. J^π values for ^{142}Pr, ^{146}Pm, ^{150}Eu, ^{154}Tb, ^{158}Ho, ^{162}Tm, ^{166}Lu, ^{170}Ta, ^{174}Re, ^{178}Ir and ^{182}Au are taken from ENSDF.

Nuclide	Ex	J^π	$T_{1/2}$	Q_ε	$Q_{\varepsilon p}$	$Q_{\varepsilon\alpha}$	$BR_{\beta F}$	Experimental
^{142}Pr		2^-	19.12(4) h*	2.164(1)	-8.145(4)	2.051(2)		[**1966Ot03, 1968La17**]
^{146}Pm		3^-	5.53(5) y	1.542(3)	-7.117(8)	2.654(5)		[**1967Bu12**]
^{150}Eu		5^-	36.9(9) y	0.972(4)	-6.017(6)	3.709(6)		[**1993Th04**]
^{154}Tb		0	21.4(5) h	0.240(50)	-4.078(45)	4.470(45)		[**1973La20**]
^{158}Ho		5^+	11.5(5) m	4.220(27)	-2.713(27)	5.094(27)		[**1962Sc10**]
^{162}Tm		1^-	21.77(26) m	4.857(26)	-1.570(26)	6.505(26)		[**1971Ch30**]
^{166}Lu		6^-	2.65(10) m	5.570(30)	-0.380(30)	7.888(30)		[**1974De09**]
^{170}Ta		(3^+)	6.76(6(m	6.120(40)	0.656(28)	9.031(29)		[**1976Le04**]
^{174}Re			2.40(15) m	6.550(40)	1.434(40)	10.156(40)		[**1977Ha24**]
^{178}Ir			12(2) s	7.290(23)	2.726(34)	11.548(34)		[**1973HaVR**]
^{182}Au		(2^+)	15.6(4) s	7.864(23)	3.870(19)	12.815(23)		[**1992Ro21**]
^{186}Tl		(2^-)	$3.4^{+0.5}_{-0.4}$ s	8.656(24)	4.686(21)	13.861(25)		[**2020St11**]
^{186m}Tl	0.077(56)	(7^+)	27.5(10) s	8.733(61)	4.763(60)	13.938(61)		[**1977Co21**]
^{190}Bi		(3^+)	6.3(1) s	9.821(24)	6.731(23)	15.518(24)	$2.5(5) \times 10^{-5}$	[**2009An11, 1988Hu03**]
^{190m}Bi	0.191(65)	(10^-)	6.2(1) s	10.012(69)	6.922(69)	15.709(69)	$4.1^{+0.8}_{-1.5}\times 10^{-5}$	[**2009An11, 1988Hu03**]
^{194}At		(2^-)	253(10) ms	10.288(27)	7.879(25)	17.275(27)	0.059(4)%***	[**2014Gh09, 2009An11**, 2013An03]
^{194m}At	0.056(21)**	$(9^-, 10^-)$	310(8) ms	10.344(34)	7.935(33)	17.331(34)	0.059(4)%***	[**2014Gh09, 2009An11**, 2013An03]
^{198}Fr		(2^-)	15(3) ms	10.810(30)	8.644(32)	18.157(34)		[**2013Ka16, 2013Uu01**]
^{198m1}Fr	x	$(6^+, 7^+)$	16^{+13}_{-5} ms	10.810(30)+x	8.644(32)+x	18.157(34)+x		[**2013Uu01**]
^{198m2}Fr	y	h.s.	1.1(7) ms	10.810(30)+y	8.644(32)+y	18.157(34)+y		[**2013Ka16**]

* Weighted average of 19.14(5) h [1966Ot03] and 19.09(7) h [1968La17].
** Deduced from α-decay energies [2009An11].
*** value is acombination of the two isomers [2014Gh09].

