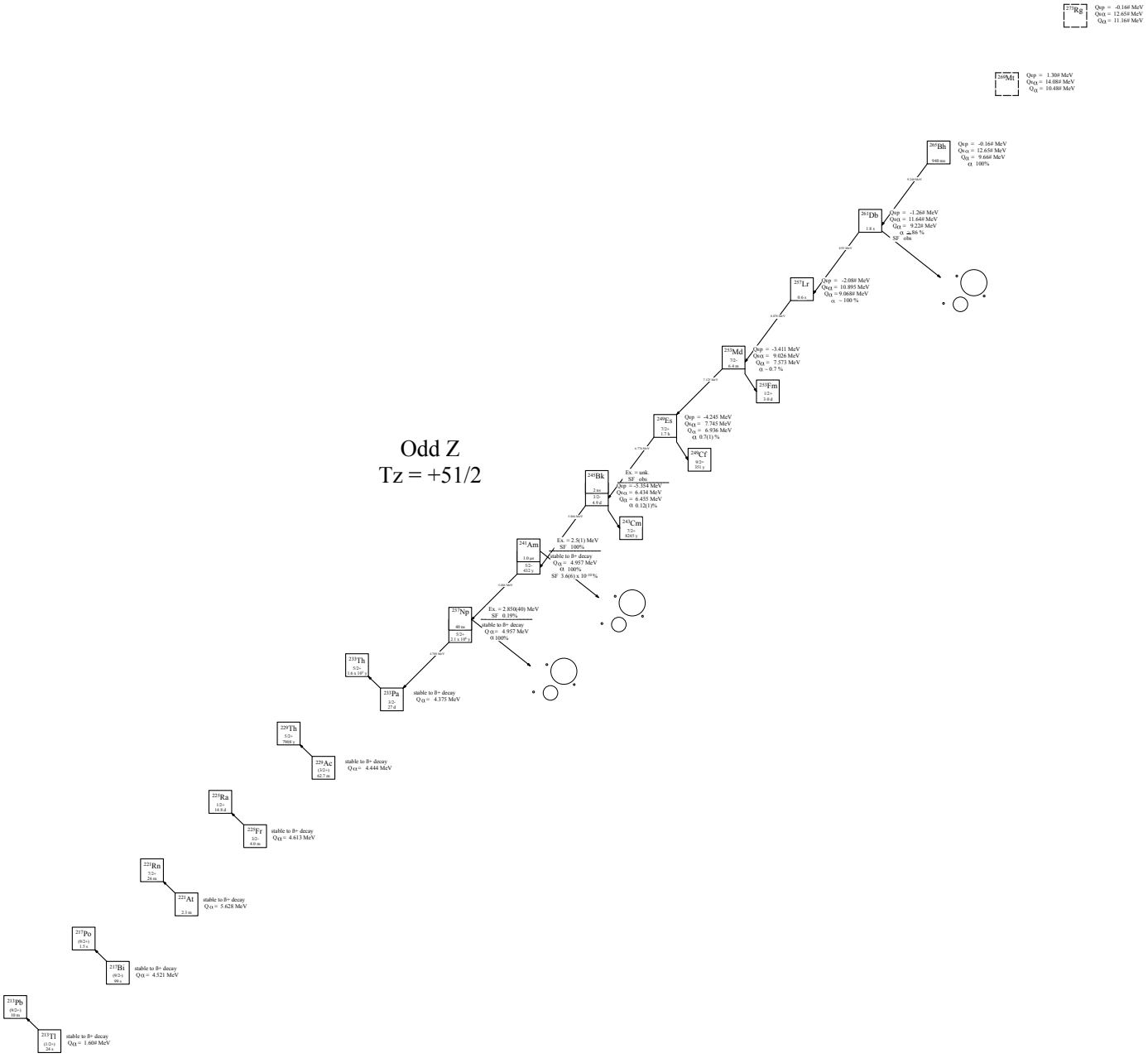

Fig. 1: Known experimental values for heavy particle emission of the odd-Z T_z= +51/2 nuclei.

Last updated 1/14/25

Table 1
Observed and predicted β-delayed particle emission from the odd-Z, T_z = +51/2 nuclei. Unless otherwise stated, all Q-values are taken from [2021Wa16] or deduced from values therein. J^π values for XX are taken from ENSDF.

Nuclide	Ex.	J^π	$T_{1/2}$	Q_ε	Q_{β^-}	$Q_{\beta^- \alpha}$	Experimental
^{209}Au*			$>$ 300 ns	6.38(43)#	8.35(50)#	8.35(50)#	[**2010Al24**]
^{213}Tl*		$(1/2^+)$	23.8(44) s	-6.42(30)#	4.987(28)	8.15(15)	[**2017Ca12**]
^{217}Bi*		$(9/2^-)$	98.5(8) s	-3.53(30)#	2.847(19)#	9.689(19)	[**2003Ku25**]
^{221}At*			2.3(3) m	-2.991(24)	2.311(15)	8.655(16)	[**1989Bu09**]
^{225}Fr*		$3/2^-$	4.0(2) m	-2.714(16)	1.828(12)	7.105(13)	[**1983Ny01**]
^{229}Ac*		$(3/2^+)$	62.7(5) m	-1.872(20)	1.104(12)	6.452(12)	[**1973Ch24**]
^{233}Pa*		$3/2^-$	26.975(13) d	-1.242(1)	0.570(2)	5.659(3)	[**2000Us01**]
^{237}Np		$5/2^+$	2.144(7)$\times 10^6$ y	-0.519(1)	-0.220(1)	——	[**1992Lo03**]
^{237m}Np	2.850(40)		40(12) ns	2.331(40)	2.630(40)	8.558(40)	[**1973Wo03**]
^{241}Am		$5/2^-$	432.0(2) y	-0.021	-0.767(1)	——	[**1975Ra35**]
^{241m}Am	2.5(1)		1.0(3) μs	2.5(1)	1.7(1)	——	[**1969La14, 1993Ku16**]
					$Q_{\varepsilon p}$	$Q_{\varepsilon \alpha}$	
^{245}Bk		$3/2^-$	4.90(3) d	0.809(2)	-5.354(2)	6.434(2)	[**1976Ah03**]
^{245m}Bk	x		2(1) ns	0.809(2)+x	-5.354(2)+x	6.434(2)+x	[**1971Re11**]
^{249}Es		$7/2^+$	1.7(1) h	1.450(30)#	-4.245(58)#	7.745(30)#	[**1970Ah01**]
^{253}Md		$7/2^-$	$6.4^{+11.6}_{-3.6}$ m	1.830(30)#	-3.411(59)#	9.026(32)#	[**1992Ka08**]
^{257}Lr			0.6(1) s	2.420(50)#	-2.08(13)#	10.895(44)#	[**1971Es01**]
^{261}Db			1.8(6) s	2.99(13)#	-1.26(17)#	11.64(11)#	[**1971Fl02**]
^{265}Bh			$0.94^{+0.70}_{-0.31}$ s	3.60(28)#	-0.16(34)#	12.65(25)#	[**2004Ga29**]
^{269}Mt				4.81(34)#	1.30(49)#	14.08(34)#	
^{273}Rg				4.60(42)#	2.11(63)#	15.97(42)#	

* 100% β^- emitter.

Table 2
Particle separation, Q-values, and measured values for direct particle emission of the odd-Z, T_z = +51/2 nuclei. Unless otherwise stated, all S and Q-values are taken from [2021Wa16] or deduced from values therein.

