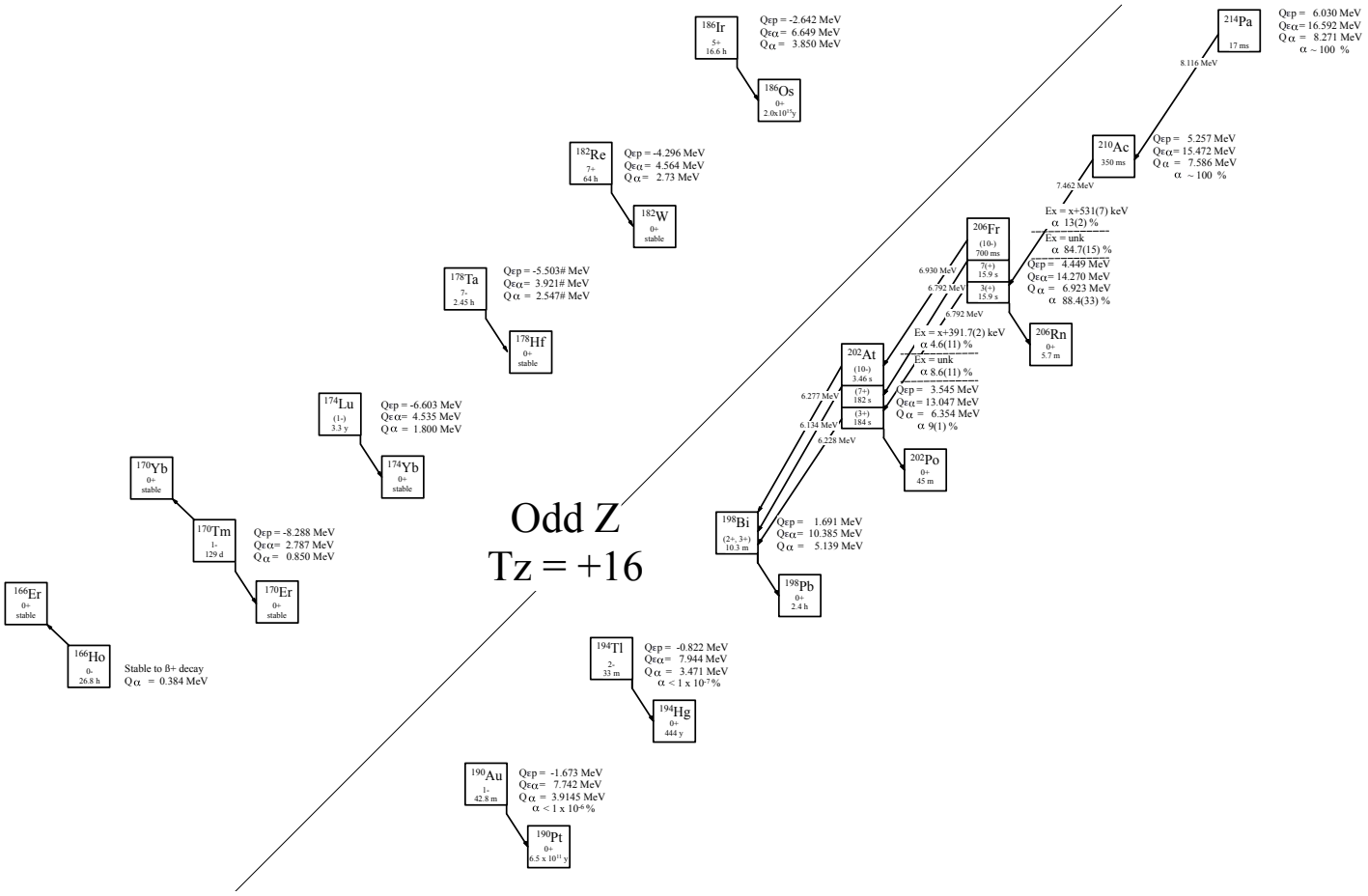

Fig. 1: Known experimental values for heavy particle emission of the odd-Z T_z= +16 nuclei.

