NUCLEAR WALLET CARDS

(Fifth edition)

JULY 1995

JAGDISH K. TULI

NATIONAL NUCLEAR DATA CENTER

for

The U.S. Nuclear Data Network

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INTRODUCTION

This is an updated edition of the 1990 booklet of the same name†.

This booklet presents selected properties of all known nuclides and their known isomeric states.

The data given here are taken mostly from the adopted properties of the various nuclides as given in the *Evaluated Nuclear Structure Data File* (ENSDF)[1]. The data in ENSDF are based on experimental results and are published in *Nuclear Data Sheets*[2] for A≥45 and in *Nuclear Physics*[3,4] for A<45. For nuclides for which either there are no data in ENSDF or those data have since been superseded, the half–life and the decay modes are taken either from recent literature[5] or from other sources[e.g., 6,7,8]. The ground–state mass excesses are from the mass adjustments by G. Audi and A. H. Wapstra[9]. The isotopic abundances are those of N. E. Holden[10].

For other references, experimental data, and information on the data measurements, please refer to the original evaluations [1–4]. The data[1] were updated to **June 30, 1995**.

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†The first *Nuclear Wallet Cards* was produced by F. Ajzenberg–Selove and C. L. Busch in 1971. The Isotopes Project, Lawrence Berkeley National Laboratory, produced the next edition in 1979 based upon the *Table of Isotopes*, 7th edition (1978)[12]. The third (1985) and the fourth (1990) editions were published by J. K. Tuli, National Nuclear Data Center, Brookhaven National Laboratory.

Explanation of Table

Column 1, Isotope (Z, El, A):

Nuclides are listed in order of increasing atomic number (Z), and are subordered by increasing mass number (A). All isotopic species are included as well as all isomers with half–life≥0.1 s, and some other isomers which decay by SF or α emissions. A nuclide is included even if only its mass estimate or its production cross section is available. For the latter nuclides T½ limit is given[8] .

Isomeric states are denoted by the symbol "m" after the mass number and are given in the order of increasing excitation energy.

The ^{235}U thermal fission products, with fractional cumulative yields≥10^{-6}, are *italicized* in the table. The information on fission products is taken from the ENDF/B–VI fission products file[11].

The names for elements Z=104–109 are those adopted by the American Chemical Society Nomenclature Committee. The symbols Rf (Rutherfordium) and Ha (Hahnium) have, not been accepted internationally due to conflicting claims about the discovery of these elements.

Column 2, Jπ:

Spin and parity assignments, without and with parentheses, are based upon strong and weak arguments, respectively. See the introductory pages of any January issue of *Nuclear Data Sheets*[2] for description of strong and weak arguments for Jπ assignments.

Explanation of Table (cont.)

Column 3, Mass Excess, Δ:

Mass excesses, M−A, are given in MeV with $\Delta(^{12}C)=0$, by definition. For isomers the values are obtained by adding the excitation energy to the Δ(g.s.) values. Wherever the excitation energy is not known, the mass excess for the next lower isomer (or g.s.) is given. The values are given to the accuracy determined by uncertainty in Δ(g.s.) (maximum of three figures after the decimal). The uncertainty is ≤9 in the last significant figure. An appended "s" denotes that the value is obtained from systematics.

Column 4, T½, Γ or Abundance:

The half–life and the abundance (in **bold face**) are shown followed by their units ("%" symbol in the case of abundance) which are followed by the uncertainty, in *italics*, in the last significant figure. For example, 8.1 s *10* means 8.1±1.0 s. For some very short–lived nuclei, level widths rather than half–lives are given. There also, the width is followed by units (e.g., eV, keV, or MeV) which are followed by the uncertainty in *italics*, if known.

Column 5, Decay Mode:

Decay modes are given in decreasing strength from left to right, followed by the percentage branching, if known ("w" indicates a weak branch). The percentage branching is omitted where there is no competing mode of decay or no other mode has been observed.

Explanation of Table (cont.)

The various modes of decay are given below:

β–	β^- decay
ε	ε (electron capture), or ε+β^+, or β^+ decay
IT	isomeric transition (through γ or conver–sion–electron decay)
n, p, α, ...	neutron, proton, alpha, ... decay
SF	spontaneous fission
2β–, 3α, ...	double β^- decay ($\beta^-\beta^-$), decay through emission of 3 α's, ...
β–n, β–p, β–α, ...	delayed n, p, α, ... emission following β^- decay
εp, εα, εSF, ...	delayed p, α, SF, ... decay following ε or β^+ decay

Appendices:

The appendices have been updated to conform to the Fundamental Physical Constants[13]. For properties of the elementary particles and for the astrophysical constants please see the Review of Particle Properties, *Physical Review* D50, 1173 (1994) and its subsequent biennial updates. See also the World Wide Web at URL: http://pdg.lbl.gov/

Acknowledgements

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Nuclear Wallet Cards

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
0	**n**	1	1/2+	8.071	10.4 m *2*	β–
1	**H**	1	1/2+	7.289	**99.985% *1***	
		2	1+	13.136	**0.015% *1***	
		3	1/2+	14.950	12.33 y *6*	β–
		4	2–	26.0	5.42 MeV	n
		5		38.5		
		6		41.9		
2	**He**	3	1/2+	14.931	**0.000137% *3***	
		4	0+	2.425	**99.999863% *3***	
		5	3/2–	11.39	0.60 MeV *2*	α, n
		6	0+	17.594	806.7 ms *15*	β–
		7	(3/2)–	26.11	160 keV *30*	n
		8	0+	31.598	119.0 ms *15*	β–, β–n 16%
		9	(1/2–)	40.82	≈0.3 MeV	n
		10	0+	48.81	0.3 MeV *2*	n
3	**Li**	4	2–	25.3	6.03 MeV	p
		5	3/2–	11.68	≈1.5 MeV	α, p
		6	1+	14.086	**7.5% *2***	
		7	3/2–	14.908	**92.5% *2***	
		8	2+	20.945	838 ms *6*	β–, β–2α
		9	3/2–	24.954	178.3 ms *4*	β–, β–n 49.5%, β–n2α
		10		33.44	1.2 MeV *3*	n
		11	3/2–	40.79	8.5 ms *2*	β–, β–nα 0.027%, β–n
4	**Be**	6	0+	18.375	92 keV *6*	2p
		7	3/2–	15.769	53.29 d *7*	ε
		8	0+	4.942	6.8 eV *17*	2α
		9	3/2–	11.348	**100%**	
		10	0+	12.607	1.51×10^{6} y *6*	β–
		11	1/2+	20.174	13.81 s *8*	β–, β–α 3.1%
		12	0+	25.08	23.6 ms *9*	β–, β–n < 1%
		13	(1/2,5/2)+	35.16	0.9 MeV *5*	n
		14	0+	39.9	4.35 ms *17*	β–, β–n 81%, β–2n 5%
5	**B**	7	(3/2–)	27.87	1.4 MeV *2*	p, 2p, 3p
		8	2+	22.921	770 ms *3*	εα, ε, ε2α
		9	3/2–	12.416	0.54 keV *21*	2α, p
		10	3+	12.051	**19.9% *2***	
		11	3/2–	8.668	**80.1% *2***	
		12	1+	13.369	20.20 ms *2*	β–, β–3α 1.58%
		13	3/2–	16.562	17.36 ms *16*	β–
		14	2–	23.66	13.8 ms *10*	β–
		15		28.97	10.5 ms *3*	β–
		16	(0–)	37.1s		n
		17	(3/2–)	43.7	5.08 ms *5*	β–, β–xn
		18		52.3s		
		19		59.4s		
6	**C**	8	0+	35.09	230 keV *50*	2p
		9	(3/2–)	28.914	126.5 ms *9*	ε, εp, ε2α

Nuclear Wallet Cards

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
6	**C**	10	0+	15.699	19.255 s *53*	ε
		11	3/2–	10.650	20.39 m *2*	ε
		12	0+	0.000	**98.89% *1***	
		13	1/2–	3.125	**1.11% *1***	
		14	0+	3.020	5730 y *40*	β–
		15	1/2+	9.873	2.449 s *5*	β–
		16	0+	13.694	0.747 s *8*	β–
		17		21.04	193 ms *13*	β–, β–n 32%
		18	0+	24.92	88 ms *+9–8*	β–
		18	0+	24.92	66 ms *+25–15*	β–n 19%
		19		32.8	49 ms *4*	β–, β–n 61%
		20	0+	37.6	14 ms *6*	β–, β–n 72%
		21		46.0s		
		22	0+	52.6s	>200 ns	
7	**N**	10		39.7s		
		11	1/2+	25.3	1.58 MeV *+75–52*	p
		12	1+	17.338	11.000 ms *16*	ε, ε3α 3.44%
		13	1/2–	5.345	9.965 m *4*	ε
		14	1+	2.863	**99.634% *9***	
		15	1/2–	0.101	**0.366% *9***	
		16	2–	5.682	7.13 s *2*	β–
		16m	0–	5.802	7.25 μs *6*	β–, IT
		17	1/2–	7.87	4.173 s *4*	β–, β–n
		18	1–	13.12	624 ms *12*	β–, B–
		19		15.86	0.304 s *16*	β–, β–n≈62.4%
		20		21.77	100 ms *+30–20*	β–, β–n≈61%
		21		25.23	95 ms *13*	β–, β–n 84%
		22		32.1	24 ms *7*	β–, β–n 35%
		23		37.7s	>200 ns	
		24		47.0s		
8	**O**	12	0+	32.06	0.40 MeV *25*	p
		13	(3/2–)	23.111	8.58 ms *5*	ε
		14	0+	8.007	70.606 s *18*	ε
		15	1/2–	2.855	122.24 s *16*	ε
		16	0+	–4.737	**99.762% *15***	
		17	5/2+	–0.809	**0.038% *3***	
		18	0+	–0.782	**0.200% *12***	
		19	5/2+	3.332	26.91 s *8*	β–
		20	0+	3.797	13.51 s *5*	β–
		21	(1/2,3/2,5/2)+	8.06	3.42 s *10*	β–
		22	0+	9.28	2.25 s *15*	β–
		23		14.6	82 ms *37*	β–, β–n 31%
		24	0+	19.0	61 ms *26*	β–, β–n 58%
		25		27.1s		
		26	0+	35.2s		
9	**F**	14	(2–)	33.6s		p
		15	(1/2+)	16.8	1.0 MeV *2*	p
		16	0–	10.680	40 keV *20*	p
		17	5/2+	1.952	64.49 s *16*	ε
		18	1+	0.873	109.77 m *5*	ε
		19	1/2+	–1.487	**100%**	

Nuclear Wallet Cards

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
9	**F**	20	2+	−0.017	11.00 s *2*	β−
		21	5/2+	−0.048	4.158 s *20*	β−
		22	4+,(3+)	2.79	4.23 s *4*	β−
		23	(3/2,5/2)+	3.33	2.23 s *14*	β−
		24	(1,2,3)+	7.54	0.34 s *8*	β−
		25		11.27		β−, β−n
		26		18.3		
		27		25.0	>200 ns	
		28		33.2s		
		29		40.3s	>200 ns	
10	**Ne**	15		41.4s		
		16	0+	23.99	122 keV *37*	p
		17	1/2−	16.49	109.2 ms *6*	ε, εp, εα
		18	0+	5.319	1672 ms *8*	ε
		19	1/2+	1.751	17.22 s *2*	ε
		20	0+	−7.042	**90.48%** ***3***	
		21	3/2+	−5.732	**0.27%** ***1***	
		22	0+	−8.024	**9.25%** ***3***	
		23	5/2+	−5.154	37.24 s *12*	β−
		24	0+	−5.95	3.38 m *2*	β−
		25	(1/2,3/2)+	−2.06	602 ms *8*	β−
		26	0+	0.43	0.23 s *6*	β−
		27		7.09	32 ms *2*	β−, β−n
		28	0+	11.3	14 ms *10*	β−, β−n 16%
		29		18.0	0.2 s *1*	β−n?
		30	0+	22.2	>200 ns	
		31		30.8s		
		32	0+	37.2s	>200 ns	
11	**Na**	17		35.2s		
		18		25.3s		
		19		12.93		
		20	2+	6.845	447.9 ms *23*	ε
		21	3/2+	−2.184	22.49 s *4*	ε
		22	3+	−5.182	2.6019 y *4*	ε
		23	3/2+	−9.530	**100%**	
		24	4+	−8.418	14.9590 h *12*	β−
		24m	1+	−7.946	20.20 ms *7*	IT 99.95%, β− 0.05%
		25	5/2+	−9.358	59.1 s *6*	β−
		26	3+	−6.90	1.072 s *9*	β−
		27	5/2+	−5.58	301 ms *6*	β−, β−n 0.08%
		28	1+	−1.03	30.5 ms *4*	β−, β−n 0.58%
		29		2.62	44.9 ms *12*	β−
		29	3/2	2.62	44.9 ms *12*	β−n 21.5%
		30	2+	8.59	48 ms *2*	β−, β−n 30%, β−2n 1.17%, β−α 5.5×10^{-5}%
		31	3/2+	12.7	17.0 ms *4*	β−, β−n 37%, β−2n 0.9%
		32	(3−,4−)	18.3	13.2 ms *4*	β−, β−n 24%, β−2n 8%
		33		26.	8.2 ms *4*	β−, β−n 52%, β−2n 12%

Nuclear Wallet Cards

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
11	**Na**	34		33.s	5.5 ms *10*	β–, β–n, β–2n 57.5%
		35		41.s	1.5 ms *5*	β–, β–n
12	**Mg**	19		32.0s		
		20	0+	17.57	95 ms *+80–50*	ε, εp≥3%
		21	(3/2,5/2)+	10.91	122 ms *3*	ε, εp 29.3%
		22	0+	–0.397	3.857 s *9*	ε
		23	3/2+	–5.473	11.317 s *11*	ε
		24	0+	–13.933	**78.99%** ***3***	
		25	5/2+	–13.193	**10.00%** ***1***	
		26	0+	–16.215	**11.01%** ***2***	
		27	1/2+	–14.587	9.458 m *12*	β–
		28	0+	–15.019	20.91 h *3*	β–
		29	3/2+	–10.66	1.30 s *12*	β–
		30	0+	–8.88	335 ms *17*	β–
		31		–3.22	230 ms *20*	β–, β–n 1.7%
		32	0+	–0.80	120 ms *20*	β–, β–n 2.4%
		33		5.2	90 ms *20*	β–, β–n 17%
		34	0+	8.5	20 ms *10*	β–, β–n
		35		16.3s	>200 ns	
		36	0+	20.9s	>200 ns	
13	**Al**	21		26.1s	<35 ns	
		22		18.18s	70 ms *+50–35*	ε, εp>0%, ε2p>0%
		23		6.77	0.47 s *3*	ε, εp
		24	4+	–0.055	2.053 s *4*	ε, εα 0.04%
		24m	1+	0.371	131.3 ms *25*	IT 82%, ε 18%, εα 0.03%
		25	5/2+	–8.916	7.183 s *12*	ε
		26	5+	–12.210	7.4×10^5 y *3*	ε
		26m	0+	–11.982	6.3452 s *19*	ε
		27	5/2+	–17.197	**100%**	
		28	3+	–16.851	2.2414 m *12*	β–
		29	5/2+	–18.215	6.56 m *6*	β–
		30	3+	–15.87	3.60 s *6*	β–
		31	(3/2,5/2)+	–14.95	644 ms *25*	β–
		32	1+	–11.06	33 ms *4*	β–
		33		–8.50	>1 μs	
		34		–2.86	60 ms *18*	β–, β–n 27%
		35		–0.1	150 ms *50*	β–, β–n 65%
		36		5.9	>1 μs	
		37		9.6	>1 μs	
		38		15.7s	>200 ns	
		39			>200 ns	
14	**Si**	22	0+	32.2s	6 ms *3*	ε, εp
		23		23.8s	>200 ns	
		24	0+	10.75	102 ms *35*	ε, εp≈7%
		25	5/2+	3.83	220 ms *3*	ε, εp
		26	0+	–7.145	2.234 s *13*	ε
		27	5/2+	–12.385	4.16 s *2*	ε
		28	0+	–21.493	**92.23%** ***1***	
		29	1/2+	–21.895	**4.67%** ***21***	
		30	0+	–24.433	**3.10%** ***1***	

Nuclear Wallet Cards

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
14	**Si**	31	3/2+	–22.949	157.3 m *3*	β–
		32	0+	–24.081	172 y *4*	β–
		33		–20.49	6.18 s *18*	β–
		34	0+	–19.96	2.77 s *20*	β–
		35		–14.36	0.78 s *12*	β–
		36	0+	–12.4	0.45 s *6*	β–, β–n < 10%
		37		–6.5	>1 μs	β–n < 15%
		38	0+	–3.7	>1 μs	
		39		2.1s	>1 μs	
		40	0+	5.4s	>200 ns	
		41		11.8s	>200 ns	
		42	0+		>200 ns	
15	**P**	24		32.0s		
		25		18.9s		
		26	(3+)	11.0s	20 ms *+35–15*	ε, εp 2%, ε2p
		27	(1/2+)	–0.75	260 ms *80*	ε, εp 6%
		28	3+	–7.161	270.3 ms *5*	ε
		29	1/2+	–16.952	4.140 s *14*	ε
		30	1+	–20.201	2.498 m *4*	ε
		31	1/2+	–24.441	**100%**	
		32	1+	–24.305	14.262 d *14*	β–
		33	1/2+	–26.338	25.34 d *12*	β–
		34	1+	–24.558	12.43 s *8*	β–
		35	1/2+	–24.858	47.3 s *7*	β–
		36		–20.25	5.6 s *3*	β–
		37		–18.99	2.31 s *13*	β–
		38		–14.5	0.64 s *14*	β–, β–n < 10%
		39		–12.6	0.16 s *+30–10*	β–, β–n 41%
		40		–8.3	260 ms *80*	β–, β–n 30%
		41		–4.8	120 ms *20*	β–, β–n 30%
		42		0.1s	110 ms *30*	β–, β–n 50%
		43		3.1s	33 ms *3*	β–, β–n
		44			>200 ns	
		45			>200 ns	
		46			>200 ns	
16	**S**	26	0+	26.0s		
		27		17.5s		ε
		28	0+	4.1	125 ms *10*	ε, εp > 0%
		29	5/2+	–3.16	187 ms *4*	ε
		30	0+	–14.063	1.178 s *5*	ε
		31	1/2+	–19.045	2.572 s *13*	ε
		32	0+	–26.016	**95.02%** ***9***	
		33	3/2+	–26.586	**0.75%** ***1***	
		34	0+	–29.932	**4.21%** ***8***	
		35	3/2+	–28.846	87.51 d *12*	β–
		36	0+	–30.664	**0.02%** ***1***	
		37	7/2–	–26.896	5.05 m *2*	β–
		38	0+	–26.861	170.3 m *7*	β–
		39	(3/2,5/2,7/2)–	–23.16	11.5 s *5*	β–
		40	0+	–22.8	8.8 s *22*	β–
		41		–18.6	>1 μs	
		42	0+	–17.2	0.56 s *6*	β–, β–n < 4%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
16	**S**	43		–12.5	220 ms *65*	β–, β–n 40%
		44	0+	–10.9s	123 ms *10*	β–, β–n 18%
		45		–4.8s	82 ms *13*	β–
		46	0+		>200 ns	
		47			>200 ns	
		48	0+		>200 ns	
17	**Cl**	28		26.6s		
		29		13.1s		
		30		4.4s		
		31		–7.06	150 ms *25*	ε, εp 0.44%
		32	1+	–13.331	298 ms *1*	ε, εα 0.01%, εp 7.0×10^{-3}%
		33	3/2+	–21.003	2.511 s *3*	ε
		34	0+	–24.440	1.5264 s *14*	ε
		34m	3+	–24.294	32.00 m *4*	ε 55.4%, IT 44.6%
		35	3/2+	–29.014	**75.77%** ***5***	
		36	2+	–29.522	3.01×10^{5} y *2*	β– 98.1%, ε 1.9%
		37	3/2+	–31.761	**24.23%** ***5***	
		38	2–	–29.798	37.24 m *5*	β–
		38m	5–	–29.127	715 ms *3*	IT
		39	3/2+	–29.800	55.6 m *2*	β–
		40	2–	–27.56	1.35 m *2*	β–
		41	(1/2,3/2)+	–27.34	38.4 s *8*	β–
		42		–25.0	6.8 s *3*	β–
		43		–24.0	3.3 s *2*	β–
		44		–20.0	0.43 s *6*	β–, β–n < 8%
		45		–18.9	400 ms *43*	β–, β–n 24%
		46		–14.8s	0.22 s *4*	β–, β–n 60%
		47		–11.2s	>200 ns	β–, β–n ≤ 3%
		48			>200 ns	
		49			≥170 ns	
		51			>200 ns	
18	**Ar**	30	0+	20.1s		
		31		11.3s		
		32	0+	–2.18	98 ms *2*	ε, εp
		33	1/2+	–9.38	173.0 ms *20*	ε, εp 38.7%
		34	0+	–18.378	844.5 ms *34*	ε
		35	3/2+	–23.048	1.775 s *4*	ε
		36	0+	–30.230	**0.3365%** ***30***	
		37	3/2+	–30.948	35.04 d *4*	ε
		38	0+	–34.715	**0.0632%** ***5***	
		39	7/2–	–33.242	269 y *3*	β–
		40	0+	–35.040	**99.6003%** ***30***	
		41	7/2–	–33.067	109.34 m *12*	β–
		42	0+	–34.42	32.9 y *11*	β–
		43	(3/2,5/2)	–31.98	5.37 m *6*	β–
		44	0+	–32.26	11.87 m *5*	β–
		45		–29.72	21.48 s *15*	β–
		46	0+	–29.72	8.4 s *6*	β–
		47		–25.9		
		48	0+	–23.2s		
		49			≥170 ns	

Nuclear Wallet Cards

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
18	**Ar**	50	0+		≥170 ns	
		51			>200 ns	
19	**K**	32		20.4s		
		33		6.8s		
		34		−1.5s		
		35	3/2+	−11.17	190 ms *30*	ε , εp 0.37%
		36	2+	−17.425	342 ms *2*	ε , εp 0.05%, εα 3.4×10^{-3}%
		37	3/2+	−24.799	1.226 s *7*	ε
		38	3+	−28.802	7.636 m *18*	ε
		38m	0+	−28.672	923.9 ms *6*	ε
		39	3/2+	−33.807	**93.2581%** ***44***	
		40	4−	−33.535	1.277×10^{9} y *8*	β− 89.28%,
					0.0117% ***1***	ε 10.72%
		41	3/2+	−35.559	**6.7302%** ***44***	
		42	2−	−35.021	12.360 h *3*	β−
		43	3/2+	−36.593	22.3 h *1*	β−
		44	2−	−35.81	22.13 m *19*	β−
		45	3/2+	−36.61	17.3 m *6*	β−
		46	(2−)	−35.42	105 s *10*	β−
		47	1/2+	−35.697	17.50 s *24*	β−
		48	(2−)	−32.12	6.8 s *2*	β− , β−n 1.14%
		49	(3/2+)	−30.32	1.26 s *5*	β− , β−n 86%
		50	(0−,1,2−)	−25.4	472 ms *4*	β− , β−n 29%
		51	(1/2+,3/2+)		365 ms *5*	β− , β−n 47%
		52			105 ms *5*	β− , β−n >88%
		53	(3/2+)		30 ms *5*	β− , β−n 85%
		54			10 ms *5*	β− , β−n
20	**Ca**	34	0+	13.2s		
		35		4.44s	50 ms *30*	ε , ε2p
		36	0+	−6.44	102 ms *2*	ε , εp ≈20%
		37	3/2+	−13.16	181.1 ms *10*	ε , εp 76%
		38	0+	−22.059	440 ms *8*	ε
		39	3/2+	−27.276	859.6 ms *14*	ε
		40	0+	−34.846	**96.941%** ***18***	
		41	7/2−	−35.138	1.03×10^{5} y *4*	ε
		42	0+	−38.547	**0.647%** ***9***	
		43	7/2−	−38.408	**0.135%** ***6***	
		44	0+	−41.469	**2.086%** ***12***	
		45	7/2−	−40.813	162.61 d *9*	β−
		46	0+	−43.135	**0.004%** ***3***	
		47	7/2−	−42.340	4.536 d *3*	β−
		48	0+	−44.215	$>6\times10^{18}$ y	2β−
					0.187% ***4***	
		49	3/2−	−41.290	8.718 m *6*	β−
		50	0+	−39.571	13.9 s *6*	β−
		51	(3/2−)	−35.90	10.0 s *8*	β− , β−n
		52	0+	−32.5	4.6 s *3*	β−
		53	(3/2−,5/2−)	−27.9s	90 ms *15*	β− , β−n >30%
21	**Sc**	36		13.9s		
		37		2.8s		

Nuclear Wallet Cards

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
21	**Sc**	38		−4.9s		
		39		−14.17		
		40	4−	−20.526	182.3 ms *7*	ε , εp 0.44%, εα 0.02%
		41	7/2−	−28.642	596.3 ms *17*	ε
		42	0+	−32.121	681.3 ms *7*	ε
		42m	7+,(5,6)+	−31.505	61.7 s *4*	ε
		43	7/2−	−36.188	3.891 h *12*	ε
		44	2+	−37.816	3.927 h *8*	ε
		44m	6+	−37.545	58.6 h *1*	IT 98.8%, ε 1.2%
		45	7/2−	−41.069	**100%**	
		45m	3/2+	−41.057	318 ms *7*	IT
		46	4+	−41.759	83.79 d *4*	β−
		46m	1−	−41.616	18.75 s *4*	IT
		47	7/2−	−44.332	3.3492 d *6*	β−
		48	6+	−44.493	43.67 h *9*	β−
		49	7/2−	−46.552	57.2 m *2*	β−
		50	5+	−44.54	102.5 s *5*	β−
		50m	(2,3)+	−44.28	0.35 s *4*	IT>97.5%, β−<2.5%
		51	(7/2)−	−43.22	12.4 s *1*	β−
		52	3+	−40.5	8.2 s *2*	β−
		53		−38.0s	>1 μs	
		54		−34.0	>1 μs	
		55		−30.s	>1 μs	
22	**Ti**	38	0+	9.1s		
		39		1.2s	26 ms *8*	
		40	0+	−8.9	50 ms *15*	ε , εp
		41	3/2+	−15.71s	80 ms *2*	ε , εp≈100%
		42	0+	−25.121	199 ms *6*	ε
		43	7/2−	−29.320	509 ms *5*	ε
		44	0+	−37.548	49 y *3*	ε
		45	7/2−	−39.007	184.8 m *5*	ε
		46	0+	−44.125	**8.25%** ***3***	
		47	5/2−	−44.932	**7.44%** ***2***	
		48	0+	−48.487	**73.72%** ***3***	
		49	7/2−	−48.558	**5.41%** ***2***	
		50	0+	−51.426	**5.18%** ***2***	
		51	3/2−	−49.727	5.76 m *1*	β−
		52	0+	−49.464	1.7 m *1*	β−
		53	(3/2)−	−46.8	32.7 s *9*	β−
		54	0+	−45.6	>1 μs	
		55		−41.7	>1 μs	
		56	0+	−39.1	>200 ns	
		57		−34.0s	>200 ns	
		58	0+		>150 ns	
23	**V**	40		10.3s		
		41		−0.2s		
		42		−8.2s	<55 ns	
		43	(7/2−)	−18.0s	>800 ms	ε
		44		−23.85s	90 ms *25*	ε , εα
		44m	6+	−23.85s	155 ms	IT?
		45	7/2−	−31.87	547 ms *6*	ε

Nuclear Wallet Cards

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
23	**V**	46	0+	–37.074	422.37 ms *20*	ε
		47	3/2–	–42.004	32.6 m *3*	ε
		48	4+	–44.475	15.9735 d *25*	ε
		49	7/2–	–47.956	330 d *15*	ε
		50	6+	–49.218	1.4×10^{17} y *4*	ε 83%,
					0.250% *2*	β– 17%
		51	7/2–	–52.198	**99.750% *2***	
		52	3+	–51.438	3.743 m *5*	β–
		53	7/2–	–51.845	1.61 m *4*	β–
		54	3+	–49.89	49.8 s *5*	β–
		55	(7/2–)	–49.1	6.54 s *15*	β–
		56		–46.2	>1 μs	
		57		–44.3	>200 ns	
		58		–40.3	>200 ns	
		59		–37.9	>200 ns	β–
		60		–33.1	>200 ns	
		61			>150 ns	
24	**Cr**	42	0+	6.0s		
		43	(3/2+)	–2.14s	21 ms *+4–3*	ε , εp , εα?
		44	0+	–13.5s	53 ms *+4–3*	εp
		45		–19.4s	50 ms *6*	ε , εp>27%
		46	0+	–29.47	0.26 s *6*	ε
		47	3/2–	–34.55	500 ms *15*	ε
		48	0+	–42.815	21.56 h *3*	ε
		49	5/2–	–45.326	42.3 m *1*	ε
		50	0+	–50.255	$>1.8\times10^{17}$ y	2ε
					4.345% *13*	
		51	7/2–	–51.445	27.702 d *4*	ε
		52	0+	–55.413	**83.789% *18***	
		53	3/2–	–55.281	**9.501% *17***	
		54	0+	–56.929	**2.365% *7***	
		55	3/2–	–55.104	3.497 m *3*	β–
		56	0+	–55.289	5.94 m *10*	β–
		57	3/2–,5/2–,7/2–	–52.39	21.1 s *10*	β–
		58	0+	–51.9	7.0 s *3*	β–
		59		–47.8	0.74 s *24*	β–
		60	0+	–46.8	0.57 s *6*	β–
		61		–42.8	>200 ns	β–
		62	0+	–41.2	>200 ns	
		63			>150 ns	
		64	0+		>1 μs	
25	**Mn**	44		6.4s		
		45		–5.1s		
		46	(4+)	–12.4s	41 ms *+7–6*	ε , εp
		47		–22.3s	>200 ns	εp
		48	4+	–29.29s	158.1 ms *22*	ε , εp 0.28%,
						$\varepsilon\alpha<6.0\times10^{-4}$%
		49	5/2–	–37.61	382.1 ms *68*	ε
		50	0+	–42.622	283.88 ms *46*	ε
		50m	5+	–42.393	1.75 m *3*	ε
		51	5/2–	–48.237	46.2 m *1*	ε
		52	6+	–50.701	5.591 d *3*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
25	**Mn**	52m	2+	−50.323	21.1 m *2*	ε 98.25%, IT 1.75%
		53	7/2−	−54.684	3.74×10^{6} y *4*	ε
		54	3+	−55.552	312.12 d *10*	ε , β− < 0.001%
		55	5/2−	−57.707	**100%**	
		56	3+	−56.906	2.5785 h *2*	β−
		57	5/2−	−57.485	85.4 s *18*	β−
		58	3+	−55.90	65.3 s *7*	β−
		58m	+	−55.90	3.0 s *1*	β−
		59	3/2−,5/2−	−55.47	4.6 s *1*	β−
		60	0+	−52.8	51 s *6*	β−
		60m	3+	−52.5	1.77 s *2*	β− 88.5%, IT 11.5%
		61	(5/2)−	−51.6	0.71 s *1*	β−
		62	(3+)	−48.5	0.88 s *15*	β−
		63		−46.8	0.25 s *4*	β−
		64		−43.1	>200 ns	
		65		−40.9	>200 ns	β−
		66			>150 ns	
26	**Fe**	45		13.6s		
		46	0+	0.8s	20 ms *+20−8*	εp?
		47		−6.6s	27 ms *+32−10*	εp?
		48	0+	−18.1s	≥200 ns	
		49	(7/2−)	−24.6s	75 ms *10*	ε , εp ≤ 60%
		50	0+	−34.47	150 ms *30*	ε , εp ≈ 0%
		51	(5/2−)	−40.22	305 ms *5*	ε
		52	0+	−48.33	8.275 h *8*	ε
		52m	(12+)	−41.51	45.9 s *6*	ε
		53	7/2−	−50.941	8.51 m *2*	ε
		53m	19/2−	−47.901	2.58 m *4*	IT
		54	0+	−56.249	**5.845%** ***35***	
		55	3/2−	−57.475	2.73 y *3*	ε
		56	0+	−60.601	**91.754%** ***36***	
		57	1/2−	−60.176	**2.119%** ***10***	
		58	0+	−62.149	**0.282%** ***4***	
		59	3/2−	−60.659	44.503 d *6*	β−
		60	0+	−61.407	1.5×10^{6} y *3*	β−
		61	3/2−,5/2−	−58.92	5.98 m *6*	β−
		62	0+	−58.90	68 s *2*	β−
		63	(5/2)−	−55.5	6.1 s *6*	β−
		64	0+	−54.9	2.0 s *2*	β−
		65		−51.3	0.4 s *2*	β−
		66	0+	−50.3	>200 ns	
		67		−46.6	>200 ns	β−
		68	0+	−44.2s	0.10 s *6*	β−
		69			>150 ns	
27	**Co**	48		1.8s		
		49		−9.9s		
		50		−17.5s	≥200 ns	
		51		−27.5s		
		52		−34.32s		ε , εp
		53	(7/2−)	−42.64	240 ms *20*	ε
		53m	(19/2−)	−39.45	247 ms *12*	ε ≈ 98.5%, p ≈ 1.5%
		54	0+	−48.006	193.28 ms *14*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
27	**Co**	54m	(7)+	−47.806	1.48 m *2*	ε
		55	7/2−	−54.024	17.53 h *3*	ε
		56	4+	−56.035	77.27 d *3*	ε
		57	7/2−	−59.340	271.79 d *9*	ε
		58	2+	−59.842	70.82 d *3*	ε
		58m	5+	−59.817	9.15 h *10*	IT
		59	7/2−	−62.224	**100%**	
		60	5+	−61.645	1925.1 d *5*	β−
		60m	2+	−61.585	10.467 m *6*	IT 99.76%, β− 0.24%
		61	7/2−	−62.895	1.650 h *5*	β−
		62	2+	−61.43	1.50 m *4*	β−
		62m	5+	−61.41	13.91 m *5*	β− > 99%, IT < 1%
		63	(7/2)−	−61.84	27.4 s *5*	β−
		64	1+	−59.79	0.30 s *3*	β−
		65	(7/2)−	−59.16	1.20 s *6*	β−
		66	(3+)	−56.1	0.23 s *2*	β−
		67	(7/2−)	−55.3	0.42 s *7*	β−
		68		−51.8	0.18 s *10*	β−
		69		−51.0	0.27 s *5*	β−
		70		−46.8s	>200 ns	β−
		71		−45.0s	0.20 s *5*	β−
		72			>1 μs	
28	**Ni**	50	0+	−3.8s	>150 ns	
		51		−11.4s	>200 ns	
		52	0+	−22.65s	38 ms *5*	ε , εp 17%
		53	(7/2−)	−29.4s	45 ms *15*	ε
		54	0+	−39.21		ε
		55	7/2−	−45.33	212.1 ms *38*	ε
		56	0+	−53.90	6.077 d *12*	ε
		57	3/2−	−56.076	35.60 h *6*	ε
		58	0+	−60.223	**68.077% *9***	
		59	3/2−	−61.151	7.6×10^{4} y *5*	ε
		60	0+	−64.468	**26.223% *8***	
		61	3/2−	−64.217	**1.140% *1***	
		62	0+	−66.743	**3.634% *2***	
		63	1/2−	−65.509	100.1 y *20*	β−
		64	0+	−67.096	**0.926% *1***	
		65	5/2−	−65.123	2.5172 h *3*	β−
		66	0+	−66.03	54.6 h *4*	β−
		67	(1/2−)	−63.74	21 s *1*	β−
		68	0+	−63.49	19 s *+3−6*	β−
		69		−60.4	11.4 s *3*	β−
		70	0+	−59.5		β−
		71		−55.9	1.86 s *35*	β−
		72	0+	−54.7	2.06 s *30*	β−
		73		−50.3s	0.90 s *15*	β−
		74	0+	−48.7s	1.1 s *5*	β−
		75		−44.2s	>1 μs	
		76	0+	−42.2s	>150 ns	
		77		−37.2s		
		78	0+	−35.s		
29	**Cu**	52		−2.6s		