Table 2
Particle separation, Q-values, and measured values for direct particle emission of the odd-Z, T_z = +12 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
^{142}Pr	5.644(1)	14.052(2)	0.302(2)		
^{146}Pm	5.311(4)	13.282(5)	1.907(4)		
^{150}Eu	4.945(6)	12.504(8)	2.237(7)		
^{154}Tb	4.563(45)	11.846(45)	2.211(46)		
^{158}Ho	4.052(27)	10.674(27)	1.544(53)		
^{162}Tm	3.565(27)	9.673(30)	2.285(38)		
^{166}Lu	3.015(40)	8.690(39)	3.032(40)		
^{170}Ta	2.710(40)	7.643(47)	3.458(41)		
^{174}Re	2.235(40)	6.921(40)	4.040(40)		
^{178}Ir	1.587(24)	5.769(34)	4.994(34)		
^{182}Au	1.211(23)	4.904(29)	5.525(4)	0.13(5)%	[**1995Bi01**, 1993BiZY, 1992BiZZ, 1979Ha10, 1970Ha18]
^{186}Tl	0.988(25)	4.142(30)	5.996(26)	obs	[**2020St11**]
^{186m}Tl	0.911(62)	4.065(64)	6.073(63)	0.006(2)%	[**1977Co21, 1976Ij01**, 1977IjZZ, 1976ToZR, 1976To06]
^{190}Bi	0.041(25)	2.837(37)	6.862(3)	90^{+10}_{-30}%	[**2003An26, 1991Va04**, 2013Ny01, 2009An11, 2003AnZZ, 1997An09, 1993An19, 1988Hu03, 1985HuZY]
^{190m}Bi	-0.150(70)	2.646(375)	7.053(65)	70(9)%	[**2003An26, 1991Va04**, 2013Ny01, 2009An11, 2003AnZZ, 1997An09, 1993An19, 1988Hu03, 1985HuZY, 1974Le02, 1972Ga27]
^{194}At	-0.320(28)	1.760(38)	7.454(11)	$\approx$ 100%*	[**2009An11**, 2013Ka16, 2013Ny01, 2013Uu01, 1995Le15, 1984YaZY]
^{194m}At	-0.376(35)	1.648(43)	7.510(24)	$\approx$ 100%*	[**2009An11**, 2013Ka16, 2013Ny01, 2013Uu01]
^{198}Fr	-0.778(35)	1.087(43)	7.770(15)**	100%*	[**2013Ka16, 2013Uu01**]
^{198m1}Fr	-0.778(35)-x	1.087(43)-x	7.770(15)+x	100%*	[**2013Uu01**]
^{198m2}Fr	-0.778(35)-y	1.087(43)-y	7.770(15)+y	100%*	[**2013Ka16**]

* based on short half-life.
** Deduced from α energy, 7.869(20) in [2021Wa16].

Table 3
direct α emission from ^{182}Au*, $J^{\pi} = (2^{+})$, $T_{1/2}$= 15.6(4) s**, BR_{α} = 0.13(5)%.

E_{α}(c.m.)	E_{α}(lab)	I_{α}(rel)	I_{α}(abs)	J^{π}_{f}	$E_{daughter}$(^{178}Ir)	coincident γ-rays	R_0 (fm)***	HF
5.402(5)	5.283(5)	10(1)%	0.009(4)%		0.123		1.529(10)	15^{+11}_{-5}
5.472(5)	5.352(5)	100(1)%	0.094(36)%	(2^{+})	0.0544	0.0544	1.529(10)	$3.3^{+2.3}_{-1.2}$
5.524(5)	5.403(5)	29(1)%	0.027(10)%		0.0	——	1.529(10)	21^{+15}_{-7}

* All values from [1995Bi01], except where noted.
** [1992Ro21].
*** Interpolated between 1.5468(62) fm ^{180}Pt and 1.5120(81) ^{184}Hg.

Table 4
direct α emission from ^{186}Tl*, $J^{\pi} = (2^{-})$, $T_{1/2}$= $3.4^{+0.5}_{-0.4}$ s, BR_{α} = obs.

E_{α}(c.m.)	E_{α}(lab)**	I_{α}(rel)	J^{π}_{f}	$E_{daughter}$(^{182}Au)	coincident γ-rays	R_0 (fm)***	HF
(5.647)	(5.526)	4.4%		0.2731	0.0253, 0.1041, 0.1294,0.1437, 0.2731	1.5002(82)	
(5.651)	(5.529)	5.3%		0.2702	0.0253, 0.1041, 0.1294,0.1408	1.5002(82)	
5.647(51)	5.670(51)	100%		0.129	0.0253, 0.1041, 0.1294	1.5002(82)	

* All values from [2020St11].
** [2020St11] report one α transition feeding a level at 129 keV in ^{182}Au. However, they report γ's in coincidence with an α multiplet from 4.550 to 6.500 MeV that arise from 273.1 and 270.2-keV levels in ^{182}Au. The intensities recorded here are based on the intensities of the coincident γ-rays.