Table 1
Observed and predicted β-delayed particle emission from the odd-Z, T_z = +16 nuclei. J^π values for ^{166}Ho, ^{170}Tm, ^{174}Lu, ^{178}Ta, ^{182}Re, ^{186}Ir, ^{190}Au, ^{194}Tl and ^{198}Bi are taken from ENSDF. Unless otherwise stated, all Q-values are taken from [2021Wa16] or deduced from values therein.

Nuclide	Ex	J^π	$T_{1/2}$	Q_ε	$Q_{\varepsilon p}$	$Q_{\varepsilon\alpha}$	Experimental
^{166}Ho*		0^-	26.827(5) h	-1.854(1)	——	——	[**1989Ab05**]
^{170}Tm**		1^-	128.6(3) d	0.312(2)	-8.288(20)	2.787(1)	[**1968Re04**]
^{174}Lu		(1^-)	3.6(4) y	1.374(2)	-6.603(5)	4.535(2)	[**1962Bo12**]
^{178}Ta		7^-	2.45(5) h	1.840(50)#	-5.503(52)#	3.921(52)#	[**1975Wa24**]
^{182}Re		7^+	64.3(5) h	2.800(100)	-4.296(102)	4.564(102)	[**2011Bo01**]
^{186}Ir		5^+	16.64(3) h	3.828(17)	-2.642(17)	6.649(17)	[**1982Al34**]
^{190}Au		1^-	42.8(10) m	4.473(4)	-1.673(13)	7.742(4)	[**1973Jo11**]
^{194}Tl		2^-	33.0(5) m	5.246(14)	-0.822(16)	7.944(14)	[**2003Su30**]
^{198}Bi		$(2^+, 3^+)$	10.3(3) m	6.694(29)	1.691(31)	10.385(28)	[**1982Hu04**]
^{202}At		(3^+)	184(1) s	7.346(29)	3.545(30)	13.047(29)	[**1992Hu04**]
^{202m1}At	x	(7^+)	182(2) s	7.346(29)+x	3.545(30)+x	13.047(29)+x	[**1992Hu04**]
^{202m2}At	0.3917(2) + x	(10^-)	3.46(5) s	7.738(29)+x	3.937(30)+x	13.439(29)+x	[**1992Hu04**]
^{206}Fr		$3(^+)$	15.9(3) s***	7.886(29)	4.449(30)	14.270(29)	[**1981Ri04**]
^{206m1}Fr	x	$7(^+)$	15.9(3) s***	7.886(29)+x	4.449(30)+x	14.270(29)+x	[**1981Ri04**]
^{206m2}Fr	x + 0.531(7)	$10(^-)$	0.7(1) s	8.417(30)+x	4.980(31)+x	14.801(30)+x	[**2016Ly01, 1981Ri04**]
^{210}Ac			350(50) ms	8.320(60)	5.257(63)	15.472(63)	[**1968Va04**]
^{214}Pa			17(3) ms	8.760(80)	6.030(82)	16.592(82)	[**2000He17, 1995Ni05, 1996An21**]

* 100% β^- emitter.
** 99.869(10)% β^-, 0.131(10)% ε emitter [2018Ba41].
*** Combination of $T_{1/2}$ from ^{206gs}Fr and ^{206m1}Fr [1981Ri04].