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
29	**Cu**	53		–13.5s		
		54		–21.7s		
		55		–32.1s	>200 ns	ε , εp
		56		–38.6s	>200 ns	ε , εp
		57	3/2–	–47.31	199.4 ms *32*	ε
		58	1+	–51.660	3.204 s *7*	ε
		59	3/2–	–56.352	81.5 s *5*	ε
		60	2+	–58.341	23.7 m *4*	ε
		61	3/2–	–61.980	3.333 h *5*	ε
		62	1+	–62.795	9.74 m *2*	ε
		63	3/2–	–65.576	**69.17%** ***3***	
		64	1+	–65.421	12.700 h *2*	ε 61%, β– 39%
		65	3/2–	–67.260	**30.83%** ***3***	
		66	1+	–66.254	5.088 m *11*	β–
		67	3/2–	–67.300	61.83 h *12*	β–
		68	1+	–65.54	31.1 s *15*	β–
		68m	(6–)	–64.82	3.75 m *5*	IT 84%, β– 16%
		69	3/2–	–65.740	2.85 m *15*	β–
		70	1+	–62.96	4.5 s *10*	β–
		70m	3–,4–,5–	–62.82	47 s *5*	β–
		71	(3/2–)	–62.76	19.5 s *16*	β–
		72	(1+)	–59.9s	6.6 s *1*	β–
		73		–59.2s	3.9 s *3*	β–
		74	(1+,3+)	–55.8s	1.594 s *10*	β–
		75		–54.6s	1.224 s *3*	β– , β–n 3.5%
		76m		–50.7s	0.641 s *6*	β– , β–n 3%
		76m		–50.7s	1.27 s *30*	β–
		77		–49.1s	0.469 s *8*	β–
		78		–44.9s	0.342 s *11*	β–
		79		–42.7s	188 ms *25*	β– , β–n 55%
30	**Zn**	54	0+	–6.6s		
		55		–14.9s		
		56	0+	–25.7s		
		57	(7/2–)	–32.7s	40 ms *10*	ε , εp ≥65%
		58	0+	–42.29	65 ms *9*	ε
		59	3/2–	–47.26	182.0 ms *18*	ε , εp 0.1%
		60	0+	–54.18	2.38 m *5*	ε
		61	3/2–	–56.34	89.1 s *2*	ε
		62	0+	–61.17	9.186 h *13*	ε
		63	3/2–	–62.210	38.47 m *5*	ε
		64	0+	–66.000	**48.6%** ***3***	
		65	5/2–	–65.908	244.26 d *26*	ε
		66	0+	–68.897	**27.9%** ***2***	
		67	5/2–	–67.877	**4.1%** ***1***	
		68	0+	–70.004	**18.8%** ***4***	
		69	1/2–	–68.415	56.4 m *9*	β–
		69m	9/2+	–67.976	13.76 h *2*	IT 99.97%, β– 0.03%
		70	0+	–69.560	$>5\times10^{14}$ y	
					0.6% ***1***	
		71	1/2–	–67.32	2.45 m *10*	β–
		71m	9/2+	–67.16	3.96 h *5*	β– , IT ≤0.05%
		72	0+	–68.126	46.5 h *1*	β–

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
30	**Zn**	73	(1/2)–	–65.41	23.5 s *10*	β–
		73m	(7/2+)	–65.21	5.8 s *8*	β–, IT
		74	0+	–65.71	95.6 s *12*	β–
		75	(7/2+)	–62.47	10.2 s *2*	β–
		76	0+	–62.0	5.7 s *3*	β–
		77	(7/2+)	–58.6	2.08 s *5*	β–
		77m	(1/2–)	–57.8	1.05 s *10*	IT>50%, β–<50%
		78	0+	–57.2	1.47 s *15*	β–
		79	(9/2+)	–53.4s	0.995 s *19*	β–, β–n 1.3%
		80	0+	–51.8	0.545 s *16*	β–, β–n 1%
		81		–46.1s	0.29 s *5*	β–, β–n 7.5%
		82	0+	–42.1s		
31	**Ga**	56		–4.7s		
		57		–16.4s		
		58		–24.0s		
		59		–34.1s		
		60		–40.0s		
		61	(3/2–)	–47.3s	0.15 s *3*	ε
		62	0+	–52.00	116.12 ms *23*	ε
		63	3/2–,5/2–	–56.7	32.4 s *5*	ε
		64	0+	–58.835	2.630 m *11*	ε
		65	3/2–	–62.653	15.2 m *2*	ε
		66	0+	–63.722	9.49 h *7*	ε
		67	3/2–	–66.877	3.2612 d *6*	ε
		68	1+	–67.083	67.629 m *24*	ε
		69	3/2–	–69.321	**60.108% *6***	
		70	1+	–68.905	21.14 m *3*	β– 99.59%, ε 0.41%
		71	3/2–	–70.135	**39.892% *6***	
		72	3–	–68.584	14.10 h *2*	β–
		72m	(0+)	–68.464	39.68 ms *13*	IT
		73	3/2–	–69.704	4.86 h *3*	β–
		74	(3–)	–68.05	8.12 m *12*	β–
		74m	(0)	–67.99	9.5 s *10*	IT 75%, β–<50%
		75	3/2–	–68.464	126 s *2*	β–
		76	(2+,3+)	–66.20	32.6 s *6*	β–
		77	(3/2–)	–65.87	13.2 s *2*	β–
		78	(3+)	–63.66	5.09 s *5*	β–
		79	(3/2–)	–62.5	2.847 s *3*	β–, β–n 0.089%
		80	(3)	–59.1	1.697 s *11*	β–, β–n 0.89%
		81	(5/2–)	–58.0	1.221 s *5*	β–, β–n 12.3%
		82	(1,2,3)	–52.9s	0.599 s *2*	β–, β–n 22.3%
		83		–49.5s	0.31 s *1*	β–, β–n 40%
		84		–44.4s	85 ms *10*	β–, β–n 70%
32	**Ge**	58	0+	–8.4s		
		59		–17.0s		
		60	0+	–27.8s		
		61	(3/2–)	–33.7s	40 ms *15*	ε, εp≈80%
		62	0+	–42.2s	0.11 s *6*	ε?
		63		–46.9s	0.095 s *+23–20*	ε?
		64	0+	–54.4	63.7 s *25*	ε
		65	(3/2)–	–56.4	30.9 s *5*	ε
		66	0+	–61.62	2.26 h *5*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
32	**Ge**	67	1/2–	–62.654	18.9 m *3*	ε
		68	0+	–66.977	270.82 d *27*	ε
		69	5/2–	–67.094	39.05 h *10*	ε
		70	0+	–70.561	**21.23%** ***4***	
		71	1/2–	–69.905	11.43 d *3*	ε
		72	0+	–72.585	**27.66%** ***3***	
		73	9/2+	–71.297	**7.73%** ***1***	
		73m	1/2–	–71.230	0.499 s *11*	IT
		74	0+	–73.422	**35.94%** ***2***	
		75	1/2–	–71.856	82.78 m *4*	β–
		75m	7/2+	–71.716	47.7 s *5*	IT 99.97%, β– 0.03%
		76	0+	–73.213	**7.44%** ***2***	
		77	7/2+	–71.214	11.30 h *1*	β–
		77m	1/2–	–71.054	52.9 s *6*	β– 79%, IT 21%
		78	0+	–71.862	88.0 m *10*	β–
		79	(1/2)–	–69.49	18.98 s *3*	β–
		*79*m	(7/2+)	–69.30	39.0 s *10*	β– 96%, IT 4%
		80	0+	–69.45	29.5 s *4*	β–
		81	(9/2+)	–66.3	7.6 s *6*	β–
		81m	(1/2+)	–65.6	7.6 s *6*	β–
		82	0+	–65.5	4.60 s *35*	β–
		83	(5/2+)	–61.0s	1.85 s *6*	β–
		84	0+	–58.4s	0.947 s *11*	β–, β–n 10.8%
		85		–53.4s	0.54 s *5*	β–, β–n 14%
		86	0+	–50.0s	>150 ns	
33	**As**	60		–6.4s		
		61		–18.1s		
		62		–25.0s		
		63		–33.8s		
		64		–39.7s		
		65		–47.1s	0.19 s *+11–7*	ε
		66		–51.8s	0.10 s *+7–5*	ε
		67	(5/2–)	–56.6	42.5 s *12*	ε
		68	3	–58.9	151.6 s *8*	ε
		69	5/2–	–63.08	15.2 m *2*	ε
		70	4(+)	–64.34	52.6 m *3*	ε
		71	5/2–	–67.893	65.28 h *15*	ε
		72	2–	–68.229	26.0 h *1*	ε
		73	3/2–	–70.956	80.30 d *6*	ε
		74	2–	–70.859	17.77 d *2*	ε 66%, β– 34%
		75	3/2–	–73.032	**100%**	
		76	2–	–72.289	1.0778 d *20*	β–
		77	3/2–	–73.916	38.83 h *5*	β–
		78	2–	–72.816	90.7 m *2*	β–
		79	3/2–	–73.636	9.01 m *15*	β–
		80	1+	–72.12	15.2 s *2*	β–
		81	3/2–	–72.533	33.3 s *8*	β–
		82	(1+)	–70.24	19.1 s *5*	β–
		*82*m	(5–)	–70.24	13.6 s *4*	β–
		83	(5/2–,3/2–)	–69.9	13.4 s *3*	β–
		84	(3)–	–66.1s	4.02 s *3*	β–, β–n 0.28%
		85	(3/2–)	–63.5s	2.002 s *13*	β–, β–n 59.4%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
33	**As**	*86*		–59.4s	0.945 s *8*	β–, β–n 33%
		87	(3/2–)	–56.3s	0.49 s *4*	β–, β–n 15.4%
		88		–51.6s	>150 ns	
		89			>150 ns	
34	**Se**	65		–32.9s	<50 ms	ε
		66	0+	–41.7s		
		67		–46.5s	107 ms *35*	ε, εp
		68	0+	–54.1s	35.5 s *7*	ε
		69	(3/2–)	–56.30	27.4 s *2*	ε, εp 0.05%
		70	0+	–61.9s	41.1 m *3*	ε
		71	5/2–	–63.1s	4.74 m *5*	ε
		72	0+	–67.89	8.40 d *8*	ε
		73	9/2+	–68.22	7.15 h *8*	ε
		73m	3/2–	–68.19	39.8 m *13*	IT 72.6%, ε 27.4%
		74	0+	–72.213	**0.89%** ***2***	
		75	5/2+	–72.169	119.779 d *4*	ε
		76	0+	–75.251	**9.36%** ***11***	
		77	1/2–	–74.599	**7.63%** ***6***	
		77m	7/2+	–74.437	17.36 s *5*	IT
		78	0+	–77.025	**23.78%** ***9***	
		79	7/2+	–75.917	$\leq 6.5\times10^{5}$ y	β–
		79m	1/2–	–75.821	3.92 m *1*	IT 99.94%, β– 0.06%
		80	0+	–77.759	**49.61%** ***10***	
		81	1/2–	–76.389	18.45 m *12*	β–
		*81*m	7/2+	–76.286	57.28 m *2*	IT 99.95%, β– 0.05%
		82	0+	–77.593	1.1×10^{20} y *+3–1*	2β–
					8.73% ***6***	
		83	9/2+	–75.340	22.3 m *3*	β–
		*83*m	1/2–	–75.112	70.1 s *4*	β–
		84	0+	–75.95	3.1 m *1*	β–
		85	(5/2+)	–72.43	31.7 s *9*	β–
		86	0+	–70.54	15.3 s *9*	β–
		87	(5/2+)	–66.58	5.29 s *11*	β–, β–n 0.36%
		88	0+	–63.87	1.53 s *6*	β–, β–n 0.99%
		89	(5/2+)	–59.6s	0.41 s *4*	β–, β–n 7.8%
		90	0+	–56.4s	>150 ns	
		91		–50.9s	0.27 s *5*	β–, β–n 21%
35	**Br**	68		–38.9s		
		69?		–46.7s	<100 ns	p
		70		–51.6s	79.1 ms *8*	ε
		70m		–51.6s	2.2 s *2*	ε
		71	(5/2)–	–56.6s	21.4 s *6*	ε
		72	3+	–59.2	78.6 s *24*	ε
		72m	1–	–59.1	10.6 s *3*	IT≈100%, ε
		73	1/2–	–63.6	3.4 m *2*	ε
		74	(0–)	–65.31	25.4 m *3*	ε
		74m	4(+)	–65.29	46 m *2*	ε
		75	3/2–	–69.14	96.7 m *13*	ε
		76	1–	–70.288	16.2 h *2*	ε
		76m	(4)+	–70.186	1.31 s *2*	IT>99.4%, ε<0.6%
		77	3/2–	–73.234	57.036 h *6*	ε
		77m	9/2+	–73.128	4.28 m *10*	IT

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
35	**Br**	78	1+	−73.452	6.46 m *4*	ε ≥ 99.99%, β− ≤ 0.01%
		79	3/2−	−76.068	**50.69%** ***7***	
		79m	9/2+	−75.860	4.86 s *4*	IT
		80	1+	−75.889	17.68 m *2*	β− 91.7%, ε 8.3%
		80m	5−	−75.803	4.4205 h *8*	IT
		81	3/2−	−77.974	**49.31%** ***7***	
		82	5−	−77.496	35.30 h *2*	β−
		82m	2−	−77.450	6.13 m *5*	IT 97.6%, β− 2.4%
		83	3/2−	−79.008	2.40 h *2*	β−
		84	2−	−77.78	31.80 m *8*	β−
		*84*m	(5−,6−)	−77.46	6.0 m *2*	β−
		85	3/2−	−78.61	2.90 m *6*	β−
		86	(2−)	−75.64	55.1 s *4*	β−
		87	3/2−	−73.85	55.60 s *15*	β−, β−n 2.52%
		88	(1,2−)	−70.73	16.34 s *8*	β−, β−n 6.58%
		89	(3/2−,5/2−)	−68.56	4.40 s *3*	β−, β−n 13.8%
		90		−64.61	1.92 s *2*	β−, β−n 25.2%
		91		−61.55	0.541 s *5*	β−, β−n 20%
		92	(2−)	−56.62	0.343 s *15*	β−, β−n 33.1%
		93	(5/2−)	−53.0s	102 ms	β−, β−n 77%
		94			70 ms *20*	β−, β−n 30%
36	**Kr**	69				
		70	0+	−41.0s		
		71		−46.1s	97 ms *9*	ε, εp
		72	0+	−54.1	17.2 s *3*	ε
		73	5/2−	−56.9	27.0 s *12*	ε, εp 0.68%
		74	0+	−62.17	11.50 m *11*	ε
		75	(5/2)+	−64.24	4.3 m *2*	ε
		76	0+	−68.98	14.8 h *1*	ε
		77	5/2+	−70.170	74.4 m *6*	ε
		78	0+	−74.158	$\geq 2.0\times10^{21}$ y	
					0.35% ***2***	
		79	1/2−	−74.442	35.04 h *10*	ε
		79m	7/2+	−74.312	50 s *3*	IT
		80	0+	−77.893	**2.25%** ***2***	
		81	7/2+	−77.693	2.29×10^{5} y *11*	ε
		81m	1/2−	−77.502	13.10 s *3*	IT, ε 2.5×10^{-3}%
		82	0+	−80.588	**11.6%** ***1***	
		83	9/2+	−79.981	**11.5%** ***1***	
		83m	1/2−	−79.939	1.83 h *2*	IT
		84	0+	−82.430	**57.0%** ***3***	
		85	9/2+	−81.478	3934.4 d *14*	β−
		*85*m	1/2−	−81.173	4.480 h *8*	β− 78.6%, IT 21.4%
		86	0+	−83.261	**17.3%** ***2***	
		87	5/2+	−80.706	76.3 m *6*	β−
		88	0+	−79.69	2.84 h *3*	β−
		89	(3/2+,5/2+)	−76.72	3.15 m *4*	β−
		90	0+	−74.96	32.32 s *9*	β−
		91	(5/2+)	−71.35	8.57 s *4*	β−
		92	0+	−68.83	1.840 s *8*	β−, β−n 0.03%
		93	(1/2+)	−64.1	1.286 s *10*	β−, β−n 2.01%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
36	**Kr**	*94*	0+	–61.2s	0.20 s *1*	β–, β–n 5.7%
		95		–56.1s	0.78 s *3*	β–
		96	0+	–53.3s	>50 ms	
		97			>150 ns	β–
37	**Rb**	72		–38.1s		
		73		–46.3s		
		74	(0+)	–51.7	64.9 ms *5*	ε
		75	(3/2–,5/2–)	–57.220	19.0 s *12*	ε
		76	1(–)	–60.477	36.5 s *6*	ε
		77	3/2–	–64.826	3.78 m *4*	ε
		78	0(+)	–66.934	17.66 m *8*	ε
		78m	4(–)	–66.831	5.74 m *5*	ε 90%, IT 10%
		79	5/2+	–70.793	22.9 m *5*	ε
		80	1+	–72.170	33.4 s *7*	ε
		81	3/2–	–75.455	4.576 h *5*	ε
		81m	9/2+	–75.369	30.5 m *3*	IT 97.6%, ε 2.4%
		82	1+	–76.187	1.273 m *2*	ε
		82m	5–	–76.118	6.472 h *6*	ε, IT<0.33%
		83	5/2–	–79.071	86.2 d *1*	ε
		84	2–	–79.748	32.77 d *14*	ε 96.2%, β– 3.8%
		84m	6–	–79.284	20.26 m *4*	IT
		85	5/2–	–82.165	**72.165%** ***20***	
		86	2–	–82.745	18.631 d *18*	β– 99.995%, ε 5.2×10^{-3}%
		86m	6–	–82.189	1.017 m *3*	IT
		87	3/2–	–84.593	4.75×10^{10} y *4*	β–
					27.835% ***20***	
		88	2–	–82.602	17.78 m *11*	β–
		89	3/2–	–81.703	15.15 m *12*	β–
		90	0–	–79.351	158 s *5*	β–
		*90*m	3–	–79.244	258 s *4*	β– 97.4%, IT 2.6%
		91	3/2(–)	–77.788	58.4 s *4*	β–
		92	0–	–74.81	4.492 s *20*	β–, β–n 0.01%
		93	5/2–	–72.70	5.84 s *2*	β–, β–n 1.35%
		94	3(–)	–68.53	2.702 s *5*	β–, β–n 10.01%
		95	5/2–	–65.86	377.5 ms *8*	β–, β–n 8.73%
		96	2+	–61.23	202.8 ms *33*	β–, β–n 14%
		97	3/2+	–58.38	169.9 ms *7*	β–, β–n 25.1%
		98	(1,0)	–54.27	114 ms *5*	β–, β–n 13.6%, β–2n 0.05%
		98m	(4,5)	–54.00	96 ms *3*	β–, β–n?
		99	(5/2+)	–50.9	50.3 ms *7*	β–, β–n 20.7%
		100		–46.7s	51 ms *8*	β–, β–n 5.6%
		101		–43.6	32 ms *4*	β–, β–n 31%
		102			37 ms *5*	β–, β–n 18%
38	**Sr**	74	0+			
		75		–46.6s	>150 ns	ε, εp
		76	0+	–54.4s	8.9 s *3*	ε
		77	(5/2+,7/2+)	–58.0	9.0 s *2*	ε, εp<0.25%
		78	0+	–63.172	2.5 m *3*	ε
		79	3/2(–)	–65.475	2.25 m *10*	ε
		80	0+	–70.302	106.3 m *15*	ε

Nuclear Wallet Cards

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
38	**Sr**	81	1/2–	–71.524	22.3 m *4*	ε
		82	0+	–76.007	25.55 d *15*	ε
		83	7/2+	–76.795	32.41 h *3*	ε
		83m	1/2–	–76.536	4.95 s *12*	IT
		84	0+	–80.643	**0.56%** ***1***	
		85	9/2+	–81.100	64.84 d *2*	ε
		85m	1/2–	–80.861	67.63 m *4*	IT 86.6%, ε 13.4%
		86	0+	–84.519	**9.86%** ***1***	
		87	9/2+	–84.876	**7.00%** ***1***	
		87m	1/2–	–84.487	2.827 h *1*	IT 99.7%, ε 0.3%
		88	0+	–87.918	**82.58%** ***1***	
		89	5/2+	–86.205	50.53 d *7*	β–
		90	0+	–85.941	28.78 y *4*	β–
		91	5/2+	–83.649	9.63 h *5*	β–
		92	0+	–82.92	2.71 h *1*	β–
		93	5/2+	–80.16	7.423 m *24*	β–
		94	0+	–78.837	75.3 s *2*	β–
		95	1/2+	–75.16	23.90 s *14*	β–
		96	0+	–72.98	1.07 s *1*	β–
		97	1/2+	–68.80	429 ms *5*	β–, β–n≤0.05%
		98	0+	–66.61	0.653 s *2*	β–, β–n 0.25%
		99	3/2+	–62.2	0.269 s *1*	β–, β–n 0.1%
		100	0+	–60.2	202 ms *3*	β–, β–n 0.98%
		101	(5/2)	–55.4	118 ms *3*	β–, β–n 2.52%
		102	0+	–53.1	69 ms *6*	β–, β–n 5.5%
39	**Y**	77		–46.9s		
		78		–52.6s	>150 ns	
		79	(5/2+)	–58.4	14.8 s *6*	ε, εp
		80	(3,4,5)	–61.2s	35 s *2*	ε
		81	(5/2+)	–66.01	72.4 s *13*	ε
		82	1+	–68.2	9.5 s *3*	ε
		83	(9/2+)	–72.33	7.08 m *6*	ε
		83m	(3/2–)	–72.27	2.85 m *2*	ε 60%, IT 40%
		84	1+	–74.2	4.6 s *2*	ε
		84m	(5–)	–73.7	40 m *1*	ε
		85	(1/2)–	–77.85	2.68 h *5*	ε
		85m	9/2+	–77.83	4.86 h *13*	ε, IT<2.0×10^{-3}%
		86	4–	–79.28	14.74 h *2*	ε
		86m	(8+)	–79.06	48 m *1*	IT 99.31%, ε 0.69%
		87	1/2–	–83.015	79.8 h *3*	ε
		87m	9/2+	–82.634	13.37 h *3*	IT 98.43%, ε 1.57%
		88	4–	–84.295	106.65 d *4*	ε
		89	1/2–	–87.701	**100%**	
		89m	9/2+	–86.793	16.06 s *4*	IT
		90	2–	–86.487	64.10 h *8*	β–
		90m	7+	–85.805	3.244 h *5*	IT, β– 1.8×10^{-3}%
		91	1/2–	–86.349	58.51 d *6*	β–
		*91*m	9/2+	–85.793	49.71 m *4*	IT, β–<1.5%
		92	2–	–84.831	3.54 h *1*	β–
		93	1/2–	–84.24	10.18 h *8*	β–
		*93*m	7/2+	–83.49	0.82 s *4*	IT
		94	2–	–82.348	18.7 m *1*	β–

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
39	**Y**	*95*	1/2–	–81.239	10.3 m *1*	β–
		96	0–	–78.35	5.34 s *5*	β–
		*96*m	(8)+	–78.35	9.6 s *2*	β–
		97	(1/2–)	–76.26	3.75 s *3*	β–, β–n 0.058%
		*97*m	(9/2)+	–75.59	1.17 s *3*	β–>99.3%, IT<0.7%, β–n<0.08%
		*97*m	(27/2–)	–72.74	142 ms *8*	IT>80%, β–<20%
		98	(0)–	–72.44	0.548 s *2*	β–, β–n 0.331%
		*98*m	(4,5)	–72.44	2.0 s *2*	β– 90%, IT<20%, β–n 3.4%
		99	(5/2+)	–70.20	1.470 s *7*	β–, β–n 1.9%
		100	1–,2–	–67.30	735 ms *7*	β–, β–n 1.02%
		100m	(3,4,5)	–67.30	0.94 s *3*	β–
		101	(5/2+)	–64.91	448 ms *19*	β–, β–n 1.94%
		102	low	–61.89	0.30 s *1*	β–
		102	high	–61.89	0.36 s *4*	β–
		103		–58.6s	0.23 s *3*	
		104		–54.9s	>150 ns	
		105			>150 ns	
40	**Zr**	80	0+	–55.3s	>150 ns	
		81		–58.9	15 s *5*	ε, εp
		82	0+	–64.2	32 s *5*	ε
		83	(1/2–)	–66.46	44 s *1*	ε, εp
		84	0+	–71.5s	25.9 m *8*	ε
		85	7/2+	–73.2	7.86 m *4*	ε
		85m	(1/2–)	–72.9	10.9 s *3*	IT≤92%, ε>8%
		86	0+	–77.81	16.5 h *1*	ε
		87	(9/2)+	–79.349	1.68 h *1*	ε
		87m	(1/2)–	–79.013	14.0 s *2*	IT
		88	0+	–83.63	83.4 d *3*	ε
		89	9/2+	–84.869	78.41 h *12*	ε
		89m	1/2–	–84.281	4.18 m *1*	IT 93.77%, ε 6.23%
		90	0+	–88.769	**51.45%** ***3***	
		90m	5–	–86.450	809.2 ms *20*	IT
		91	5/2+	–87.893	**11.22%** ***4***	
		92	0+	–88.456	**17.15%** ***2***	
		93	5/2+	–87.119	1.53×10^{6} y *10*	β–
		94	0+	–87.268	**17.38%** ***4***	
		95	5/2+	–85.659	64.02 d *5*	β–
		96	0+	–85.441	3.9×10^{19} y *9* **2.80%** ***2***	2β–
		97	1/2+	–82.950	16.90 h *5*	β–
		98	0+	–81.27	30.7 s *4*	β–
		99	(1/2+)	–77.77	2.1 s *1*	β–
		100	0+	–76.61	7.1 s *4*	β–
		101	(3/2+)	–73.46	2.1 s *3*	β–
		102	0+	–71.74	2.9 s *2*	β–
		103	(5/2)	–68.4	1.3 s *1*	β–
		104	0+	–66.3s	1.2 s *3*	β–
		105		–62.4s	≈1 s	β–
		106	0+	–60.2s	>150 ns	
		107			>150 ns	

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
41	**Nb**	82		–53.0s	>150 ns	
		83	(5/2+)	–59.0	4.1 s *3*	ε
		84	(3+)	–61.9s	12 s *3*	ε , εp
		85	(9/2+)	–67.2	20.9 s *7*	ε
		86	(5+)	–69.83	88 s *1*	ε
		87	(1/2–)	–74.18	3.7 m *1*	ε
		87m	(9/2+)	–74.18	2.6 m *1*	ε
		88	(8+)	–76.4s	14.5 m *1*	ε
		88m	(4–)	–76.4s	7.8 m *1*	ε
		89	(1/2)–	–80.58	1.18 h *10*	ε
		89m	(9/2+)	–80.58	1.9 h *2*	ε
		90	8+	–82.658	14.60 h *5*	ε
		90m	4–	–82.533	18.81 s *6*	IT
		91	9/2+	–86.639	6.8×10^{2} y *13*	ε
		91m	1/2–	–86.535	60.86 d *22*	IT 93%, ε 7%
		92	(7)+	–86.450	3.47×10^{7} y *24*	ε , β– <0.05%
		92m	(2)+	–86.315	10.15 d *2*	ε
		93	9/2+	–87.210	**100%**	
		93m	1/2–	–87.179	16.13 y *14*	IT
		94	(6)+	–86.366	2.03×10^{4} y *16*	β–
		94m	3+	–86.325	6.263 m *4*	IT 99.5%, β– 0.5%
		95	9/2+	–86.783	34.975 d *7*	β–
		95m	1/2–	–86.547	86.6 h *8*	IT 94.4%, β– 5.6%
		96	6+	–85.605	23.35 h *5*	β–
		97	9/2+	–85.608	72.1 m *7*	β–
		*97*m	1/2–	–84.865	52.7 s *18*	IT
		98	1+	–83.527	2.86 s *6*	β–
		*98*m	(5+)	–83.443	51.3 m *4*	β– 99.9%, IT<0.2%
		99	9/2+	–82.33	15.0 s *2*	β–
		*99*m	1/2–	–81.96	2.6 m *2*	β– >96.2%, IT<3.8%
		100	1+	–79.94	1.5 s *2*	β–
		*100*m	(4+,5+)	–79.46	2.99 s *11*	β–
		101	+	–78.94	7.1 s *3*	β–
		*102*m	1+	–76.35	1.3 s *2*	β–
		*102*m		–76.35	4.3 s *4*	β–
		103	(5/2+)	–75.32	1.5 s *2*	β–
		104	(1+)	–72.2	4.8 s *4*	β– , β–n 0.71%
		*104*m		–72.0	0.92 s *4*	β–
		105	(5/2+)	–70.86	2.95 s *6*	β–
		106		–67.0s	1.02 s *5*	β–
		107		–65.0s	330 ms *50*	β–
		108		–61.0s	0.17 s *2*	
		109			0.6 s *3*	
		110			>150 ns	
42	**Mo**	84	0+	–55.8s	>150 ns	
		85		–59.1s	>150 ns	
		86	0+	–65.0s	19.6 s *11*	ε
		87	(7/2+)	–67.7	14.5 s *3*	ε , εp>0%
		88	0+	–72.70	8.0 m *2*	ε
		89	(9/2+)	–75.00	2.04 m *11*	ε
		89m	(1/2–)	–74.62	190 ms *15*	IT
		90	0+	–80.169	5.67 h *5*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
42	**Mo**	91	9/2+	–82.21	15.49 m *1*	ε
		91m	1/2–	–81.55	65.0 s *7*	IT 50.1%, ε 49.9%
		92	0+	–86.806	**14.84%** ***4***	
		93	5/2+	–86.805	4.0×10^{3} y *8*	ε
		93m	21/2+	–84.380	6.85 h *7*	IT 99.88%, ε 0.12%
		94	0+	–88.411	**9.25%** ***3***	
		95	5/2+	–87.709	**15.92%** ***5***	
		96	0+	–88.792	**16.68%** ***5***	
		97	5/2+	–87.542	**9.55%** ***3***	
		98	0+	–88.113	**24.13%** ***7***	
		99	1/2+	–85.967	65.94 h *1*	β–
		100	0+	–86.185	1.2×10^{19} y *+3–2*	2β–
					9.63% ***3***	
		101	1/2+	–83.512	14.61 m *3*	β–
		102	0+	–83.56	11.3 m *2*	β–
		103	(3/2+)	–80.85	67.5 s *15*	β–
		104	0+	–80.33	60 s *2*	β–
		105	(3/2+)	–77.34	35.6 s *16*	β–
		106	0+	–76.26	8.4 s *5*	β–
		107		–72.9	3.5 s *5*	β–
		108	0+	–71.3s	1.09 s *2*	β–
		109		–67.4s	0.53 s *6*	β–
		110	0+	–65.7s	0.30 s *4*	β–
		111			>150 ns	
		112	0+		>150 ns	
		113			>150 ns	
43	**Tc**	86		–53.1s	>150 ns	
		87		–59.1s	>150 ns	
		88	(6+,7+)	–62.6s	6.4 s *8*	ε
		89	(9/2+)	–67.5	12.8 s *9*	ε
		89m	(1/2–)	–67.5	12.9 s *8*	ε
		90	1+	–71.0s	8.7 s *2*	ε
		90m	4,5,6	–70.5s	49.2 s *4*	ε
		91	(9/2)+	–76.0	3.14 m *2*	ε
		91m	(1/2)–	–75.6	3.3 m *1*	ε , IT<1%
		92	(8)+	–78.94	4.23 m *15*	ε
		93	9/2+	–83.604	2.75 h *5*	ε
		93m	1/2–	–83.212	43.5 m *10*	IT 76.7%, ε 23.3%
		94	7+	–84.155	293 m *1*	ε
		94m	(2)+	–84.080	52.0 m *10*	ε , IT<0.1%
		95	9/2+	–86.018	20.0 h *1*	ε
		95m	1/2–	–85.979	61 d *2*	ε 96.12%, IT 3.88%
		96	7+	–85.819	4.28 d *7*	ε
		96m	4+	–85.785	51.5 m *10*	IT 98%, ε 2%
		97	9/2+	–87.221	2.6×10^{6} y *4*	ε
		97m	1/2–	–87.124	90.1 d *10*	IT, ε<0.34%
		98	(6)+	–86.429	4.2×10^{6} y *3*	β–
		99	9/2+	–87.324	2.111×10^{5} y *12*	β–
		99m	1/2–	–87.181	6.01 h *1*	IT, β– 3.7×10^{-3}%
		100	1+	–86.017	15.8 s *1*	β–
		101	(9/2)+	–86.34	14.22 m *1*	β–
		102	1+	–84.568	5.28 s *15*	β–