Nuclide	S_p	Q_α	BR_α	BR_{SF}	Experimental
^{209}Au	9.02(57)#	0.95(64)#			
^{213}Tl	8.53(30)#	1.60(40)#			
^{217}Bi	6.07(20)#	4.521(32)			
^{221}At	5.770(23)	5.628(23)			
^{225}Fr	5.913(15)	4.613(18)			
^{229}Ac	5.539(12)	4.444(17)			
^{233}Pa	5.246(1)	4.375(12)			
^{237}Np	4.8622(3)	4.957(1)	100%		[**2002Wo03**, 2008De10, 2000Lu01, 2000Sc04, 2000Wo01, 1992Lo03, 1992Mo03, 1990Bo44, 1990Lo04, 1988Wo01, 1981Ba68, 1979Go12, 1976BaZZ, 1976Sk01, 1975PeZI, 1970Cl11, 1969Va06, 1969HoZY, 1968Ba25, 1968Ob02, 1961Ba44, 1960Br12, 1955St04, 1949Ma01, 1949SeZU, 1948Ma16, 1948Wa04]
^{237m}Np	-2.102(40)	7.807(40)		0.19%	[**1977Mi09**, 1973Wo03]
^{241}Am	4.4800(2)	5.6378(1)	100%	$3.6(6)\times10^{-10}$%	[**1971Gr17, 1970Go26, 1968Go26, 1963Ba65, 1964Ba26**, 2021Ta23, 2020Yo01, 2016Di11, 2010Mo01, 1998Ya17, 1994Bl12, 1993Ku16, 1992El10, 1986Pa17, 1978Ge06, 1978Ge17, 1978Ov01, 1977VaZW, 1975Ra35, 1974Po16, 1972Jo07. 1971Cl02, 1970Ga27, 1969KaZR, 1968Ka09, 1968St02, 1966Ko06, 1966Le13, 1965Ar09, 1964Ka29, 1964Wo03, 1963Ba35, 1963Pa06, 1962Ba51, 1962Le11, 1961Dr03, 1957Ha10, 1957Ro20, 1956Go43, 1955Go57, 1954As05, 1953AsZZ, 1952As04, 1952As40, 1952Be47, 1952Ha68]
^{241m}Am	2.0(1)	8.1(1)		100%	[**1969La14, 1993Ku16**
^{245}Bk	3.927(1)	6.455(1)	0.12(1)%		[**1974Po08**, 1976Ah03, 1975Ba25, 1966Ah01, 1966Ah02, 1956Ch77, 1956Ma32, 1951Hu39]
^{245m}Bk	3.927(1)-x	6.455(1)+x		obs	[**1971Re11**, 1972Ga42, 1970ReZN]
^{249}Es	3.352(31)#	6.936(30)	0.7(1)%		[**1989Ha27, 1970Ah01**, 1989HaZG, 1976Ah07, 1956Ha80]
^{253}Md	2.933(32)#	7.573(8)	≈0.7%		[**2012He09, 2005He27**, 2011An13, 1992Ka08]
^{257}Lr	2.447(45)#	9.068(31)#	≈ 100%***		[**1997He29, 1971Es01**, 2010AsZY, 2009Qi04, 2009QiZZ, 2004Ga29, 1976BeYM, 1971EsZX]
^{261}Db	2.13(23)#	9.22(10)#	≥82%	obs	[**1998La30, 1971Fl02, 1971Gh01**, 2013AsZZ, 2004Ga29, 1971Dr01, 1971FlZV]
^{265}Bh	1.68(37)#	9.66(21)#	100%		[**2004Ga29**]
^{269}Mt	0.96(43)#	10.48(20)#			
^{273}Rg	0.49(58)#	11.16(25)#			

* Deduced from the weighted average of the partial half=life for SF of $1.29(3)\times10^{14}$ y [1968Go26] and $1.15(2)\times10^{14}$ y [1970Go96] (reported as λ_F = $6.04(13)\times10^{-15}$ y.

** Weighted average of 1.50(60) μs [1969La14] and 0.9(3) μs [1993Ku16].

*** [1971Es01] report an upper limit for electron capture of 15%.

Table 3
direct α emission from ^{237}Np*, J^{π} = 5/2$^+$, T$_{1/2}$ = 2.144(7)$\times 10^6$ y, BR_{α} = 100%.

E_{α}(c.m.)	E_{α}(lab)	I_{α}(rel)	I_{α}(abs)	J_f^{π}**	$E_{daughter}$(^{233}Pa)**	coincident γ-rays (keV)**	HF
4.5926(19)	4.5151(19)	0.073(8)%	0.035(4)%	9/2$^+$	0.3659	6.7, 17.4, 22.6, 29.4, 46.5, 54.4, 57.1, 63.9, 70.5, 86.5, 108.7, 106.1, 109.1, 117.7, 141.7, 153,4, 155.2, 186,7, 202.9, 212.3, 257.1, 262.4, 279.7	58^{+8}_{-6}
4.6283(22)	4.5502(22)	0.023(6)%	0.011(3)%		0.3280(26)*		360^{+140}_{-80}
4.6511(26)	4.5726(26)	0.101(48)%	0.048(23)%	(7/2$^-$)	0.3060(1)	8.2, 17.4, 29.4, 46.5, 49.0, 57.1, 86.5, 88.0, 94.7, 115.4, 131.1, 153.5, 162.5, 170.9, 186.8, 195.0, 201.7, 219.8, 248.9, 250.5, 257.4	120^{+110}_{-40}
4.6572(14)	4.5786(14)	0.775(48)%	0.369(23)%	7/2$^+$	0.3005	5.7, 8.2, 17.4, 22.6, 29.4, 36.2, 46.5, 57.1, 62.6, 63.9, 70.5, 86.5, 88.0, 94.7, 115.4, 131.1, 134.7, 143.2, 151.4, 180.9, 191.4, 195.0, 196.9, 201.7, 214.0, 229.9, 237.9	17.1(11)
4.6781(18)	4.5991(18)	0.779(19)%	0.371(9)%	(7/2$^+$)	0.2797	5.7, 17.4, 22.6, 29.4, 46.5, 57.1, 63.9, 70.5, 86.5, 170.6, 176.1, 193.2, 209.2, 222.6	24.2(6)
4.6990(21)	4.6197(21)	0.067(17)%	0.032(8)%	5/2$^-$	0.2572	8.2, 17.4, 29.4, 46.5, 57.1, 86.5, 88.0, 94.7, 115.4, 131.1, 153.5, 162.5, 170.9, 186.8, 195.0, 201.7, 250.5, 257.4	$410^{+140}_{-80}\times 10^3$
4.7197(10)	4.6400(10)	13.50(7)%	6.43(3)%	5/2$^+$	0.2379	8.2, 17.4, 29.4, 36.2, 46.5, 57.1, 86.5, 88.0, 94.7, 115.4, 131.1, 134.7, 143.2, 151.4, 180.9, 195.0, 201.7, 237.9	2.82(4)
4.7451(9)	4.6650(9)	7.301(51)%	3.478(24)%	5/2$^+$	0.2123	6.7, 17.4, 29.4, 46.5, 57.1, 63.9, 70.5, 86.5, 108.7, 117.7, 141.7, 155.2, 212.3	2.97(10)
4.7609(18)	4.6805(18)	0.042(8)%	0.020(4)%		0.1955(23)*		$1.8^{+0.5}_{-0.3}\times 10^3$
4.7789(8)	4.6982(8)	1.123(21)%	0.535(10)%		0.1775(16)*		92(4)
4.7917(7)	4.7108(7)	2.464(27)%	1.174(13)%	(11/2$^-$)	0.1633	22.6, 29.4, 54.4, 57.1, 86.5, 106.1	52.9(8)
4.8483(8)	4.7665(8)	19.56(61)%	9.32(29)%	9/2$^+$	0.1091	22.6, 29.4, 57.1, 86.5	16.0(5)
4.8533(8)	4.7714(8)	48.59(61)%	23.15(29)%	7/2$^+$	0.1037	17.4, 29.4, 46.5, 57.1, 86.5	7.02(11)
4.8702(9)	4.7880(9)	100.0(2)%	47.64(6)%	5/2$^+$	0.0865	29.4, 57.1, 86.5	4.49(5)
4.8860(10)	4.8035(10)	4.228(36)%	2.014(17)%	5/2$^-$	0.0705	5.7, 63.9, 70.5	136.9(18)
4.8995(10)	4.8168(10)	5.101(36)%	2.430(17)%	7/2$^-$	0.0571	57.1	119.7(15)
4.9073(36)	4.8245(36)	0.029(23)%	0.014(11)%		0.0490(39)*		$3^{+10}_{-1}\times 10^4$
4.9321(49)	4.8489(49)	0.013(8)%	0.006(4)%		0.0242(51)*		$1.0^{+1.9}_{-0.4}\times 10^3$
4.9499(14)	4.8664(14)	1.11(8)%	0.53(4)%	1/2$^-$	0.0067	6.7	$1.41(13)\times 10^3$
4.9564(14)	4.8727(14)	5.02(8)%	2.39(4)%	3/2$^-$	0.00	—	348(10)