Table 5
direct α emission from ^{186m}Tl, Ex = 77(56) keV, $J^{\pi} = (7^{+})$, $T_{1/2}$= 27.5(10) s*, BR_{α} = 0.006(2)%**.

E_{α}(c.m.)	E_{α}(lab)	I_{α}(abs)	J^{π}_{f}	$E_{daughter}$(^{182}Au)	coincident γ-rays	R_0 (fm)***	HF
5.765(10)	5.641(10)**	0.006(2)%**	2^{+}	0.0	——	1.5002(82)	160^{+90}_{-50}

* [1977Co21].
** [1976Ij01]
*** Interpolated between 1.5120(81) fm ^{184}Hg and 1.4885(12) fm ^{188}Pb.

Table 6
direct α emission from ^{190}Bi*, $J^{\pi} = (3^{+})$, $T_{1/2}$= 6.3(1) s, $BR_{\alpha} = 90^{+10}_{-30}$%**.

E_{α}(c.m.)	E_{α}(lab)	I_{α}(rel)	I_{α}(abs)	J^{π}_{f}***	$E_{daughter}$(^{186}Tl)	coincident γ-rays	R_0 (fm)$^{@}$	HF
6.359(10)	6.225(10)	0.06(1)%	$0.054^{+0.011}_{-0.020}$%		0.507	0.213, 0.294	1.5029(12)	120^{+70}_{-9}
6.550(10)	6.412(10)	0.10(2)%	$0.09^{+0.02}_{-0.03}$%		0.314	0.314	1.5029(12)	720^{+380}_{-70}
6.569(5)	6.431(5)	100%	90^{+10}_{-30}%	(3^{+})	0.294	0.079, 0.105, 0.111	1.5029(12)	$0.90^{+0.40}_{-0.09}$
6.647(5)	6.507(5)**	0.24(8)%**	$0.22^{+0.08}_{-0.10}$%	(2^{-})	0.226	0.105, 0.111	1.5029(12)	700^{+300}_{-110}
6.753(10)	6.611(10)	2.2(3)%	$1.98^{+0.35}_{-0.71}$%	(4^{+})	0.105	0.105	1.5029(12)	200^{+100}_{-19}
6.860(10)	6.716(10)	1.5(2)%	$1.35^{+0.23}_{-0.48}$%	(2^{-})	0.0	——	1.5029(12)	710^{+390}_{-60}

* All values from[2003An26], except where noted.
** [1991Va04].
*** [2022Ba26].
$^{@}$ Interpolated between 1.4885(12) fm ^{188}Pb and 1.51737(13) fm ^{192}Po.

Table 7
direct α emission from ^{190m}Bi*, J^{π} = (10^{-}), $T_{1/2}$= 6.2(1) s, BR_{α} = 70(9)%**.

E_{α}(c.m.)	E_{α}(lab)	I_{α}(rel)	I_{α}(abs)	J_f^{π}***	$E_{daughter}$(^{186}Tl)	coincident γ-rays	R_0 (fm)[@]	HF
6.529(10)	6.392(10)	0.24(4)%	0.16(3)%		0.441	0.441	1.5029(12)	330^{+100}_{-60}
6.595(5)	6.456(5)	100%	67(9)%		0.374	0.374	1.5029(12)	$1.43^{+0.25}_{-0.19}$
6.611(10)	6.472(10)	0.41(7)%	0.28(6)%		0.356	0.895, 0.267, 0.385	1.5029(12)	410^{+130}_{-80}
6.687(10)	6.546(10)	0.046(8)%	0.031(7)%		0.281	0.281	1.5029(12)	$7.0^{+2.2}_{-1.4}\times10^{3}$
6.711(10)	6.570(10)	0.039(8)%	0.026(6)%		0.255	0.255	1.5029(12)	$1.0^{+0.4}_{-0.2}\times10^{4}$
6.879(10)	6.734(10)	1.5(2)%	1.01(19)%		0.0895	0.0895	1.5029(12)	$1.07^{+0.27}_{-0.18}\times10^{3}$
6.966(10)	6.819(10)	2.0(3)%	1.34(27)%		0.0	——	1.5029(12)	$1.7^{+0.5}_{-0.3}\times10^{3}$

* All values from[2003An26], except where noted.
** [1991Va04].
*** [2022Ba26].
[@] Interpolated between 1.4885(12) fm ^{188}Pb and 1.51737(13) fm ^{192}Po.