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
43	**Tc**	*102*m	(4,5)	–84.568	4.35 m *7*	β– 98%, IT 2%
		103	5/2+	–84.60	54.2 s *8*	β–
		104	(3+)	–82.49	18.3 m *3*	β–
		105	(5/2+)	–82.29	7.6 m *1*	β–
		106	(1,2)	–79.78	35.6 s *6*	β–
		107		–79.1	21.2 s *2*	β–
		108	(2+)	–75.9	5.17 s *7*	β–
		109		–74.87s	0.87 s *4*	β–
		110		–71.4s	0.92 s *3*	β–
		111		–69.8s	0.30 s *3*	β–
		112		–65.9s	0.28 s *4*	β–
		113		–64.0s	130 ms *50*	β–
		114			>150 ns	
		115			>150 ns	
44	**Ru**	87			>1.5 μs	
		88	0+		>150 ns	
		89		–59.5s		
		90	0+	–65.4s	13 s *5*	ε
		91	(9/2+)	–68.6	9 s *1*	ε
		91m	(1/2–)	–68.6	7.6 s *8*	ε > 0%, εp > 0%, IT
		92	0+	–74.4s	3.65 m *5*	ε
		93	(9/2)+	–77.27	59.7 s *6*	ε
		93m	(1/2)–	–76.53	10.8 s *3*	ε 78%, IT 22%, εp 0.01%
		94	0+	–82.56	51.8 m *6*	ε
		95	5/2+	–83.45	1.643 h *14*	ε
		96	0+	–86.067	**5.52%** ***6***	
		97	5/2+	–86.107	2.9 d *1*	ε
		98	0+	–88.225	**1.88%** ***6***	
		99	5/2+	–87.618	**12.7%** ***1***	
		100	0+	–89.219	**12.6%** ***1***	
		101	5/2+	–87.950	**17.0%** ***1***	
		102	0+	–89.099	**31.6%** ***2***	
		103	3/2+	–87.260	39.26 d *2*	β–
		104	0+	–88.092	**18.7%** ***2***	
		105	3/2+	–85.931	4.44 h *2*	β–
		106	0+	–86.324	373.59 d *15*	β–
		107	(5/2)+	–83.9	3.75 m *5*	β–
		108	0+	–83.7	4.55 m *5*	β–
		109	(5/2+)	–80.85	34.5 s *10*	β–
		110	0+	–80.1	14.6 s *10*	β–
		111		–76.8s	2.12 s *7*	β–
		112	0+	–75.9s	1.75 s *7*	β–
		113		–72.2s	0.80 s *5*	β–
		114	0+	–70.8s	0.57 s *5*	β–
		115		–66.8s	0.40 s *10*	β–, β–n
		116	0+	–65.2s	>150 ns	
		117			>150 ns	
		118	0+		>150 ns	
45	**Rh**	89			>1.5 μs	
		90			>150 ns	
		91			>150 ns	

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
45	**Rh**	92		–63.4s	>150 ns	
		93		–69.2s		
		94m	(8+)	–72.9s	25.8 s *2*	ε
		94m	(3+)	–72.9s	70.6 s *6*	ε
		95	(9/2)+	–78.3	5.02 m *10*	ε
		95m	(1/2)–	–77.8	1.96 m *4*	IT 88%, ε 12%
		96	(6+)	–79.62	9.90 m *10*	ε
		96m	(3+)	–79.57	1.51 m *2*	IT 60%, ε 40%
		97	9/2+	–82.58	30.7 m *6*	ε
		97m	1/2–	–82.32	46.2 m *16*	ε 94.4%, IT 5.6%
		98	(2)+	–83.17	8.7 m *2*	ε
		98m	(5+)	–83.17	3.5 m *3*	ε>0%, IT
		99	1/2–	–85.51	16.1 d *2*	ε
		99m	9/2+	–85.45	4.7 h *1*	ε>99.84%, IT<0.16%
		100	1–	–85.59	20.8 h *1*	ε
		100m	(5+)	–85.59	4.6 m *2*	IT≈98.3%, ε≈1.7%
		101	1/2–	–87.41	3.3 y *3*	ε
		101m	9/2+	–87.25	4.34 d *1*	ε 93.6%, IT 6.4%
		102	(1–,2–)	–86.776	207 d *3*	ε 80%, β– 20%
		102m	6(+)	–86.635	≈2.9 y	ε 99.73%, IT 0.23%
		103	1/2–	–88.023	**100%**	
		103m	7/2+	–87.983	56.114 m *9*	IT
		104	1+	–86.951	42.3 s *4*	β– 99.55%, ε 0.45%
		104m	5+	–86.822	4.34 m *3*	IT 99.87%, β– 0.13%
		105	7/2+	–87.848	35.36 h *6*	β–
		105m	1/2–	–87.718	≈40 s	IT
		106	1+	–86.363	29.80 s *8*	β–
		106m	(6)+	–86.226	131 m *2*	β–
		107	7/2+	–86.86	21.7 m *4*	β–
		108m	1+	–85.0	16.8 s *5*	β–
		108m	(5+)	–85.0	6.0 m *3*	β–
		109	7/2+	–85.01	80 s *2*	β–
		110m	1+	–82.9	3.2 s *2*	β–
		110m	(≥4)	–82.9	28.5 s *15*	β–
		111	(7/2+)	–82.3s	11 s *1*	β–
		112m	1+	–79.5s	3.8 s *6*	β–
		112m	≥4	–79.5s	6.8 s *2*	β–
		113		–78.8s	2.80 s *12*	β–
		114	(1+)	–75.6s	1.85 s *5*	β–
		114m	(≥4)	–75.6s	1.85 s *5*	β–
		115	(7/2+)	–74.4	0.99 s *5*	β–
		116m	1+	–71.1s	0.68 s *6*	β–
		116m	(5,6,7)	–71.1s	0.9 s *4*	β–
		117	(7/2+)	–69.5s	0.44 s *4*	β–
		118		–65.7s	>150 ns	
		119		–63.9s	>150 ns	
		120			>150 ns	
		121			>150 ns	
46	**Pd**	91			>1.5 μs	
		92	0+		>150 ns	
		93			60 s *20*	εp?

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
46	**Pd**	94	0+	–66.3s	9.0 s *5*	ε
		95		–70.2s		
		95m	(21/2+)	–68.2s	13.3 s *3*	ε≥91.3%, IT≤9.7%, εp 0.9%
		96	0+	–76.2	122 s *2*	ε
		97	(5/2+)	–77.8	3.10 m *9*	ε
		98	0+	–81.29	17.7 m *3*	ε
		99	(5/2)+	–82.15	21.4 m *2*	ε
		100	0+	–85.23	3.63 d *9*	ε
		101	(5/2+)	–85.43	8.47 h *6*	ε
		102	0+	–87.926	**1.02%** ***1***	
		103	5/2+	–87.480	16.991 d *19*	ε
		104	0+	–89.392	**11.14%** ***8***	
		105	5/2+	–88.414	**22.33%** ***8***	
		106	0+	–89.905	**27.33%** ***3***	
		107	5/2+	–88.372	6.5×10^{6} y *3*	β–
		107m	11/2–	–88.157	21.3 s *5*	IT
		108	0+	–89.521	**26.46%** ***9***	
		109	5/2+	–87.603	13.7012 h *24*	β–
		109m	11/2–	–87.414	4.696 m *3*	IT
		110	0+	–88.35	**11.72%** ***9***	
		111	5/2+	–86.03	23.4 m *2*	β–
		111m	11/2–	–85.86	5.5 h *1*	IT 73%, β– 27%
		112	0+	–86.34	21.03 h *5*	β–
		113	(5/2)+	–83.69	93 s *5*	β–
		113m	(9/2–)	–83.69	0.4 s *1*	IT
		113?		–83.69	≥100 s	
		114	0+	–83.49	2.42 m *6*	β–
		115	(5/2+)	–80.40	25 s *2*	β–
		115m	(11/2–)	–80.31	50 s *3*	β– 92%, IT 8%
		116	0+	–79.95	11.8 s *4*	β–
		117	(5/2+)	–76.5s	4.3 s *3*	β–
		118	0+	–75.5	1.9 s *1*	β–
		119		–72.0s	0.92 s *13*	β–
		120	0+	–70.8s	0.5 s *1*	β–
		121		–66.9s	>150 ns	
		122	0+		>150 ns	
		123			>150 ns	
47	**Ag**	94			10 ms	
		94m	(9+)		0.42 s *5*	ε, εp
		95			2.0 s *1*	ε, εp
		96	(8+,9+)	–64.6s	5.1 s *4*	ε, εp 8%
		97	(9/2+)	–70.8s	19 s *2*	ε
		98	(5+)	–72.9	46.7 s *9*	ε
		99	(9/2)+	–76.7	124 s *3*	ε
		99m	(1/2–)	–76.2	10.5 s *5*	IT
		100	(5)+	–78.15	2.01 m *9*	ε
		100m	(2)+	–78.14	2.24 m *13*	ε, IT
		101	9/2+	–81.2	11.1 m *3*	ε
		101m	1/2–	–81.0	3.10 s *10*	IT
		102	5+	–82.00	12.9 m *3*	ε
		102m	2+	–81.99	7.7 m *5*	ε 51%, IT 49%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
47	**Ag**	103	7/2+	–84.79	65.7 m *7*	ε
		103m	1/2–	–84.66	5.7 s *3*	IT
		104	5+	–85.113	69.2 m *10*	ε
		104m	2+	–85.106	33.5 m *20*	ε 99.93%, IT<0.07%
		105	1/2–	–87.07	41.29 d *7*	ε
		105m	7/2+	–87.04	7.23 m *16*	IT 99.66%, ε 0.34%
		106	1+	–86.939	23.96 m *4*	ε 99.5%, β–<1%
		106m	6+	–86.849	8.28 d *2*	ε
		107	1/2–	–88.405	**51.839% *7***	
		107m	7/2+	–88.312	44.3 s *2*	IT
		108	1+	–87.603	2.37 m *1*	β– 97.15%, ε 2.85%
		108m	6+	–87.494	418 y *21*	ε 91.3%, IT 8.7%
		109	1/2–	–88.719	**48.161% *7***	
		109m	7/2+	–88.631	39.6 s *2*	IT
		110	1+	–87.457	24.6 s *2*	β– 99.7%, ε 0.3%
		110m	6+	–87.339	249.79 d *20*	β– 98.64%, IT 1.36%
		111	1/2–	–88.217	7.45 d *1*	β–
		111m	7/2+	–88.157	64.8 s *8*	IT 99.3%, β– 0.7%
		112	2(–)	–86.62	3.130 h *9*	β–
		113	1/2–	–87.03	5.37 h *5*	β–
		113m	7/2+	–86.99	68.7 s *16*	IT 64%, β– 36%
		114	1+	–84.94	4.6 s *1*	β–
		114m	(≤6+)	–84.75	1.5 ms *5*	IT
		115	1/2–	–84.99	20.0 m *5*	β–
		*115*m	7/2+	–84.95	18.0 s *7*	β– 79%, IT 21%
		116	(2)–	–82.56	2.68 m *10*	β–
		*116*m	(5+)	–82.48	8.6 s *3*	β– 94%, IT 6%
		117	(1/2–)	–82.24	72.8 s *+20–7*	β–≈100%
		*117*m	(7/2+)	–82.21	5.34 s *5*	β– 94%, IT 6%
		118	1(–)	–79.6	3.76 s *15*	β–
		*118*m	4(+)	–79.5	2.0 s *2*	β– 59%, IT 41%
		119m	(7/2+)	–78.56	2.1 s *1*	β–
		119m	(1/2–)	–78.56	6.0 s *5*	β–
		120	3+	–75.8	1.23 s *3*	β–, β–n≤0.003%
		*120*m	6–	–75.6	0.32 s *4*	β–≈63%, IT≈37%
		121	(7/2+)	–74.5	0.78 s *1*	β–, β–n 0.08%
		122	(3+)	–71.4s	0.48 s *8*	β–, β–n 0.186%
		123	(7/2+)	–70.0s	0.309 s *15*	β–, β–n 0.55%
		124	(1,2,3)+	–66.6s	0.54 s *8*	β–, β–n≥0.1%
		125			156 ms *7*	
		126			97 ms *8*	
		127			109 ms *15*	
48	**Cd**	97m			3 s *+4–2*	ε, εp
		98	0+	–67.5s	9.2 s *3*	ε
		99	(5/2+)	–69.9s	16 s *3*	ε, εp 0.17%, εα<1.0×10^{-4}%
		100	0+	–74.3	49.1 s *5*	ε
		101	(5/2+)	–75.7	1.2 m *2*	ε
		102	0+	–79.42	5.5 m *5*	ε
		103	(5/2)+	–80.65	7.3 m *1*	ε
		104	0+	–83.976	57.7 m *10*	ε
		105	5/2+	–84.33	55.5 m *4*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
48	**Cd**	106	0+	–87.134	**1.25%** ***4***	
		107	5/2+	–86.988	6.50 h *2*	ε
		108	0+	–89.253	**0.89%** ***2***	
		109	5/2+	–88.506	462.6 d *4*	ε
		110	0+	–90.349	**12.49%** ***12***	
		111	1/2+	–89.254	**12.80%** ***8***	
		111m	11/2–	–88.858	48.54 m *5*	IT
		112	0+	–90.581	**24.13%** ***14***	
		113	1/2+	–89.049	9.3×10^{15} y *19*	β–
					12.22% ***8***	
		113m	11/2–	–88.785	14.1 y *5*	β– 99.86%, IT 0.14%
		114	0+	–90.021	**28.73%** ***28***	
		115	1/2+	–88.090	53.46 h *10*	β–
		115m	11/2–	–87.910	44.6 d *3*	β–
		116	0+	–88.719	**7.49%** ***12***	
		117	1/2+	–86.425	2.49 h *4*	β–
		*117*m	(11/2)–	–86.289	3.36 h *5*	β–
		118	0+	–86.71	50.3 m *2*	β–
		119	3/2+	–83.90	2.69 m *2*	β–
		*119*m	(11/2–)	–83.76	2.20 m *2*	β–
		120	0+	–83.97	50.80 s *21*	β–
		121	(3/2+)	–80.9	13.5 s *3*	β–
		*121*m	(11/2–)	–80.7	8.3 s *8*	β–
		122	0+	–80.6s	5.24 s *3*	β–
		123	(3/2)+	–77.31	2.10 s *2*	β–
		123m	(11/2–)	–77.00	1.82 s *3*	β–, IT
		124	0+	–76.71	1.24 s *5*	β–
		125	(3/2+)	–73.32	0.65 s *2*	β–
		125m	(11/2–)	–73.27	0.57 s *9*	β–
		126	0+	–72.33	0.506 s *15*	β–
		127	(3/2+)	–68.53	0.43 s *3*	β–
		128	0+	–67.3	0.34 s *3*	β–
		129			0.27 s *4*	β–
		130	0+		0.20 s *4*	β–, β–n ≈ 4%
49	**In**	98			>1.5 μs	
		99		–60.9s		
		100		–63.7s	6.1 s *9*	ε, εp
		101		–68.4s	16 s *3*	ε ≈ 100%, εp
		102	(5)	–70.5	24 s *4*	ε
		103	(9/2)+	–74.60	65 s *7*	ε
		104	(6+)	–76.1	1.8 m *2*	ε
		104m	(3+)	–76.0	15.7 s *5*	IT 80%, ε 20%
		105	(9/2+)	–79.48	5.07 m *7*	ε
		105m	(1/2–)	–78.81	48 s *6*	IT
		106	7+	–80.61	6.2 m *1*	ε
		106m	(3+)	–80.58	5.2 m *1*	ε
		107	9/2+	–83.56	32.4 m *3*	ε
		107m	1/2–	–82.88	50.4 s *6*	IT
		108	7+	–84.11	58.0 m *12*	ε
		108m	2+	–84.08	39.6 m *7*	ε
		109	9/2+	–86.485	4.2 h *1*	ε
		109m	1/2–	–85.835	1.34 m *7*	IT

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
49	**In**	109m	(19/2+)	–84.383	0.21 s *1*	IT
		110	7+	–86.47	4.9 h *1*	ε
		110m	2+	–86.41	69.1 m *5*	ε
		111	9/2+	–88.388	2.8047 d *5*	ε
		111m	1/2–	–87.851	7.7 m *2*	IT
		112	1+	–87.994	14.97 m *10*	ε 56%, β– 44%
		112m	4+	–87.837	20.56 m *6*	IT
		113	9/2+	–89.365	**4.29% *2***	
		113m	1/2–	–88.973	1.6582 h *6*	IT
		114	1+	–88.568	71.9 s *1*	β– 99.5%, ε 0.5%
		114m	5+	–88.378	49.51 d *1*	IT 95.6%, ε 4.4%
		115	9/2+	–89.536	4.41×10^{14} y *25*	β–
					95.71% *2*	
		115m	1/2–	–89.200	4.486 h *4*	IT 95%, β– 5%
		116	1+	–88.249	14.10 s *3*	β– 99.97%, ε < 0.06%
		116m	5+	–88.122	54.29 m *17*	β–
		116m	8–	–87.959	2.18 s *4*	IT
		117	9/2+	–88.941	43.2 m *3*	β–
		117m	1/2–	–88.626	116.2 m *3*	β– 52.9%, IT 47.1%
		118	1+	–87.228	5.0 s *5*	β–
		118m	5+	–87.168	4.45 m *5*	β–
		118m	8–	–87.028	8.5 s *3*	IT 98.6%, β– 1.4%
		119	9/2+	–87.702	2.4 m *1*	β–
		119m	1/2–	–87.391	18.0 m *3*	β– 94.4%, IT 5.6%
		120	1+	–85.73	3.08 s *8*	β–
		120	(3,4,5)+	–85.73	46.2 s *8*	β–
		120	(8–)	–85.73	47.3 s *5*	β–
		121	9/2+	–85.84	23.1 s *6*	β–
		*121*m	1/2–	–85.52	3.88 m *10*	β– 98.8%, IT 1.2%
		122	1+	–83.58	1.5 s *3*	β–
		*122*m	5+	–83.58	10.3 s *6*	β–
		*122*m	8–	–83.38	10.8 s *4*	β–
		123	9/2+	–83.43	5.98 s *6*	β–
		*123*m	1/2–	–83.10	47.8 s *5*	β–
		124	3+	–80.88	3.17 s *5*	β–
		*124*m	(8–)	–80.69	3.4 s *5*	β–
		125	9/2(+)	–80.48	2.36 s *4*	β–
		*125*m	1/2(–)	–80.12	12.2 s *2*	β–
		126	3(+)	–77.81	1.60 s *10*	β–
		*126*m	7,8,9	–77.71	1.64 s *5*	β–
		127	(9/2+)	–76.99	1.09 s *1*	β–, β–n ≤ 0.03%
		*127*m	(1/2–)	–76.53	3.66 s *4*	β–, β–n 0.69%
		128	(3)+	–74.36	0.84 s *6*	β–
		128	(3+)	–74.36	0.84 s *6*	β–n ≤ 0.038%
		*128*m	(8)–	–74.04	0.72 s *1*	β–, β–n ≤ 0.038%
		129	(9/2+)	–73.0	0.61 s *1*	β–, β–n 0.23%
		*129*m	(1/2–)	–72.6	1.23 s *3*	β– ≈ 100%, β–n 3.6%
		130	1(–)	–69.99	0.26 s *1*	β–, β–n 1.01%
		*130*m	(10–)	–69.94	0.55 s *1*	β–, β–n ≤ 1.65%
		*130*m	(5+)	–69.59	0.542 s *9*	β–, β–n ≤ 1.65%
		131	(9/2+)	–68.20	0.28 s *3*	β–, β–n ≤ 2%
		*131*m	(1/2–)	–67.84	0.35 s *5*	β– ≥ 99.98%, β–n ≤ 2%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
49	**In**	*131*m	(1/2–)	–67.84	0.35 s *5*	IT≤0.02%
		*131*m	(21/2+)	–63.93	0.32 s *6*	β–>99%, IT<1%, β–n 0.03%
		132	(7–)	–63.0	0.201 s *13*	β–, β–n 6.2%
		133			180 ms *20*	β–, β–n
50	**Sn**	100	0+	–56.5s	1.0 s *+8–3*	ε
		101		–59.6s	3 s *1*	ε, εp
		102	0+	–64.7s	>200 ns	
		103		–66.9s	7 s *3*	ε
		104	0+	–71.6	20.8 s *5*	ε
		105		–73.23	31 s *6*	ε, εp
		106	0+	–77.43	115 s *5*	ε
		107	(5/2+)	–78.56	2.90 m *5*	ε
		108	0+	–82.01	10.30 m *8*	ε
		109	5/2(+)	–82.635	18.0 m *2*	ε
		110	0+	–85.83	4.11 h *10*	ε
		111	7/2+	–85.943	35.3 m *6*	ε
		112	0+	–88.658	**0.97%** ***1***	
		113	1/2+	–88.329	115.09 d *4*	ε
		113m	7/2+	–88.252	21.4 m *4*	IT 91.1%, ε 8.9%
		114	0+	–90.557	**0.65%** ***1***	
		115	1/2+	–90.031	**0.34%** ***1***	
		116	0+	–91.523	**14.54%** ***11***	
		117	1/2+	–90.397	**7.68%** ***7***	
		117m	11/2–	–90.082	13.60 d *4*	IT
		118	0+	–91.652	**24.22%** ***11***	
		119	1/2+	–90.066	**8.58%** ***4***	
		119m	11/2–	–89.976	293.1 d *7*	IT
		120	0+	–91.102	**32.59%** ***10***	
		121	3/2+	–89.201	27.06 h *4*	β–
		121m	11/2–	–89.195	55 y *5*	IT 77.6%, β– 22.4%
		122	0+	–89.944	**4.63%** ***3***	
		123	11/2–	–87.819	129.2 d *4*	β–
		*123*m	3/2+	–87.794	40.06 m *1*	β–
		124	0+	–88.236	**5.79%** ***5***	
		125	11/2–	–85.898	9.64 d *3*	β–
		*125*m	3/2+	–85.870	9.52 m *5*	β–
		126	0+	–86.02	$\approx 1\times10^{5}$ y	β–
		127	(11/2–)	–83.51	2.10 h *4*	β–
		*127*m	(3/2+)	–83.50	4.13 m *3*	β–
		128	0+	–83.34	59.07 m *14*	β–
		*128*m	(7–)	–81.24	6.5 s *5*	IT
		129	(3/2+)	–80.6	2.23 m *4*	β–
		*129*m	(11/2–)	–80.6	6.9 m *1*	β–≈100%, IT 0.0002%
		130	0+	–80.24	3.72 m *4*	β–
		*130*m	(7–)	–78.30	1.7 m *1*	β–
		131	(3/2+)	–77.38	56.0 s *5*	β–
		*131*m	(11/2–)	–77.14	58.4 s *5*	β–, IT≤4.0×10^{-4}%
		132	0+	–76.62	39.7 s *5*	β–
		133	(7/2–)	–71.1	1.20 s *5*	β–, β–n 0.0294%
		134	0+	–67.2s	1.12 s *8*	β–, β–n 17%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
50	**Sn**	*135*			>150 ns	
		136	0+		>150 ns	
		137			>150 ns	
51	**Sb**	103			>1.5 μs	
		104		–59.0s	0.52 s *+18–13*	ε
		105		–63.9s	1.3 s *2*	ε
		106		–66.4s		
		107		–70.7s		
		108	4+	–72.5s	7.0 s *5*	ε
		109	(5/2+)	–76.25	17.0 s *7*	ε
		110	3+	–77.5s	23.0 s *4*	ε
		111	(5/2+)	–80.8s	75 s *1*	ε
		112	3+	–81.60	51.4 s *10*	ε
		113	5/2+	–84.42	6.67 m *7*	ε
		114	3+	–84.7	3.49 m *3*	ε
		115	5/2+	–87.00	32.1 m *3*	ε
		116	3+	–86.816	15.8 m *8*	ε
		116m	8–	–86.433	60.3 m *6*	ε
		117	5/2+	–88.640	2.80 h *1*	ε
		118	1+	–87.995	3.6 m *1*	ε
		118m	8–	–87.745	5.00 h *2*	ε
		119	5/2+	–89.472	38.19 h *22*	ε
		120	1+	–88.421	15.89 m *4*	ε
		120m	8–	–88.421	5.76 d *2*	ε
		121	5/2+	–89.589	**57.21%** ***5***	
		122	2–	–88.324	2.7238 d *2*	β– 97.59%, ε 2.41%
		122m	(8)–	–88.160	4.191 m *3*	IT
		123	7/2+	–89.222	**42.79%** ***5***	
		124	3–	–87.618	60.20 d *3*	β–
		124m	5+	–87.607	93 s *5*	IT 75%, β– 25%
		124m	8–	–87.581	20.2 m *2*	IT
		125	7/2+	–88.262	2.7582 y *11*	β–
		126	(8)–	–86.40	12.46 d *3*	β–
		*126*m	(5)+	–86.38	19.15 m *8*	β– 86%, IT 14%
		*126*m	(3)–	–86.36	≈11 s	
		127	7/2+	–86.709	3.85 d *5*	β–
		128	8–	–84.61	9.01 h *3*	β–
		*128*m	5+	–84.61	10.4 m *2*	β– 96.4%, IT 3.6%
		129	7/2+	–84.63	4.40 h *1*	β–
		129m	(19/2–)	–82.77	17.7 m *1*	β– 85%, IT 15%
		130	(8–)	–82.39	39.5 m *8*	β–
		*130*m	(5)+	–82.39	6.3 m *2*	β–
		131	(7/2+)	–82.02	23.03 m *4*	β–
		132	(4+)	–79.92	2.79 m *5*	β–
		*132*m	(8–)	–79.92	4.10 m *5*	β–
		133	(7/2+)	–78.96	2.5 m *1*	β–
		*134*m	(0–)	–74.0	0.78 s *6*	β–
		*134*m	(7–)	–74.0	10.22 s *9*	β–, β–n 0.091%
		135	(7/2+)	–69.7	1.662 s *10*	β–, β–n 17.6%
		136		–65.1s	0.82 s *2*	β–, β–n 24%
		137			>150 ns	
		138			>150 ns	

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
51	**Sb**	139			>150 ns	
52	**Te**	106	0+	−58.0s	60 μs *+30−10*	α
		107		−60.5s	3.1 ms *1*	α 70%, ε 30%
		108	0+	−65.7	2.1 s *1*	ε 51%, α 49%
		109		−67.58	4.6 s *3*	ε 96%, α 4%
		110	0+	−72.28	18.6 s *8*	ε ≈ 100%, α ≈ 3.0×10^{-3}%
		111		−73.47	19.3 s *4*	ε, εp
		112	0+	−77.3	2.0 m *2*	ε
		113	(7/2+)	−78.3s	1.7 m *2*	ε
		114	0+	−81.9s	15.2 m *7*	ε
		115	7/2+	−82.4	5.8 m *2*	ε
		115m	(1/2)+	−82.3	6.7 m *4*	ε ≤ 100%, IT
		116	0+	−85.32	2.49 h *4*	ε
		117	1/2+	−85.11	62 m *2*	ε
		117m	(11/2−)	−84.81	103 ms *3*	IT
		118	0+	−87.72	6.00 d *2*	ε
		119	1/2+	−87.179	16.03 h *5*	ε
		119m	11/2−	−86.918	4.70 d *4*	ε, IT 8.0×10^{-3}%
		120	0+	−89.40	**0.096%** ***2***	
		121	1/2+	−88.55	16.78 d *35*	ε
		121m	11/2−	−88.26	154 d *7*	IT 88.6%, ε 11.4%
		122	0+	−90.303	**2.603%** ***4***	
		123	1/2+	−89.171	>1×10^{13} y	ε
					0.908% ***2***	
		123m	11/2−	−88.923	119.7 d *1*	IT
		124	0+	−90.524	**4.816%** ***6***	
		125	1/2+	−89.028	**7.139%** ***6***	
		125m	11/2−	−88.883	57.40 d *15*	IT
		126	0+	−90.071	**18.952%** ***11***	
		127	3/2+	−88.290	9.35 h *7*	β−
		127m	11/2−	−88.202	109 d *2*	IT 97.6%, β− 2.4%
		128	0+	−88.993	7.7×10^{24} y *4*	2β−
					31.687% ***11***	
		129	3/2+	−87.005	69.6 m *3*	β−
		129m	11/2−	−86.899	33.6 d *1*	IT 64%, β− 36%
		130	0+	−87.353	2.7×10^{21} y *1*	2β−
					33.799% ***10***	
		131	3/2+	−85.211	25.0 m *1*	β−
		*131*m	11/2−	−85.029	30 h *2*	β− 77.8%, IT 22.2%
		132	0+	−85.21	3.204 d *13*	β−
		133	(3/2+)	−82.96	12.5 m *3*	β−
		*133*m	(11/2−)	−82.63	55.4 m *4*	β− 82.5%, IT 17.5%
		134	0+	−82.4	41.8 m *8*	β−
		135	(7/2−)	−77.83	19.0 s *2*	β−
		136	0+	−74.42	17.5 s *2*	β−, β−n 1.3%
		137	(7/2−)	−69.6	2.49 s *5*	β−, β−n 2.69%
		138	0+	−65.9s	1.4 s *4*	β−, β−n 6.3%
		139			>150 ns	
		140	0+		>150 ns	
		141			>150 ns	
		142	0+		>150 ns	