* All values from [2002Wo03], except where noted.
** [2020Si28].
*** R$_0$ = 1.51670(40) fm.

Table 4
direct α emission from ^{241}Am*, J^{π} = 5/2^{-} [@], $T_{1/2}$ = 432.0(2) y**, BR_{α} = 100%.

E_{α}(c.m.)	E_{α}(lab)	I_{α}(rel)	I_{α}(abs)	J_f^{π}[@]	$E_{daughter}$(^{237}Np)[@]	coincident γ-rays (keV)[@]	HF[@@]
4.881	4.800	1.0×10^{-4}%	8.6×10^{-5}%	7/2^{-}	0.756	26.3, 27.9, 33.2, 42.7, 43.4, 55.6, 59.5, 69.8, 75.9, 99.0, 103.0, 125.3, 597.5, 653.0, 680.1, 696.6, 722.0, 755.9	48
4.916	4.834	8×10^{-4}%	7×10^{-4}%	5/2^{-}	0.722	26.3, 27.9, 33.2, 42.7, 43.4, 55.6, 59.5, 69.8, 75.9, 99.0, 103.0, 125.3, 164.6, 208.0, 234.4, 267.5, 454.7, 563.1, 619.0, 662.4, 677.7, 722.0	10.1
5.089	5.004	1.2×10^{-4}%	1×10^{-4}%	(5/2^{-})	0.546	26.3, 27.9, 33.2, 42.7, 43.4, 59.5, 69.8, 75.9, 103.0, 164.6, 208.0, 234.4, 267.5, 278.0, 512.5, 545.5	1.1×10^{3}
5.154	5.068	1.6×10^{-4}%	1.4×10^{-4}%	(9/2^{-})	0.486	26.3, 27.9, 33.2, 42.7, 43.4, 55.6, 59.5, 67.5, 69.8, 75.9, 99.0, 103.0, 123.0, 125.3, 150.0, 161.5, 165.8, 221.5, 249.0,250.8, 264.9, 291.3	2.0×10^{3}
5.175	5.089	$\approx5\times10^{-4}$%	$\approx4\times10^{-4}$%	7/2^{+}	0.460	33.2, 42.7, 75.9, 383.8, 426.5, 459.7	$\approx1.3\times10^{3}$
5.182	5.096	$\approx5\times10^{-4}$%	$\approx4.\times10^{-4}$%	9/2^{+}	0.453	33.2, 42.7, 54.0, 75.9, 97.1 115.5, 260.8, 322.5, 376.7, 419.3, 452.6	1.3×10^{3}
5.200	5.114	05×10^{-4}%	4×10^{-4}%	(11/2^{-})	0.434	26.3, 27.9, 33.2, 42.7, 43.4, 54.0, 55.6, 59.5, 69.8, 75.9, 97.1, 99.0, 103.0, 109.7, 125.3, 146.6, 165.8, 175.1, 221.5, 249.0, 264.9, 275.8, 291.3, 304.2, 358.3	1.5×10^{3}
5.243	5.156	08×10^{-4}%	7×10^{-4}%		0.396	26.3, 27.9, 33.2, 42.7, 43.4, 55.6, 59.5, 67.5, 69.8, 75.9, 99.0, 103.0, 115.0, 123.0, 125.3, 150.0, 169.6, 204.0	1.5×10^{3}
5.265	5.178	3×10^{-4}%	3×10^{-4}%	3/2^{+}	0.371	33.2, 337.7, 370.9	4.9×10^{3}
5.270	5.182	1.0×10^{-3}%	9×10^{-4}%	5/2^{+}	0.369	26.3, 33,2, 42.7, 59.5, 75.9, 292.8, 309.1, 335.4, 368.6	1.7×10^{3}
5.282	5.194	7×10^{-4}%	6×10^{-4}%	(5/2^{-})	0.360	26.3, 33,2, 59.5, 300.1	2.9×10^{3}
5.311	5.223	1.5×10^{-3}%	1.3×10^{-3}%	(7/2^{-})	0.324	26.3, 27.9, 33.2, 42.7, 43.4, 55.6, 59.5, 69.8, 75.9, 99.0, 103.0, 125.3, 165.8, 221.5, 249.0, 264.9, 291.3	2.2×10^{3}
5.333	5.244	2.8×10^{-3}%	2.4×10^{-3}%	13/2^{-}	0.305	26.3, 27.9, 33.2, 42.7, 43.4, 54.0, 55.6, 59.5, 69.8, 75.9, 97.1, 99.0, 103.0, 125.3, 146.6, 175.1	1.6×10^{3}
5.368	5.279	6×10^{-4}%	5×10^{-4}%	3/2^{-}	0.268	26.3, 27.9, 33.2, 42.7, 43.4, 59.5, 69.8, 75.9, 103.0, 164.6, 208.0, 234.4, 267.5	1.3×10^{4}
5.412	5.322	0.017%	0.015%	11/2^{-}	0.226	26.3, 27.9, 33.2, 42.7, 43.4, 55.6, 59.5, 67.5, 69.8, 75.9, 99.0, 103.0, 123.0, 125.3, 150.0	760
5.480	5.389	1.55%	1.33%	9/2^{-}	0.159	26.3, 27.9, 33.2, 42.7, 43.4, 55.6, 59.5, 69.8, 75.9, 99.0, 103.0, 125.3	22
5.508	5.417	$\approx$0.01%	$\approx$0.01%	11/2^{+}	0.130	33.2, 42.7, 54.0, 75.9, 97.1	$\approx4.2\times10^{3}$
5.53466(13)	5.44280(13)***	14.8%	12.7%	7/2^{-}	0.103	26.3, 27.9, 33.2, 42.7, 43.4, 59.5, 69.8, 75.9, 103.0	4.8
5.561	5.469	$<$0.05%	$<$0.04%	9/2^{+}	0.076	33.2, 42.7, 75.9	$>2.2\times10^{3}$
5.57814(12)	5.48556(12)***	100%	86%	5/2^{-}	0.060	26.3, 33,2, 59.5	1.25
5.606	5.513	0.14%	0.12%	7/2^{+}	0.033	33.2	1.3×10^{3}
5.639	5.545	0.29%	0.25%	5/2^{+}	0.0	——	940

* All values from [1963Ba65, 1964Ba26], except where noted.
** [1975Ra35].
*** [1971Gr17].
[@] [2006Ba41].
[@@] R_0 = 1.508784(84) fm.