Table 2
Particle separation, Q-values, and measured values for direct particle emission of the odd-Z, T_z = +16 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
^{166}Ho	6.747(1)	15.543(2)	0.384(2)		
^{170}Tm	6.163(1)	14.314(30)	0.850(1)		
^{174}Lu	5.308(2)	12.775(6)	1.800(2)		
^{178}Ta	5.007(52)#	11.794(52)#	2.547(52)#		
^{182}Re	4.50(10)	11.09(10)	2.73(12)#		
^{186}Ir	3.655(17)	9.530(17)	3.850(10)		
^{190}Au	3.653(11)	9.067(10)	3.914(17)	$< 1 \times 10^{-6}$%	[**1963Ka17**]
^{194}Tl	3.164(21)	8.743(21)	3.471(14)	$< 1 \times 10^{-7}$%	[**1963Ka17**]
^{198}Bi	1.917(28)	6.455(30)	5.139(31)		
^{202}At	1.363(28)	4.802(36)	6.354(1)	9(1)%	[**1992Hu04, 1975BaYJ, 1974Ho27**, 2016Ly01, 1996Ta18, 1970DaZM, 1967Tr04, 1967Tr06, 1963Ho18, 1961Fo04, 1961La02]
^{202m1}At	1.363(28)	4.802(36)	6.354(1)	8.6(11)%*	[**2016Ly01, 1996Ta18, 1992Hu04, 1975BaYJ**, 1974Ho27, 1970DaZM, 1967Tr04, 1967Tr06, 1963Ho18, 1961Fo04, 1961La02]
^{202m2}At	1.363(28)	4.802(36)	6.354(1)	4.6(11)%	[**2016Ly01, 1992Hu04**]
^{206}Fr	0.826(28)	3.950(36)	6.923(3)	88.4(33)%	[**2016Ly01, 1992Hu04, 1981Ri04**, 2015Ma63, 2012Ly01 1974Ho27, 1967Va20, 1964Gr04, 1961Gr42]
^{206m1}Fr	0.826(28)-x	3.950(36)-x	6.923(3)+x	84.7(15)%	[**2016Ly01, 1992Hu04, 1981Ri04**, 2015Ma63, 2012Ly01 1974Ho27, 1967Va20, 1964Gr04, 1961Gr42]
^{206m2}Fr	0.295(29)-x	3.419(37)-x	7.436(8)+x	13(2)%	[**2016Ly01, 1992Hu04, 1981Ri04**, 2012Ly01]
^{210}Ac	0.383(62)	3.149(63)	7.586(57)	$\approx$ 100%**	[**2000He17, 1968Va04**, 2014Ya19, 1967Tr03]
^{214}Pa	-0.051(82)	2.418(84)	8.271(52)	$\approx$ 100%**	[**2000He17, 1995Ni05, 1996An21**, 1995NiZR, 1995NiZS]

* Weighted average of 8.5(15)% [2016Ly01] and 8.7(15)% [1992Hu04].
** Based on short half-life.

Table 3
direct α emission from ^{202}At, $J_i^\pi = (3^+)$, $T_{1/2}$ = 184(1) s*, BR_α = 9(1)%**.

E_α(c.m.)	E_α(lab)	I_α(rel)	I_α(abs)	J_f^π	$E_{daughter}$(^{198}Bi)	coincident γ-rays	R_0 (fm)@	HF
6.049(10)	5.929(10)*	$\approx$0.04%	$\approx$0.004%		0.425(10)		1.4915(23)	$\approx$ 220
6.193(10)	6.070(10)*	$\approx$0.2%	$\approx$0.02%		0.161(10)		1.4915(23)	$\approx$ 670
6.354(2)	6.228(2)***	100%	9(1)%	(3^+)	0.0	——	1.4915(23)	$6.5^{+0.9}_{-0.8}$

* [1992Hu04].
** [1974Ho27].
***[1975BaYJ].
** Interpolated between 1.4803(16) fm (^{200}Po) and 1.5026(16) fm (^{204}Rn).

Table 4
direct α emission from ^{202m1}At, Ex = unk., $J_i^\pi = (7^+)$, $T_{1/2}$ = 182(2) s*, BR_α = 8.6(11)%**.

E_α(c.m.)	E_α(lab)	I_α(abs)	J_f^π	$E_{daughter}$(^{198}Bi)	coincident γ-rays	R_0 (fm)@	HF
6.258(2)	6.134(2)***	8.6(11)%**	(7^+)	x		1.4915(23)	$2.7^{+0.5}_{-0.4}$

* [1992Hu04].
** Weighted average of 8.5(15)% [2016Ly01] and 8.7(15)% [1992Hu04].
*** Weighted average of 6.133(3) MeV [1996Ta18] and 6.135(2) MeV [1975BaYJ].
** Interpolated between 1.4803(16) fm (^{200}Po) and 1.5026(16) fm (^{204}Rn).

Table 5
direct α emission from ^{202m2}At*, Ex = 391.7 keV + x, $J_i^\pi = (10^-)$, $T_{1/2}$ = 3.46(5) s, BR_α = 4.6(11)%.