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
53	**I**	108		–52.6s	36 ms *6*	α 91%
		109		–57.6	100 μs *5*	p
		110		–60.3s	0.65 s *2*	ε 83%, α 17%, εp 11%, εα 1.1%
		111	(5/2+)	–65.0s	2.5 s *2*	ε 99.9%, α≈0.1%
		112		–67.1s	3.42 s *11*	ε, α≈0.0012%, εα, εp
		113	5/2+	–71.12	6.6 s *2*	ε, α 3.3×10^{-7}%
		114	(1+)	–72.8s	2.1 s *2*	ε, εp
		114m	(7)	–72.5s	6.2 s	IT
		115	(5/2+)	–76.4s	1.3 m *2*	ε
		116	1+	–77.6	2.91 s *15*	ε
		117	(5/2)+	–80.45	2.22 m *4*	ε
		118	2–	–80.67	13.7 m *5*	ε
		118m	(7–)	–80.57	8.5 m *5*	ε<100%, IT>0%
		119	5/2+	–83.67	19.1 m *4*	ε
		120	2–	–83.78	81.0 m *6*	ε
		120m	>3	–83.78	53 m *4*	ε
		121	5/2+	–86.28	2.12 h *1*	ε
		122	1+	–86.069	3.63 m *6*	ε
		123	5/2+	–87.929	13.27 h *8*	ε
		124	2–	–87.364	4.1760 d *3*	ε
		125	5/2+	–88.842	59.408 d *8*	ε
		126	2–	–87.916	13.11 d *5*	ε 56.3%, β– 43.7%
		127	5/2+	–88.988	**100%**	
		128	1+	–87.743	24.99 m *2*	β– 93.1%, ε 6.9%
		129	7/2+	–88.503	1.57×10^{7} y *4*	β–
		130	5+	–86.932	12.36 h *3*	β–
		130m	2+	–86.892	9.0 m *1*	IT 84%, β– 16%
		131	7/2+	–87.444	8.02070 d *11*	β–
		132	4+	–85.70	2.295 h *13*	β–
		*132*m	(8–)	–85.58	1.387 h *15*	IT 86%, β– 14%
		133	7/2+	–85.88	20.8 h *1*	β–
		*133*m	(19/2–)	–84.24	9 s *2*	IT
		134	(4)+	–83.95	52.5 m *2*	β–
		*134*m	(8)–	–83.64	3.60 m *10*	IT 97.7%, β– 2.3%
		135	7/2+	–83.79	6.57 h *2*	β–
		136	(1–)	–79.50	83.4 s *10*	β–
		*136*m	(6–)	–78.86	46.9 s *10*	β–
		137	(7/2+)	–76.50	24.5 s *2*	β–, β–n 6.97%
		138	(2–)	–72.30	6.49 s *7*	β–, β–n 5.5%
		139	(7/2+)	–68.84	2.280 s *11*	β–, β–n 10%
		140	(3)	–64.2s	0.86 s *4*	β–, β–n 9.3%
		141		–60.5s	0.43 s *2*	β–, β–n 22%
		142			≈0.2 s	β–
		143			>150 ns	
		144			>150 ns	
54	**Xe**	110	0+	–51.7s		α
		111		–54.4s	0.74 s *20*	α
		112	0+	–59.9	2.7 s *8*	ε 99.16%, α 0.84%
		113		–62.06	2.74 s *8*	ε 99.97%, εp 4.2%, α 0.04%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
54	**Xe**	114	0+	–66.9s	10.0 s *4*	ε
		115	(5/2+)	–68.4s	18 s *4*	ε , εp
		116	0+	–72.9s	59 s *2*	ε
		117	5/2(+)	–74.0	61 s *2*	ε , εp 2.9×10^{-3}%
		118	0+	–78.	3.8 m *9*	ε
		119	(5/2+)	–78.7	5.8 m *3*	ε
		120	0+	–81.82	40 m *1*	ε
		121	5/2(+)	–82.55	40.1 m *20*	ε
		122	0+	–85.17	20.1 h *1*	ε
		123	(1/2)+	–85.25	2.08 h *2*	ε
		124	0+	–87.658	**0.10%** ***1***	
		125	(1/2)+	–87.190	16.9 h *2*	ε
		125m	(9/2)–	–86.937	57 s *1*	IT
		126	0+	–89.174	**0.09%** ***1***	
		127	1/2+	–88.325	36.3446 d *28*	ε
		127m	9/2–	–88.028	69.2 s *9*	IT
		128	0+	–89.861	**1.91%** ***3***	
		129	1/2+	–88.697	**26.4%** ***6***	
		129m	11/2–	–88.461	8.88 d *2*	IT
		130	0+	–89.881	**4.1%** ***1***	
		131	3/2+	–88.415	**21.2%** ***4***	
		131m	11/2–	–88.251	11.934 d *21*	IT
		132	0+	–89.279	**26.9%** ***5***	
		133	3/2+	–87.648	5.2475 d *5*	β–
		*133*m	11/2–	–87.415	2.19 d *1*	IT
		134	0+	–88.124	**10.4%** ***2***	
		*134*m	7–	–86.159	290 ms *17*	IT
		135	3/2+	–86.44	9.14 h *2*	β–
		*135*m	11/2–	–85.91	15.29 m *5*	IT, β– 0.004%
		136	0+	–86.424	>9.3×10^{19} y **8.9%** ***1***	2β–?
		137	7/2–	–82.378	3.818 m *13*	β–
		138	0+	–80.12	14.08 m *8*	β–
		139	3/2–	–75.65	39.68 s *14*	β–
		140	0+	–73.00	13.60 s *10*	β–
		141	5/2+	–68.32	1.73 s *1*	β– , β–n 0.043%
		142	0+	–65.5	1.24 s *2*	β– , β–n 0.41%
		143	5/2–	–60.4s	0.30 s *3*	β–
		144	0+	–57.3s	1.15 s *20*	β–
		145			0.9 s *3*	β– , β–n
		146	0+		>150 ns	
		147			>150 ns	
55	**Cs**	112		–46.3s	0.5 ms *1*	p?
		113		–51.7	33 μs *7*	p≈100%
		114	(1+)	–54.6s	0.57 s *2*	ε≈100%, εp 7%, εα 0.16%, α 0.02%
		115		–59.7s	1.4 s *8*	ε , εp≈0.07%
		116m	(1+)	–62.4	0.70 s *4*	ε , εα>0%, εp>0%
		116m	≥5+	–62.4	3.85 s *13*	ε , εα>0%, εp>0%
		117m		–66.48	6.5 s *4*	ε
		117m		–66.48	8.4 s *6*	ε
		118	2	–68.43	14 s *2*	ε , εp<0.04%, εα<2.4×10^{-3}%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
55	**Cs**	118m	6,7,8	−68.43	17 s *3*	ε, εp<0.04%, εα<2.4×10^{-3}%
		119	9/2+	−72.34	43.0 s *2*	ε
		119m	3/2(+)	−72.34	30.4 s *1*	ε
		120	high	−73.90	57 s *6*	ε, εp≤1.0×10^{-5}%
		120	2	−73.90	64 s *3*	ε
		121	3/2(+)	−77.15	128 s *4*	ε
		121m	9/2(+)	−77.08	122 s *3*	ε 83%, IT 17%
		122	1+	−78.12	21.2 s *2*	ε
		122m	8−	−78.04	3.70 m *11*	ε
		122m	(5)−	−77.99	0.36 s *2*	IT
		123	1/2+	−81.05	5.87 m *5*	ε
		123m	(11/2)−	−80.90	1.64 s *12*	IT
		124	1+	−81.74	30.9 s *5*	ε
		124m	(7)+	−81.28	6.3 s *2*	IT
		125	(1/2+)	−84.098	45 m *1*	ε
		126	1+	−84.35	1.63 m *3*	ε
		127	1/2(+)	−86.245	6.25 h *10*	ε
		128	1+	−85.931	3.66 m *2*	ε
		129	1/2+	−87.502	32.06 h *6*	ε
		130	1+	−86.898	29.21 m *4*	ε 98.4%, β− 1.6%
		130m	5−	−86.735	3.46 m *6*	IT 99.84%, ε 0.16%
		131	5/2+	−88.063	9.689 d *16*	ε
		132	2+	−87.160	6.479 d *7*	ε 98.13%, β− 1.87%
		133	7/2+	−88.075	**100%**	
		134	4+	−86.896	2.0648 y *10*	β−, ε 3.0×10^{-4}%
		134m	8−	−86.757	2.903 h *8*	IT
		135	7/2+	−87.586	2.3×10^{6} y *3*	β−
		*135*m	19/2−	−85.953	53 m *2*	IT
		136	8−	−86.343	19 s *2*	β−, IT>0%
		136	5+	−86.343	13.16 d *3*	β−
		137	7/2+	−86.550	30.07 y *3*	β−
		138	3−	−82.893	33.41 m *18*	β−
		*138*m	6−	−82.813	2.91 m *8*	IT 81%, β− 19%
		139	7/2+	−80.706	9.27 m *5*	β−
		140	1−	−77.06	63.7 s *3*	β−
		141	7/2+	−74.47	24.94 s *6*	β−, β−n 0.035%
		142	0−	−70.52	1.70 s *2*	β−, β−n 0.091%
		143	3/2+	−67.71	1.78 s *1*	β−, β−n 1.62%
		144	1	−63.32	1.01 s *1*	β−, β−n 3.2%
		144m	(≥4)	−63.32	<1 s	β−
		145	3/2+	−60.16	0.594 s *13*	β−, β−n 14.3%
		146	1−	−55.66	0.321 s *2*	β−, β−n 14.2%
		147	(3/2+)	−52.2	0.235 s *3*	β−, β−n 28.5%
		148		−47.5	140 ms *12*	β−, β−n 25.1%
		149		−44.2s	>50 ms	
		150			>50 ms	
		151			>50 ms	
56	**Ba**	114	0+		0.4 s *+3−2*	ε, α<0.11%, ^{12}C<0.02%
		115		−48.7s	0.4 s *2*	ε
		116	0+	−54.3s	1.35 s *15*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
56	**Ba**	117	(3/2)	–57.0s	1.75 s *7*	ε , εα > 0%, εp > 0%
		118	0+	–62.0s	5.2 s *2*	ε
		119	(5/2+)	–64.	5.4 s *3*	ε , εp > 0%
		120	0+	–68.9	32 s *5*	ε
		121	5/2(+)	–70.3	29.5 s *5*	ε , εp 0.02%
		122	0+	–74.3s	1.95 m *15*	ε
		123	5/2+	–75.6s	2.7 m *4*	ε
		124	0+	–79.09	11.9 m *10*	ε
		125	1/2(+)	–79.5	3.5 m *4*	ε
		126	0+	–82.68	100 m *2*	ε
		127	1/2(+)	–82.8	12.7 m *4*	ε
		127m	7/2(–)	–82.7	1.9 s *2*	IT
		128	0+	–85.41	2.43 d *5*	ε
		129	1/2+	–85.07	2.23 h *11*	ε
		129m	7/2+	–85.06	2.17 h *4*	ε > 0%
		130	0+	–87.271	**0.106%** ***2***	
		131	1/2+	–86.693	11.50 d *6*	ε
		131m	9/2–	–86.506	14.6 m *2*	IT
		132	0+	–88.439	**0.101%** ***3***	
		133	1/2+	–87.558	3854 d *4*	ε
		133m	11/2–	–87.270	38.9 h *1*	IT 99.99%, ε 0.01%
		134	0+	–88.954	**2.417%** ***27***	
		135	3/2+	–87.855	**6.592%** ***18***	
		135m	11/2–	–87.587	28.7 h *2*	IT
		136	0+	–88.891	**7.854%** ***36***	
		136m	7–	–86.860	0.3084 s *19*	IT
		137	3/2+	–87.726	**11.23%** ***4***	
		*137*m	11/2–	–87.064	2.552 m *1*	IT
		138	0+	–88.266	**71.70%** ***7***	
		139	7/2–	–84.918	83.06 m *28*	β–
		140	0+	–83.278	12.752 d *3*	β–
		141	3/2–	–79.73	18.27 m *7*	β–
		142	0+	–77.825	10.6 m *2*	β–
		143	5/2–	–73.95	14.33 s *8*	β–
		144	0+	–71.78	11.5 s *2*	β– , β–n 3.6%
		145	5/2–	–68.05	4.31 s *16*	β–
		146	0+	–65.04	2.22 s *7*	β–
		147	(3/2–)	–61.49	0.893 s *1*	β– , β–n 0.06%
		148	0+	–58.0	0.607 s *25*	β– , β–n ≤ 0.4%
		149		–54.0s	0.344 s *7*	β– , β–n 0.43%
		150	0+	–50.7s	0.3 s	β–
		151			>150 ns	
57	**La**	118		–49.8s		
		119		–54.8s		
		120		–57.7s	2.8 s *2*	ε , εp
		121		–62.4s	5.3 s *2*	ε
		122		–64.5s	8.7 s *7*	ε , εp
		123		–68.7s	17 s *3*	ε
		124	(7+)	–70.3s	29 s *2*	ε
		125	(11/2–)	–73.9s	76 s *6*	ε
		126		–75.1s	54 s *2*	ε > 0%
		127	(3/2+)	–78.1s	3.8 m *5*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
57	**La**	127m	(11/2–)	–78.1s	5.0 m *5*	IT?
		128	4–,5–	–78.8	5.0 m *3*	ε
		129	3/2+	–81.35	11.6 m *2*	ε
		129m	11/2–	–81.18	0.56 s *5*	IT
		130	3(+)	–81.7s	8.7 m *1*	ε
		131	3/2+	–83.7	59 m *2*	ε
		132	2–	–83.73	4.8 h *2*	ε
		132m	6–	–83.54	24.3 m *5*	IT 76%, ε 24%
		133	5/2+	–85.3	3.912 h *8*	ε
		134	1+	–85.24	6.45 m *16*	ε
		135	5/2+	–86.65	19.5 h *2*	ε
		136	1+	–86.02	9.87 m *3*	ε
		136m		–85.79	114 ms *3*	IT
		137	7/2+	–87.13	6×10^{4} y *2*	ε
		138	5+	–86.529	1.05×10^{11} y *2*	ε 66.4%,
					0.0902% *2*	β– 33.6%
		139	7/2+	–87.235	**99.9098% *2***	
		140	3–	–84.325	1.6781 d *3*	β–
		141	(7/2+)	–82.942	3.92 h *3*	β–
		142	2–	–80.037	91.1 m *5*	β–
		143	(7/2)+	–78.19	14.2 m *1*	β–
		144	(3–)	–74.90	40.8 s *4*	β–
		145		–72.98	24.8 s *20*	β–
		146	2–	–69.16	6.27 s *10*	β–
		*146*m	(6–)	–69.16	10.0 s *1*	β–
		147	(3/2+,5/2+)	–67.24	4.015 s *8*	β–, β–n 0.04%
		148	(2–)	–63.2	1.428 s *12*	β–, β–n 0.15%
		149		–61.3s	1.05 s *3*	β–, β–n 1.4%
		150		–57.2s	0.86 s *5*	β–, β–n 2.7%
		151		–54.6s	>150 ns	
		152			>150 ns	
		153			>150 ns	
58	**Ce**	121		–52.5s		
		122	0+	–57.7s	8.7 s *7*	ε, εp
		123	(5/2)	–60.1s	3.8 s	ε, εp
		124	0+	–64.7s	6 s *2*	ε
		125	(5/2+)	–66.6s	9.0 s *6*	ε, εp
		126	0+	–70.7s	50 s *3*	ε>0%
		127		–72.0s	32 s *4*	ε
		128	0+	–75.6s	≈3 m	ε
		129		–76.3s	3.5 m *3*	ε
		130	0+	–79.5s	25 m *2*	ε
		131	(7/2+)	–79.7	10.2 m *3*	ε
		131m	(1/2+)	–79.7	5.0 m *10*	ε
		132	0+	–82.4s	3.51 h *11*	ε
		133	9/2–	–82.4s	4.9 h *4*	ε
		133m	1/2+	–82.4s	97 m *4*	ε
		134	0+	–84.7	3.16 d *4*	ε
		135	1/2(+)	–84.63	17.7 h *2*	ε
		135m	11/2(–)	–84.18	20 s *1*	IT
		136	0+	–86.49	**0.19% *1***	
		137	3/2+	–85.90	9.0 h *3*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
58	**Ce**	137m	11/2–	–85.65	34.4 h *3*	IT 99.22%, ε 0.78%
		138	0+	–87.57	**0.25% *1***	
		139	3/2+	–86.957	137.640 d *23*	ε
		139m	11/2–	–86.203	54.8 s *10*	IT
		140	0+	–88.087	**88.48% *10***	
		141	7/2–	–85.444	32.501 d *5*	β–
		142	0+	–84.542	$>5\times10^{16}$ y	2β–?
					11.08% *10*	
		143	3/2–	–81.616	33.039 h *6*	β–
		144	0+	–80.441	284.893 d *8*	β–
		145	(3/2–)	–77.10	3.01 m *6*	β–
		146	0+	–75.70	13.52 m *13*	β–
		147	(5/2–)	–72.18	56.4 s *10*	β–
		148	0+	–70.4	56 s *1*	β–
		149		–66.80	5.3 s *2*	β–
		150	0+	–65.0	4.0 s *6*	β–
		151		–61.5s	1.02 s *6*	β–
		152	0+	–59.0s	1.4 s *2*	β–
		153		–55.0s	>150 ns	
		154	0+		>150 ns	
		155			>150 ns	
59	**Pr**	121			1.4 s *8*	ε
		122				
		123				
		124		–53.0s	1.2 s *2*	ε, εp
		125		–57.8s		
		126		–60.3s	3.1 s *3*	ε>0%, εp
		127		–64.4s	15.1 s *CA*	ε
		128		–66.3s	3.1 s *2*	ε, εp
		129		–70.0s	24 s *5*	ε>0%
		130		–71.4s	40.0 s *4*	ε
		131	(3/2+)	–74.5	1.53 m *5*	ε
		131m	(11/2–)	–74.3	5.7 s *2*	IT 95%, ε 5%
		132		–75.3s	1.6 m *3*	ε
		133	5/2(+)	–78.1s	6.5 m *3*	ε
		134	2–	–78.5s	17 m *2*	ε
		134m	(5–)	–78.5s	≈11 m	ε
		135	3/2(+)	–80.9	24 m *2*	ε
		136	2+	–81.37	13.1 m *1*	ε
		137	5/2+	–83.20	1.28 h *3*	ε
		138	1+	–83.14	1.45 m *5*	ε
		138m	7–	–82.77	2.12 h *4*	ε
		139	5/2+	–84.828	4.41 h *4*	ε
		140	1+	–84.699	3.39 m *1*	ε
		141	5/2+	–86.025	**100%**	
		142	2–	–83.797	19.12 h *4*	β– 99.98%, ε 0.02%
		142m	5–	–83.793	14.6 m *5*	IT
		143	7/2+	–83.077	13.57 d *2*	β–
		144	0–	–80.759	17.28 m *5*	β–
		144m	3–	–80.700	7.2 m *3*	IT 99.93%, β– 0.07%
		145	7/2+	–79.636	5.984 h *10*	β–
		146	(2)–	–76.74	24.15 m *18*	β–

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
59	**Pr**	*147*	(3/2+)	−75.47	13.4 m *4*	β−
		148	1−	−72.5	2.27 m *4*	β−
		*148*m	(4)	−72.4	2.0 m *1*	β−
		149	(5/2+)	−70.99	2.26 m *7*	β−
		150	(1)−	−68.00	6.19 s *16*	β−
		151	(3/2−,5/2−)	−66.79	18.90 s *7*	β−
		152	(4−)	−63.5s	3.63 s *12*	β−
		153		−61.5s	4.3 s *2*	β−
		154	(3+,2+)	−57.7s	2.3 s *1*	β−
		155		−55.3s		
60	**Nd**	127		−55.4s	1.8 s *4*	ε , εp
		128	0+	−60.2s		ε
		129	(5/2+)	−62.2s	4.9 s *2*	ε , εp
		130	0+	−66.3s	28 s *3*	ε
		131	(5/2)	−67.9	27 s *2*	ε , εp
		132	0+	−71.6s	1.75 m *17*	ε
		133		−72.5s	70 s *10*	ε
		133m	(9/2−)	−72.5s	<2 m	ε
		134	0+	−75.8s	8.5 m *15*	ε
		135	9/2(−)	−76.2s	12.4 m *6*	ε
		135m		−76.2s	5.5 m *5*	ε
		136	0+	−79.16	50.65 m *33*	ε
		137	1/2+	−79.51	38.5 m *15*	ε
		137m	11/2−	−78.99	1.60 s *15*	IT
		138	0+	−82.0s	5.04 h *9*	ε
		139	3/2+	−82.04	29.7 m *5*	ε
		139m	11/2−	−81.81	5.50 h *20*	ε 88.2%, IT 11.8%
		140	0+	−84.48	3.37 d *2*	ε
		141	3/2+	−84.202	2.49 h *3*	ε
		141m	11/2−	−83.445	62.0 s *8*	IT, ε<0.05%
		142	0+	−85.959	**27.13% *12***	
		143	7/2−	−84.011	**12.18% *6***	
		144	0+	−83.757	2.29×10^{15} y *16*	α
					23.80% *12*	
		145	7/2−	−81.441	**8.30% *6***	
		146	0+	−80.935	**17.19% *9***	
		147	5/2−	−78.156	10.98 d *1*	β−
		148	0+	−77.417	**5.76% *3***	
		149	5/2−	−74.385	1.728 h *1*	β−
		150	0+	−73.693	$>1.1\times10^{19}$ y	2β−?
					5.64% *3*	
		151	(3/2)+	−70.956	12.44 m *7*	β−
		152	0+	−70.16	11.4 m *2*	β−
		153	(1/2:5/2)	−67.1s	28.9 s *4*	β−
		154	0+	−65.6s	25.9 s *2*	β−
		155		−62.0s	8.9 s *2*	β−
		156	0+	−60.1s	5.47 s *11*	β−
		157		−56.1s		
61	**Pm**	130		−55.5s	2.2 s *5*	ε , εp
		131		−59.8s		
		132	(3+)	−61.7s	6.3 s *7*	ε , εp≈5.0×10^{-5}%
		133		−65.5s	12 s *3*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
61	**Pm**	134	(2+)	–66.9s	≈5 s	ε
		134m	(5+)	–66.9s	22 s *1*	ε
		135	(11/2–)	–70.1s	40 s *3*	ε
		136	(2+)	–71.3	47 s *2*	ε
		136	5(+),6–	–71.3	107 s *6*	ε
		137	11/2–	–73.9s	2.4 m *1*	ε
		138	1+	–75.1s	10 s *2*	ε
		138m	(3+)	–75.1s	3.24 m *5*	ε
		138m	(5–)	–75.1s	3.24 m	ε
		139	(5/2)+	–77.52	4.15 m *5*	ε
		139m	(11/2)–	–77.33	180 ms *20*	IT, ε?
		140	1+	–78.39	9.2 s *2*	ε
		140m	8–	–78.39	5.95 m *5*	ε
		141	5/2+	–80.49	20.90 m *5*	ε
		142	1+	–81.09	40.5 s *5*	ε
		143	5/2+	–82.970	265 d *7*	ε
		144	5–	–81.425	363 d *14*	ε
		145	5/2+	–81.278	17.7 y *4*	ε, α 3×10^{-7}%
		146	3–	–79.463	5.53 y *5*	ε 66%, β– 34%
		147	7/2+	–79.052	2.6234 y *2*	β–
		148	1–	–76.878	5.370 d *9*	β–
		148m	6–	–76.740	41.29 d *11*	β– 95%, IT 5%
		149	7/2+	–76.075	53.08 h *5*	β–
		150	(1–)	–73.61	2.68 h *2*	β–
		151	5/2+	–73.399	28.40 h *4*	β–
		152	1+	–71.27	4.12 m *8*	β–
		*152*m	4–	–71.12	7.52 m *8*	β–
		*152*m	(8)	–71.10	13.8 m *2*	β– ≈ 100%, IT ≈ 0%
		153	5/2–	–70.67	5.4 m *2*	β–
		154	(0,1)	–68.4	1.73 m *10*	β–
		*154*m	(3,4)	–68.4	2.68 m *7*	β–
		155	(5/2–)	–67.0s	41.5 s *2*	β–
		156	4(–)	–64.22	26.70 s *10*	β–
		157	(5/2–)	–62.2s	10.56 s *10*	β–
		158		–59.0s	4.8 s *5*	β–
		159		–56.5s		
62	**Sm**	131			1.2 s *2*	ε, εp > 0%
		132	0+		4.0 s *3*	ε, εp
		133	(5/2+)	–57.1s	2.9 s *2*	ε, εp
		134	0+	–61.5s	10 s *1*	ε
		135	(7/2+)	–63.0s	10 s *2*	ε, εp
		136	0+	–66.8s	47 s *2*	ε
		137	(9/2–)	–67.9s	45 s *1*	ε
		138	0+	–71.2s	3.1 m *2*	ε
		139	(1/2)+	–72.1	2.57 m *10*	ε
		139m	(11/2)–	–71.6	10.7 s *6*	IT 93.7%, ε 6.3%
		140	0+	–75.4s	14.82 m *12*	ε
		141	1/2+	–75.94	10.2 m *2*	ε
		141m	11/2–	–75.77	22.6 m *2*	ε 99.69%, IT 0.31%
		142	0+	–78.99	72.49 m *5*	ε
		143	3/2+	–79.527	8.83 m *1*	ε
		143m	11/2–	–78.773	66 s *2*	IT 99.76%, ε 0.24%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
62	**Sm**	144	0+	–81.975	**3.1%** ***1***	
		145	7/2–	–80.661	340 d *3*	ε
		146	0+	–81.005	10.3×10^{7} y *5*	α
		147	7/2–	–79.276	1.06×10^{11} y *2*	α
					15.0% ***2***	
		148	0+	–79.346	7×10^{15} y *3*	α
					11.3% ***1***	
		149	7/2–	–77.146	$>2\times10^{15}$ y	α?
					13.8% ***1***	
		150	0+	–77.061	**7.4%** ***1***	
		151	5/2–	–74.586	90 y *8*	β–
		152	0+	–74.772	**26.7%** ***2***	
		153	3/2+	–72.569	46.27 h *1*	β–
		154	0+	–72.465	**22.7%** ***2***	
		155	3/2–	–70.201	22.3 m *2*	β–
		156	0+	–69.372	9.4 h *2*	β–
		157	(3/2–)	–66.8	482 s *4*	β–
		158	0+	–65.3s	5.30 m *3*	β–
		159	(5/2–)	–62.2s	11.37 s *15*	β–
		160	0+	–60.3s	9.6 s *3*	β–
		161		–56.8s		
63	**Eu**	134			0.5 s *2*	ε , εp > 0%
		135		–54.3s	1.5 s *2*	ε
		136	(7+)	–56.4s	3.3 s *3*	ε , εp 0.09%
		136	(3+)	–56.4s	3.7 s *3*	ε , εp 0.09%
		137	(11/2–)	–60.4s	11 s *2*	ε
		138	(6–)	–62.0s	12.1 s *6*	ε
		139	(11/2)–	–65.4s	17.9 s *6*	ε
		140	1+	–67.0s	1.51 s *2*	ε
		140m	(5–)	–66.8s	125 ms *2*	IT , ε < 1%
		141	5/2+	–70.4	41.4 s *7*	ε
		141m	11/2–	–70.3	2.7 s *3*	IT 87% , ε 13%
		142	1+	–71.63	2.4 s *2*	ε
		142m	8–	–71.63	1.22 m *2*	ε
		143	5/2+	–74.36	2.57 m *3*	ε
		144	1+	–75.65	10.2 s *3*	ε
		145	5/2+	–78.001	5.93 d *4*	ε
		146	4–	–77.127	4.59 d *3*	ε
		147	5/2+	–77.554	24.1 d *6*	ε , α 2.2×10^{-3}%
		148	5–	–76.24	54.5 d *5*	ε , α 9.4×10^{-7}%
		149	5/2+	–76.454	93.1 d *4*	ε
		150	5(–)	–74.800	36.9 y *9*	ε
		150m	0–	–74.758	12.8 h *1*	β– 89% , ε 11% , IT ≤ 5.0×10^{-8}%
		151	5/2+	–74.663	**47.8%** ***15***	
		152	3–	–72.898	13.537 y *6*	ε 72.1% , β– 27.9%
		152m	0–	–72.852	9.3116 h *13*	β– 72% , ε 28%
		152m	8–	–72.750	96 m *1*	IT
		153	5/2+	–73.377	**52.2%** ***15***	
		154	3–	–71.748	8.593 y *4*	β– 99.98% , ε 0.02%
		154m	(8–)	–71.603	46.3 m *4*	IT
		155	5/2+	–71.828	4.7611 y *13*	β–

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
63	**Eu**	156	0+	−70.094	15.19 d *8*	β−
		157	5/2+	−69.471	15.18 h *3*	β−
		158	(1−)	−67.21	45.9 m *2*	β−
		159	5/2+	−66.057	18.1 m *1*	β−
		160	1(−)	−63.4s	38 s *4*	β−
		161		−61.8s	26 s *3*	β−
		162		−58.6s	10.6 s *10*	β−
		163		−56.5s		
64	**Gd**	137		−51.6s	7 s *3*	ε
		138	0+	−55.9s		
		139		−57.7s	4.9 s *10*	ε , εp
		140	0+	−61.5s	15.8 s *4*	ε
		141	(1/2+)	−63.1s	14 s *4*	ε , εp 0.03%
		141m	(11/2−)	−62.8s	24.5 s *5*	ε 89%, IT 11%
		142	0+	−67.1s	70.2 s *6*	ε
		143	(1/2)+	−68.4	39 s *2*	ε
		143m	(11/2−)	−68.2	112 s *2*	ε
		144	0+	−71.9s	4.5 m *1*	ε
		145	1/2+	−72.95	23.0 m *4*	ε
		145m	11/2−	−72.20	85 s *3*	IT 94.3%, ε 5.7%
		146	0+	−76.097	48.27 d *10*	ε
		147	7/2−	−75.367	38.06 h *12*	ε
		148	0+	−76.279	74.6 y *30*	α
		149	7/2−	−75.135	9.28 d *10*	ε , α 4.3×10^{-4}%
		150	0+	−75.771	1.79×10^{6} y *8*	α
		151	7/2−	−74.199	124 d *1*	ε , α 1.0×10^{-6}%
		152	0+	−74.716	1.08×10^{14} y *8*	α
					0.20% ***1***	
		153	3/2−	−72.892	241.6 d *2*	ε
		154	0+	−73.716	**2.18%** ***3***	
		155	3/2−	−72.080	**14.80%** ***5***	
		156	0+	−72.545	**20.47%** ***4***	
		157	3/2−	−70.834	**15.65%** ***3***	
		158	0+	−70.700	**24.84%** ***12***	
		159	3/2−	−68.572	18.479 h *4*	β−
		160	0+	−67.952	**21.86%** ***4***	
		161	5/2−	−65.516	3.66 m *5*	β−
		162	0+	−64.290	8.4 m *2*	β−
		163	(5/2−)	−61.5s	68 s *3*	β−
		164	0+	−59.7s	45 s *3*	β−
		165		−56.5s		
65	**Tb**	139		−48.4s		
		140	5	−51.s	2.4 s *2*	ε , p 0.26%
		141	(5/2−)	−54.8s	3.5 s *2*	ε
		141m		−54.8s	7.9 s *6*	ε
		142	1+	−57.1s	597 ms *17*	ε , εp ≈ 3.0×10^{-7}%
		142m	(5−)	−56.8s	303 ms *7*	ε , εp, IT
		143	(11/2−)	−61.0s	12 s *1*	ε
		143m	(5/2+)	−61.0s	<21 s	IT
		144	(1+)	−63.0s	≈1 s	ε
		144m	(6−)	−62.6s	4.25 s *15*	IT 66%, ε 34%
		145	(1/2+)	−66.4	31.6 s *6*	ε ?

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
65	Tb	145m	(11/2–)	–66.4	29.5 s *15*	ε
		146	1+	–68.0	8 s *4*	ε
		146m	5–	–68.0	24.1 s *5*	ε
		146m	(10+)	–67.2	1.18 ms *2*	
		147	(1/2+)	–70.76	1.7 h *1*	ε
		147m	(11/2)–	–70.70	1.92 m *7*	ε
		148	2–	–70.59	60 m *3*	ε
		148m	9+	–70.50	2.30 m *10*	ε
		149	1/2+	–71.499	4.118 h *25*	ε 83.3%, α 16.7%
		149m	11/2–	–71.463	4.16 m *4*	ε 99.98%, α 0.02%
		150	(2–)	–71.115	3.48 h *16*	ε , α<0.05%
		150m	(9+)	–70.645	5.8 m *2*	ε ≈ 100%
		151	1/2(+)	–71.633	17.609 h *1*	ε , α 0.0095%
		151m	(11/2–)	–71.533	25 s *3*	IT 93.8%, ε 6.2%
		152	2–	–70.73	17.5 h *1*	ε , $\alpha < 7.0\times10^{-7}$%
		152m	8+	–70.22	4.2 m *1*	IT 78.8%, ε 21.2%
		153	5/2+	–71.322	2.34 d *1*	ε
		154	0	–70.15	21.5 h *4*	ε , β–<0.1%
		154m	3–	–70.15	9.4 h *4*	ε 78.2%, IT 21.8%, β–<0.1%
		154m	7–	–70.15	22.7 h *5*	ε 98.2%, IT 1.8%
		155	3/2+	–71.26	5.32 d *6*	ε
		156	3–	–70.101	5.35 d *10*	ε , β–
		156m	(7–)	–70.051	24.4 h *10*	IT
		156m	(0+)	–70.013	5.3 h *2*	ε , IT
		157	3/2+	–70.774	99 y *10*	ε
		158	3–	–69.480	180 y *11*	ε 83.4%, β– 16.6%
		158m	0–	–69.370	10.70 s *17*	IT , β–<0.6%, ε<0.01%
		159	3/2+	–69.542	**100%**	
		160	3–	–67.846	72.3 d *2*	β–
		161	3/2+	–67.471	6.88 d *3*	β–
		162	1–	–65.68	7.60 m *15*	β–
		163	3/2+	–64.605	19.5 m *3*	β–
		164	(5+)	–62.1	3.0 m *1*	β–
		165	(3/2+)	–60.7s	2.11 m *10*	β–
		166		–57.7s		
		167		–55.8s		
66	Dy	141	(9/2–)	–45.5s	0.9 s *2*	ε , εp
		142	0+	–50.2s	2.3 s *3*	ε , $\varepsilon p \approx 8.0\times10^{-5}$%
		143		–52.2s	3.9 s *4*	ε , εp
		144	0+	–56.8s	9.1 s *4*	ε , εp
		145	(1/2+)	–58.7s	10.5 s *15*	ε
		145m	(11/2–)	–58.7s	13.6 s *10*	ε
		146	0+	–62.9	33.2 s *7*	ε
		146m	10+	–59.9	150 ms *20*	IT
		147	1/2+	–64.38	40 s *10*	ε , εp>0%
		147m	11/2–	–63.63	55.7 s *7*	ε 65%, IT 35%
		148	0+	–67.91	3.1 m *1*	ε
		149	(7/2–)	–67.69	4.20 m *14*	ε
		149m	(27/2–)	–65.03	0.490 s *15*	IT 99.3%, ε 0.7%
		150	0+	–69.321	7.17 m *5*	ε 64%, α 36%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
66	**Dy**	151	7/2(−)	−68.762	17.9 m *3*	ε 94.4%, α 5.6%
		152	0+	−70.128	2.38 h *2*	ε 99.9%, α 0.1%
		153	7/2(−)	−69.151	6.4 h *1*	ε 99.991%, α 9.4×10^{-3}%
		154	0+	−70.400	3.0×10^{6} y *15*	α
		155	3/2−	−69.16	9.9 h *2*	ε
		156	0+	−70.534	**0.06%** ***1***	
		157	3/2−	−69.432	8.14 h *4*	ε
		157m	11/2−	−69.233	21.6 ms *16*	IT
		158	0+	−70.417	**0.10%** ***1***	
		159	3/2−	−69.177	144.4 d *2*	ε
		160	0+	−69.682	**2.34%** ***5***	
		161	5/2+	−68.065	**18.9%** ***1***	
		162	0+	−68.190	**25.5%** ***2***	
		163	5/2−	−66.390	**24.9%** ***2***	
		164	0+	−65.977	**28.2%** ***2***	
		165	7/2+	−63.621	2.334 h *1*	β−
		165m	1/2−	−63.513	1.257 m *6*	IT 97.76%, β− 2.24%
		166	0+	−62.593	81.6 h *1*	β−
		167	(1/2−)	−59.94	6.20 m *8*	β−
		168	0+	−58.5s	8.7 m *3*	β−
		169	(5/2−)	−55.6	39 s *8*	β−
67	**Ho**	143		−42.2s		
		144		−45.0s	0.7 s *1*	ε, εp
		145		−49.6s		
		146	(10+)	−52.2s	3.6 s *3*	ε, εp
		147	(11/2−)	−56.2s	5.8 s *4*	ε, εp
		148	1+	−58.5s	2.2 s *11*	ε
		148m	6−	−58.5s	9.3 s *2*	ε, εp 0.08%
		149	(11/2−)	−61.67	21.1 s *2*	ε
		149m	(1/2+)	−61.62	56 s *3*	ε
		150	2−	−62.1s	72 s *4*	ε
		150m	(9)+	−61.3s	23.3 s *3*	ε
		151	(11/2−)	−63.63	35.2 s *1*	ε 78%, α 22%
		151m	(1/2+)	−63.59	47.2 s *10*	α≈80%, ε?
		152	2−	−63.65	161.8 s *3*	ε 88%, α 12%
		152m	9+	−63.49	50.0 s *4*	ε 89.2%, α 10.8%
		153	11/2−	−65.023	2.02 m *3*	ε 99.95%, α 0.05%
		153m	1/2+	−64.955	9.3 m *5*	ε 99.82%, α 0.18%
		154	(2)−	−64.648	11.76 m *19*	ε 99.98%, α 0.02%
		154m	8+	−64.328	3.10 m *14*	ε, α<1.0×10^{-3}%, IT≈0%
		155	5/2+	−66.06	48 m *1*	ε
		156	(5+)	−65.5s	56 m *1*	ε
		156m	(2+)	−65.4s	9.5 s *15*	IT
		157	7/2−	−66.89	12.6 m *2*	ε
		158	5+	−66.18	11.3 m *4*	ε
		158m	2−	−66.11	28 m *2*	IT>81%, ε<19%
		158m	(9+)	−66.00	21.3 m *23*	ε≈93%
		159	7/2−	−67.339	33.05 m *11*	ε
		159m	1/2+	−67.133	8.30 s *8*	IT
		160	5+	−66.39	25.6 m *3*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
67	**Ho**	160m	2–	–66.33	5.02 h *5*	IT 65%, ε 35%
		160m	(9+)	–66.22	3 s	IT
		161	7/2–	–67.206	2.48 h *5*	ε
		161m	1/2+	–66.995	6.76 s *7*	IT
		162	1+	–66.050	15.0 m *10*	ε
		162m	6–	–65.944	67.0 m *7*	IT 62%, ε 38%
		163	7/2–	–66.387	4570 y *25*	ε
		163m	1/2+	–66.089	1.09 s *3*	IT
		164	1+	–64.990	29 m *1*	ε 60%, β– 40%
		164m	6–	–64.850	37.5 m *+15–5*	IT
		165	7/2–	–64.907	**100%**	
		166	0–	–63.080	26.763 h *4*	β–
		166m	(7)–	–63.074	1.20×10^{3} y *18*	β–
		167	7/2–	–62.292	3.1 h *1*	β–
		168	3+	–60.08	2.99 m *7*	β–
		168m	(6+)	–60.03	132 s *4*	IT≥99.5%, β–≤0.5%
		169	7/2–	–58.81	4.7 m *1*	β–
		170	(6+)	–56.25	2.76 m *5*	β–
		170m	(1+)	–56.13	43 s *2*	β–
		171	(7/2–)	–54.5	53 s *2*	β–
		172			25 s *3*	β–
68	**Er**	145		–39.3s		
		146	0+	–44.8s	1.7 s *6*	ε , εp>0%
		147	(11/2–)	–47.1s	2.5 s *2*	ε , εp>0%
		147m	(1/2+)	–47.1s	≈2.5 s	ε , εp>0%
		148	0+	–51.8s	4.6 s *2*	ε
		149	(1/2+)	–53.9s	4 s *2*	ε , εp 7%
		149m	(11/2–)	–53.2s	8.9 s *2*	ε 96.5%, IT 3.5%, εp 0.18%
		150	0+	–58.0s	18.5 s *7*	ε
		151	(7/2–)	–58.4s	23.5 s *13*	ε
		151m	(27/2–)	–55.8s	0.58 s *2*	IT 95.3%, ε 4.7%
		152	0+	–60.55	10.3 s *1*	α 90%, ε 10%
		153	(7/2–)	–60.46	37.1 s *2*	α 53%, ε 47%
		154	0+	–62.617	3.73 m *9*	ε 99.53%, α 0.47%
		155	7/2–	–62.22	5.3 m *3*	ε 99.98%, α 0.02%
		156	0+	–64.1s	19.5 m *10*	ε , $\alpha\ 5\times10^{-6}$%
		157	3/2–	–63.42	18.65 m *10*	ε≈100%, α<0.02%
		157m	(9/2+)	–63.27	76 ms *6*	IT
		158	0+	–65.3s	2.29 h *6*	ε
		159	3/2–	–64.571	36 m *1*	ε
		160	0+	–66.06	28.58 h *9*	ε
		161	3/2–	–65.203	3.21 h *3*	ε
		162	0+	–66.345	**0.14%** ***1***	
		163	5/2–	–65.177	75.0 m *4*	ε
		164	0+	–65.952	**1.61%** ***2***	
		165	5/2–	–64.531	10.36 h *4*	ε
		166	0+	–64.934	**33.6%** ***2***	
		167	7/2+	–63.299	**22.95%** ***15***	
		167m	1/2–	–63.091	2.269 s *6*	IT
		168	0+	–62.999	**26.8%** ***2***	
		169	1/2–	–60.931	9.40 d *2*	β–