Table 5
direct α emission from ^{245}Bk*, J^{π} = 3/2$^-$, $T_{1/2}$ = 4.90(3) d**, BR_{α} = 0.12(1)%**.

E_{α}(c.m.)	E_{α}(lab)	I_{α}(rel)	I_{α}(abs)	J^{π}_f***	$E_{daughter}$(^{241}Am)	coincident γ-rays (keV)***	R_0(fm)	HF
5.905(4)	5.809(4)	4.2(5)%	0.1(2)%	7/2$^-$	0.549(6)	41.2, 77.0, 455.9, 471.8, 510.0	1.49673(49)	18(3)
5.951(4)	5.854(4)	19.1(10)%	0.49(5)%	5/2$^-$	0.503(6)	32.6, 41.2, 164.8, 205.9, 298.6, 410.8, 463.3, 504.5	1.49673(49)	7.0(9)
5.963(4)	5.866(4)	100(3)%	2.6(2)%		0.491(6)		1.49673(49)	1.5(2)
6.079(5)	5.980(5)	4.1(1)%	0.11(1)%		0.375(6)		1.49673(49)	153(19)
6.135(4)	6.035(4)	2.6(4)%	0.07(1)%	11/2$^+$	0.319(6)	41.2, 116.4, 162.4	1.49673(49)	470^{+110}_{-80}
6.183(4)	6.082(4)	29(2)%	0.74(7)%		0.271(6)		1.49673(49)	72(9)
6.220(4)	6.118(4)	70.7(28)%	1.82(16)%	7/2$^+$	0.235(6)	139.9	1.49673(49)	44(6)
6.248(4)	6.146(4)	85.1(31)%	2.20(19)%	5/2$^+$	0.206(6)	41.2, 164.8, 205.9	1.49673(49)	51(6)
6.296(4)	6.193(4)	5.6(5)%	0.14(2)%	11/2$^-$	0.159(6)	41.2, 116.4	1.49673(49)	$1.3(2)\times10^3$
6.362(4)	6.258(4)	7.0(5)%	0.18(2)%	9/2$^-$	0.093(6)		1.49673(49)	$2.2(3)\times10^3$
6.414(4)	6.309(4)	69.8(26)%	1.80(16)%	7/2$^-$	0.041(6)	41.2	1.49673(49)	390(50)
6.454(4)	6.349(4)	72.1(29)%	1.86(17)%	5/2$^-$	0.0	——	1.49673(49)	590(60)

* All values from [1974Po08], except where noted. E_{α} values are adjusted by +1.0 keV as recomended in [1991Ry01].
** [1976Ah03].
*** [2015Ne16].

Table 6
direct α emission from ^{249}Es*, $T_{1/2}$ = 1.7(1) h**, BR_{α} = 0.7(1)%**.

E_{α}(c.m.)	E_{α}(lab)	I_{α}(rel)	I_{α}(abs)	J^{π}_f	$E_{daughter}$(^{245}Bk)	coincident γ-rays (keV)	R_0(fm)	HF
6.826(12)	6.716(12)	8(5)%	0.05(4)%		0.061(12)		1.4820(36)	16^{+47}_{-8}
6.887(2)	6.776(2)	100%	0.65(10)%		0.0?	——	1.4820(36)	$2.3^{+0.6}_{-0.5}$

* All values from [1989Ha27], except where noted.
** [1970Ah01].

Table 7
direct α emission from ^{253}Md*, $T_{1/2} = 6.4^{+11.6}_{-3.6}$ m**, BR_{α} = ≈0.7%***.

E_{α}(c.m.)	E_{α}(lab)	I_{α}(rel)	I_{α}(abs)	J^{π}_f	$E_{daughter}$(^{249}Es)	coincident γ-rays (keV)	R_0(fm)	HF
7.217(15)	7.103(15)				x	390.8(4)		
7.237(15)	7.123(15)			7/2$^-$	≈0.421	304.2(4), 353.2(4)		

* All values from [2012He09], except where noted.
** [1992Ka08].
*** [2005He27].

Table 8
direct α emission from ^{257}Lr*, $T_{1/2}$ = 0.6(1) s, BR_{α} = ≈100%.

E_{α}(c.m.)	E_{α}(lab)	I_{α}(rel)	I_{α}(abs)	J^{π}_f	$E_{daughter}$(^{253}Md)	coincident γ-rays (keV)	R_0(fm)	HF
8.773	8.636**							
8.949(20)	8.870(20)	23(3)%	19(2)%		0.061(28)		1.473(10)	$5.2^{+2.4}_{-1.9}$
9.010(20)	8.870(20)	100%	81(2)%		0.0	——	1.473(10)	$1.8^{+0.7}_{-0.6}$

* All values from [1971Es01], except where noted. This reference reports an upper limit for electron capture of 15%.
** Tentative assignment by [1997He29].

Table 9
direct α emission from ^{261}Db*, $T_{1/2}$ = 1.8(6) s**, BR_α = >82 %.

E_α(c.m.)	E_α(lab)	I_α(abs)	J^π_f	$E_{daughter}$(^{257}Lr)	coincident γ-rays (keV)	R_0(fm)	HF
9.07	8.93	>82 %				1.477(25)	1.7

* All values from [1971Gh01], except where noted.
** [1971Fl02].
*** [1998La30] determined the BR_F to be $\leq$ 18%

Table 10
direct α emission from ^{265}Bh*, $T_{1/2} = 0.94^{+0.70}_{-0.31}$ s, BR_α = 100%.

E_α(c.m.)	E_α(lab)	I_α(abs)	J^π_f	$E_{daughter}$(^{249}Es)	coincident γ-rays (keV)	R_0(fm)	HF
9.392(50)	9.240(50)	100%		0.0?		1.470(17)	$1.2^{+0.8}_{-0.6}$

* All values from [2004Ga29].

References used in the Tables

[1] **1948Ma16** L. B. Magnusson, T. J. La Chapelle, J. Am. Chem. Soc. **70**, 3534 (1948). https://doi.org/10.1021/ja01191a002

[2] **1948Wa04** A. C. Wahl, G. T. Seaborg, Phys. Rev. **73**, 940 (1948). https://doi.org/10.1103/PhysRev.73.940

[3] **1949Ma01** L. Magnusson, T. LaChapelle, The Transuranium Elements: Research Papers, Book 1, Vol. 14B, paper 1. 7, G. T. Seaborg ed., p. 39 (1949).

[4] **1949SeZU** G. T. Seaborg, The Transuranium Elements: Research Papers, Book 2, Vol. 14B, paper 22. 3, G. T. Seaborg ed., p. 1572 (1949).