E_α(c.m.)	E_α(lab)	I_α(abs)	J_f^π	$E_{daughter}$(^{198}Bi)	coincident γ-rays	R_0 (fm)**	HF
6.404(5)	6.277(5)	4.6(11)%	(10^-)	0.249 + x		1.4915(23)	$0.39^{+0.13}_{-0.08}$

* All values from [1992Hu04].
** Interpolated between 1.4803(16) fm (^{200}Po) and 1.5026(16) fm (^{204}Rn).

Table 6
direct α emission from ^{206}Fr, $J_i^\pi = 3(^+)$, $T_{1/2}$ = 15.9(3) s*, BR_α = 88.4(33)%**.

E_α(c.m.)	E_α(lab)	I_α(abs)	J_f^π	$E_{daughter}$(^{202}At)	coincident γ-rays	R_0 (fm)@	HF
6.926(5)	6.792(5)***	88.4(33)%**	(3^+)	0.0	——	1.5028(38)	$2.05^{+0.22}_{-0.20}$

* Combination of $T_{1/2}$ from ^{206gs}Fr and ^{206m1}Fr [1981Ri04].
** [2016Ly01].
*** Unresolved doublet de-exciting the $3(^+)$ and $7(^+)$ isomers in ^{206}Fr [1992Hu04].
@ Interpolated between 1.5026(16) fm (^{204}Rn) and 1.5029(36) fm (^{208}Ra).

Table 7
direct α emission from ^{206m1}Fr, Ex = unk., $J_i^\pi = 7(^+)$, $T_{1/2}$ = 15.9(3) s* , BR_α = 84.7(15)%**.

E_α(c.m.)	E_α(lab)	I_α(abs)	J_f^π	$E_{daughter}$(^{202}At)	coincident γ-rays	R_0 (fm)@	HF
6.926(5)	6.792(5)***	84.7(15)%**	(7^+)	x		1.5028(38)	$2.16^{+0.22}_{-0.20}$

* Combination of $T_{1/2}$ from ^{206gs}Fr and ^{206m1}Fr [1981Ri04].
** [2016Ly01].
*** Unresolved doublet de-exciting the $3(^+)$ and $7(^+)$ isomers in ^{206}Fr [1992Hu04].
@ Interpolated between 1.5026(16) fm (^{204}Rn) and 1.5029(36) fm (^{208}Ra).

Table 8
direct α emission from ^{206m2}Fr, Ex = 531(7) keV + x, $J_i^\pi = 10(^-)$, $T_{1/2}$ = 0.7(1) s*, BR_α = 13(2)%**.

E_α(c.m.)	E_α(lab)	I_α(abs)	J_f^π	$E_{daughter}$(^{202}At)	coincident γ-rays	R_0 (fm)@	HF
7.067(5)	6.930(5)	13(2)%**	(10^-)	0.531(7) + x	0.531	1.5028(38)	$2.0^{+0.8}_{-0.6}$

* [1981Ri04].
** [2016Ly01].
*** [1992Hu04].
@ Interpolated between 1.5026(16) fm (^{204}Rn) and 1.5029(36) fm (^{208}Ra).

Table 9
direct α emission from ^{210}Ac*, $T_{1/2}$ = 350(50) ms, $BR_\alpha = \approx 100\%$.

E_α(c.m.)	E_α(lab)	I_α(abs)	J^π_f	$E_{daughter}$(^{206}Fr)	coincident γ-rays	R_0 (fm)[@]	HF
7.607(8)	7.462(8)	$\approx$ 100%			——	1.5044(44)	1.81(33)

* All Values from [1968Va04].
** Interpolated between 1.5029(36) fm (^{208}Ra) and 1.5058(26) fm (^{212}Th).

Table 10
direct α emission from ^{214}Pa*, $T_{1/2}$ = 17(3) ms, $BR_\alpha = \approx 100\%$.

E_α(c.m.)	E_α(lab)	I_α(abs)	J^π_f	$E_{daughter}$(^{210}Ac)	coincident γ-rays	R_0 (fm)[@]	HF
8.271(15)	8.116(15)	$\approx$ 100%			——	1.496(33)	$1.4^{+1.5}_{-0.8}$

* All values from [2000He17, 1996An21, 1995Ni02].
** Interpolated between 1.5058(26) fm (^{212}Th) and 1.486(33) fm (^{216}U).

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