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
68	**Er**	170	0+	−60.118	**14.9%** *2*	
		171	5/2−	−57.728	7.516 h *2*	β−
		172	0+	−56.493	49.3 h *3*	β−
		173	(7/2−)	−53.7s	1.4 m *1*	β−
		174	0+	−52.1s	3.3 m *2*	β−
69	**Tm**	146	(5−,6−)	−30.8s	62 ms *+19−14*	p
		146m	(10+)	−30.8s	206 ms *25*	p
		147	(11/2−)	−36.4s	0.559 s *26*	ε≈90%, p≈10%
		147m		−36.4s	0.39 ms *8*	p
		148m	(10+)	−39.8s	0.7 s *2*	ε
		149	(11/2−)	−44.4s	0.9 s *2*	ε , εp 0.2%
		150	(6−)	−47.1s	2.2 s *2*	ε
		151	(11/2−)	−50.9s	4.17 s *10*	ε
		151m	(1/2+)	−50.9s	6.6 s *14*	ε
		152	(2−)	−51.9s	8.0 s *10*	ε
		152m	(9)+	−51.9s	5.2 s *6*	ε
		153	(11/2−)	−54.00	1.48 s *1*	α 91%, ε 9%
		153m	(1/2+)	−53.96	2.5 s *2*	α 95%, ε 5%
		154	(2−)	−54.6s	8.1 s *3*	ε 56%, α 44%
		154m	(9+)	−54.6s	3.30 s *7*	α 90%, ε 10%, IT
		155	(11/2−)	−56.64	21.6 s *2*	ε 98.1%, α 1.9%
		155m	(1/2+)	−56.60	45 s *3*	ε>92%, α<8%
		156	2−	−56.89	83.8 s *18*	ε 99.94%, α 0.06%
		156m		−56.89	19 s *3*	α?
		157	1/2+	−58.9	3.63 m *9*	ε
		158	2−	−58.8s	3.98 m *6*	ε
		159	5/2+	−60.7	9.13 m *16*	ε
		160	1−	−60.2	9.4 m *3*	ε
		160m	5	−60.1	74.5 s *15*	IT 85%, ε 15%
		161	7/2+	−62.04	30.2 m *8*	ε
		162	1−	−61.54	21.70 m *19*	ε
		162m	5+	−61.47	24.3 s *17*	IT 82%, ε 18%
		163	1/2+	−62.738	1.810 h *5*	ε
		164	1+	−61.99	2.0 m *1*	ε
		164	6−	−61.99	5.1 m *1*	IT≈80%, ε≈20%
		165	1/2+	−62.938	30.06 h *3*	ε
		166	2+	−61.89	7.70 h *3*	ε
		167	1/2+	−62.551	9.25 d *2*	ε
		168	3+	−61.320	93.1 d *2*	ε 99.99%, β− 0.01%
		169	1/2+	−61.282	**100%**	
		170	1−	−59.804	128.6 d *3*	β− 99.85%, ε 0.15%
		171	1/2+	−59.219	1.92 y *1*	β−
		172	2−	−57.383	63.6 h *2*	β−
		173	(1/2+)	−56.262	8.24 h *8*	β−
		174	(4)−	−53.87	5.4 m *1*	β−
		175	(1/2+,3/2+)	−52.32	15.2 m *5*	β−
		176	(4+)	−49.6s	1.9 m *1*	β−
		177	(1/2+)	−47.8s	85 s *+10−15*	β−
70	**Yb**	148	0+	−30.5s		
		149		−33.7s		
		150	0+	−39.0s		
		151	(1/2+)	−41.7s	1.6 s *1*	ε , εp

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
70	**Yb**	151m	(11/2−)	−41.7s	1.6 s *1*	ε , εp
		152	0+	−46.4s	3.04 s *6*	ε , εp
		153	(7/2−)	−47.3s	4.2 s *1*	α 50%, ε 50%
		154	0+	−50.1s	0.404 s *14*	α 92.8%, ε 7.2%
		155	(7/2−)	−50.7s	1.75 s *5*	α 89%, ε 11%
		156	0+	−53.31	26.1 s *7*	ε 90%, α 10%
		157	7/2−	−53.41	38.6 s *10*	ε 99.5%, α 0.5%
		158	0+	−56.021	1.49 m *13*	ε , $\alpha \approx 2.1\times10^{-3}$%
		159	5/2(−)	−55.7	1.58 m *14*	ε
		160	0+	−58.2s	4.8 m *2*	ε
		161	3/2−	−57.9s	4.2 m *2*	ε
		162	0+	−59.8s	18.87 m *19*	ε
		163	3/2−	−59.4	11.05 m *25*	ε
		164	0+	−61.0s	75.8 m *17*	ε
		165	5/2−	−60.18	9.9 m *3*	ε
		166	0+	−61.590	56.7 h *1*	ε
		167	5/2−	−60.596	17.5 m *2*	ε
		168	0+	−61.577	**0.13%** ***1***	
		169	7/2+	−60.373	32.026 d *5*	ε
		169m	1/2−	−60.348	46 s *2*	IT
		170	0+	−60.772	**3.05%** ***6***	
		171	1/2−	−59.315	**14.3%** ***2***	
		172	0+	−59.264	**21.9%** ***3***	
		173	5/2−	−57.560	**16.12%** ***21***	
		174	0+	−56.953	**31.8%** ***4***	
		175	7/2−	−54.704	4.185 d *1*	β−
		176	0+	−53.497	**12.7%** ***2***	
		176m	(8−)	−52.447	11.4 s *3*	IT≥90%, β−<10%
		177	(9/2+)	−50.992	1.911 h *3*	β−
		177m	(1/2−)	−50.661	6.41 s *3*	IT
		178	0+	−49.70	74 m *3*	β−
		179	(1/2−)	−46.7s	8.0 m *4*	β−
		180	0+		2.4 m *5*	β−
71	**Lu**	150		−25.1s	35 ms *10*	p 80%
		151	(11/2−)	−30.7s	90 ms *10*	p 70%
		152	(5−,6−)	−34.1s	0.7 s *1*	ε , εp 15%
		153	(11/2−)	−38.5s		p ?
		154m	(7+)	−40.0s	1.12 s *8*	ε≈100%
		155	(1/2+,3/2+)	−42.7s	140 ms *20*	α , ε
		155m	(11/2−)	−42.7s	68 ms *5*	α 79%, ε 21%
		155m	(25/2−)	−40.9s	2.60 ms *7*	α≈100%
		156m		−43.9s	0.179 s *13*	α≥75%, ε≤25%
		156m		−43.9s	0.73 s *15*	α≈95%, ε≈5%
		157	(1/2+,3/2+)	−46.48	7.4 s *14*	α? , ε?
		157m	(11/2−)	−46.45	5.0 s *4*	ε 94%, α 6%
		158		−47.3s	10.4 s *1*	ε 99.09%, α 0.91%
		159		−49.68	12.1 s *10*	ε , α 0.04%
		160		−50.3s	36.1 s *3*	ε , $\alpha \le 1.0\times10^{-4}$%
		160m		−50.3s	40 s *1*	ε≤100%, α?
		161	(5/2+)	−52.6s	72 s	ε
		162	(1−)	−52.6s	1.37 m *2*	ε
		162m	(4−)	−52.6s	1.5 m	ε≤100%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
71	**Lu**	162m		–52.6s	1.9 m	ε≤100%
		163	(1/2–)	–54.8	238 s *8*	ε
		164		–54.7s	3.14 m *3*	ε
		165	(7/2+)	–56.26	10.74 m *10*	ε
		165?	1/2+	–56.26	12 m	
		166	(6–)	–56.1	2.65 m *10*	ε
		166m	(3–)	–56.1	1.41 m *10*	ε 58%, IT 42%
		166m	(0–)	–56.1	2.12 m *10*	ε>80%, IT<20%
		167	7/2+	–57.5	51.5 m *10*	ε
		168	(6–)	–57.10	5.5 m *1*	ε
		168m	3+	–56.88	6.7 m *4*	ε>95%, IT<5%
		169	7/2+	–58.079	34.06 h *5*	ε
		169m	1/2–	–58.050	160 s *10*	IT
		170	0+	–57.31	2.00 d *3*	ε
		170m	(4)–	–57.22	0.67 s *10*	IT
		171	7/2+	–57.836	8.24 d *3*	ε
		171m	1/2–	–57.765	79 s *2*	IT
		172	4–	–56.744	6.70 d *3*	ε
		172m	1–	–56.702	3.7 m *5*	IT
		173	7/2+	–56.889	1.37 y *1*	ε
		174	(1)–	–55.579	3.31 y *5*	ε
		174m	(6)–	–55.408	142 d *2*	IT 99.38%, ε 0.62%
		175	7/2+	–55.174	**97.41%** *2*	
		176	7–	–53.391	3.73×10^{10} y *5*	β–
					2.59% *2*	
		176m	1–	–53.268	3.6832 h *7*	β– 99.91%, ε 0.1%
		177	7/2+	–52.392	6.734 d *12*	β–
		177m	23/2–	–51.422	160.4 d *3*	β– 78.3%, IT 21.7%
		178	1(+)	–50.346	28.4 m *2*	β–
		178m	(9–)	–50.226	23.1 m *3*	β–
		179	7/2(+)	–49.067	4.59 h *6*	β–
		179m	1/2(+)	–48.475	3.1 ms *9*	IT
		180	(3)+	–46.69	5.7 m *1*	β–
		181	(7/2+)	–44.9s	3.5 m *3*	β–
		182	(0,1,2)		2.0 m *2*	β–
		183	(7/2+)		58 s *4*	β–
		184	high		20 s *3*	β–
		184m	low		?	β–
72	**Hf**	154	0+	–33.3s	2 s *1*	ε≈100%, α≈0%
		155		–34.7s	0.89 s *12*	ε, α
		156	0+	–38.0s	25 ms *4*	α≥81%
		157		–39.0s	110 ms *6*	α 86%, ε 14%
		158	0+	–42.2s	2.86 s *18*	ε 56%, α 44%
		159		–43.0s	5.6 s *4*	ε 59%, α 41%
		160	0+	–45.98	13.0 s *15*	ε 97.7%, α 2.3%
		161		–46.27	16.8 s *8*	ε≥99.71%, α≤0.29%
		162	0+	–49.18	37.6 s *8*	ε 99.99%, α 6.3×10^{-3}%
		163		–49.3s	40.0 s *6*	ε
		164	0+	–51.8s	111 s *8*	ε
		165	(5/2–)	–51.7s	76 s *4*	ε
		166	0+	–53.8s	6.77 m *30*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
72	**Hf**	167	(5/2−)	−53.5s	2.05 m *5*	ε
		168	0+	−55.3s	25.95 m *20*	ε
		169	(5/2)−	−54.81	3.24 m *4*	ε
		170	0+	−56.2s	16.01 h *13*	ε
		171	(7/2+)	−55.4s	12.1 h *4*	ε
		172	0+	−56.39	1.87 y *3*	ε
		173	1/2−	−55.3s	23.6 h *1*	ε
		174	0+	−55.851	2.0×10^{15} y *4*	α
					0.162% *3*	
		175	5/2−	−54.488	70 d *2*	ε
		176	0+	−54.582	**5.206% *5***	
		177	7/2−	−52.890	**18.606% *4***	
		177m	23/2+	−51.575	1.08 s *6*	IT
		177m	37/2−	−50.150	51.4 m *5*	IT
		178	0+	−52.445	**27.297% *4***	
		178m	8−	−51.298	4.0 s *2*	IT
		178m	16+	−49.999	31 y *1*	IT
		179	9/2+	−50.473	**13.629% *6***	
		179m	1/2−	−50.098	18.67 s *4*	IT
		179m	25/2−	−49.367	25.05 d *25*	IT
		180	0+	−49.790	**35.100% *7***	
		180m	8−	−48.648	5.5 h *1*	IT 99.7%, β− 0.3%
		181	1/2−	−47.414	42.39 d *6*	β−
		182	0+	−46.060	9×10^{6} y *2*	β−
		182m	8−	−44.887	61.5 m *15*	β− 58%, IT 42%
		183	(3/2−)	−43.29	1.067 h *17*	β−
		184	0+	−41.50	4.12 h *5*	β−
		184m	8−	−41.50	48 s *10*	β−
		185			3.5 m *6*	β−
73	**Ta**	156	(2−)	−26.4s	0.11 s *+6−3*	ε 50%, p 50%
		157		−29.7s	5.3 ms *18*	α>77%
		158		−31.3s	36.8 ms *16*	α 93%, ε 7%
		159		−34.5s	0.57 s *18*	α 80%, ε 20%
		160		−35.9s	1.5 s *2*	ε 66%, α 34%
		161		−38.77	3.00 s *15*	ε≈95%, α≈5%
		162		−39.9s	3.60 s *15*	ε 99.92%, α 0.08%
		163		−42.51	11.0 s *8*	ε≈99.72%, α≈0.28%
		164	(3+)	−43.2s	14.2 s *3*	ε
		165		−45.8s	31.0 s *15*	ε
		166	(2)+	−46.1s	31.5 s *20*	ε
		167		−48.5s	1.33 m *7*	ε
		168	(2−,3+)	−48.6s	2.0 m *1*	ε
		169	(5/2−)	−50.4s	4.9 m *4*	ε
		170	(3+)	−50.2s	6.76 m *6*	ε
		171	(5/2−)	−51.7s	23.3 m *3*	ε
		172	(3+)	−51.5	36.8 m *3*	ε
		173	5/2−	−52.5s	3.14 h *13*	ε
		174	3(+)	−52.01	1.05 h *3*	ε
		175	7/2+	−52.5s	10.5 h *2*	ε
		176	(1)−	−51.5	8.09 h *5*	ε
		177	7/2+	−51.724	56.56 h *6*	ε
		178	1+	−50.5	9.31 m *3*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
73	**Ta**	178	(7)–	–50.5	2.36 h *8*	ε
		178m	(15–)	–49.1	60 ms *5*	IT
		179	7/2+	–50.362	1.82 y *3*	ε
		179m	(25/2+)	–49.044	9.0 ms *2*	IT
		179m	(37/2+)	–47.721	52 ms *3*	IT
		180	1+	–48.936	8.152 h *6*	ε 86%, β– 14%
		180m	9–	–48.861	$>1.2\times10^{15}$ y	β–? , ε?
		181	7/2+	–48.441	**99.988% *2***	
		182	3–	–46.433	114.43 d *3*	β–
		182m	5+	–46.417	283 ms *3*	IT
		182m	10–	–45.913	15.84 m *10*	IT
		183	7/2+	–45.296	5.1 d *1*	β–
		184	(5–)	–42.84	8.7 h *1*	β–
		185	(7/2+)	–41.40	49.4 m *15*	β–
		186	2,3	–38.61	10.5 m *5*	β–
		187		–36.9s		
74	**W**	158	0+	–24.3s	0.9 ms *3*	α
		159		–25.8s	7.3 ms *27*	α≈99.5%, ε≈0.5%
		160	0+	–29.5s	81 ms *15*	α≥54%
		161		–30.7s	410 ms *40*	α≈82%, ε≈18%
		162	0+	–34.1s	1.39 s *4*	ε 53%, α 47%
		163		–35.1s	2.75 s *25*	ε 59%, α 41%
		164	0+	–38.28	6.4 s *8*	ε 97.4%, α 2.6%
		165		–38.81	5.1 s *5*	ε , α<0.2%
		166	0+	–41.90	18.8 s *4*	ε 99.97%, α 0.04%
		167		–42.2s	19.9 s *5*	α, ε
		168	0+	–44.8s	51 s *2*	ε≈100%, α 3.2×10^{-3}%
		169	(5/2–)	–44.9s	80 s *6*	ε
		170	0+	–47.2s	2.42 m *4*	ε
		171	(5/2–)	–47.2s	2.38 m *4*	ε
		172	0+	–49.0s	6.6 m *9*	ε
		173	5/2–	–48.5s	7.6 m *2*	ε
		174	0+	–50.2s	31 m *1*	ε
		175	(1/2–)	–49.6s	35.2 m *6*	ε
		176	0+	–50.7s	2.5 h *1*	ε
		177	(1/2–)	–49.7s	135 m *3*	ε
		178	0+	–50.4	21.6 d *3*	ε
		179	(7/2)–	–49.30	37.05 m *16*	ε
		179m	(1/2)–	–49.08	6.40 m *7*	IT 99.72%, ε 0.28%
		180	0+	–49.644	**0.120% *1***	
		180m	8–	–48.114	5.47 ms *9*	IT
		181	9/2+	–48.253	121.2 d *2*	ε
		182	0+	–48.246	**26.498% *29***	
		183	1/2–	–46.366	$>1.1\times10^{17}$ y **14.314% *4***	
		183m	11/2+	–46.057	5.2 s *3*	IT
		184	0+	–45.706	$>3\times10^{17}$ y **30.642% *8***	α?
		185	3/2–	–43.389	75.1 d *3*	β–
		185m	11/2+	–43.192	1.67 m *3*	IT
		186	0+	–42.512	**28.426% *37***	