[5] **1951Hu39** E. K. Hulet, S. G. Thompson, A. Ghiorso, K. Street, Jr., Phys. Rev. **84**, 366 (1951). https://doi.org/10.1103/PhysRev.84.366.2

[6] **1952As04** F. Asaro, F. L. Reynolds, I. Perlman, Phys. Rev. **85**, 758A (1952). https://doi.org/10.1103/PhysRev.85.758A

[7] **1952As40** F. Asaro, F. L. Reynolds, I. Perlman, Phys. Rev. **87**, 277 (1952). https://doi.org/10.1103/PhysRev.87.277

[8] **1952Be47** J. K. Beling, J. O. Newton, B. Rose, Phys. Rev. **87**, 670 (1952). https://doi.org/10.1103/PhysRev.87.670

[9] **1952Ha68** B. G. Harvey, Phys. Rev. **85**, 482 (1952). https://doi.org/10.1103/PhysRev.85.482

[10] **1953AsZZ** F. Asaro, Thesis, Univ. California (1953); UCRL-2180 (1953).

[11] **1954As05** F. Asaro, I. Perlman, Phys. Rev. **93**, 1423 (1954). https://doi.org/10.1103/PhysRev.93.1423

[12] **1955Go57** L. L. Goldin, G. I. Novikova, E. F. Tretyakov, Conf. Acad. Sci. USSR Peaceful Uses of Atomic Energy, Session Div. Phys. Math. Sci. , Moscow, p. 226 (1955); Consultants Bureau Transl. p. 167 (1956).

[13] **1955St04** F. S. Stephens, Jr., Thesis, Univ. California (1955); UCRL-2970 (1955).

[14] **1956Ch77** A. Chetham-Strode, Jr., Thesis, Univ. California (1956).; UCRL-3322 (1956).

[15] **1956Go43** L. L. Goldin, G. I. Novikova, E. F. Tretyakov, Phys. Rev. **103**, 1004 (1956). https://doi.org/10.1103/PhysRev.103.1004

[16] **1956Ha80** B. G. Harvey, A. Chetham-Strode, A. Ghiorso, G. R. Choppin, S. G. Thompson, Phys. Rev. **104**, 1315 (1956). https://doi.org/10.1103/PhysRev.104.1315

[17] **1956Ma32** L. B. Magnusson, A. M. Friedman, D. Engelkemeir, P. R. Fields, F. Wagner, Jr., Phys. Rev. **102**, 1097 (1956). https://doi.org/10.1103/PhysRev.102.1097

[18] **1957Ha10** G. R. Hall, T. L. Markin, J. Inorg. Nuclear Chem. **4**, 137 (1957). https://doi.org/10.1016/0022-1902(57).80058-X

[19] **1957Ro20** S. Rosenblum, M. Valadares, J. Milsted, J. Phys. Radium **18**, 609 (1957). https://doi.org/10.1051/jphysrad:019570018011060900

[20] **1960Br12** F. P. Brauer, R. W. Stromatt, J. D. Ludwick, F. P. Roberts, W. L. Lyon, J. Inorg. Nuclear Chem. **12**, 234 (1960). https://doi.org/10.1016/0022-1902(60).80366-1

[21] **1961Ba44** S. A. Baranov, V. M. Kulakov, P. S. Samoilov, A. G. Zelenkov, Y. F. Rodionov, Zhur. Eksptl. i Teoret. Fiz. **41**, 1733 (1961).; Soviet Phys. JETP **14**, 1232 (1962).

[22] **1961Dr03** V. A. Druin, V. L. Mikheev, N. K. Skobelev, Zhur. Eksptl. i Teoret. Fiz. **40**, 1261 (1961).; Soviet Phys. JETP **13**, 889 (1961).

[23] **1962Ba51** S. A. Baranov, V. M. Kulakov, A. G. Zelenkov, V. M. Shatinskii, Zhur. Eksptl. i Teoret. Fiz. **43**, 795 (1962).; Soviet Phys. JETP **16**, 562 (1963).

[24] **1962Le11** C. F. Leang, Compt. Rend. **255**, 3155 (1962).

[25] **1963Ba65** S. A. Baranov, V. M. Kulakov, V. M. Shatinskii, Zh. Eksperim. i Teor. Fiz. **45**, 1811 (1963).; Soviet Phys. JETP **18**, 1241 (1964).

[26] **1963Pa06** J. J. H. Park, J. L. Wolfson, Phys. Canada **19**, No. 3, 14, Abstr. 4. 2 (1963).

[27] **1964Ba26** S. A. Baranov, V. M. Kulakov, V. M. Shatinsky, Nucl. Phys. **56**, 252 (1964). https://doi.org/10.1016/0029-5582(64).90478-X

[28] **1964Ka29** R. Kamoun, R. Ballini, D. Djecknavorian, Compt. Rend. Congr. Intern. Phys. Nucl. , Paris, P. Gugenberger, Ed. , Centre National de la Recherche Scientifique, Paris, Vol. II, p. 571(1964).

[29] **1964Wo03** J. L. Wolfson, J. J. H. Park, Can. J. Phys. 42, 1387 (1964).; Erratum Can. J. Phys. **48**, 2782 (1970). https://doi.org/10.1139/p64-125

[30] **1965Ar09** R. J. Armani, R. Gold, ANL-7110, p. 23 (1965).

[31] **1966Ah01** I. Ahmad, F. Asaro, I. Perlman, UCRL-16580, p. 21 (1966).

[32] **1966Ah02** I. Ahmad, Thesis, Univ. California (1966).; UCRL-16888 (1966).

[33] **1968Ba25** S. A. Baranov, V. M. Kulakov, V. M. Shatinskii, Yadern. Fiz. **7**, 727 (1968).; Soviet J. Nucl. Phys. **7**, 442 (1968).

[34] **1966Ko06** L. N. Kondratev, E. F. Tretyakov, Izv. Akad. Nauk SSSR, Ser. Fiz. 30, 386 (1966).; Bull. Acad. Sci. USSR, Phys. Ser. 30, 393 (1967).

[35] **1966Le13** C. M. Lederer, J. K. Poggenburg, F. Asaro, J. O. Rasmussen, I. Perlman, Nucl. Phys. **84**, 481 (1966). https://doi.org/10.1016/0029-5582(66).91010-8

[36] **1968Go26** R. Gold, R. J. Armani, J. Roberts, ANL-7310, p. 20(1968).

[37] **1968Ka09** R. Kamoun, R. Ballini, S. Bergstrom-Rohlin, J. -M. Kuchly, P. Siffert, Compt. Rend. **266**B, 1241 (1968).

[38] **1968Ob02** E. S. Oberhofer, Thesis, North Carolina State University (1968).

[39] **1968St02** R. E. Stone, E. K. Hulet, J. Inorg. Nucl. Chem. **30**, 2003 (1968). https://doi.org/10.1016/0022-1902(68).80190-3

[40] **1969HoZY** W. Hoekstra, Thesis, Technische Hogeschool, Delft (1969).

[41] **1969KaZR** R. Kamoun, R. Ballini, Proc. Int. Conf. Radioactivity in Nucl. Spectrosc. , Nashville, Tenn. (1969)., J. H. Hamilton, J. C. Manthuril, Eds. , Gordon and Breach, New York, Vol. 2, p. 1291 (1972).

