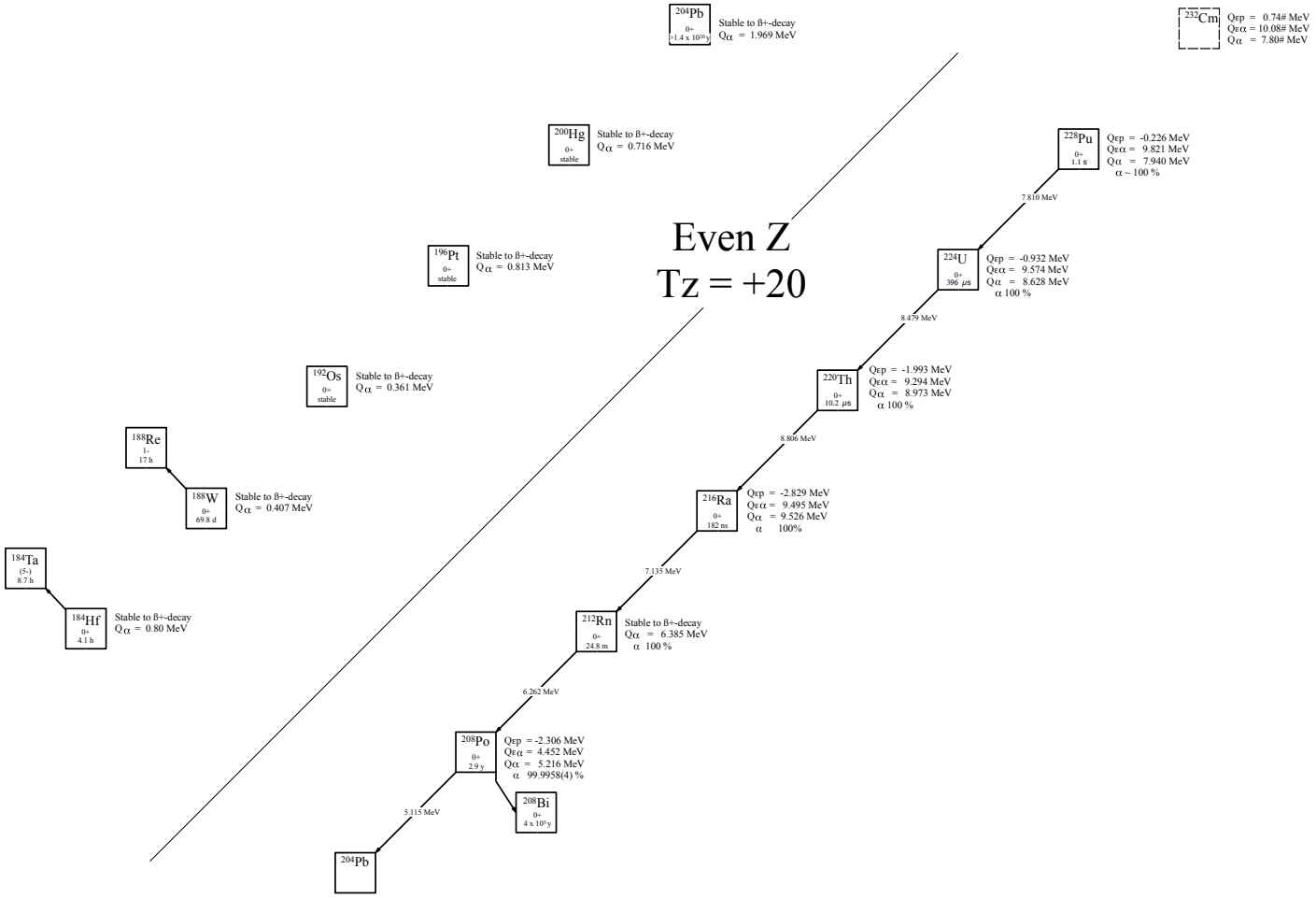

Fig. 1: Known experimental values for heavy particle emission of the even-Z T_z= +20 nuclei.

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Table 1
Observed and predicted β-delayed particle emission from the even-Z, T_z = +20 nuclei. Unless otherwise stated, all Q-values are taken from [2021Wa16] or deduced from values therein.