Nuclear Wallet Cards

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
74	**W**	187	3/2–	–39.907	23.72 h *6*	β–
		188	0+	–38.669	69.4 d *5*	β–
		189	(3/2–)	–35.5	11.5 m *3*	β–
		190	0+	–34.3	30.0 m *15*	β–
75	**Re**	160		–17.2s	0.64 ms *8*	p 89%, α 11%
		161		–20.8s	15 ms *4*	α≈100%
		162		–22.6s	0.10 s *3*	ε<97%, α>3%
		163		–26.0s	260 ms *40*	α 64%, ε 36%
		164		–27.5s	0.88 s *24*	α≈58%, ε≈42%
		165		–30.69	2.4 s *6*	ε 87%, α 13%
		166		–31.9s	2.8 s *3*	α
		167	(1/2)	–34.8s	3.4 s *4*	α≈100%
		167	(1/2)	–34.8s	6.2 s *5*	ε≈99%, α≈1%
		168	(5+,6+,7+)	–35.8s	4.4 s *1*	ε≈100%, α≈5.0×10^{-3}%
		169		–38.3s	8.1 s *5*	ε≈100%, α≈1.0×10^{-4}%
		169m		–38.3s	16.3 s *8*	α≈100%
		170	(5+)	–39.0s	9.2 s *2*	ε
		171	(9/2–)	–41.5s	15.2 s *4*	ε
		172m	(5)	–41.6s	15 s *3*	ε
		172m	(2)	–41.6s	55 s *5*	ε
		173	(5/2–)	–43.7s	1.98 m *26*	ε
		174		–43.7s	2.40 m *4*	ε
		175	(5/2–)	–45.3s	5.89 m *5*	ε
		176	3(+)	–45.1s	5.3 m *3*	ε
		177	(5/2–)	–46.3s	14 m *1*	ε
		178	(3+)	–45.8	13.2 m *2*	ε
		179	(5/2)+	–46.59	19.5 m *1*	ε
		180	(1)–	–45.84	2.44 m *6*	ε
		181	5/2+	–46.51	19.9 h *7*	ε
		182	7+	–45.4	64.0 h *5*	ε
		182m	2+	–45.4	12.7 h *2*	ε
		183	5/2+	–45.810	70.0 d *14*	ε
		184	3(–)	–44.223	38.0 d *5*	ε
		184m	8(+)	–44.035	169 d *8*	IT 75.4%, ε 24.6%
		185	5/2+	–43.822	**37.40% *2***	
		186	1–	–41.930	89.25 h *7*	β– 93.1%
		186	1–	–41.930	90.64 h *9*	ε 6.9%
		186m	(8+)	–41.781	2.0×10^{5} y *5*	IT, β–<10%
		187	5/2+	–41.218	4.35×10^{10} y *13* **62.60% *2***	β–, α<1.0×10^{-4}%
		188	1–	–39.018	17.021 h *25*	β–
		188m	(6)–	–38.846	18.59 m *4*	IT
		189	5/2+	–37.979	24.3 h *4*	β–
		190	(2)–	–35.6	3.1 m *3*	β–
		190m	(6–)	–35.4	3.2 h *2*	β– 54.4%, IT 45.6%
		191	(3/2+,1/2+)	–34.35	9.8 m *5*	β–
		192		–31.7s	16 s *1*	β–
		193		–30.3s		
76	**Os**	162	0+	–15.1s	1.9 ms *7*	α
		163		–16.7s	?	α, ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
76	**Os**	164	0+	–20.6s	41 ms *20*	α≈98%, ε≈2%
		165		–21.9s	73 ms *8*	α>60%, ε<40%
		166	0+	–25.6s	194 ms *17*	α 72%, ε 18%
		167		–26.7s	0.83 s *12*	α 67%, ε 33%
		168	0+	–30.04	2.2 s *1*	ε 51%, α 49%
		169		–30.7	3.4 s *2*	ε 89%, α 11%
		170	0+	–33.93	7.1 s *2*	ε 88%, α 12%
		171	(5/2–)	–34.4s	8.0 s *7*	ε 98.3%, α 1.7%
		172	0+	–37.2s	19.2 s *5*	ε 99.8%, α 0.2%
		173	(5/2–)	–37.5s	16 s *5*	ε 99.98%, α 0.02%
		174	0+	–39.9s	44 s *4*	ε 99.98%, α 0.02%
		175	(5/2–)	–40.0s	1.4 m *1*	ε
		176	0+	–41.9s	3.6 m *5*	ε
		177	(1/2–)	–41.8s	2.8 m *3*	ε
		178	0+	–43.4	5.0 m *4*	ε
		179	(1/2–)	–42.9s	6.5 m *3*	ε
		180	0+	–44.4s	21.5 m *4*	ε
		181	1/2–	–43.6s	105 m *3*	ε
		181m	(7/2)–	–43.5s	2.7 m *1*	ε
		182	0+	–44.54	22.10 h *25*	ε
		183	9/2+	–43.7s	13.0 h *5*	ε
		183m	1/2–	–43.5s	9.9 h *3*	ε 85%, IT 15%
		184	0+	–44.255	$>5.6\times10^{13}$ y	
					0.020% *3*	
		185	1/2–	–42.809	93.6 d *5*	ε
		186	0+	–43.000	2.0×10^{15} y *11*	α
					1.58% *10*	
		187	1/2–	–41.221	**1.6% *1***	
		188	0+	–41.139	**13.3% *2***	
		189	3/2–	–38.988	**16.1% *3***	
		189m	9/2–	–38.957	5.8 h *1*	IT
		190	0+	–38.708	**26.4% *4***	
		190m	(10)–	–37.003	9.9 m *1*	IT
		191	9/2–	–36.396	15.4 d *1*	β–
		191m	3/2–	–36.322	13.10 h *5*	IT
		192	0+	–35.882	**41.0% *3***	
		192m	(10–)	–33.867	5.9 s *1*	IT>87%, β–<13%
		193	3/2–	–33.396	30.11 h *1*	β–
		194	0+	–32.436	6.0 y *2*	β–
		195		–29.7	6.5 m	β–
		196	0+	–28.30	34.9 m *2*	β–
77	**Ir**	166		–13.5s	>5 ms	α 99%
		167		–17.1s	>5 ms	α≤100%, p
		168		–18.7s	?	α≤100%
		169		–21.99	0.4 s *1*	α≈100%, ε, p
		170		–23.3s	1.05 s *15*	α 75%, ε 25%
		171		–26.3s	1.5 s *1*	α≈100%, ε, p
		172	(3+)	–27.3s	4.4 s *3*	ε 98%, α≈2%
		172m	(7+)	–27.2s	2.0 s *1*	ε 77%, α 23%
		173m	(3/2+,5/2+)	–30.1s	9.0 s *8*	ε>93%, α<7%
		173m	(11/2–)	–30.1s	2.20 s *5*	ε 88%, α 12%
		174	(3+)	–30.9s	9 s *2*	ε 99.6%, α 0.4%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
77	**Ir**	174m	(7+)	–30.7s	4.9 s *3*	ε 97.48%, α 00.52%
		175	(5/2–)	–33.4s	9 s *2*	ε 99.15%, α 0.85%
		176		–34.0s	8 s *1*	ε 97.9%, α 2.1%
		177	(5/2–)	–36.2s	30 s *2*	ε 99.94%, α 0.06%
		178		–36.3s	12 s *2*	ε
		179	(5/2)–	–38.1s	79 s *1*	ε
		180		–38.0s	1.5 m *1*	ε
		181	(5/2)–	–39.5s	4.90 m *15*	ε
		182	(5+)	–38.9	15 m *1*	ε
		183	5/2–	–40.2s	57 m *4*	ε
		184	5–	–39.7	3.09 h *3*	ε
		185	5/2–	–40.4s	14.4 h *1*	ε
		186	5+	–39.17	16.64 h *3*	ε
		186m	2–	–39.17	2.0 h *1*	ε≥100%, IT>0%
		187	3/2+	–39.718	10.5 h *3*	ε
		187m	9/2–	–39.532	30.3 ms *6*	IT
		188	1–	–38.329	41.5 h *5*	ε
		188m		–38.329	4.2 ms *2*	IT
		189	3/2+	–38.46	13.2 d *1*	ε
		190	(4)+	–36.7	11.78 d *10*	ε
		190m	(7)+	–36.7	1.2 h	IT
		190m	(11)–	–36.5	3.25 h *20*	ε 94.4%, IT 5.6%
		191	3/2+	–36.709	**37.3% *5***	
		191m	11/2–	–36.539	4.94 s *3*	IT
		191m		–34.662	5.5 s *7*	IT
		192	4(+)	–34.836	73.830 d *18*	β– 95.24%, ε 4.76%
		192m	1(–)	–34.779	1.45 m *5*	IT 99.98%, β– 0.02%
		192m	(9)	–34.681	241 y *9*	IT
		193	3/2+	–34.537	**62.7% *5***	
		193m	11/2–	–34.457	10.53 d *4*	IT
		194	1–	–32.532	19.15 h *3*	β–
		194m	(10,11)	–32.342	171 d *11*	β–
		195	3/2+	–31.693	2.5 h *2*	β–
		195m	11/2–	–31.593	3.8 h *2*	β– 95%, IT 5%
		196	(0–)	–29.45	52 s *1*	β–
		196m	(10,11–)	–29.04	1.40 h *2*	β–≈100%, IT<0.3%
		197	3/2+	–28.28	5.8 m *5*	β–
		197m	11/2–	–28.17	8.9 m *3*	β– 99.75%, IT 0.25%
		198		–25.8s	8 s *1*	β–
78	**Pt**	168	0+	–11.1s	?	α≤100%
		169		–12.6s	2.5 ms *+25–10*	α≤100%
		170	0+	–16.5s	6 ms *+5–2*	α
		171		–17.6s	25 ms *9*	α≈99%, ε≈1%
		172	0+	–21.15	0.104 s *7*	α 94%, ε 6%
		173		–21.9	342 ms *18*	α 84%, ε 16%
		174	0+	–25.32	0.90 s *1*	α 83%, ε 17%
		175		–25.8s	2.52 s *8*	α 64%, ε 36%
		176	0+	–28.9s	6.33 s *15*	ε 62%, α 38%
		177	(5/2–)	–29.4s	11 s *1*	ε 94.4%, α 5.6%
		178	0+	–31.9s	21.1 s *6*	ε 92.3%, α 7.7%
		179	1/2–	–32.3s	21.2 s *4*	ε 99.76%, α 0.24%
		180	0+	–34.3s	52 s *3*	ε , α≈0.3%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
78	**Pt**	181	1/2−	−34.3s	51 s *5*	ε , α≈0.06%
		182	0+	−36.1	2.2 m *1*	ε 99.96%, α 0.04%
		183	1/2−	−35.7s	6.5 m *10*	ε , α≈1.3×10^{-3}%
		183m	(7/2)−	−35.6s	43 s *5*	ε , α<4.0×10^{-4}% , IT
		184	0+	−37.4s	17.3 m *2*	ε , α≈0.001%
		185	9/2+	−36.6s	70.9 m *24*	ε , α?
		185m	1/2−	−36.5s	33.0 m *8*	ε>98%, IT<2%, α?
		186	0+	−37.79	2.0 h *1*	ε , α≈1.4×10^{-4}%
		187	3/2−	−36.6s	2.35 h *3*	ε
		188	0+	−37.823	10.2 d *3*	ε , α 2.6×10^{-5}%
		189	3/2−	−36.49	10.87 h *12*	ε
		190	0+	−37.325	6.5×10^{11} y *3*	α
					0.01% *1*	
		191	3/2−	−35.691	2.96 d *4*	ε
		192	0+	−36.296	**0.79% *6***	
		193	1/2−	−34.480	50 y *9*	ε
		193m	13/2+	−34.330	4.33 d *3*	IT
		194	0+	−34.779	**32.9% *6***	
		195	1/2−	−32.813	**33.8% *6***	
		195m	13/2+	−32.554	4.02 d *1*	IT
		196	0+	−32.664	**25.3% *6***	
		197	1/2−	−30.439	19.8915 h *19*	β−
		197m	13/2+	−30.039	95.41 m *18*	IT 96.7%, β− 3.3%
		198	0+	−29.924	**7.2% *2***	
		199	5/2−	−27.409	30.80 m *21*	β−
		199m	(13/2)+	−26.985	13.6 s *4*	IT
		200	0+	−26.62	12.5 h *3*	β−
		201	(5/2−)	−23.74	2.5 m *1*	β−
		202	0+		44 h *15*	β−
79	**Au**	171				α , p
		172		−9.2s	4 ms *1*	α≤100%, p<2%
		173		−12.7	59 ms *+45−18*	α≤100%
		174		−14.0s	120 ms *20*	α>0%
		175		−17.1s	200 ms *22*	α 94%, ε 6%
		176		−18.4s	1.25 s *30*	α , ε
		177		−21.2s	1.18 s *7*	ε≥60%, α≤40%
		178		−22.4s	2.6 s *5*	ε≤60%, α≥40%
		179		−24.9s	7.1 s *3*	ε 78%, α 22%
		180		−25.7s	8.1 s *3*	ε≤98.2%, α≥1.8%
		181	5/2−	−28.0s	11.4 s *5*	ε 98.5%, α 1.5%
		182		−28.3s	15.6 s *4*	ε 99.87%, α 0.13%
		183	(5/2)−	−30.2s	42.0 s *12*	ε 99.64%, α 0.36%
		184	5+	−30.2s	12.0 s *2*	ε
		184m	2+	−30.2s	53.0 s *14*	ε 99.98%, α 0.02%, IT
		185	5/2−	−31.9s	4.25 m *6*	ε 99.74%, α 0.26%
		185m		−31.9s	6.8 m *3*	ε<100%, IT
		186	3−	−31.7	10.7 m *5*	ε
		187	1/2+	−33.0s	8.4 m *3*	ε , α 3.0×10^{-3}%
		187m	9/2−	−32.9s	2.3 s *1*	IT
		188	1(−)	−32.5s	8.84 m *6*	ε
		189	1/2+	−33.6s	28.7 m *3*	ε , α<3.0×10^{-5}%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
79	**Au**	189m	11/2−	−33.4s	4.59 m *11*	ε , IT > 0%
		190	1−	−32.88	42.8 m *10*	ε , α < 1.0×10^{-6}%
		190m	(11−)	−32.88	125 ms *20*	IT?
		191	3/2+	−33.86	3.18 h *8*	ε
		191m	(11/2−)	−33.59	0.92 s *11*	IT
		192	1−	−32.78	4.94 h *9*	ε
		192m	(11−)	−32.78	160 ms *20*	IT?
		193	3/2+	−33.412	17.65 h *15*	ε
		193m	11/2−	−33.122	3.9 s *3*	IT 99.97%, ε ≈ 0.03%
		194	1−	−32.29	38.02 h *10*	ε
		194m	(5+)	−32.18	600 ms *8*	IT
		194m	(11−)	−31.81	420 ms *10*	IT
		195	3/2+	−32.586	186.10 d *5*	ε
		195m	11/2−	−32.267	30.5 s *2*	IT
		196	2−	−31.158	6.183 d *10*	ε 92.5%, β− 7.5%
		196m	5+	−31.073	8.1 s *2*	IT
		196m	12−	−30.562	9.7 h *1*	IT
		197	3/2+	−31.157	**100%**	
		197m	11/2−	−30.749	7.73 s *6*	IT
		198	2−	−29.598	2.69517 d *21*	β−
		198m	(12−)	−28.786	2.27 d *2*	IT
		199	3/2+	−29.111	3.139 d *7*	β−
		200	1(−)	−27.28	48.4 m *3*	β−
		200m	12−	−26.31	18.7 h *5*	β− 82%, IT 18%
		201	3/2+	−26.40	26 m *1*	β−
		202	(1−)	−24.4	28.8 s *19*	β−
		203	3/2+	−23.14	60 s *6*	β−
		204	(2−)	−20.9s	39.8 s *9*	β−
		205	3/2+		31 s *2*	β−
80	**Hg**	174	0+	−6.8s		
		175		−8.2s	20 ms *+40−13*	α
		176	0+	−11.80	34 ms *+18−9*	α ≈ 100%
		177		−12.7	0.130 s *5*	α 85%, ε 15%
		178	0+	−16.32	0.254 s *19*	α ≈ 70%, ε ≈ 30%
		179		−17.0s	1.09 s *4*	α ≈ 53%, ε ≈ 47%, εp ≈ 0.15%
		180	0+	−20.2s	3.0 s *2*	ε 51%, α 49%
		181	1/2(−)	−20.7s	3.6 s *3*	ε 64%, α 36%
		182	0+	−23.5s	10.83 s *6*	ε 84.8%, α 15.2%
		183	1/2−	−23.9s	9.4 s *7*	ε 74.5%, α 25.5%, εp 0.06%
		184	0+	−26.2s	30.6 s *3*	ε 98.89%, α 1.11%
		185	1/2−	−26.1s	49.1 s *10*	ε 94%, α 6%
		185m	13/2+	−26.0s	21.6 s *15*	IT 54%, ε 46%, α ≈ 0.03%
		186	0+	−28.4	1.38 m *7*	ε 99.98%, α 0.02%
		187	13/2+	−28.1s	2.4 m *3*	ε , α > 1.2×10^{-4}%
		187m	3/2−	−28.1s	1.9 m *3*	ε , α > 2.5×10^{-4}%
		188	0+	−30.2s	3.25 m *15*	ε , α 3.7×10^{-5}%
		189	3/2−	−29.7s	7.6 m *1*	ε , α < 3.0×10^{-5}%
		189m	13/2+	−29.7s	8.6 m *1*	ε , α < 3.0×10^{-5}%
		190	0+	−31.4s	20.0 m *5*	ε , α < 5.0×10^{-5}%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
80	**Hg**	191	(3/2−)	−30.68	49 m *10*	ε
		191m	13/2+	−30.68	50.8 m *15*	ε
		192	0+	−32.1s	4.85 h *20*	ε
		193	3/2−	−31.07	3.80 h *15*	ε
		193m	13/2+	−30.93	11.8 h *2*	ε 92.9%, IT 7.1%
		194	0+	−32.25	520 y *32*	ε
		195	1/2−	−31.08	9.9 h *5*	ε
		195m	13/2+	−30.90	41.6 h *8*	IT 54.2%, ε 45.8%
		196	0+	−31.844	**0.15% *1***	
		197	1/2−	−30.558	64.14 h *5*	ε
		197m	13/2+	−30.259	23.8 h *1*	IT 91.4%, ε 8.6%
		198	0+	−30.971	**9.97% *8***	
		199	1/2−	−29.563	**16.87% *10***	
		199m	13/2+	−29.031	42.6 m *2*	IT
		200	0+	−29.520	**23.10% *16***	
		201	3/2−	−27.679	**13.18% *8***	
		202	0+	−27.362	**29.86% *20***	
		203	5/2−	−25.284	46.612 d *18*	β−
		204	0+	−24.708	**6.87% *4***	
		205	1/2−	−22.304	5.2 m *1*	β−
		206	0+	−20.96	8.15 m *10*	β−
		207	(9/2+)	−16.3	2.9 m *2*	β−
		208	0+		42 m *+23−12*	β−
81	**Tl**	176		0.6s		
		177		−2.9s	<1 μs	
		178		−4.4s		
		179		−7.8s	0.16 s *+9−4*	α≈100%
		179m	(9/2−)	−7.8s	1.4 ms *5*	α≈100%
		180		−9.1s	1.9 s *9*	εSF≈1×10^{-4}%, α, ε
		181	(1/2+)	−12.2s	3.4 s *6*	ε?
		182	(7+)	−13.4s	3.1 s *10*	ε>96%, α<4%
		183	(1/2+)	−16.2s	6.9 s *7*	ε>0%
		183m	(9/2−)	−15.7s	60 ms *15*	IT?, α<0.01%
		184	(2+)	−17.0s	11 s *1*	ε 97.9%, α 2.1%
		185	(1/2+)	−19.5s	19.5 s *5*	ε
		185m	(9/2−)	−19.0s	1.83 s *12*	α, IT
		186	(7+)	−20.0s	27.5 s *10*	ε, α 6.0×10^{-4}%
		186m	(10−)	−19.6s	2.9 s *2*	IT
		187	(1/2+)	−22.2s	≈51 s	ε<100%, α>0%
		187m	(9/2−)	−21.9s	15.60 s *12*	ε<100%, IT<100%, α>0%
		188m	(2−)	−22.4s	71 s *2*	ε
		188m	(7+)	−22.4s	71 s *1*	ε
		189	(1/2+)	−24.5s	2.3 m *2*	ε
		189m	(9/2−)	−24.2s	1.4 m *1*	ε, IT<4%
		190m	(2)−	−24.4s	2.6 m *3*	ε
		190m	(7+)	−24.4s	3.7 m *3*	ε
		191	(1/2+)	−26.2s	?	ε?
		191m	9/2(−)	−25.9s	5.22 m *16*	ε
		192m	(2−)	−25.9s	9.6 m *4*	ε
		192m	(7+)	−25.9s	10.8 m *2*	ε
		193	1/2(+)	−27.4s	21.6 m *8*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
81	**Tl**	193m	(9/2−)	−27.1s	2.11 m *15*	IT 75%, ε 25%
		194	2−	−27.0s	33.0 m *5*	ε , α<1.0×10^{-7}%
		194m	(7+)	−27.0s	32.8 m *2*	ε
		195	1/2+	−28.3s	1.16 h *5*	ε
		195m	9/2−	−27.8s	3.6 s *4*	IT
		196	2−	−27.5s	1.84 h *3*	ε
		196m	(7+)	−27.1s	1.41 h *2*	ε 95.5%, IT 4.5%
		197	1/2+	−28.37	2.84 h *4*	ε
		197m	9/2−	−27.77	0.54 s *1*	IT
		198	2−	−27.51	5.3 h *5*	ε
		198m	7+	−26.97	1.87 h *3*	ε 54%, IT 46%
		199	1/2+	−28.12	7.42 h *8*	ε
		200	2−	−27.064	26.1 h *1*	ε
		201	1/2+	−27.20	72.912 h *17*	ε
		201m	(9/2−)	−26.28	2.035 ms *7*	IT
		202	2−	−26.00	12.23 d *2*	ε
		203	1/2+	−25.776	**29.524%** ***14***	
		204	2−	−24.360	3.78 y *2*	β− 97.1%, ε 2.9%
		205	1/2+	−23.835	**70.476%** ***14***	
		206	0−	−22.268	4.199 m *15*	β−
		206m	(12−)	−19.625	3.74 m *3*	IT
		207	1/2+	−21.045	4.77 m *2*	β−
		207m	11/2−	−19.697	1.33 s *11*	IT
		208	5(+)	−16.763	3.053 m *4*	β−
		209	(1/2+)	−13.648	2.20 m *7*	β−
		210	(5+)	−9.26	1.30 m *3*	β−, β−n 7.0×10^{-3}%
82	**Pb**	178	0+	3.4s		
		179		2.0s		
		180	0+	−1.92s		
		181	(13/2+)	−2.9	45 ms *20*	α<100%, ε≈2%
		182	0+	−6.82	55 ms *+40−35*	α≤100%
		183	(1/2−)	−7.5s	300 ms *80*	α≈94%, ε≈6%
		184	0+	−11.0s	0.55 s *6*	α, ε ?
		185		−11.6s	4.1 s *3*	α≤100%
		186	0+	−14.6s	4.7 s *1*	α<100%
		187m		−15.0s	15.2 s *3*	α, ε
		187m	(13/2+)	−15.0s	18.3 s *3*	ε>90%, α<10%
		188	0+	−17.6s	25.5 s *1*	ε 78%, α 22%
		189		−17.8s	51 s *3*	ε>99%, α≈0.4%
		190	0+	−20.3	1.2 m *1*	ε 99.1%, α 0.9%
		191	(3/2−)	−20.3s	1.33 m *8*	ε 99.99%, α 0.01%
		191m	(13/2+)	−20.2s	2.18 m *8*	ε , α≈0.02%
		192	0+	−22.6s	3.5 m *1*	ε 99.99%, α 6.2×10^{-3}%
		193	(3/2−)	−22.3s	?	ε
		193m	(13/2+)	−22.2s	5.8 m *2*	ε
		194	0+	−24.2s	12.0 m *5*	ε , α 7.3×10^{-6}%
		195	3/2−	−23.8s	≈15 m	ε
		195m	13/2+	−23.6s	15.0 m *12*	ε
		196	0+	−25.4s	37 m *3*	ε≈100%, α≤3.0×10^{-5}%
		197	3/2−	−24.8s	8 m *2*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
82	**Pb**	197m	13/2+	–24.5s	43 m *1*	ε 81%, IT 19%
		198	0+	–26.10s	2.40 h *10*	ε
		199	3/2–	–25.24	90 m *10*	ε
		199m	13/2+	–24.81	12.2 m *3*	IT 93%, ε 7%
		200	0+	–26.25	21.5 h *4*	ε
		201	5/2–	–25.29	9.33 h *3*	ε
		201m	13/2+	–24.66	61 s *2*	IT > 99%, ε < 1%
		202	0+	–25.948	52.5×10^{3} y *28*	ε , α < 1%
		202m	9–	–23.778	3.53 h *1*	IT 90.5%, ε 9.5%
		203	5/2–	–24.801	51.873 h *9*	ε
		203m	13/2+	–23.976	6.3 s *2*	IT
		203m	29/2–	–21.852	0.48 s *2*	IT
		204	0+	–25.124	$\geq1.4\times10^{17}$ y **1.4%** *1*	α?
		204m	9–	–22.938	67.2 m *3*	IT
		205	5/2–	–23.784	1.53×10^{7} y *7*	ε
		206	0+	–23.801	**24.1%** *1*	
		207	1/2–	–22.467	**22.1%** *1*	
		207m	13/2+	–20.834	0.806 s *6*	IT
		208	0+	–21.764	**52.4%** *1*	
		209	9/2+	–17.628	3.253 h *14*	β–
		210	0+	–14.742	22.3 y *2*	β– , α 1.9×10^{-6}%
		211	9/2+	–10.496	36.1 m *2*	β–
		212	0+	–7.557	10.64 h *1*	β–
		213	(9/2+)	–3.2s	10.2 m *3*	β–
		214	0+	–0.189	26.8 m *9*	β–
83	**Bi**	185		–1.8s		
		186		–3.3s		
		187	(9/2–)	–6.1s	35 ms *4*	α > 50%
		187m	(1/2+)	–6.0s	0.8 ms *6*	α > 50%
		188m		–7.3s	44 ms *3*	α, ε
		188m		–7.3s	0.21 s *9*	α, ε
		189	(9/2–)	–9.8s	680 ms *30*	α > 50%, ε < 50%
		189m	(1/2+)	–9.7s	7.0 ms *2*	α > 50%, ε < 50%
		190m	(3+)	–10.7s	5.7 s *8*	α ≈ 90%, ε ≈ 10%
		190m	(10–)	–10.7s	5.9 s *6*	α 70%, ε 30%
		191	(9/2–)	–13.0s	12 s *1*	α 60%, ε 40%
		191m	(1/2+)	–12.7s	150 ms *15*	α 75%, ε ≤ 25%
		192	(3+)	–13.6s	34.6 s *9*	ε 88%, α 12%
		192m	(10–)	–13.5s	40.6 s *4*	ε 90%, α 10%
		193	(9/2–)	–15.8s	67 s *3*	ε 95%, α 5%
		193m	(1/2+)	–15.5s	3.2 s *7*	α 90%, ε ≈ 10%
		194	(3+)	–16.1s	95 s *3*	ε , α 0.46%
		194m	(6+,7+)	–16.1s	92 s *5*	ε 99.93%, α 0.07%
		194m	(10–)	–16.1s	115 s *4*	ε 99.8%, α 0.2%
		195	(9/2–)	–17.9s	183 s *4*	ε 99.97%, α 0.03%
		195m	(1/2+)	–17.5s	87 s *1*	ε 67%, α 33%
		196	(3+)	–18.1	308 s *12*	ε ≈ 100%, α 1.2×10^{-3}%
		196m	(7+)	–17.9	0.6 s *5*	ε > 0%
		196m	(10–)	–17.8	240 s *3*	ε 74.2%, IT 25.8%, α 3.8×10^{-4}%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
83	**Bi**	197	(9/2−)	−19.6	9.33 m *50*	ε , α 1.0×10^{-4}%
		197m	(1/2+)	−19.1	5.04 m *16*	α 55%, ε 45%, IT<0.3%
		198	(2+,3+)	−19.5	10.3 m *3*	ε
		198m	(7+)	−19.5	11.6 m *3*	ε
		198m	(10−)	−19.3	7.7 s *5*	IT
		199	9/2−	−20.89	27 m *1*	ε
		199m	(1/2+)	−20.21	24.70 m *15*	ε≥98%, IT≤2%, α≈0.01%
		200	7+	−20.36	36.4 m *5*	ε
		200m	(2+)	−20.36	31 m *2*	ε>90%, IT<10%
		200m	(10−)	−19.93	0.40 s *5*	IT
		201	9/2−	−21.45	108 m *3*	ε , α<1.0×10^{-4}%
		201m	1/2+	−20.60	59.1 m *6*	ε>93%, IT≤6.8%, α≈0.3%
		202	5+	−20.79	1.72 h *5*	ε , α<1×10^{-5}%
		203	9/2−	−21.55	11.76 h *5*	ε , α≈1.0×10^{-5}%
		203m	1/2+	−20.45	303 ms *5*	IT
		204	6+	−20.69	11.22 h *10*	ε
		205	9/2−	−21.076	15.31 d *4*	ε
		206	6(+)	−20.043	6.243 d *3*	ε
		207	9/2−	−20.069	31.55 y *5*	ε
		208	(5)+	−18.884	3.68×10^{5} y *4*	ε
		209	9/2−	−18.272	**100%**	
		210	1−	−14.806	5.013 d *5*	β− , α 1.3×10^{-4}%
		210m	9−	−14.535	3.04×10^{6} y *6*	α
		211	9/2−	−11.869	2.14 m *2*	α 99.72%, β− 0.28%
		212	1(−)	−8.131	60.55 m *6*	β− 64.06%, α 35.94%, β−α 0.014%
		212m	(9−)	−7.881	25.0 m *2*	α 67%, β− 33%
		212m		−6.221	7.0 m *3*	β−≈100%
		213	9/2−	−5.241	45.59 m *6*	β− 97.91%, α 2.09%
		214	1−	−1.21	19.9 m *4*	β− 99.98%, α 0.02%
		215		1.71	7.6 m *2*	β−
		216		5.8s	3.6 m *4*	β−
84	**Po**	190	0+	−4.6s	9.6 ms *+47−44*	α
		191		−5.1s	15.5 ms *+60−35*	α
		192	0+	−7.9s	0.034 s *3*	α≈99%, ε≈1%
		193		−8.3s	0.45 s *4*	α
		193m		−8.3s	0.24 s *1*	α
		194	0+	−10.9	0.392 s *4*	α
		195	(3/2−)	−11.1s	4.64 s *9*	α 75%, ε 25%
		195m	(13/2+)	−10.9s	1.92 s *2*	α≈90%, ε≈10%, IT<0.01%
		196	0+	−13.5s	5.8 s *2*	α≈98%, ε≈2%
		197	(3/2−)	−13.4s	53.6 s *10*	ε 56%, α 44%
		197m	(13/2+)	−13.2s	25.8 s *2*	α 84%, ε 16%, IT 0.01%
		198	0+	−15.5s	1.76 m *3*	α 57%, ε 43%
		199	(3/2−)	−15.3s	5.48 m *16*	ε 92.5%, α 7.5%
		199m	13/2+	−15.0s	4.17 m *4*	ε 73.5%, α 24%, IT 2.5%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
84	**Po**	200	0+	–17.0s	11.5 m *1*	ε 88.9%, α 11.1%
		201	3/2–	–16.6s	15.3 m *2*	ε 98.4%, α 1.6%
		201m	13/2+	–16.1s	8.9 m *2*	IT 56%, ε 41%, α≈2.9%
		202	0+	–17.98s	44.7 m *5*	ε 98%, α 2%
		203	5/2–	–17.31	36.7 m *5*	ε 99.89%, α 0.11%
		203m	13/2+	–16.67	45 s *2*	IT≈100%, α≈0.04%
		204	0+	–18.34	3.53 h *2*	ε 99.34%, α 0.66%
		205	5/2–	–17.54	1.66 h *2*	ε 99.96%, α 0.04%
		206	0+	–18.197	8.8 d *1*	ε 94.55%, α 5.45%
		207	5/2–	–17.160	5.80 h *2*	ε 99.98%, α 0.02%
		207m	19/2–	–15.777	2.79 s *8*	IT
		208	0+	–17.483	2.898 y *2*	α, ε
		209	1/2–	–16.380	102 y *5*	α 99.52%, ε 0.48%
		210	0+	–15.969	138.376 d *2*	α
		211	9/2+	–12.448	0.516 s *3*	α
		211m	(25/2+)	–10.986	25.2 s *6*	α 99.98%, IT 0.02%
		212	0+	–10.385	0.299 μs *2*	α
		212m	(18+)	–7.463	45.1 s *6*	α 99.93%, IT 0.07%
		213	9/2+	–6.667	4.2 μs *8*	α
		214	0+	–4.484	164.3 μs *20*	α
		214m	0+	–3.069	99 ps *3*	IT 99.86%, α 0.14%
		215	9/2+	–0.545	1.781 ms *4*	α, β– 2.3×10^{-4}%
		216	0+	1.774	0.145 s *2*	α
		217		5.9s	<10 s	α>95%, β–<5%
		218	0+	8.351	3.10 m *1*	α 99.98%, β– 0.02%
85	**At**	194		–0.8s	0.18 s *8*	α
		195		–3.2s	?	α>75%, ε<25%
		196		–4.0s	0.3 s *1*	α>0%
		197	(9/2–)	–6.3s	0.35 s *4*	α 96%, ε 4%
		197m	(1/2+)	–6.2s	3.7 s *25*	α≤100%, ε
		198	(3+)	–6.7s	4.2 s *3*	α 90%, ε 10%
		198m	(10–)	–6.6s	1.0 s *2*	α 84%, ε 16%
		199	(9/2–)	–8.7s	7.2 s *5*	α 90%, ε 10%
		200	(3+)	–9.0	43 s *1*	α 57%, ε 43%
		200m	(7+)	–8.9	47 s *1*	ε≈57%, α 43%
		200m	(10–)	–8.7	3.5 s *2*	IT≈84%, α≈10.5%, ε≈4.5%
		201	(9/2–)	–10.7	89 s *3*	α 71%, ε 29%
		202	(2+,3+)	–10.8	184 s *1*	ε≤87%, α≥13%
		202m	(7+)	–10.7	182 s *2*	ε 91.3%, α 8.7%
		202m	(10–)	–10.3	0.46 s *5*	IT, α 9.6×10^{-2}%
		203	9/2–	–12.26	7.4 m *2*	ε 69%, α 31%
		204	7+	–11.87	9.2 m *2*	ε 96.2%, α 3.8%
		204m	(10–)	–11.28	108 ms *10*	IT
		205	9/2–	–13.01	26.2 m *5*	ε 90%, α 10%
		206	(5)+	–12.48	30.0 m *6*	ε 99.11%, α 0.89%
		207	9/2–	–13.25	1.80 h *4*	ε 91.4%, α 8.6%
		208	6+	–12.51	1.63 h *3*	ε 99.45%, α 0.55%
		209	9/2–	–12.894	5.41 h *5*	ε 95.9%, α 4.1%
		210	(5)+	–11.987	8.1 h *4*	ε 99.82%, α 0.18%
		211	9/2–	–11.661	7.214 h *7*	ε 58.2%, α 41.8%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
85	**At**	212	(1−)	−8.630	0.314 s *2*	α, ε < 0.03%, β− < 2.0×10^{-6}%
		212m	(9−)	−8.408	0.119 s *3*	α > 99%, IT < 1%
		213	9/2−	−6.594	125 ns *6*	α
		214	1−	−3.394	558 ns *10*	α
		214m		−3.335	265 ns *30*	α < 100%
		214m	9−	−3.163	760 ns *15*	α ≤ 100%
		215	9/2−	−1.266	0.10 ms *2*	α
		216	1(−)	2.243	0.30 ms *3*	α, ε < 0.006%, β− < 3×10^{-7}%
		217	9/2−	4.386	32.3 ms *4*	α 99.99%, β− 0.01%
		218	(2−)	8.09	1.6 s *4*	α 99.9%, β− 0.1%
		219		10.52	56 s *3*	α ≈ 97%, β− ≈ 3%
		220		14.3s	3.71 m *4*	β−
		221			2.3 m *2*	β−
		222			54 s *10*	β−
		223			50 s *7*	β−
86	**Rn**	198	0+	−1.1	?	α, ε
		198m	0+	−1.1	50 ms *9*	α, ε, IT
		199	(3/2−)	−1.6s	0.62 s *3*	α 94%, ε 6%
		199m	(13/2+)	−1.6s	0.32 s *2*	α 97%, ε 3%
		200	0+	−4.0s	1.06 s *2*	α ≈ 98%, ε ≈ 2%
		201	(3/2−)	−4.2s	7.0 s *4*	α ≈ 80%, ε ≈ 20%
		201m	(13/2+)	−3.9s	3.8 s *4*	α ≈ 90%, ε ≈ 10%, IT ≈ 0%
		202	0+	−6.3s	9.85 s *20*	ε < 30%, α
		203	(3/2,5/2)−	−6.2s	45 s *3*	α 66%, ε 34%
		203m	(13/2+)	−5.9s	28 s *2*	α ≈ 80%, ε ≈ 20%, IT < 0.1%
		204	0+	−8.0s	1.24 m *3*	α 73%, ε 27%
		205	5/2−	−7.8s	2.8 m *1*	ε 77%, α 23%
		206	0+	−9.17s	5.67 m *17*	α 62%, ε 38%
		207	5/2−	−8.64	9.25 m *17*	ε 79%, α 21%
		208	0+	−9.66	24.35 m *14*	α 62%, ε 38%
		209	5/2−	−8.96	28.5 m *10*	ε 83%, α 17%
		210	0+	−9.61	2.4 h *1*	α 96%, ε 4%
		211	1/2−	−8.770	14.6 h *2*	ε 72.7%, α 27.4%
		212	0+	−8.674	23.9 m *12*	α
		213	(9/2+)	−5.712	25.0 ms *2*	α
		214	0+	−4.335	0.27 μs *2*	α
		214m	6+	−2.892	0.7 ns *3*	IT < 100%, α > 0%
		214m	8+	−2.710	6.5 ns *30*	IT ≈ 90%, α ≈ 10%
		215	9/2+	−1.184	2.30 μs *10*	α
		216	0+	0.240	45 μs *5*	α
		217	9/2+	3.647	0.54 ms *5*	α
		218	0+	5.204	35 ms *5*	α
		219	5/2+	8.826	3.96 s *1*	α
		220	0+	10.604	55.6 s *1*	α
		221	7/2(+)	14.5s	25 m *2*	β− 78%, α 22%
		222	0+	16.366	3.8235 d *3*	α
		223	7/2		23.2 m *4*	β−
		224	0+		107 m *3*	β−

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
86	**Rn**	225	7/2−		4.5 m *3*	β−
		226	0+		6.0 m *5*	β−
		227			22.5 s *7*	β−
		228	0+		65 s *2*	β−
87	**Fr**	201	(9/2−)	3.7s	48 ms *15*	α, ε < 1%
		202	(3+)	3.1s	0.34 s *4*	α ≤ 97%, ε ≥ 3%
		202m	(10−)	3.2s	≈0.34 s	α ≤ 94%, ε ≥ 6%
		203	(9/2−)	1.0s	0.55 s *2*	α ≈ 95%, ε ≈ 5%
		204	(3+)	0.6	1.7 s *3*	α ≈ 80%, ε ≈ 20%
		204m	(7+)	0.6	2.6 s *3*	α ≤ 100%
		204m	(10−)	0.9	≈1 s	α ≤ 100%, IT
		205	(9/2−)	−1.2	3.85 s *10*	α, ε < 1%
		206	(2+,3+)	−1.4	15.9 s *2*	α, ε
		206m	(7+)	−1.4	15.9 s *?*	α ≤ 84%
		206m	(10−)	−0.8	0.7 s *1*	α, IT?
		207	9/2−	−2.93	14.8 s *1*	α 95%, ε 5%
		208	7+	−2.67	59.1 s *3*	α 90%, ε 10%
		209	9/2−	−3.80	50.0 s *3*	α 89%, ε 11%
		210	6+	−3.35	3.18 m *6*	α 60%, ε 40%
		211	9/2−	−4.16	3.10 m *2*	α > 80%, ε < 20%
		212	5+	−3.56	20.0 m *6*	ε 57%, α 43%
		213	9/2−	−3.563	34.6 s *3*	α 99.45%, ε 0.55%
		214	(1−)	−0.975	5.0 ms *2*	α
		214m	(8−)	−0.853	3.35 ms *5*	α
		215	9/2−	0.304	86 ns *5*	α
		216	(1−)	2.97	0.70 μs *2*	α, ε < 2×10^{-7}%
		217	9/2−	4.301	16 μs *2*	α
		218	(1−)	7.046	1.0 ms *6*	α
		218m		7.132	22.0 ms *5*	α ≤ 100%
		219	9/2−	8.608	20 ms *2*	α
		220	1+	11.469	27.4 s *3*	α 99.65%, β− 0.35%
		221	5/2−	13.269	4.9 m *2*	α, β− < 0.1%, ^{14}C 9×10^{-13}%
		222	2−	16.34	14.2 m *3*	β−
		223	3/2(−)	18.379	22.00 m *7*	β− 99.99%, α 6.0×10^{-3}%
		224	1(−)	21.64	3.30 m *10*	β−
		225	3/2−	23.85	4.0 m *2*	β−
		226	1	27.30	48 s *1*	β−
		227	1/2+	29.66	2.47 m *3*	β−
		228	2−	33.3	39 s *1*	β−
		229	(1/2+)		50.2 s *4*	β−
		230			19.1 s *5*	β−
		231			17.5 s *8*	β−
		232			5 s *1*	β−
88	**Ra**	204	0+	6.0s	45 ms *+55−21*	α
		205		5.8s	0.22 s *6*	α, ε
		206	0+	3.5s	0.24 s *2*	α ≈ 100%
		207	(5/2−,3/2−)	3.5s	1.3 s *2*	α ≈ 90%, ε ≈ 10%
		207m	(13/2+)	3.9s	55 ms *10*	IT 85%, α 15%, ε ≈ 0.35%
		208	0+	1.7s	1.3 s *2*	α 95%, ε 5%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
88	Ra	209	5/2−	1.8s	4.6 s *2*	α≈90%, ε≈10%
		210	0+	0.42s	3.7 s *2*	α≈96%, ε≈4%
		211	5/2(−)	0.83	13 s *2*	α>93%, ε<7%
		212	0+	−0.20	13.0 s *2*	α≈90%, ε≈15%
		213	1/2−	0.32	2.74 m *6*	α 80%, ε 20%
		213m		2.09	2.1 ms *1*	IT≈99%, α≈1%
		214	0+	0.08	2.46 s *3*	α 99.94%, ε 0.06%
		215	(9/2+)	2.519	1.59 ms *9*	α
		216	0+	3.277	182 ns *10*	α, ε
		217	(9/2+)	5.874	1.7 μs *1*	α
		218	0+	6.64	15.6 μs *1*	α
		219	(7/2)+	9.37	10 ms *3*	α
		220	0+	10.26	17 ms *2*	α
		221	5/2+	12.957	28 s *2*	α, ^{14}C 1×10^{-12}%
		222	0+	14.309	38.0 s *5*	α, ^{14}C 2.3×10^{-8}%
		223	3/2+	17.230	11.435 d *4*	α, ^{14}C 6.4×10^{-8}%
		224	0+	18.818	3.66 d *4*	α, ^{12}C 4.3×10^{-9}%
		225	1/2+	21.986	14.9 d *2*	β−
		226	0+	23.661	1600 y *7*	α, ^{14}C 3×10^{-9}%
		227	3/2+	27.171	42.2 m *5*	β−
		228	0+	28.935	5.75 y *3*	β−
		229	5/2(+)	32.43	4.0 m *2*	β−
		230	0+	34.54	93 m *2*	β−
		231	(7/2−,1/2+)		103 s *3*	β−
		232	0+		250 s *50*	β−
		233			30 s *5*	β−
		234	0+		30 s *10*	β−
89	Ac	207			22 ms *+40−9*	α
		208	(3+)		95 ms *+24−16*	α≈99%
		208m	(10−)		25 ms *+9−5*	α≈90%
		209	(9/2−)	8.9	0.10 s *5*	α≈99%, ε≈1%
		210		8.6	0.35 s *5*	α≈96%, ε≈4%
		211		7.12	0.25 s *5*	α≈100%
		212		7.27	0.93 s *5*	α≈97%, ε≈3%
		213		6.13	0.80 s *5*	α≤100%
		214		6.42	8.2 s *2*	α≥89%, ε≤11%
		215	9/2−	6.01	0.17 s *1*	α 99.91%, ε 0.09%
		216	(1−)	8.11	≈0.33 ms	α
		216m	(9−)	8.11	0.33 ms *2*	α
		217	9/2−	8.69	69 ns *4*	α, ε≤2%
		218		10.83	1.06 μs *9*	α
		219	9/2−	11.56	11.8 μs *15*	α
		220		13.74	26.1 ms *5*	α, ε 5×10^{-4}%
		221		14.51	52 ms *2*	α
		222	(1−)	16.60	5.0 s *5*	α 99%, ε≤2%
		222m		16.60	63 s *4*	α≥88%, IT≤10%, ε≤2%
		223	(5/2−)	17.816	2.10 m *5*	α 99%, ε 1%
		224	0−	20.221	2.9 h *2*	ε 90.9%, α 9.1%, β−<1.6%
		225	(3/2−)	21.629	10.0 d *1*	α
		226	(1)	24.302	29.4 h *1*	β− 83%, ε 17%, α 0.006%

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89	**Ac**	227	3/2–	25.846	21.773 y *3*	β– 98.62%, α 1.38%
		228	3(+)	28.889	6.15 h *2*	β–, α 5.5×10^{-6}%
		229	(3/2+)	30.67	62.7 m *5*	β–
		230	(1+)	33.6	122 s *3*	β–
		231	(1/2+)	35.9	7.5 m *1*	β–
		232	(1+)	39.1	119 s *5*	β–
		233	(1/2+)		145 s *10*	β–
		234			44 s *7*	β–
90	**Th**	210	0+		9 ms+17–4	α
		211			37 ms+28–11	α
		212	0+	12.0s	30 ms *+20–10*	α, ε≈0.3%
		213		12.1s	140 ms *25*	α≤100%
		214	0+	10.67s	100 ms *25*	α
		215	(1/2–)	10.92	1.2 s *2*	α
		216	0+	10.29	0.028 s *2*	α, ε≈0.006%
		216	(8+,11–)	12.32	0.18 ms *4*	IT≈97%, α≈3%
		217	(9/2+)	12.17	0.252 ms *7*	α
		218	0+	12.36	109 ns *13*	α
		219		14.46	1.05 μs *3*	α
		220	0+	14.65	9.7 μs *6*	α, ε 2×10^{-7}%
		221	(7/2+)	16.93	1.68 ms *6*	α
		222	0+	17.19	2.2 ms *2*	α
		223	(5/2)+	19.36	0.60 s *2*	α
		224	0+	19.99	1.05 s *2*	α
		225	(3/2)+	22.304	8.72 m *4*	α≈90%, ε≈10%
		226	0+	23.185	30.6 m *1*	α
		227	(1/2+)	25.802	18.72 d *2*	α
		228	0+	26.763	1.9131 y *9*	α, ^{20}O 1×10^{-11}%
		229	5/2+	29.579	7880 y *120*	α
		230	0+	30.856	7.538×10^{4} y *30*	α, SF≤5.×10^{-11}%
		231	5/2+	33.810	25.52 h *1*	β–, α≈1.0×10^{-8}%
		232	0+	35.443	1.405×10^{10} y *6* **100%**	α, SF<1.0×10^{-9}%
		233	1/2+	38.728	22.3 m *1*	β–
		234	0+	40.610	24.10 d *3*	β–
		235	(1/2+)	44.25	7.1 m *2*	β–
		236	0+		37.5 m *2*	β–
		237			5.0 m *9*	β–
91	**Pa**	213			5.3 ms *+40–16*	α
		214			17 ms *3*	α
		215		17.7	15 ms *4*	α
		216		17.71	105 ms *12*	α≈80%, ε≈20%
		217		17.04	3.4 ms *2*	α
		217m		18.89	1.5 ms *2*	α≤100%
		218		18.64	0.11 ms *2*	α
		219	9/2–	18.52	53 ns *10*	α
		220		20.37	0.78 μs *16*	α?
		221	9/2–	20.37	5.9 μs *17*	α
		222		22.0s	3.3 ms *3*	α
		223		22.32	5 ms *1*	α
		224		23.86	0.95 s *15*	α 99.9%, ε 0.1%
		225		24.33	1.7 s *2*	α