[42] **1969La14** N. L. Lark, G. Sletten, J. Pedersen, S. Bjornholm, Nucl. Phys. A**139**, 481 (1969). https://doi.org/10.1016/0375-9474(69).90273-5

[43] **1969Va06** J. M. Vara, R. Gaeta, Nucl. Phys. A**130**, 586 (1969). https://doi.org/10.1016/0375-9474(69).90869-0

[44] **1970Ah01** I. Ahmad, R. K. Sjoblom, R. F. Barnes, E. P. Horwitz, P. R. Fields, Nucl. Phys. A**140**, 141 (1970). https://doi.org/10.1016/0375-9474(70).90890-0

[45] **1970Cl11** J. E. Cline, IN-1448 (1970).

[46] **1970Ga27** D. Galliker, E. Hugentobler, B. Hahn, Helv. Phys. Acta **43**, 593 (1970).

[47] **1970Go06** R. Gold, R. J. Armani, J. H. Roberts, Phys. Rev. C**1**, 738 (1970). https://doi.org/10.1103/PhysRevC.1.738

[48] **1970ReZN** R. Repnow, V. Metag, P. von Brentano, REPT 1970 Ann Rept Max-Planck Inst(Heidelberg).,P56.

[49] **1971Cl02** R. G. Clarkson, P. von Brentano, H. L. Harney, Nucl. Phys. A**161**, 49 (1971). https://doi.org/10.1016/0375-9474(71).90319-8

[50] **1971Dr01** V. A. Druin, A. G. Demin, Y. P. Kharitonov, G. N. Akapev, V. I. Rud, G. Y. Sung-Ching-Yang, L. P. Chelnokov, K. A. Gavrilov, Yad. Fiz. **13**, 251 (1971).; Sov. J. Nucl. Phys. **13**, 139 (1971).

[51] **1971Es01** K. Eskola, P. Eskola, M. Nurmia, A. Ghiorso, Phys. Rev. C**4**, 632 (1971). https://doi.org/10.1103/PhysRevC.4.632

[52] **1971EsZX** K. Eskola, REPT UCRL-20426,P38

[53] **1971Fl02** G. N. Flerov, Y. T. Oganesian, Y. V. Lobanov, Y. A. Lazarev, S. P. Tretiakova, I. V. Kolesov, V. M. Plotko, Nucl. Phys. A**160**, 181 (1971). https://doi.org/10.1016/0375-9474(70).90182-X

[54] **1971FlZV** G. N. Flerov, Y. A. Lazarev, Y. V. Lobanov, Y. T. Oganesyan, S. P. Tretyakova, Proc. Int. Conf. Heavy Ion Physics, Dubna, p. 125 (1971).; JINR-D7-5769 (1971).; Transl. ORNL-tr-2711 (1974).

[55] **1971Gh01** A. Ghiorso, M. Nurmia, K. Eskola, P. Eskola, Phys. Rev. C**4**, 1850 (1971). https://doi.org/10.1103/PhysRevC.4.1850

[56] **1971Gr17** B. Grennberg, A. Rytz, Metrologia **7**, 65 (1971). https://doi.org/10.1088/0026-1394/7/2/005

[57] **1971Re11** R. Repnow, V. Metag, P. von Brentano, Z. Phys. **243**, 418 (1971). https://doi.org/10.1007/BF01396616

[58] **1972Jo07** J. Jove, R. Robert, Radiochim. Radioanal. Lett. **10**, 139 (1972).

[59] **1972Ga42** Y. P. Gangrskii, Nguen Kong Khan, D. D. Pulatov, At. Energ. **33**, 829 (1972).; Sov. At. Energy **33**, 948 (1973).

[60] **1973Ch24** K. Chayawattanangkur, G. Herrmann, N. Trautmann, J. Inorg. Nucl. Chem. **35**, 3061 (1973). https://doi.org/10.1016/0022-1902(73).80003-X

[61] **1973Wo03** K. L. Wolf, J. P. Unik, Phys. Lett. **43**B, 25 (1973). https://doi.org/10.1016/0370-2693(73).90534-0

[62] **1974Po08** F. T. Porter, I. Ahmad, M. S. Freedman, J. Milsted, A. M. Friedman, Phys. Rev. C **10**, 803 (1974). https://doi.org/10.1103/PhysRevC.10.803

[63] **1974Po16** V. G. Polyukhov, G. A. Timofeev, P. A. Privalova, P. F. Baklanova, At. Energ. **36**, 319 (1974).; Sov. At. Energy **36**, 402 (1974).

[64] **1975Ba25** S. A. Baranov, V. M. Shatinsky, L. V. Chistyakov, V. M. Shubko, Yad. Fiz. **21**, 230 (1975).; Sov. J. Nucl. Phys. **21**, 122 (1975).

[65] **1975PeZI** D. M. Peterson, Thesis, North Carolina State Univ. (1973).; Dissertation Abst, 35B, 6032 (1975).

[66] **1975Ra35** H. Ramthun, W. Muller, Int. J. Appl. Radiat. Isotop. **26**, 589 (1975). https://doi.org/10.1016/0020-708X(75).90076-9

[67] **1976Ah03** I. Ahmad, D. D. Sharma, R. K. Sjoblom, Nucl. Phys. A**258**, 221 (1976). https://doi.org/10.1016/0375-9474(76).90003-8

[68] **1976Ah07** I. Ahmad, R. K. Sjoblom, P. R. Fields, Phys. Rev. C**14**, 218 (1976). https://doi.org/10.1103/PhysRevC.14.218

[69] **1976BaZZ**S. A. Baranov, A. G. Zelenkov, V. M. Kulakov, Proc. Advisory Group Meeting on Transactinium Nucl. Data, Karlsruhe, Vol. III, p. 249 (1976).; IAEA-186 (1976).

[70] **1976BeYM** C. E. Bemis, Jr. , D. C. Hensley, P. F. Dittner, R. L. Hahn, R. J. Silva, J. R. Tarrant, L. D. Hunt, ORNL-5137, p. 73 (1976).

[71] **1976Sk01** M. Skalsey, R. D. Connor, Can. J. Phys. **54**, 1409 (1976). https://doi.org/10.1139/p76-165

[72] **1977Mi09** E. Migneco, G. Russo, R. De Leo, A. Pantaleo, Phys. Rev. C**16**, 1919 (1977). https://doi.org/10.1103/PhysRevC.16.1919

[73] **1977VaZW**V. I. Vakatov, H. Sodan, R. Kalpakchieva, Y. T. Oganesyan, Y. E. Penionzhkevich, V. N. Polyanskii, L. P. Chelnokov, JINR-P7-10123 (1977).

[74] **1978Ge06** A. Genoux-Lubain, G. Ardisson, Radiochem. Radioanal. Lett. **33**, 59 (1978).

[75] **1978Ge17** A. Genoux-Lubain, G. Ardisson, C. R. Acad. Sci. , Ser. B **287**, 13 (1978).

[76] **1978Ov01** V. V. Ovechkin, Izv. Akad. Nauk SSSR, Ser. Fiz. **42**, 101 (1978).; Bull. Acad. Sci. USSR, Phys. Ser. **42**, No. 1, 82 (1978).