Nuclide	J^π	$T_{1/2}$	Q_ε	$Q_{\varepsilon p}$	$Q_{\varepsilon\alpha}$	Experimental
^{184}Hf*	0^+	4.12(5) h	-5.20(20#	——	——	[**1973Wa18**]
^{188}W*	0^+	69.78(12) d	-4.76(20)#	——	——	[**2014Un01**]
^{192}Os	0^+	stable	-4.290(70)	——	——	
^{196}Pt	0^+	stable	-3.210(40)	——	——	
^{200}Hg	0^+	stable	-2.463(27)	——	——	
^{204}Pb	0^+	$>1.4 \times 10^{20}$ y	-0.7638(2)	——	——	[**2013Be16**]
^{208}Po	0^+	2.888 y	1.401(2)	-2.306(1)	4.452(2)	[**1966Ha29**]
^{212}Rn	0^+	24.8(5) m**	-0.031(4)	——	——	[**1971Go35, 1968Cr02**]
^{216}Ra	0^+	182(10) ns	0.320(9)	-2.829(10)	9.495(8)	[**1973No09**]
^{220}Th	0^+	10.2(4) μs***	0.946(15)	-1.993(15)	9.294(14)	[**2019Pa45, 1973Ha32**]
^{224}U	0^+	396(17) μs	1.880(17)	-0.932(17)	9.574(16)	[**2014Lo10**]
^{228}Pu	0^+	$1.1^{+2.0}_{-0.5}$ s	2.28(10)#	-0.226(25)	9.821(25)#	[**2003Ni10**]
^{232}Cm	0^+		2.91(36)#	0.74(20)#	10.08(23)#	

* 100% β^- emitter
** Weighted average of 22.0(10) m [1971Go35] and 25.5(5) m [1968Cr02].

Table 2
Particle separation, Q-values, and measured values for direct particle emission of the even-Z, T_z = +20 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
^{184}Hf	9.072(89)	17.18(40)#	0.80(30)#		
^{188}W	9.061(56)#	16.822(51)#	0.407(40)		
^{192}Os	8.821(10)	16.091(35)	0.361(4)		
^{196}Pt	8.241(1)	14.787(2)	0.813(2)		
^{200}Hg	7.698(1)	14.177(2)	0.716(1)		
^{204}Pb	6.6375(3)	12.342(1)	1.969(1)		
^{208}Po	4.704(2)	8.262(1)	5.216(1)	99.9958(4)%	[**1993Sa14, 1970Ra14, 1969Go23, 1967Ti04, 1966Ha29**, 1955Mo68, 1953AsZZ, 1951Ka03, 1951Ka37, 1947Te01]
^{212}Rn	4.301(4)	7.284(3)	6.385(3)	100%	[**1971Go35**, 2003Ni10, 2003NiZV, 1970AfZZ, 1970TaZS, 1968Cr02, 1963Uh01, 1959Ka15, 1955Mo68, 1952Mo23, 1950Hy27]
^{216}Ra	4.316(11)	6.967(12)	9.526(7)	100%	[**1973No09**, 2017Su18, 1975No09, 1972No06, 1961Gr43]
^{220}Th	4.169(53)	6.534(17)	8.973(11)	100%	[**2019Pa45, 1973Ha32**, 1991AnZZ, 1973HaWU]
^{224}U	3.884(77)	6.038(18)	8.628(7)	100%	[**2014Lo10**, 2003Ni10, 2003NiZV, 1994AnZY, 1994Ye08, 1993AnZS, 1993ToZW, 1992To02, 1992ToZV, 1991An10, 1991An13, 1990AnZU]
^{228}Pu	3.760(80)	5.799(26)	7.940(18)	$\approx$ 100%*	[**1994An02, 1994Ye08**, 2004NiZZ, 2003Ni10, 2003NiZV, 2001NiZY, 1994AnZX, 1994AnZY]
^{232}Cm	3.37(36)#	5.18(20)#	7.80(20)#		

* Based on short half-life.