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
91	**Pa**	226		26.01	1.8 m *2*	α 74%, ε 26%
		227	(5/2−)	26.821	38.3 m *3*	α 85%, ε 15%
		228	(3+)	28.874	22 h *1*	ε 98.15%, α 1.85%
		229	(5/2+)	29.895	1.50 d *5*	ε 99.52%, α 0.48%
		230	(2−)	32.166	17.4 d *5*	ε 91.6%, β− 8.4%, α 3.2×10^{-3}%
		231	3/2−	33.420	32760 y *110*	α, SF ≤ 3.0×10^{-7}%
		232	(2−)	35.938	1.31 d *2*	β−, ε 3.0×10^{-3}%
		233	3/2−	37.483	26.967 d *2*	β−
		234	4+	40.337	6.70 h *5*	β−
		234m	(0−)	40.411	1.17 m *3*	β− 99.84%, IT 0.16%
		235	(3/2−)	42.32	24.5 m *2*	β−
		236	1(−)	45.3	9.1 m *1*	β−
		237	(1/2+)	47.6	8.7 m *2*	β−
		238	(3−)	50.76	2.3 m *1*	β−, SF < 2.6×10^{-6}%
92	**U**	218	0+	21.88s	1.5 ms *+73−7*	α
		219		23.2s	42 μs *+34−13*	α
		220	0+	23.0s		
		221		24.5s		
		222	0+	24.3s	1.0 μs *+10−4*	α
		223		25.82	18 μs *+10−5*	α
		224	0+	25.70	1.0 ms *4*	α
		225		27.37	95 ms *15*	α
		226	0+	27.32	0.20 s *5*	α
		227	(3/2+)	29.00	1.1 m *1*	α
		228	0+	29.22	9.1 m *2*	α > 95%, ε < 5%
		229	(3/2+)	31.204	58 m *3*	ε ≈ 80%, α ≈ 20%
		230	0+	31.603	20.8 d	α
		231	(5/2−)	33.78	4.2 d *1*	ε
		231	(3/2+,5/2+)	33.78	4.2 d *1*	α ≈ 4×10^{-3}%
		232	0+	34.601	68.9 y *4*	α, Ne 9×10^{-10}%
		233	5/2+	36.912	1.592×10^{5} y *2*	α, SF < 6.0×10^{-9}%, Ne 7×10^{-11}%
		234	0+	38.140	2.455×10^{5} y *6* **0.0055% *5***	α, SF 1.7×10^{-9}%, Mg 1×10^{-11}%, Ne 9×10^{-12}%
		235	7/2−	40.913	703.8×10^{6} y *5* **0.720% *1***	α, SF 7.0×10^{-9}%, Ne 8×10^{-10}%
		235m	1/2+	40.913	≈25 m	IT
		236	0+	42.440	2.342×10^{7} y *3*	α, SF 9.6×10^{-8}%
		236m		42.440	121 ns *2*	SF 0.013%
		237	1/2+	45.385	6.75 d *1*	β−
		238	0+	47.305	4.468×10^{9} y *3* **99.2745% *15***	α, SF 0.5×10^{-4}%
		238m	0+	47.305	267 ns *3*	SF 0.015%
		239	5/2+	50.570	23.45 m *2*	β−
		240	0+	52.708	14.1 h *1*	β−, α
		242	0+		16.8 m *5*	β−
93	**Np**	225		31.58		
		226		32.7s	31 ms *8*	α

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
93	**Np**	227		32.56	0.51 s *6*	α
		228		33.7s	1.07 m *3*	ε , εSF
		229		33.76	3.85 m *14*	α > 50%, ε < 50%
		230		35.21	4.6 m *3*	ε ≤ 97%, α ≥ 3%
		231	(5/2)	35.61	48.8 m *2*	ε 98%, α 2%
		232	(4+)	37.3s	14.7 m *3*	ε
		233	(5/2+)	38.1s	36.2 m *1*	ε , α ≤ 1.0×10^{-3}%
		234	(0+)	39.950	4.4 d *1*	ε
		235	5/2+	41.037	396.1 d *12*	ε , α 2.6×10^{-3}%
		236	(6–)	43.38	154×10^{3} y *6*	ε 87.3%, β– 12.5%, α 0.16%
		236m	1	43.44	22.5 h *4*	ε 52%, β– 48%
		237	5/2+	44.867	2.144×10^{6} y *7*	α, SF ≤ 2×10^{-10}%
		237m		47.667	45 ns *5*	SF ≤ 100%
		238	2+	47.450	2.117 d *2*	β–
		239	5/2+	49.304	2.3565 d *4*	β–
		240	(5+)	52.32	61.9 m *2*	β–
		240m	1(+)	52.32	7.22 m *2*	β– 99.89%, IT 0.11%
		241	(5/2+)	54.26	13.9 m *2*	β–
		242	(1+)	57.4	2.2 m *2*	β–
		242	(6)	57.4	5.5 m *1*	β–
		243	(5/2–)	59.92	1.85 m *15*	β–
		244	(7–)		2.29 m *16*	
94	**Pu**	228	0+		?	α, SF
		229			?	α
		230	0+	36.92	≈200 s	α ≤ 100%
		231		38.4s		
		232	0+	38.36	34.1 m *7*	ε 80%, α 20%
		233		40.05	20.9 m *4*	ε 99.88%, α 0.12%
		234	0+	40.338	8.8 h *1*	ε ≈ 94%, α ≈ 6%
		235	(5/2+)	42.20s	25.3 m *5*	ε , α 2.7×10^{-3}%
		236	0+	42.893	2.858 y *8*	α, SF 1.4×10^{-7}%
		237	7/2–	45.087	45.2 d *1*	ε , α 4.2×10^{-3}%
		237m	1/2+	45.233	0.18 s *2*	IT
		237m		47.687	85 ns *15*	SF ≤ 100%
		237m		47.987	1.1 μs *1*	SF ≤ 100%
		238	0+	46.158	87.7 y *3*	α, SF 1.9×10^{-7}%
		239	1/2+	48.583	24110 y *30*	α, SF 3×10^{-10}%
		240	0+	50.120	6564 y *11*	α, SF 5.7×10^{-6}%
		241	5/2+	52.950	14.35 y *10*	β–, α 2.5×10^{-3}%, SF < 2×10^{-14}%
		242	0+	54.712	3.733×10^{5} y *12*	α, SF 5.5×10^{-4}%
		242m	0+	54.712	3.5 ns *6*	SF
		242m	0+	54.712	28 ns	SF
		243	7/2+	57.749	4.956 h *3*	β–
		244	0+	59.799	8.08×10^{7} y *10*	α 99.88%, SF 0.12%
		244m	0+	59.799	400 ps *100*	SF ≤ 100%
		245	(9/2–)	63.10	10.5 h *1*	β–
		246	0+	65.39	10.84 d *2*	β–
		247			2.27 d *23*	β–
95	**Am**	232			79 s *2*	ε ≈ 98%, α ≈ 2%
		233		43.3s		

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
95	**Am**	234		44.5s	2.32 m *8*	ε 99.96%, α 0.04%
		235		44.7s	?	
		236		46.2s		α, ε
		237	5/2(−)	46.8s	73.0 m *10*	ε 99.98%, α 0.03%
		237m		49.2s	5 ns *2*	SF≤100%
		238	1+	48.42	98 m *2*	ε>99.99%, α 0.0001%
		239	(5/2)−	49.386	11.9 h *1*	ε 99.99%, α 0.01%
		240	(3−)	51.50	50.8 h *3*	ε, α 1.9×10^{-4}%
		241	5/2−	52.929	432.2 y *7*	α, SF 4×10^{-10}%
		241m		55.129	1.2 μs *3*	SF
		242	1−	55.463	16.02 h *2*	β− 82.7%, ε 17.3%
		242m	5−	55.512	141 y *2*	IT 99.54%, α 0.46%, SF< $.5\times10^{-10}$%
		242m		57.663	14.0 ms	SF, IT, α<1.5%
		243	5/2−	57.167	7370 y *40*	α, SF 3.7×10^{-9}%
		244	(6−)	59.875	10.1 h *1*	β−
		244m		59.875	≈6.5 μs	SF≤100%
		244m		59.875	0.90 ms *15*	SF≤100%
		244m	1+	59.963	≈26 m	β− 99.96%, ε 0.04%
		245	(5/2)+	61.893	2.05 h *1*	β−
		246	(7−)	64.99	39 m *3*	β−
		246m	2(−)	64.99	25.0 m *2*	β−, IT<0.01%
		247	(5/2)	67.2s	23.0 m *13*	β−
		248		70.5s	?	β−
96	**Cm**	232	0+		1 m *?*	SF<30.3%
		235		48.0s	?	
		236	0+	47.9s		α, ε
		237		49.3s		
		238	0+	49.38	2.4 h *1*	ε≥90%, α≤10%
		239	(7/2−)	51.1s	≈2.9 h	ε, α<0.1%
		240	0+	51.715	27 d *1*	α>99.5%, ε<0.5%, SF 3.9×10^{-6}%
		241	1/2+	53.697	32.8 d *2*	ε 99%, α 1%
		242	0+	54.798	162.79 d *9*	α, SF 6.2×10^{-6}%
		242m		54.798	40 ps *15*	SF≤100%
		242m		57.598	180 ns *70*	SF?, IT?
		243	5/2+	57.176	29.1 y *1*	α 99.71%, ε 0.29%, SF 5.3×10^{-9}%
		244	0+	58.447	18.10 y *2*	α, SF 1.3×10^{-4}%
		244m	0+	58.447	>500 ns	SF≤100%
		244m	6+	59.487	34 ms *2*	SF≤ $.77\times10^{-9}$%
		245	7/2+	60.999	8500 y *100*	α, SF 6.1×10^{-7}%
		246	0+	62.612	4730 y *100*	α 99.97%, SF 0.03%
		247	9/2−	65.527	1.56×10^{7} y *5*	α
		248	0+	67.385	3.40×10^{5} y *4*	α 91.74%, SF 8.26%
		249	1/2(+)	70.743	64.15 m *3*	β−
		250	0+	72.98	≈9700 y	SF≈80%, α≈11%, β−≈9%
		251	(1/2+)	76.64	16.8 m *2*	β−
		252	0+		<2 d	β−
97	**Bk**	237		53.2s		

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
97	**Bk**	238		54.3s	144 s *5*	ε , εSF 0.048%
		239	(7/2+)	54.4s		
		240		55.7s	4.8 m *8*	ε≈100%, εSFw
		241	(7/2+)	56.1s	?	
		242		57.8s	7.0 m *13*	ε
		242m		57.8s	9.5 ns *20*	SF>0%
		242m		57.8s	600 ns *100*	SF>0%
		243	(3/2–)	58.685	4.5 h *2*	ε≈99.85%, α≈0.15%
		244	(1–)	60.70	4.35 h *15*	ε 99.994%, α 6.0×10^{-3}%
		244m		60.70	820 ns *60*	SF≤100%
		245	3/2–	61.809	4.94 d *3*	ε 99.88%, α 0.12%
		246	2(–)	63.96	1.80 d *2*	ε , α<0.2%
		247	(3/2–)	65.482	1380 y *250*	α≤100%
		248	1(–)	68.10	23.7 h *2*	β– 70%, ε 30%, α<0.001%
		248	(6+)	68.10	>9 y	α>70%
		249	7/2+	69.843	320 d *6*	β– , α 1.4×10^{-3}%, SF 4.7×10^{-8}%
		250	2–	72.945	3.217 h *5*	β–
		251	(3/2–)	75.22	55.6 m *11*	β– , α≈1.0×10^{-5}%
		252		78.5s		
		253		80.8s		
98	**Cf**	238	0+		1 s *?*	SF<25%
		239		58.3s	39 s *+37–12*	α>50%, ε ?
		240	0+	58.0s	1.06 m *15*	α≈100%
		241		59.4s	3.78 m *70*	ε≈75%, α≈25%
		242	0+	59.33	3.49 m *12*	α>0%
		243	(1/2+)	60.9s	10.7 m *5*	ε≈86%, α≈14%
		244	0+	61.469	19.4 m *6*	α
		245	(5/2+)	63.377	45.0 m *15*	ε 64%, α 36%
		246	0+	64.085	35.7 h *5*	α , ε<5.0×10^{-4}%, SF 2.0×10^{-4}%
		247	(7/2+)	66.128	3.11 h *3*	ε 99.97%, α 0.04%
		248	0+	67.233	333.5 d *28*	α , SF 0.0029%
		249	9/2–	69.718	351 y *2*	α , SF 5.2×10^{-7}%
		250	0+	71.165	13.08 y *9*	α 99.92%, SF 0.08%
		251	1/2+	74.127	898 y *44*	α
		252	0+	76.027	2.645 y *8*	α 96.91%, SF 3.09%
		253	(7/2+)	79.293	17.81 d *8*	β– 99.69%, α 0.31%
		254	0+	81.33	60.5 d *2*	SF 99.69%, α 0.31%
		255	(9/2+)	84.8s	85 m *18*	β–
		256	0+		12.3 m *12*	SF , β–<1%, α≈1.0×10^{-6}%
99	**Es**	241		63.9s		
		242		64.9s	≈7 s	ε , εSF
		243		64.9s	21 s *2*	ε≤70%, α≥30%
		244		66.0s	37 s *4*	ε 96%, α 4%
		245	(3/2–)	66.4s	1.1 m *1*	ε 60%, α 40%
		246	(4–,6+)	68.0s	7.7 m *5*	ε 90.1%, α 9.9%
		247	(7/2+)	68.60s	4.55 m *26*	ε≈93%, α≈7%
		248	(2–,0+)	70.29	27 m *4*	ε>99%, α≈0.25%

Nuclear Wallet Cards

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
99	**Es**	249	7/2(+)	71.17s	102.2 m *6*	ε 99.43%, α 0.57%
		250	(6+)	73.3s	8.6 h *1*	ε > 97%, α < 3%
		250m	1(−)	73.3s	2.22 h *5*	ε ≥ 99%, α ≤ 1%
		251	(3/2−)	74.504	33 h *1*	ε 99.51%, α 0.49%
		252	(5−)	77.29	471.7 d *19*	α 76%, ε 24%, β− ≈ 0.01%
		253	7/2+	79.007	20.47 d *3*	α, SF 8.7×10^{-6}%
		254	(7+)	81.988	275.7 d *5*	α, ε < 1.0×10^{-4}%, SF < 3.0×10^{-6}%, β− 1.7×10^{-6}%
		254m	2+	82.066	39.3 h *2*	β− 98%, IT < 3%, α 0.33%, ε 0.08%, SF < 0.05%
		255	(7/2+)	84.08	39.8 d *12*	β− 92%, α 8%, SF 4.1×10^{-3}%
		256	(1+)	87.1s	25.4 m *24*	β−
		256m	(8+)	87.1s	≈7.6 h	β−
		257		89.4s	2 s *?*	SF?
100	**Fm**	242	0+		0.8 ms *2*	SF > 0%
		243		69.4s	0.18 s *+8−4*	α ≤ 100%, SF ≤ 0.36%
		244	0+	69.1s	3.3 ms *4*	SF ≤ 100%
		245		70.2s	4.2 s *13*	α ≤ 100%, SF ≤ 0.11%
		246	0+	70.12	1.1 s *2*	α 92%, SF 8%, ε ≤ 1%
		247?		71.5s	35 s *4*	α ≥ 50%, ε ≤ 50%
		247m		71.5s	9.2 s *23*	α ≤ 100%
		248	0+	71.90	36 s *3*	α 99%, ε ≈ 1%, SF ≈ 0.05%
		249	(7/2+)	73.6s	2.6 m *7*	ε ≈ 85%, α ≈ 15%
		250	0+	74.07	30 m *3*	α > 90%, ε < 10%, SF ≈ 6.0×10^{-4}%
		250m		75.07	1.8 s *1*	IT > 80%, SF < 0.8×10^{-4}%
		251	(9/2−)	75.978	5.30 h *8*	ε 98.2%, α 1.8%
		252	0+	76.810	25.39 h *5*	α, SF 0.0023%
		253	1/2+	79.340	3.00 d *12*	ε 88%, α 12%
		254	0+	80.897	3.240 h *2*	α 99.94%, SF 0.06%
		255	7/2+	83.793	20.07 h *7*	α, SF 2.4×10^{-5}%
		256	0+	85.479	157.6 m *13*	SF 91.9%, α 8.1%
		257	(9/2+)	88.581	100.5 d *2*	α 99.79%, SF 0.21%
		258	0+	90.5s	370 μs *43*	SF
		259		93.7s	1.5 s *3*	SF
		260	0+		≈4 ms	SF
101	**Md**	247		76.1s	2.9 s *17*	α ≤ 100%
		248		77.1s	7 s *3*	ε 80%, α 20%, SF ≤ 0.05%
		249		77.3s	24 s *4*	α ≈ 70%, ε ≈ 30%
		250		78.7s	52 s *6*	ε 93%, α 7%
		251		79.1s	4.0 m *5*	ε ≥ 90%, α ≤ 10%
		252		80.7s	4.8 m *+8−5*	ε
		253		81.3s	≈6 m	ε ≤ 100%
		254		83.6s	10 m *3*	ε
		254		83.6s	28 m *8*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
101	**Md**	255	(7/2−)	84.835	27 m *2*	ε 92%, α 8%, SF≤0.15%
		256	(0−,1−)	87.61	78.1 m *18*	ε 90.7%, α 9.3%, SF<2.8%
		257	(7/2−)	88.990	5.52 h *5*	ε 90%, α 10%, SF<1%
		258	(1−)	91.684	60 m *2*	ε
		258	(8−)	91.684	51.5 d *3*	α, SF≤0.003%
		259	(7/2−)	93.6s	1.60 h *6*	SF≈100%, α<3%
		260		96.6s	27.8 d *8*	SF>73%, α<25%, ε<15%, β−<10%
		261		98.4s		
102	**No**	250	0+		0.25 ms *5*	SF, α≈0.05%
		251		82.8s	0.8 s *3*	α≈100%, ε≈1%, SF<10%
		252	0+	82.87	2.30 s *22*	α 73.1%, SF 26.9%
		253	(9/2−)	84.5s	1.7 m *3*	α≈80%, ε≈20%
		254	0+	84.72	55 s *3*	α 90%, ε 10%, SF 0.25%
		254m		85.22	0.28 s *4*	IT>80%, SF≥0.2%
		255	(1/2+)	86.85	3.1 m *2*	α 61.4%, ε 38.6%
		256	0+	87.816	2.91 s *5*	α 99.5%, SF 0.5%
		257	(7/2+)	90.22	25 s *2*	α≈100%
		258	0+	91.5s	1.2 ms *2*	SF, α 0.001%
		259	(9/2+)	94.1s	58 m *5*	α 75%, ε 25%, SF<10%
		260	0+	95.6s	106 ms *8*	SF
		261		98.5s		
		262	0+	100.2s	≈5 ms	SF
		263		103.2s		
103	**Lr**	252			≈1 s	α≈90%, ε≈10%, SF<1%
		253		88.7s	1.3 s *+6−3*	α 90%, SF<20%, ε≈1%
		254		89.9s	13 s *2*	α 78%, ε 22%, SF<0.1%
		255		90.1s	22 s *4*	α 85%, ε<30%
		256		92.0s	28 s *3*	α>80%, ε<20%, SF<0.03%
		257	(9/2+)	92.7s	0.646 s *25*	α, SF≤.65×10^{-3}%
		258		94.9s	3.9 s *4*	α>95%, ε<5%, SF<5%
		259		95.93s	6.1 s *4*	α 80%, SF 20%, ε<0.5%
		260		98.3s	180 s *30*	α 75%, ε≈15%, SF<10%
		261		99.6s	39 m *12*	SF
		262		102.3s	3.6 h *3*	ε, SF<10%
		263		103.8s		
		264		106.5s		
		265		108.2s		
104	**Rf**	253			≈1.8 s	α≈50%, SF≈50%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
104	**Rf**	254	0+		0.5 ms *2*	SF, α≈0.3%
		255	(9/2−)	94.6s	1.5 s *2*	SF 52%, α 48%
		256	0+	94.25	6.7 ms *2*	SF 98%, α 2.2%
		257	(7/2+)	96.2s	4.7 s *3*	α 79.6%, ε 18%, SF 2.4%
		258	0+	96.4s	12 ms *2*	SF≈87%, α≈13%
		259		98.38s	3.1 s *7*	α 93%, SF 7%, ε≈0.3%
		260	0+	99.2s	20.1 ms *7*	SF≈98%, α≈2%
		261		101.5s	65 s *10*	α>80%, ε≤10%, SF<10%
		262	0+	102.5s	1.2 s *+10−5*	SF
		263		105.0s		
		264	0+	106.3s		
		265		108.8s		
		266	0+	110.4s		
105	**Ha**	255			1.6 s *+6−4*	α≈80%, SF≈20%
		256			2.6 s *+14−8*	α≤90%, SF≤40%, ε≈10%
		257		100.5s	1.3 s *+5−3*	α 82%, SF 17%, ε 1%
		258		101.8s	4.4 s *+9−6*	α 67%, ε 33%, SF<1%
		258		101.8s	20 s *10*	ε
		259		102.2s	?	α
		260		103.8s	1.52 s *13*	α≥90%, SF≤10%, ε ?
		261		104.4s	1.8 s *4*	α>50%, SF<50%
		262		106.5s	34 s *4*	α 64%, SF 33%, ε≈3%
		263		107.4s	27 s *+10−7*	SF≈57%, α≈43%
		264		109.6s		
		265		110.7s		
		266		113.0s		
106	**Sg**	259	(1/2+)	106.8s	0.9 s *2*	α>80%, SF<20%
		260	0+	106.60	3.6 ms *+9−6*	α 50%, SF 50%
		261		108.4s	0.23 s *3*	α>90%, SF<10%
		262	0+	108.6s		
		263		110.5s	0.8 s *2*	SF≈70%, α≈30%
		264	0+	111.1s		
		265		113.1s	≈16 s	α, SF<50%
		266	0+	114.0s	≈20 s	α, SF<50%
107	**Ns**	260				α
		261		113.4s	11.8 ms *+53−28*	α>90%, SF<10%
		262		114.7s	102 ms *26*	α≥80%, SF≤20%
		262m		115.0s	8.0 ms *21*	α>70%, SF<30%
		263		114.9s		
		264		116.4s		
		265		116.8s		
		266		118.7s		
108	**Hs**	263			<1 s	α
		264	0+	119.8	0.08 ms *+40−4*	α, SF<1.5%
		265		121.6s	1.8 ms *+22−7*	α≈100%, SF≤9%
		266	0+	121.7s		
		267			60 ms *+30−15*	α

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
108	**Hs**	267			33 ms *17*	
109	**Mt**	266		128.4s	3.4 ms *+61–13*	α≈100%, SF≤5.5%
		267				
		268			70 ms *65*	α
110		267?			≈3 μs	α
		269			0.17 ms *+16–6*	α
		271			1.1 ms *+6–3*	α
		271			0.06 s *+27–3*	α
		272	0+		≈8.6 ms	SF
111		272			1.5 ms *+20–5*	α

Appendix–I Table of Elemental Properties

Z	El	Atomic Weight[a]	Density (g/cc)[b]	Melting Pt. (°C)[b]	Boiling Pt. (°C)[b]	Oxidation States[b]
1	H	1.00794 *7*	8.988×10^{-5}[d]	–259.34	–252.87	+1,–1
2	He	4.002602 *2*	1.785×10^{-4}[f]	(26 atm)	–268.93	0
3	Li	6.941 *2*	0.534[c]	180.5	1342	+1
4	Be	9.012182 *3*	1.848[c]	1287	2471	+2
5	B	10.811 *5*	2.34[h]	2075	(5 mm) 4000 (subl.)	+3
6	C	12.011	1.8 to 2.1[i]	≈3550	4827	+2,+4,–4
7	N	14.00674 *7*	0.0012506[j]	–210.00	–195.79	+1,+2,+3,+4, +5,–1,–2,–3
8	O	15.9994 *3*	0.001429[k]	–218.79	–182.95	–2
9	F	18.9984032 *5*	0.001696	–219.62[g]	–188.12[g]	–1
10	Ne	20.1797 *6*	8.9990×10^{-4}	–248.59	–246.088[g]	0
11	Na	22.989770 *2*	0.971[c]	97.72	883	+1
12	Mg	24.3050 *6*	1.738[c]	650	1090	+2
13	Al	26.981539 *5*	2.6989[c]	660.32	2519	+3
14	Si	28.0855 *3*	2.33[e]	1414	3265	+2,+4,–4
15	P	30.973761 *2*	1.82[l]	44.15[l]	277[l]	+3,+5,–3
16	S	32.066 *6*	2.07[cm]	115.21[m]	444.60	+4,+6,–2
17	Cl	35.4527 *9*	0.003214	–101.5	–34.04	+1,+5,+7,–1
18	Ar	39.948	0.0017837	–189.35	–185.85	0
19	K	39.0983	0.862[c]	63.38	759	+1
20	Ca	40.078 *4*	1.55[c]	842	1484	+2
21	Sc	44.955910 *8*	2.989[e]	1541	2830	+3
22	Ti	47.867	4.54	1668	3287	+2,+3,+4
23	V	50.9415	6.11 (18.7 °C)	1910	3407	+2,+3,+4,+5
24	Cr	51.9961 *6*	7.18 to 7.20[c]	1907	2671	+2,+3,+6
25	Mn	54.938049 *9*	7.21 to 7.44[n]	1246	2061	+2,+3,+4,+7
26	Fe	55.845 *2*	7.874[c]	1538	2861	+2,+3
27	Co	58.933200 *9*	8.9[c]	1495	2927	+2,+3
28	Ni	58.6934 *2*	8.902[e]	1455	2913	+2,+3
29	Cu	63.546 *3*	8.96[c]	1084.62	2562	+1,+2
30	Zn	65.39 *2*	7.133[e]	419.53	907	+2
31	Ga	69.723	5.904 (29.6 °C)	29.76	2204	+3
32	Ge	72.61 *2*	5.323[e]	938.25	2833	+2,+4
33	As	74.92160 *2*	5.73[o]	817[o] (28 atm)	614[o] (subl.)	+3,+5,–3
34	Se	78.96 *3*	4.79[p]	221[p]	685[p]	+4,+6,–2
35	Br	79.904	3.12[u]	–7.2	58.78	+1,+5,–1
36	Kr	83.80	0.003733	–157.36	–153.22	0
37	Rb	85.4678 *3*	1.532[c]	39.31	688	+1
38	Sr	87.62	2.54	777	1382	+2
39	Y	88.90585 *2*	4.469[e]	1526	3336	+3
40	Zr	91.224 *2*	6.506[c]	1855	4409	+4
41	Nb	92.90638 *2*	8.57[c]	2477	4744	+3,+5
42	Mo	95.94	10.22[c]	2623	4639	+6
43	Tc	(98)	11.50[t]	2157	4265	+4,+6,+7
44	Ru	101.07 *2*	12.41[c]	2334	4150	+3

Appendix–I Table of Elemental Properties

Z	El	Atomic Weight[a]	Density (g/cc)[b]	Melting Pt. (°C)[b]	Boiling Pt. (°C)[b]	Oxidation States[b]
45	Rh	102.90550 *2*	12.41[c]	1964	3695	+3
46	Pd	106.42	12.02[c]	1554.9	2963	+2,+4
47	Ag	107.8682 *2*	10.50[c]	961.78	2162	+1
48	Cd	112.411 *8*	8.65[c]	321.07	767	+2
49	In	114.818 *3*	7.31[c]	156.60	2072	+3
50	Sn	118.710 *7*	5.75[q]	231.93	2602	+2,+4
51	Sb	121.760	6.691[c]	630.63	1587	+3,+5,–3
52	Te	127.60 *3*	6.24[c]	449.51	988	+4,+6,–2
53	I	126.90447 *3*	4.93[v]	113.7	184.4	+1,+5,+7,–1
54	Xe	131.29 *2*	0.005887	–111.75	–108.04	0
55	Cs	132.90545 *2*	1.873[c]	28.44	671	+1
56	Ba	137.327 *7*	3.5[c]	727	1897	+2
57	La	138.9055 *2*	6.145[e]	920	3455	+3
58	Ce	140.115 *4*	6.770[e]	799	3424	+3,+4
59	Pr	140.90765 *2*	6.773[r] 6.64[s]	931	3510	+3
60	Nd	144.24 *3*	7.008	1016	3066	+3
61	Pm	(145)	7.264[e]	1042	3000	+3
62	Sm	150.36 *3*	7.520[r] 7.40[s]	1072	1790	+2,+3
63	Eu	151.965 *9*	5.244[e]	822	1596	+2,+3
64	Gd	157.25 *3*	7.901[e]	1314	3264	+3
65	Tb	158.92534 *2*	8.230	1359	3221	+3
66	Dy	162.50 *3*	8.551[e]	1411	2561	+3
67	Ho	164.93032 *2*	8.795[e]	1472	2694	+3
68	Er	167.26 *3*	9.066[e]	1529	2862	+3
69	Tm	168.93421 *2*	9.321[e]	1545	1946	+3
70	Yb	173.04 *3*	6.903[r] 6.966[s]	824	1194	+2,+3
71	Lu	174.967	9.841[e]	1663	3393	+3
72	Hf	178.49 *2*	13.31[c]	2233	4603	+4
73	Ta	180.9479	16.654	3017	5458	+5
74	W	183.84	19.3[c]	3422	5555	+6
75	Re	186.207	21.02[c]	3186	5596 (est.)	+4,+6,+7
76	Os	190.23 *3*	22.57	3033	5012	+3,+4
77	Ir	192.217 *3*	22.42 (17 °C)	2446	4428	+3,+4
78	Pt	195.08 *3*	21.45[c]	1768.4	3825	+2,+4
79	Au	196.96655 *2*	≈19.3[c]	1064.18	2856	+1,+3
80	Hg	200.59 *2*	13.546[c]	–38.83	356.73	+1,+2
81	Tl	204.3833 *2*	11.85[c]	304	1473	+1,+3
82	Pb	207.2	11.35[c]	327.46	1749	+2,+4
83	Bi	208.98038 *2*	9.747[c]	271.40	1564	+3,+5
84	Po	(209)	9.32[r]	254		+2,+4
85	At	(210)		302		
86	Rn	(222)	0.00973	–71	–61.7	0
87	Fr	(223)		27		+1
88	Ra	(226)	5?	700		+2
89	Ac	(227)	10.07[t]	1051	3198	+3
90	Th	232.03805 *2*	11.72	1750	4788	+4

Appendix–I Table of Elemental Properties

Z	El	Atomic Weight[a]	Density (g/cc)[b]	Melting Pt. (°C)[b]	Boiling Pt. (°C)[b]	Oxidation States[b]
91	Pa	(231)	15.37[t]	1572		+4,+5
92	U	238.0289	≈18.95	1135	4131	+3,+4,+5,+6
93	Np	(237)	20.25[c]	644	3902 (est.)	+3,+4,+5,+6
94	Pu	(244)	19.84[e]	640	3228	+3,+4,+5,+6
95	Am	(243)	13.67[c]	1176		+3,+4,+5,+6
96	Cm	(247)	13.51[t]	1345		+3
97	Bk	(247)	14 (est.)	1050		+3,+4
98	Cf	(251)		900		+3
99	Es	(252)		860		+3
100	Fm	(257)		1527		+3
101	Md	(258)		827		+2,+3
102	No	(259)		827		+2,+3
103	Lr	(261)		1627		+3

Footnotes and References

a) Atomic weights of many elements are not invariant and depend on the origin and treatment of the material. The values given here apply to elements as they exist naturally on earth and are from N. E. Holden, *Handbook of Chemistry and Physics, 76th edition, 1995*. Uncertainty is 1 in last significant figure unless expressly given.

Masses are scaled to 12 for ^{12}C.

Parenthetical whole numbers represent the mass numbers (A) of the longest lived isotopes for radioactive elements.

Isotopic masses (and more precise atomic weights for some mono–isotopic elements) may be calculated as $A+(\Delta/931.494)$, where A is the mass number and Δ is the mass excess as given in the *Nuclear Wallet Cards*.

b) C.R. Hammond, in *CRC Handbook of Chemistry and Physics, 75th edition, 1994*, 4–1, 4–122. Where specified, exact temperature and pressure conditions are given; the conditions for all gases have been inferred to be 0 °C and 1 atm. The densities for the follow–ing gaseous elements are for diatomic molecules: H, N, O, F, Cl. In general, densities for gases (in g/cc) may be approximated by the formula: density=MP/82.05T, where M is the molecular weight in g, P the pressure in atm, and T the temperature in °K. The reported oxidation states do not include some uncommon states, or those states predicted by periodicity, but not confirmed chemically.

c) At 20 °C.

d) For gas; density (liquid)=0.0708 g/cc at b.p.; density (solid)=0.0706 g/cc at –262 °C.

f) For gas; density (liquid)=0.1221 g/cc at b.p.

e) At 25 °C.

f) For gas; density (liquid)=1.221 g/cc at b.p.

g) At 1 atm.

h) For crystal form; density (amorphous)=2.37 g/cc.

i) For amorphous carbon; density (graphite)=1.9 to 2.3 g/cc; density (gem diamond)=3.513 g/cc at 25 °C; density (other diamond)=3.15 to 3.53 g/cc.

j) For gas; density (liquid)=0.808 g/cc at b.p.; density (solid)=1.026 g/cc at –252 °C.

k) For gas; density (liquid)=1.14 g/cc at b.p.

l) For white phosphorus; density (red)=2.20 g/cc; density (black)=2.25 to 2.69 g/cc.

m) For rhombic sulfur; melting point (monoclinic)=119.0 °C; density (monoclinic)=1.957 g/cc at 20 °C.

n) Depending on allotropic form.

o) For gray arsenic; density (yellow)=1.97 g/cc.

p) For gray selenium; density (vitreous)=4.28 g/cc.

q) For gray tin; density (white)=7.13 g/cc.

r) For α modification.

s) For β modification.

t) Calculated.

u) For liquid at 20 °C; 0.00759 g/cc for gas.

v) For solid at 20 °C; 0.01127 g/cc for gas.