[77] **1979Go12** L. Gonzalez, R. Gaeta, E. Vano, J. M. Los Arcos, Nucl. Phys. A**324**, 126 (1979). https://doi.org/10.1016/0375-9474(79).90083-6

[78] **1981Ba68** M. F. Banham, A. J. Fudge, J. Radioanal. Chem. **64**, 167 (1981). https://doi.org/10.1007/BF02518349

[79] **1983Ny01** K. Nybo, T. F. Thorsteinsen, G. Lovhoiden, E. R. Flynn, J. A. Cizewski, R. K. Sheline, D. Decman, D. G. Burke, G. Sletten, P. Hill, N. Kaffrell, W. Kurcewicz, G. Nyman, Nucl. Phys. A**408**, 127 (1983). https://doi.org/10.1016/0375-9474(83).90353-6

[80] **1986Pa17** M. Paul, I. Ahmad, W. Kutschera, Phys. Rev. C**34**, 1980 (1986). https://doi.org/10.1103/PhysRevC.34.1980

[81] **1988Wo01** S. A. Woods, P. Christmas, P. Cross, S. M. Judge, W. Gelletly, Nucl. Instrum. Methods Phys. Res. A**264**, 333 (1988).; Addendum Nucl. Instrum. Methods Phys. Res. A272, 924 (1988). https://doi.org/10.1016/0168-9002(88).90923-0

[82] **1989Bu09** D. G. Burke, H. Folger, H. Gabelmann, E. Hagebo, P. Hill, P. Hoff, O. Jonsson, N. Kaffrell, W. Kurcewicz, G. Lovhoiden, K. Nybo, G. Nyman, H. Ravn, K. Riisager, J. Rogowski, K. Steffensen, T. F. Thorsteinsen, and the ISOLDE

Collaboration, Z. Phys. A**333**, 131 (1989).

[83] **1989Ha27** Y. Hatsukawa, T. Ohtsuki, K. Sueki, H. Nakahara, I. Kohno, M. Magara, N. Shinohara, H. L. Hall, R. A. Henderson, C. M. Gannett, J. A. Leyba, R. B. Chadwick, K. E. Gregorich, D. Lee, M. J. Nurmia, D. C. Hoffman, Nucl. Phys. A**500**, 90 (1989). https://doi.org/10.1016/0375-9474(89)90131-0

[84] **1989HaZG** Y. Hatsukawa, T. Ohtsuki, K. Sueki, H. Nakahara, I. Kohno, M. Magara, N. Shinohara, K. E. Gregorich, D. Lee, D. C. Hoffman, Inst. Nucl. Study, Univ. Tokyo, Ann. Rept. , 1988, p. 26 (1989).

[85] **1990Bo44** G. Bortels, D. Mouchel, R. Eykens, E. Garcia-Torano, M. L. Acena, R. A. P. Wiltshire, M. King, A. J. Fudge, P. Burger, Nucl. Instrum. Methods Phys. Res. A**295**, 199 (1990). https://doi.org/10.1016/0168-9002(90).90438-C

[86] **1990Lo04** I. M. Lowles, T. D. Mac Mahon, M. F. Banham, A. J. Fudge, R. A. P. Wiltshire, Nucl. Instrum. Methods Phys. Res. A**286**, 556 (1990). https://doi.org/10.1016/0168-9002(90).90916-T

[87] **1991Ry01** A Rytz, At Data NuclData Tables **47**, 205 (1991). https://doi.org/10.1016/0092-640X(91)90002-L

[88] **1992El10** S. U. El-Kameesy, Acta Phys. Acad. Sci. Hung. **71**, 15 (1992).

[89] **1992Ka08** B. Kadkhodayan, R. A. Henderson, H. L. Hall, J. D. Leyba, K. R. Czerwinski, S. A. Kreek, N. J. Hannink, K. E. Gregorich, D. M. Lee, M. J. Nurmia, D. C. Hoffman, Radiochim. Acta **56**, 1 (1992). https://doi.org/10.1524/ract.1992.56.1.1

[90] **1992Lo03** I. M. Lowles, T. D. Mac Mahon, R. A. P. Wiltshire, D. Crossley, A. J. Fudge, Nucl. Instrum. Methods Phys. Res. A**312**, 339 (1992). https://doi.org/10.1016/0168-9002(92).90178-7

[91] **1992Mo03** K. J. Moody, E. K. Hulet, P. B. Price, Phys. Rev. C**45**, 1392 (1992). https://doi.org/10.1103/PhysRevC.45.1392

[92] **1993Ku16** I. A. Kukushkin, V. E. Makarenko, Yu. D. Molchanov, G. A. Otroshchenko, Yad. Fiz. **56**, No 9, 13 (1993).; Phys. Atomic Nuclei **56**, 1157 (1993).

[93] **1994Bl12** C. J. Bland, Nucl. Instrum. Methods Phys. Res. A339, 180 (1994). https://doi.org/10.1016/0168-9002(94).91801-5

[94] **1997He29** F. P. Hessberger, S. Hofmann, V. Ninov, P. Armbruster, H. Folger, G. Munzenberg, H. J. Schott, A. G. Popeko, A. V. Yeremin, A. N. Andreyev, S. Saro, Z. Phys. A**359**, 415 (1997). https://doi.org/10.1007/s002180050422

[95] **1998La30** M. R. Lane, K. E. Gregorich, D. M. Lee, B. Wierczinski, C. A. McGrath, M. B. Hendricks, D. A. Shaughnessy, D. A. Strellis, E. R. Sylwester, P. A. Wilk, D. C. Hoffman, Phys. Rev. C**58**, 3413 (1998). https://doi.org/10.1103/PhysRevC.58.3413

[96] **1998Ya17** J. Yang, J. Ni, Nucl. Instrum. Methods Phys. Res. A**413**, 239 (1998). https://doi.org/10.1016/S0168-9002(98)00147-8

[97] **2000Lu01** A. Luca, M. Etcheverry, J. Morel, Appl. Radiat. Isot. **52**, 481 (2000). https://doi.org/10.1016/S0969-8043(99).00198-0

[98] **2000Sc04** U. Schotzig, E. Schonfeld, H. Janszen, Appl. Radiat. Isot. **52**, 883 (2000). https://doi.org/10.1016/S0969-8043(99).00137-2

[99] **2000Us01** K. Usman, T. D. MacMahon, Appl. Radiat. Isot. **52**, 585 (2000). https://doi.org/10.1016/S0969-8043(99).00214-6

[100] **2000Wo01** S. A. Woods, D. H. Woods, P. de Lavison, S. M. Jerome, J. L. Makepeace, M. J. Woods, L. J. Husband, S. Lineham, Appl. Radiat. Isot. **52**, 475 (2000). https://doi.org/10.1016/S0969-8043(99).00197-9

[101] **2002Wo03** M. J. Woods, D. H. Woods, S. A. Woods, L. J. Husband, S. M. Jerome, C. Michotte, G. Ratel, M. Crespo, E. Garcia-Torano, L. Rodriguez, A. Luca, B. Denecke, G. Sibbens, J. Morel, M. Etcheverry, D. Santry, H. Janssen, E. Schonfeld, U. Schotzig, Appl. Radiat. Isot. **56**, 415 (2002). https://doi.org/10.1016/S0969-8043(01).00224-X

[102] **2003Ku25** J. Kurpeta, A. Plochocki, A. N. Andreyev, J. Aysto, A. De Smet, H. De Witte, A. -H. Evensen, V. Fedoseyev, S. Franchoo, M. Gorska, M. Huhta, M. Huyse, Z. Janas, A. Jokinen, M. Karny, E. Kugler, W. Kurcewicz, U. Koster, J. Lettry, A. Nieminen, K. Partes, M. Ramdhane, H. L. Ravn, K. Rykaczewski, J. Szerypo, K. Van de Vel, P. Van Duppen, L. Weissman, G. Walter, A. Wohr, and the IS387 and ISOLDE Collaborations, Eur. Phys. J. A **18**, 5 (2003). https://doi.org/10.1140/epja/i2003-10065-7