Table 3
direct α emission from ^{208}Po*, $J^\pi = 0^+$, $T_{1/2}$ = 2.888 y, BR_α = 99.9958(4)%**

E_α(c.m.)	E_α(lab)***	I_α(rel)	I_α(abs)	J^π_f	$E_{daughter}$(^{204}Pb)	coincident γ-rays	R_0 (fm)	HF
4.303(15)	4.220(15)	$2.4(7) \times 10^{-4}$%	$2.4(7) \times 10^{-4}$%	2^+	0.899[@]	0.899[@]	1.42967(74)	$0.54^{+0.22}_{-0.12}$[@@]
5.215(2)	5.115(2)***	100%	99.9958(4)%**	0^+	0.0	——	1.42967(74)	0.98(2)

* All values from [1966Ha29], except where noted.
** [1993Sa14] report a BR_ε equal to 0.0042(4)%.
*** Weighted average from [1991Ry01] based on 5.114(3) MeV [1970Ra14] (modified to 5.113(3) MeV), 5.116(2) MeV [1969Go23], 5.118(5) MeV [1967Ti04] (modified to 5.120(3) MeV), 5.110(5) MeV [1966Ha29] and 5.108(3) MeV [1953AsZZ] (modified to 5.114(3) MeV).
[@] [2010Ch02].
[@@] This unphysicaly low HF value may indicate that the branching ratio is too high or that the reported transition is incorrect.

Table 4
direct α emission from ^{212}Rn*, $J^\pi = 0^+$, $T_{1/2}$ = 24.8(5) m**, BR_α = 100%**

E_α(c.m.)	E_α(lab)***	I_α(rel)	I_α(abs)	J^π_f	$E_{daughter}$(^{208}Po)	coincident γ-rays	R_0 (fm)	HF
5.996(3)	5.883(3)	0.050(5)%	0.050(5)%	2^+	0.687	0.687	1.4343(25)	$1.43^{+0.19}_{-0.16}$
6.382(3)	6.262(3)	100%	99.95(5)%	0^+	0.0	——	1.4343(25)	1.01(2)

* All values from [1971Go35], except where noted.
** Weighted average of 22.0(10) m [1971Go35] and 25.5(5) m [1968Cr02].
*** This low HF value may indicate that the branching ratio is too high or that the reported transition is incorrect.

Table 5
direct α emission from ^{216}Ra*, $J^\pi = 0^+$, $T_{1/2}$ = 182(10) ns, BR_α = 100%

E_α(c.m.)	E_α(lab)	I_α(abs)	J^π_f	$E_{daughter}$(^{212}Rn)	coincident γ-rays	R_0 (fm)	HF
9.525(8)	9.349(8)	100%	0^+	0.0	——	1.5433(36)	1.05(6)

* All values from [1973No09].

Table 6
direct α emission from ^{220}Th, $J^\pi = 0^+$, $T_{1/2}$ = 10.2(4) μs*, BR_α = 100%

E_α(c.m.)	E_α(lab)	I_α(abs)	J^π_f	$E_{daughter}$(^{216}Ra)	coincident γ-rays	R_0 (fm)	HF
8.969(13)	8.806(13)**	100%	0^+	0.0	——	1.6051(43)	2.53(10)***

* Weighted average of 10.4(4) μs [2019Pa45] and 9.7(6) μs [1973Ha32].
** Weighted average of 8.813(13) MeV [2019Pa45] and 8.790(20) MeV [1973Ha32].
*** Expect this transition to be an unhindered $0^+ \rightarrow 0^+$. The reason for the larger HF is unknown.

Table 7
direct α emission from ^{224}U*, $J^\pi = 0^+$, $T_{1/2}$ = 396(17) μs, BR_α = 100%

E_α(c.m.)	E_α(lab)	I_α(rel)	I_α(abs)	J^π_f	$E_{daughter}$(^{220}Th)	coincident γ-rays	R_0 (fm)	HF
8.242(18)	8.095(11)	3.5(8)%	3.4(8)%	2^+	0.387(2)	0.387(2)	1.5514(30)	$2.2^{+0.7}_{-0.5}$
8.633(8)	8.479(8)	100%	96.6(8)%	0^+	0.0	——	1.5514(30)	1.009(10)

* All values from [2014Lo10].

Table 8
direct α emission from ^{228}Pu, $J^\pi = 0^+$, $T_{1/2} = 1.1^{+2.0}_{-0.5}$ s*, $BR_\alpha = \approx 100\%$

E_α(c.m.)	E_α(lab)	I_α(abs)	J^π_f	$E_{daughter}$(^{224}U)	coincident γ-rays	R_0 (fm)	HF
7.949(20)	7.810(20)**	≈100%	0^+	0.0	——	1.480(42)	$1.1^{+2.0}_{-0.5}$

* [2003Ni10].
* [1994An02, 1994Ye08].

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