Table 8
direct α emission from ^{194}At*, J^{π} = (2^{-}), $T_{1/2}$= 253(10) ms, BR_{α} = $\approx$ 100%**.

E_{α}(c.m.)	E_{α}(lab)	I_{α}(rel)	I_{α}(abs)	J_f^{π}	$E_{daughter}$(^{190}Bi)	coincident γ-rays	R_0 (fm)***	HF
7.295(15)	7.145(15)	11(4)%	9(3)%		0.168(15)	0.0465, 0.076	1.551(15)	$7^{+5}_{-3}\times10^{3}$
7.341(15)	7.190(15)	100(5)%	83(3)%		0.121(15)	0.076	1.551(15)	10^{+4}_{-3}
7.419(15)	7.266(15)	8(4)%	7(3)%		0.045(15)		1.551(15)	220^{+200}_{-100}
7.464(15)	7.31(15)	>1.26%	>1.0(5)%	(3^{+})	0.0	——	1.551(15)	$>2.1\times10^{3}$

* All values from [2009An11].
** Based on short half-life.
*** Interpolated between 1.51737(13) fm ^{192}Po and 1.585(15) fm ^{196}Rn.

Table 9
direct α emission from ^{194m}At*, Ex. = 56(21) keV, J^{π} = (9^{-}, 10^{-}),$T_{1/2}$= 310(8) ms, BR_{α} = $\approx$ 100%**.

E_{α}(c.m.)	E_{α}(lab)	I_{α}(rel)	I_{α}(abs)	J_f^{π}	$E_{daughter}$(^{190}Bi)	coincident γ-rays	R_0 (fm)***	HF
7.053(15)	6.908(15)	1.3(4)%	1.0(3)%		0.465	0.274	1.551(15)	110^{+70}_{-40}
7.234(15)	7.085(15)	17(3)%	13(2)%		0.288	0.097	1.551(15)	34^{+14}_{-11}
7.285(15)	7.135(15)	10(3)%	8(2)%		0.231	0.40	1.551(15)	90^{+50}_{-30}
7.329(15)	7.178(15)	100(9)%	78(5)%	(10^{-})	0.191		1.551(15)	12^{+5}_{-4}

* All values from [2009An11].
** Based on short half-life.
*** Interpolated between 1.51737(13) fm ^{192}Po and 1.585(15) fm ^{196}Rn.

Table 10
direct α emission from ^{198}Fr*, J^{π} = (2^{-}), $T_{1/2}$= 15(3) ms, BR_{α} = $\approx$ 100%**.

E_{α}(c.m.)	E_{α}(lab)	I_{α}(abs)	J_f^{π}	$E_{daughter}$(^{194}At)	coincident γ-rays	R_0 (fm)	HF
7.770(15)	7.613(15)***	100%	(2^{-})	0.0	——		

* [2013Ka16].
** Based on short half-life.
*** From [2013Uu01]. [2013ka16] report an α transition of $\approx$ 7.710 MeV and an unresolved multiplet from 7.470 and 7.920 MeV.

Table 11
direct α emission from ^{198m1}Fr*, Ex. = x, J^{π} = (6^{+}, 7^{+}), $T_{1/2}$= $16\ ^{+13}_{-5}$ ms, BR_{α} = 100%**.

E_{α}(c.m.)	E_{α}(lab)	I_{α}(abs)	J_f^{π}	$E_{daughter}$(^{194}At)	coincident γ-rays	R_0 (fm)	HF
7.842(15)	7.684(15)	100%	(6^{+}, 7^{+})	x'			

* All values from [2013Uu01].

** Based on short half-life.

Table 12
direct α emission from ^{198m2}Fr*, Ex. = y, J^{π} = high spin, $T_{1/2}$= 1.1(7) ms, BR_{α} = 100%**.

E_{α}(c.m.)	E_{α}(lab)	I_{α}(abs)	J_f^{π}	$E_{daughter}$(^{194}At)	coincident γ-rays	R_0 (fm)	HF
7.736-8.094	7.580-7.930***	100%		y'			

* All values from [2013Ka16].
** Based on short half-life.
*** Unresolved multiplet.

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