[103] **2004Ga29** Z. G. Gan, J. S. Guo, X. L. Wu, Z. Qin, H. M. Fan, X. G. Lei, H. Y. Liu, B. Guo, H. G. Xu, R. F. Chen, C. F. Dong, F. M. Zhang, H. L. Wang, C. Y. Xie, Z. Q. Feng, Y. Zhen, L. T. Song, P. Luo, H. S. Xu, X. H. Zhou, G. M. Jin, Z. Ren, Eur. Phys. J. A **20**, 385 (2004). https://doi.org/10.1140/epja/i2004-10020-2

[104] **2005He27** F. P. Hessberger, S. Antalic, B. Streicher, S. Hofmann, D. Ackermann, B. Kindler, I. Kojouharov, P. Kuusiniemi, M. Leino, B. Lommel, R. Mann, K. Nishio, S. Saro, B. Sulignano, Eur. Phys. J. A **26**, 233 (2005). https://doi.org/10.1140/epja/i2005-10171-6

[105] **2006Ba41** M. S. Basunia, Nucl. Data Sheets **107**, 2323 (2006). https://doi.org/10.1016/j.nds.2006.07.001

[106] **2008De10** D. DeVries, H. Griffin, Appl. Radiat. Isot. **66**, 668 (2008). https://doi.org/10.1016/j.apradiso.2007.07.019

[107] **2009Qi04** J. Qian, A. Heinz, T. L. Khoo, R. V. F. Janssens, D. Peterson, D. Seweryniak, I. Ahmad, M. Asai, B. B. Back, M. P. Carpenter, A. B. Garnsworthy, J. P. Greene, A. A. Hecht, C. L. Jiang, F. G. Kondev, T. Lauritsen, C. J. Lister, A. Robinson, G. Savard, R. Scott, R. Vondrasek, X. Wang, R. Winkler, S. Zhu, Phys. Rev. C **79**, 064319 (2009). https://doi.org/10.1103/PhysRevC.79.064319

[108] **2009QiZZ** J. Qian, Thesis, Yale University, New Haven CT (2009).

[109] **2010Al24** H. Alvarez-Pol, J. Benlliure, E. Casarejos, L. Audouin, D. Cortina-Gil, T. Enqvist, B. Fernandez-Dominguez, A. R. Junghans, B. Jurado, P. Napolitani, J. Pereira, F. Rejmund, K. -H. Schmidt, O. Yordanov, Phys. Rev. C **82**, 041602 (2010). https://doi.org/10.1103/PhysRevC.82.041602

[110] **2010AsZY** M. Asai, H. Haba, Y. Kasamatsu, N. Sato, K. Tsukada, T. K. Sato, RIKEN Accelerator Progress Report 2009, p. ix (2010).

[111] **2010Mo01** D. S. Moreira, M. F. Koskinas, I. M. Yamazaki, M. S. Dias, Appl. Radiat. Isot. **68**, 596 (2010). https://doi.org/10.1016/j.apradiso.2009.11.004

[112] **2011An13** S. Antalic, F. P. Hessberger, D. Ackermann, S. Heinz, S. Hofmann, Z. Kalaninova, B. Kindler, J. Khuyagbaatar, I. Kojouharov, P. Kuusiniemi, M. Leino, B. Lommel, R. Mann, K. Nishio, S. Saro, B. Streicher, B. Sulignano, M. Venhart, Eur. Phys. J. A **47**, 62 (2011). https://doi.org/10.1140/epja/i2011-11062-y

[113] **2012He09** F. P. Hessberger, S. Antalic, D. Ackermann, Z. Kalaninova, S. Heinz, S. Hofmann, B. Streicher, B. Kindler, I. Kojouharov, P. Kuusiniemi, M. Leino, B. Lommel, R. Mann, K. Nishio, S. Saro, B. Sulignano, M. Venhart, Eur. Phys. J. A **48**, 75 (2012). https://doi.org/10.1140/epja/i2012-12075-8

[114] **2013AsZZ**M. Asai, K. Tsukada, N. Sato, T. K. Sato, A. Toyoshima, S. Miyashita, K. Ooe, Y. Kaneya, T. Ishii, Y. Nagame, M. Schadel, JAEA-Review 2013-057, p. 11 (2013).

[115] **2015Ne16**C. D. Nesaraja, Nucl. Data Sheets **130**, 183 (2015). https://doi.org/10.1016/j.nds.2015.11.004

[116] **2016Di11** M. P. Dion, B. W. Miller, G. A. Warren, Nucl. Instrum. Methods Phys. Res. A**830**, 6 (2016). https://doi.org/10.1016/j.nima.2016.05.041

[117] **2017Ca12** R. Caballero-Folch, C. Domingo-Pardo, J. Agramunt, A. Algora, F. Ameil, Y. Ayyad, J. Benlliure, M. Bowry, F. Calvino, D. Cano-Ott, G. Cortes, T. Davinson, I. Dillmann, A. Estrade, A. Evdokimov, T. Faestermann, F. Farinon, D. Galaviz, A. R. Garcia, H. Geissel, W. Gelletly, R. Gernhauser, M. B. Gomez Hornillos, C. Guerrero, M. Heil, C. Hinke, R. Knobel, I. Kojouharov, J. Kurcewicz, N. Kurz, Yu. A. Litvinov, L. Maier, J. Marganiec, M. Marta, T. Martinez, F. Montes, I. Mukha, D. R. Napoli, C. Nociforo, C. Paradela, S. Pietri, Zs. Podolyak, A. Prochazka, S. Rice, A. Riego, B. Rubio, H. Schaffner, Ch. Scheidenberger, K. Smith, E. Sokol, K. Steiger, B. Sun, J. L. Tain, M. Takechi, D. Testov, H. Weick, E. Wilson, J. S. Winfield, R. Wood, P. J. Woods, A. Yeremin, Phys. Rev. C **95**, 064322 (2017). https://doi.org/10.1103/PhysRevC.95.064322

[118] **2020Si28** B. Singh, J. K. Tuli, E. Browne, Nucl. Data Sheets **170**, 499 (2020). https://doi.org/10.1016/j.nds.2020.11.002

[119] **2020Yo01** M. D. Yoho, K. E. Koehler, D. T. Becker, D. A. Bennett, M. H. Carpenter, M. P. Croce, J. D. Gard, J. A. B. Mates, D. J. Mercer, N. J. Ortiz, D. R. Schmidt, C. M. Smith, D. S. Swetz, A. D. Tollefson, J. N. Ullom, L. R. Vale, A. L. Wessels, D. T. Vo, Nucl. Instrum. Methods Phys. Res. A**977**, 164307 (2020). https://doi.org/10.1016/j.nima.2020.164307

[120] **2021Ta23** M. P. Takacs, K. Kossert, Appl. Radiat. Isot. **176**, 109858 (2021). https://doi.org/10.1016/j.apradiso.2021.109858

[121] **2021Wa16** M. Wang, W. J. Huang, F. G. Kondev, G. Audi, S. Naimi, Chin. Phys. C **45**, 030003 (2021). doi: 10.1088/1674-1137/abddaf