Appendix–II Frequently–Used Constants

The frequently used constants are given below in familiar units. Only approximate values are given, see App–III for values to current known precision

Symbol	Constant	Value
$1/\alpha=\hbar c/e^2$	Fine structure constant	137.0
c	Speed of light in vacuum	2.998×10^{10} cm/s
h $\hbar=h/2\pi$ $\hbar c$	Planck constant	6.626×10^{-27} erg s 6.582×10^{-22} MeV s 197.3 MeV fm
$k=R/N_A$	Boltzmann constant	8.617×10^{-11} MeV/K
$r_e=e^2/m_ec^2$	Classical e^- radius	2.818 fm
$\lambda\!\!\!^{-}_{C,e}=\hbar/m_ec$	Compton wavelength of e^-	386.2 fm
$\lambda\!\!\!^{-}_{C,p}=\hbar/m_pc$	Compton wavelength of p	0.210 fm
$\lambda\!\!\!^{-}_{C,\pi}=\hbar/m_\pi c$	Compton wavelength of π	1.414 fm
u	Atomic mass unit	931.5 MeV/c^2
m_e	Electron mass	0.511 MeV/c^2
m_n	Neutron mass	939.6 MeV/c^2
m_p	Proton mass	938.3 MeV/c^2
m_d	Deuteron mass	1875.6 MeV/c^2
$m_{\pi^\pm}$	$\pi^\pm$ mass	139.6 MeV/c^2
m_{π°	π^0 mass	135.0 MeV/c^2
m_W	$W^\pm$ boson mass	80.2 GeV/c^2
m_Z	Z^0 boson mass	91.2 GeV/c^2
$\mu_N=\hbar e/2m_pc$	Nuclear magneton	3.152×10^{-18} MeV/Gauss
μ_p	Proton magnetic moment	2.793 μ_N
μ_n	Neutron magnetic moment	1.913 μ_N

1 fm=10^{-13} cm	1 Å=10^{-8} cm	π=3.1416
1 barn=10^{-24} cm^2	1 eV/c^2=1.783×10^{-33} g	
1 joule=10^7 erg	1 coulomb=2.998×10^9 esu	
1 newton=10^5 dyne	1 tesla=10^4 gauss	

Appendix–III Fundamental Constants

Unless otherwise noted, the information presented in this table is from *The 1986 Adjustment of the Fundamental Physical Constants*[a]. The constants are arranged alphabetically according to the symbols by which they are denoted. The numbers in *italics* are the one–standard–deviation uncertainty in the last digits of the values given. The unified atomic mass scale ($^{12}C \equiv 12$) has been used throughout. Values are given for both SI and cgs units. In cgs units "permittivity of vacuum" μ_0 and "permeability of vacuum" ε_0 are dimensionless unit quantities; in SI units they have the values [f]

$$\mu_0 = 4\pi \times 10^{-7}\ \mathrm{m \cdot kg \cdot s^{-2} \cdot A^{-2}} = 4\pi \times 10^{-7}\ \mathrm{N \cdot A^{-2}} = 4\pi \times 10^{-7}\ \mathrm{T \cdot A^{-1}}$$
$$\varepsilon_0 = 1/\mu_0 c^2$$

The factor in square brackets given in the definition of a quantity is to be omitted to obtain the expression in cgs units [f].

The following abbreviations are used:

A = ampere

C = coulomb

cm = centimeter

emu = electromagnetic unit

esu = electrostatic unit

G = gauss

g = gram

Hz = hertz = cycles/sec

J = joule

K = degree Kelvin

kg = kilogram

m = meter

mol = mole

N = newton

s = second

T = tesla

u = atomic mass unit (unified scale)

V = volt

W = watt

Wb = Weber

Appendix–III Fundamental Constants

Symbol	Constant	Value	Units (SI)[b]	Units (cgs)[b]
$a_0=r_e/\alpha^2$	Bohr radius	5.29177249 *24*	10^{-11} m	10^{-9} cm
$\alpha=e^2/\hbar c[4\pi\varepsilon_0]$ $1/\alpha$	Fine structure constant	0.00729735308 *33* 137.0359895 *61*		
c	Speed of light in vacuum	2.99792458[(e)]	10^8 m s^{-1}	10^{10} cm s^{-1}
$c_1=2\pi hc^2$	First radiation constant	3.7417749 *22*	10^{-16} W m^2	10^{-5} erg cm^2 s^{-1}
$c_2=hc/k$	Second radiation constant	1.438769 *12*	10^{-2} m K	cm K
e	Elementary charge	4.8032068 *15* 1.60217733 *49*	10^{-10} esu 10^{-19} C	10^{-20} emu
2e/h	Josephson frequency–voltage ratio	4.8359767 *14*	10^{14} Hz V^{-1}	
$-e/m_e$	Electron specific charge	1.75881962 *53*	10^{11} C kg^{-1}	10^7 emu g^{-1}
$F=N_Ae$	Faraday constant	9.6485309 *29*	10^4 C mol^{-1}	10^3 emu mol^{-1}
γ_p	Gyromagnetic ratio of proton	2.67522128 *81*	10^8 s^{-1} T^{-1}	10^4 s^{-1} G^{-1}
γ_p'	Gyromagnetic ratio of proton (uncorrected for diamagnetism of H_2O)	2.67515255 *81*	10^8 s^{-1} T^{-1}	10^4 s^{-1} G^{-1}
G	Gravitational constant	6.67259 *85*	10^{-11} m^3 kg^{-1} s^{-2}	10^{-8} cm^{-3} g^{-1} s^{-2}

Appendix–III Fundamental Constants

Symbol	Constant	Value	Units (SI)[b]	Units (cgs)[b]
h	Planck constant	6.6260755 *40*	10^{-34} J s	10^{-27} erg s
$\hbar=h/2\pi$		1.05457266 *63*	10^{-34} J s	10^{-27} erg s
$hc/(2e[c])$	Quantum of magnetic flux	2.06783461 *61*	10^{-15} Wb	10^{-7} G cm^2
$k=R/N_A$	Boltzmann costant	1.380658 *12*	10^{-23} J K^{-1}	10^{-16} erg K^{-1}
$\lambda_{C,e}=h/m_e c$	Compton wavelength of electron	2.42631058 *22*	10^{-12} m	10^{-10} cm
$\lambda_{C,p}=h/m_p c$	Compton wavelength of proton	1.32141002 *12*	10^{-15} m	10^{-13} cm
$\lambda_{C,n}=h/m_n c$	Compton wavelength of neutron	1.31959110 *12*	10^{-15} m	10^{-13} cm
m_e	Electron mass	5.48579903 *13*	10^{-4} u	10^{-4} u
m_H	Mass of hydrogen atom	1.007825032 *1*[(c)]	u	u
m_μ	Muon mass	0.113428913 *17*	u	u
m_n	Neutron mass	1.008664904 *14*	u	u
m_p	Proton mass	1.007276470 *12*	u	u
$m_{\pi\pm}$	$\pi^\pm$ mass	0.1498345 *4*[(d)]	u	u
$m_{\pi 0}$	π^0 mass	0.144903 *6*[(d)]	u	u

Appendix–III Fundamental Constants

Symbol	Constant	Value	Units (SI)[b]	Units (cgs)[b]
$\mu_B=[c]e\hbar/2m_ec$	Bohr magneton	9.2740154 *31*	10^{-24} J T^{-1}	10^{-21} erg G^{-1}
μ_e/μ_B	Magnetic moment of electron in units of μ_B	1.001159652193 *10*		
μ_μ	Muon magnetic moment	4.4904514 *15*	10^{-26} J T^{-1}	10^{-23} erg Gs^{-1}
$\mu_N=[c]e\hbar/2m_pc$	Nuclear magneton	5.0507866 *17*	10^{-27} J T^{-1}	10^{-24} erg G^{-1}
N_A	Avogadro constant	6.0221367 *36*	10^{23} mol^{-1}	10^{23} mol^{-1}
R	Molar gas constant	8.314510 *70*	J mol^{-1} K^{-1}	10^7 erg mol^{-1} K^{-1}
$R_\infty=m_ec\alpha^2/2h$	Rydberg constant for infinite mass	1.0973731534 *13*	10^7 m^{-1}	10^5 cm^{-1}
$r_e=\hbar\alpha/m_ec$	Classical e^- radius	2.81794092 *38*	10^{-15} m	10^{-13} cm
$\sigma=(\pi^2/60)k^4/\hbar^3c^2$	Stefan–Boltzmann constant	5.67051 *19*	10^{-8} W m^{-2} K^{-4} erg cm^{-2} s^{-1} K^{-4}	10^{-5}
$u = 1/N_A$	Atomic mass unit	1.6605402 *10* 931.49432 *28*	10^{-27} kg MeV	10^{-24} g

1 year (sidereal) = 365.25636 days = 3.1558150 $\times 10^7$ s, 1 year (tropical) = 3.15569 $\times 10^7$ s

Appendix–III Fundamental Constants

a) E. R. Cohen and B. N. Taylor, *Rev. Mod. Phys.* 59, 1121(1987); *CODATA* Bulletin #63, Nov., 1986; *Physics Today*, August 1995, Part 2, BG9

b) Quantities are given in the International System of Units (SI) except for the atomic mass unit; this unit is not part of the SI.

c) The 1993 Atomic Mass Evaluation, G. Audi and A. H. Wapstra, *Nuclear Physics* A565, 1 (1993)

d) Review of Particle Properties, Particle Data Group, *Phys. Rev*, D50, 1173 (1994)

e) Speed of light in vacuum is now an exact constant as a result of redefinition of meter [P. Giacomo, *Metrologia* 20, 25 (1984)].

f) General Section by H. L. Anderson and E. R. Cohen in *A Physicist's Desk Reference*, H. L. Anderson, Editor–in–Chief, AIP, New York (1989)

Appendix–IV Energy–Equivalent Factors†

units	erg	eV	s^{-1}	cm^{-1}
erg	1.0	1.60217733 *49*$\times10^{-12}$	6.6260755 *40*$\times10^{-27}$	1.9864475 *12*$\times10^{-16}$
eV	6.2415064 *19*$\times10^{11}$	1.0	4.1356692 *12*$\times10^{-15}$	1.23984244 *37*$\times10^{-4}$
s^{-1}	1.50918897 *90*$\times10^{26}$	2.41798836 *72*$\times10^{14}$	1.0	2.99792458 $\times10^{10}$
cm^{-1}	5.0341125 *30*$\times10^{15}$	8.0655410 *24*$\times10^{3}$	3.335640952$\times10^{-11}$	1.0
deg K	7.242924 *61*$\times10^{15}$	1.160445 *10*$\times10^{4}$	4.799216 *41*$\times10^{-11}$	1.438769 *12*
g	1.11265006$\times10^{-21}$	1.78266270 *54*$\times10^{-33}$	7.3725032 *44*$\times10^{-48}$	2.2102209 *13*$\times10^{-37}$
u	6.7005308 *40*$\times10^{2}$	1.07354385 *33*$\times10^{-9}$	4.43982224 *40*$\times10^{-24}$	1.33102522 *12*$\times10^{-13}$

(1 cal = 4.1840 J, 1 J = 10^7 erg)

Note: In the above table all entries in the same column are equivalent. The various units of energy are connected as follows:

1 erg = $1/c^2$ g = $1/(mc^2)$ u = $1/(hc)$ cm^{-1} = $1/h$ s^{-1} = $1/k$ ^{0}K = $1/e$ eV

Examples: 1 eV = 1.602..$\times10^{-12}$ erg = 1.073..$\times10^{-9}$ u= 3.829..$\times10^{-20}$ cal

e/h = 2.417..$\times10^{14}$ s^{-1}, $e/(hc)$ = 8.0654..$\times10^{3}$ cm^{-1}

e/c^2 = 1.782..$\times10^{-33}$ g, e/mc^2 = 1.073..$\times10^{-9}$ u

e/k = 1.160..$\times10^{4}$ deg K

Appendix–IV Energy–Equivalent Factors†

units	deg K	g	u
erg	$1.380658\ 12\times10^{-16}$	8.987551787×10^{20}	$1.49241909\ 88\times10^{-3}$
eV	$8.617385\ 73\times10^{-5}$	$5.6095862\ 17\times10^{32}$	$9.3149432\ 28\times10^{8}$
s^{-1}	$2.083674\ 18\times10^{10}$	$1.35639140\ 81\times10^{47}$	$2.25234242\ 40\times10^{23}$
cm^{-1}	$6.950387\ 59\times10^{-1}$	$4.5244347\ 27\times10^{36}$	$7.51300563\ 69\times10^{12}$
deg K	1.0	$6.509616\ 55\times10^{36}$	$1.0809478\ 91\times10^{13}$
g	$1.536189\ 13\times10^{-37}$	1.0	$1.6605402\ 10\times10^{-24}$
u	$9.251140\ 78\times10^{-14}$	$6.0221367\ 36\times10^{23}$	1.0

Note: In the above table all entries in the same column are equivalent.

Example: 1u ≡ 1.492..×10^{-3} erg = 9.314..×10^{8} eV = 3.567..×10^{-11} cal, etc.

† From 1986 Fundamental Constants, E.R. Cohhen and B.N. Taylor, *Rev. Mod. Physics* 59, 1121 (1987); CODATA Bulletin #63 (Nov. 1986); *Physics Today*, August 1995, Part 2, BG9.

Appendix–V Observed Λ Hypernuclides†

El	A	J(g.s.)	B_Λ(g.s.)* (MeV)	Excited (bound) states (E or B_Λ^*) (MeV)
H	3	1/2	0.13 *5*	
	4	0	2.04 *4*	E=1.05 *4*
He	4	0	2.39 *3*	E=1.15 *4*
	5	1/2	3.12 *2*	
	6	(1)	4.18 *10*	
	8		7.16 *70*	
Li	6		4.50	
	7	(1/2)	5.58 *3*	E=2.034 *23*
	8	1	6.80 *3*	
	9		8.50 *12*	
Be	7	1/2	5.16 *8*	
	8		6.84 *5*	
	9	1/2	6.71 *4*	B_Λ[b]=3.0 *3*,0.5 *5*
	10		9.11 *22*	
B	9		8.29 *18*	
	10		8.89 *12*	
	11	5/2	10.24 *5*	
	12	1	11.37 *6*	
C	12	1	10.76 *19*	E[e]=2.58 *17*,6.89 *42*,10.68 *12*
	13	1/2	11.69 *12*	E[cd]=4.4,10.4
	14		12.17 *33*	
N	14		12.17	E=10.5[d]
	15		13.59 *15*	
O	16		12.5[b] *4*	B_Λ[b]=6.6 *2*,2.74 *13*
	18		14.5[a]	E=13[d]
Al	27		17.5[a]	B_Λ=9[d]
Si	28		16.0[b] *3*	B_Λ[b]=12.7 *4*,6.4 *1*,3.3 *5*
S	32		17.5 *5*	B_Λ=6[d]
Ca	40		18.7[b] *11*	B_Λ[b]=15.8 *8*,12.6 *7*,10.4 *3*, 7.6 *3*,4.8 *2*,2.0 *2*
V	51		20[b] *2*	B_Λ[b]=17 *3*,14.2 *6*,11.6 *7*, 8.0 *8*,5.0 *3*,1.5 *8*
Fe	56		21	
Y	89		22[b] *2*	B_Λ[b]=15.2 *2*,8.7 *1*,2.3 *1*
Bi	209		23.5[a]	

†From H. Bando, T. Motoba, and J. Zofka *Int. J. Mod. Phys.* A5, 4021 (1990), except where indicated otherwise.
* Λ binding energy
a Theoretical value
b From (π^+,K^+) – R. Chrien, BNL, Priv. Comm. (1990)
c From (π^+,K^+)
d From (K^-,π^-)
e From (π^+,K^+) – T. Hasegawa, et al., *Phys. Rev. Lett.* 74, 224 (1995)

Appendix–VIa Periodic Table of Elements

IA	IIA	IIIB	IVB	VB	VIB	VIIB	---	VIII	---	IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
H 1																	He 2
Li 3	Be 4											B 5	C 6	N 7	O 8	F 9	Ne 10
Na 11	Mg 12											Al 13	Si 14	P 15	S 16	Cl 17	Ar 18
K 19	Ca 20	Sc 21	Ti 22	V 23	Cr 24	Mn 25	Fe 26	Co 27	Ni 28	Cu 29	Zn 30	Ga 31	Ge 32	As 33	Se 34	Br 35	Kr 36
Rb 37	Sr 38	Y 39	Zr 40	Nb 41	Mo 42	Tc 43	Ru 44	Rh 45	Pd 46	Ag 47	Cd 48	In 49	Sn 50	Sb 51	Te 52	I 53	Xe 54
Cs 55	Ba 56	* 57–	Hf 72	Ta 73	W 74	Re 75	Os 76	Ir 77	Pt 78	Au 79	Hg 80	Tl 81	Pb 82	Bi 83	Po 84	At 85	Rn 86
Fr 87	Ra 88	** 89–	Rf 104	Ha 105	Sg 106	Ns 107	Hs 108	Mt 109									
*	La 57	Ce 58	Pr 59	Nd 60	Pm 61	Sm 62	Eu 63	Gd 64	Tb 65	Dy 66	Ho 67	Er 68	Tm 69	Yb 70	Lu 71	Lanthanides	
**	Ac 89	Th 90	Pa 91	U 92	Np 93	Pu 94	Am 95	Cm 96	Bk 97	Cf 98	Es 99	Fm 100	Md 101	No 102	Lr 103	Actinides	

Appendix–VIb List of Elements – Alphabetical

Name	Sym	Z	Name	Sym	Z
Actinium	Ac	89	Mercury	Hg	80
Aluminum	Al	13	Molybdenum	Mo	42
Americium	Am	95	Neodymium	Nd	60
Antimony	Sb	51	Neon	Ne	10
Argon	Ar	18	Neptunium	Np	93
Arsenic	As	33	Nickel	Ni	28
Astatine	At	85	Nielsbohrium	Ns	107
Barium	Ba	56	Niobium	Nb	41
Berkelium	Bk	97	Nitrogen	N	7
Beryllium	Be	4	Nobelium	No	102
Bismuth	Bi	83	Osmium	Os	76
Boron	B	5	Oxygen	O	8
Bromine	Br	35	Palladium	Pd	46
Cadmium	Cd	48	Phosphorus	P	15
Calcium	Ca	20	Platinum	Pt	78
Californium	Cf	98	Plutonium	Pu	94
Carbon	C	6	Polonium	Po	84
Cerium	Ce	58	Potassium	K	19
Cesium	Cs	55	Praseodymium	Pr	59
Chlorine	Cl	17	Promethium	Pm	61
Chromium	Cr	24	Protactinium	Pa	91
Cobalt	Co	27	Radium	Ra	88
Copper	Cu	29	Radon	Rn	86
Curium	Cm	96	Rhenium	Re	75
Dysprosium	Dy	66	Rhodium	Rh	45
Einsteinium	Es	99	Rubidium	Rb	37
Erbium	Er	68	Ruthenium	Ru	44
Europium	Eu	63	Rutherfordium	Rf	104
Fermium	Fm	100	Samarium	Sm	62
Fluorine	F	9	Scandium	Sc	21
Francium	Fr	87	Selenium	Se	34
Gadolinium	Gd	64	Seaborgium	Sg	106
Gallium	Ga	31	Silicon	Si	14
Germanium	Ge	32	Silver	Ag	47
Gold	Au	79	Sodium	Na	11
Hafnium	Hf	72	Strontium	Sr	38
Hahnium	Ha	105	Sulfur	S	16
Hassium	Hs	108	Tantalum	Ta	73
Helium	He	2	Technetium	Tc	43
Holmium	Ho	67	Tellurium	Te	52
Hydrogen	H	1	Terbium	Tb	65
Indium	In	49	Thallium	Tl	81
Iodine	I	53	Thorium	Th	90
Iridium	Ir	77	Thulium	Tm	69
Iron	Fe	26	Tin	Sn	50
Krypton	Kr	36	Titanium	Ti	22
Lanthanum	La	57	Tungsten	W	74
Lawrencium	Lr	103	Uranium	U	92
Lead	Pb	82	Vanadium	V	23
Lithium	Li	3	Xenon	Xe	54
Lutetium	Lu	71	Ytterbium	Yb	70
Magnesium	Mg	12	Yttrium	Y	39
Manganese	Mn	25	Zinc	Zn	30
Meitnerium	Mt	109	Zirconium	Zr	40
Mendelevium	Md	101			

Appendix–VIc List of Elements – by Z

Z	Sym	Name
1	H	Hydrogen
2	He	Helium
3	Li	Lithium
4	Be	Beryllium
5	B	Boron
6	C	Carbon
7	N	Nitrogen
8	O	Oxygen
9	F	Fluorine
10	Ne	Neon
11	Na	Sodium
12	Mg	Magnesium
13	Al	Aluminum
14	Si	Silicon
15	P	Phosphorus
16	S	Sulfur
17	Cl	Chlorine
18	Ar	Argon
19	K	Potassium
20	Ca	Calcium
21	Sc	Scandium
22	Ti	Titanium
23	V	Vanadium
24	Cr	Chromium
25	Mn	Manganese
26	Fe	Iron
27	Co	Cobalt
28	Ni	Nickel
29	Cu	Copper
30	Zn	Zinc
31	Ga	Gallium
32	Ge	Germanium
33	As	Arsenic
34	Se	Selenium
35	Br	Bromine
36	Kr	Krypton
37	Rb	Rubidium
38	Sr	Strontium
39	Y	Yttrium
40	Zr	Zirconium
41	Nb	Niobium
42	Mo	Molybdenum
43	Tc	Technetium
44	Ru	Ruthenium
45	Rh	Rhodium
46	Pd	Palladium
47	Ag	Silver
48	Cd	Cadmium
49	In	Indium
50	Sn	Tin
51	Sb	Antimony
52	Te	Tellurium
53	I	Iodine
54	Xe	Xenon
55	Cs	Cesium
56	Ba	Barium
57	La	Lanthanum
58	Ce	Cerium
59	Pr	Praseodymium
60	Nd	Neodymium
61	Pm	Promethium
62	Sm	Samarium
63	Eu	Europium
64	Gd	Gadolinium
65	Tb	Terbium
66	Dy	Dysprosium
67	Ho	Holmium
68	Er	Erbium
69	Tm	Thulium
70	Yb	Ytterbium
71	Lu	Lutetium
72	Hf	Hafnium
73	Ta	Tantalum
74	W	Tungsten
75	Re	Rhenium
76	Os	Osmium
77	Ir	Iridium
78	Pt	Platinum
79	Au	Gold
80	Hg	Mercury
81	Tl	Thallium
82	Pb	Lead
83	Bi	Bismuth
84	Po	Polonium
85	At	Astatine
86	Rn	Radon
87	Fr	Francium
88	Ra	Radium
89	Ac	Actinium
90	Th	Thorium
91	Pa	Protactinium
92	U	Uranium
93	Np	Neptunium
94	Pu	Plutonium
95	Am	Americium
96	Cm	Curium
97	Bk	Berkelium
98	Cf	Californium
99	Es	Einsteinium
100	Fm	Fermium
101	Md	Mendelevium
102	No	Nobelium
103	Lr	Lawrencium
104	Rf	Rutherfordium
105	Ha	Hahnium
106	Sg	Seaborgium
107	Ns	Nielsbohrium
108	Hs	Hassium
109	Mt	Meitnerium

Appendix–VII
International Nuclear Structure and Decay Data Network

International At. Energy Agency–
Nuclear Data Section
Wagramerstr. 5, P.O. Box 100
A–1400 Vienna, Austria
Contact: H. D. Lemmel

National Nuclear Data Center
Brookhaven National Laboratory
Upton, NY 11973, USA
Contact: M. R. Bhat

Nuclear Data Project
Oak Ridge National Laboratory
Oak Ridge, TN 37831, USA
Contact: M. J. Martin

Isotopes Project
Lawrence Berkeley National Laboratory
Berkeley, CA 94720, USA
Contact: J. M. Dairiki

Idaho National Engineering Laboratory
E. G. and G. Idaho, Inc.
P.O. Box 1625
Idaho Falls, ID 83415, USA
Contact: R. G. Helmer

TUNL Nuclear Data Evaluation Project, Triangle Universities Nuclear Laboratory
P.O. Box 90308,
Durham, NC 27708–0308
Contact: D. R. Tilley

Center for Nuclear Information Technology, Dept. of Chemistry
San Jose State University
San Jose, CA 95192–0101
Contact: C. A. Stone

Center for Nuclear Structure and Reaction Data
Kurchatov Inst. of At. En.
46 Ulitsa Kurchatov 123 182
Moscow, Russia
Contact: F. E. Chukreev

Nuclear Data Centre
St. Petersburg Nucl. Phys. Inst.
Gatchina, Leningrad Region
188 350, Russia
Contact: I. Kondurov

Fysisch Laboratorium
Princetonplein 5,
Postbus 80.000
3508 TA Utrecht, The Netherlands
Contact: C. van der Leun

Centre d'Etudes Nucleaires
DRF–SPH
Cedex No. 85
F–38041 Grenoble Cedex, France
Contact: J. Blachot

Nuclear Data Center
Tokai Research Establishment
JAERI
Tokai–Mura, Naka–Gun
Ibaraki–Ken 319–11, Japan
Contact: Y. Kikuchi

Department of Physics
University of Lund
Sölvegatan 14
S–223 62 Lund, Sweden
Contact: P. Ekström

Nuclear Data Project
Kuwait Institute for Scientific Research
P.O. Box 24885
Kuwait, Kuwait
Contact: A. Farhan

Laboratorium voor Kernfysica
Proeftuinstraat 86
B–9000 Gent, Belgium
Contact: D. De Frenne

Tandem Accelerator Laboratory
McMaster University
Hamilton, Ontario L8S 4K1
Canada
Contact: J. A. Kuehner

Institute of Atomic Energy
P.O. Box 275 (41), Beijing
People's Republic of China
Contact: Zhang, Zingshang

Department of Physics
Jilin University, Changchun
People's Republic of China
Contact: Huo, Junde

Appendix–VIII
The Nuclear Data Centers Network

National Nuclear Data Center
Brookhaven National Laboratory
Bldg. 197D
P.O. Box 5000
Upton, NY 11973–5000, USA
Contact: C. L. Dunford

OECD Nuclear Energy Agency–
Data Bank
Le Seine Saint–Germain
12 Boulevard des Iles
92130 Issy–les–Moulineaux
France
Contact: N. Tubbs

International Atomic
Energy Agency–
Nuclear Data Section
Wagramerstr. 5, P.O. Box 100
A–1400 Vienna, Austria
Contact: P. Oblozinsky

Federal Research Center IPPE
Centr Jadernykh Dannykh
Ploshchad Bondarenko
249 020 Obninsk, Kaluga Region
Russia
Contact: V. N. Manokhin

Kurchatov Institute
Russia Nuclear Center
46 Ulitsa Kurchatova
123182 Moscow, Russia
Contact: F. E. Chukreev

Institute of Nuclear Physics
Moscow State University
Vorob'evy Gory
119899 Moscow, Russia
Contact: V. V. Varlamov

China Nuclear Data Center
China Institute of Atomic Energy
P.O. Box 275 (41)
Beijing 102413,
People's Republic of China
Contact: Zhang, Jingshang

Japan Atomic Energy
Research Institute–
Nuclear Data Center
2–4 Shirakata Shirane
Tokai–mura, Naka–gun
Ibaraki–ken 319–11, Japan
Contact: Y. Kikuchi

RIKEN Nuclear Data Group
RIKEN
Hirosawa 2–1
Wako–shi
Saitama 351–01, Japan
Contact: Y. Tendow

Japan Charged–Particle Nuclear
Reaction Data Group
Department of Physics
Hokkaido University
Kita–10 Nishi–8, Kita–ku
Sapporo 060, Japan
Contact: K. Kato

ATOMKI Charged–Particle Nuclear
Reaction Data Group
ATOMKI, Inst of Nuclear Research of
the Hungarian Academy of Sciences
Bem ter 18/c, P.O. Box 51
H–4001 Debrecen, Hungary
Contact: F. T. Tarkanyi

Electronic Nuclear Data Access

Introduction

The National Nuclear Data Center (NNDC) and some other members of the International Nuclear Structure and Decay Data Network (See Appendix *VII*) and the Nuclear Data Centers Network (See Appendix *VIII*) provide electronic access to many of the bibliographic and numeric data bases maintained by members of these groups. Access is available by anonymous FTP, terminal (TCP/IP TELNET, DECNET SET HOST, and modem), and the World Wide Web (WWW). Some data bases or programs also are available on CD-ROM and floppy diskettes.

The contents of these various services are changing and growing continually as are the methods of accessing them. Most of the WWW home pages listed below contain current links. If you have problems or questions, please contact the NNDC at **services@bnlnd2.dne.bnl.gov**.

The data bases and other services maintained by the NNDC, the International Atomic Energy Agency Nuclear Data Section (IAEA NDS), and the OECD Nuclear Energy Agency Data Bank (NEADB) are listed starting on page *ii* followed by the methods of electronic access to these centers. Other members of the International Nuclear Structure and Decay Data Network providing electronic access are listed in alphabetical order starting on page *vi*. Sites for members of other networks providing electronic access are given on the NNDC WWW home page; other WWW sites of interest may be found on most of the home pages listed below.

An abridged, modified set of definitions of terms, acronyms, and abbreviations starts on page *viii*. The original source is

available on the Lund Nuclear Data Services (University of Lund, Sweden) WWW home page. Information on access to the Directory of Nuclear Physics Laboratories and to the DOE's Division of Nuclear Physics is also included on page *xii*.

Data Bases and Services at the NNDC, the IAEA NDS, and the OECD NEADB

The NNDC, NDS, and NEADB mirror the information available at these three centers although there are some differences in the contents and version dates of the data bases. Current major systems common to the three systems are listed below. The centers providing access to this information in various formats are shown in the square brackets following the definitions.

CINDA (***C***omputer ***I***ndex of ***N***eutron ***Da***ta)—Bibliographic references to data on neutron reactions. [NDS, NEADB, NNDC]

CODES—Includes ENDF pre-processing and utility codes and ENSDF analysis and checking codes. [NDS, NNDC]

CSISRS (***C***ross ***S***ection ***I***nformation ***S***torage and ***R***etrieval ***S***ystem)—Experimental data on nuclear reactions, along with descriptions. This also is known as **EXFOR** (***Ex***change ***For***mat). [NDS, NEADB, NNDC]

DOCUMENTATION—Includes the NNDC (NDS) On-line Data Service Manual [NDS, NNDC]and the ***E***valuated ***N***uclear ***S***tructure ***D***ata ***F***ile Manual [NDS, NEADB, NNDC].

ENDF (***E***valuated ***N***uclear ***D***ata ***F***ile)—Evaluated data on nuclear reactions and decays. [NDS, NEADB (EVA, JEF), NNDC]

ENSDF (***E***valuated ***N***uclear ***S***tructure ***D***ata ***F***ile)—Evaluated data on adopted levels and their properties, decay schemes, and nuclear structure information from reactions for all known nuclides. [IP (Isotopes Project), Lund, NDS, NEADB, NNDC]

LIBRARIES—Includes the 1993 Audi-Wapstra Atomic Mass Evaluation [NDS, NEADB, NNDC], and the International Reactor Dosimetry File—1990 (Version 2) [NDS, NNDC]

MIRD—Information on radionuclide decay in the format of the ***M***edical ***I***nternal ***R***adiation ***D***ose Committee. [Lund, NDS, NNDC]

NSR (***N***uclear ***S***cience ***R***eferences)—Bibliographic information on nuclear structure, nuclear reactions, and radioa c-tive decay; some papers on atomic physics are included that are relevant to the physics of nuclear structure. [IP (Papyrus NSR), Lund (Papyrus NSR), NDS, NEADB, NNDC]

NUDAT (***Nu***clear ***Dat***a File)—Evaluated nuclear data, including nuclear levels and their properties, nuclear masses, nuclear isomeric properties, radioactive decay radiations, and thermal cross sections and resonance integrals. [NDS, NEADB, NNDC]

PCNUDAT—An MS-DOS clone of NUDAT. [Lund, NNDC]

XRAY (Photon Attenuation and Scattering)—Attenuation coefficients and total x-ray cross sections, and scattering cross sections for polarized photons. [NDS, NNDC]

Other information available at the NNDC and NDS includes: the NNDC (NDS) address list and Newsletter; **UTILITIES** to run nuclear physics analyses and Q-value

calculation codes, to plot and display sample retrievals; and **FILES** to view and electronically transfer data files.

National Nuclear Data Center (NNDC), Brookhaven National Laboratory, USA

Anonymous FTP

•**bnlnd2.dne.bnl.gov**. User name: **anonymous**. Password: Your e-mail address.

•**Contents:** Codes, documentation, and libraries as described on pages *ii* through *iv*. Additional contents include MS-DOS versions of the ENSDF analysis and checking codes (including executables), ENSDAT (***E***valuated ***N***uclear ***S***tructure ***D***rawings ***a***nd ***T***ables), and PCNUDAT.

Terminal Access

•**TELNET: bnlnd2.dne.bnl.gov** (**130.199.112.132**). User name: **NNDC** (no password). At the prompt for assigned authorization code, enter the code or GUEST.

•**DECNET SET HOST: bnlnd2** (**44436** or **43.404**). Remaining dialog as in the TELNET instructions.

•**Modem: 516-282-2002**.

•Protocol: ASCII only. Full duplex.

•Speed: 1200 to 19200 bps. Higher speeds up to 57.6 kbps may be possible if supported by the local modem and software.

•Word: 8-bit, parity off, one stop bit.

•Thor login: **NNDC**. Password: **NNDC**. User name and password must be *capitalized*. See TELNET instructions for authorization code.

•**Contents:** See pages *ii* through *v*.

World Wide Web

•**http://www.dne.bnl.gov/nndc.html**

•**Contents**: General information, Nuclear decay data in the ***M***edical ***I***nternal ***R***adiation ***D***ose format (MIRD), Codes, documentation, and libraries as described on pages *ii* through *iv*. Mirror site for the Korean Atomic Energy Research Institute's *Table of the Nuclides*.

CD-ROM Distribution

Nuclear Data on CD-ROM (In preparation)—Includes Papyrus NSR and PCNUDAT. Contact: R.R. Kinsey (**kinsey1@ bnl.gov**)

Floppy Disk Distribution

•ENSDF Analysis and Checking Codes for MS-DOS—Contact: T.W. Burrows (**nndctb@bnl.gov**)

•PCNUDAT (Demonstration version)—Contact: R.R. Kinsey (**kinsey1@bnl.gov**).

Nuclear Data Section (NDS), IAEA, Austria

Terminal Access

•**TELNET: iaeand.iaea.or.at**. User name: **IAEANDS** (No password). At the prompt for assigned authorization code, enter the code or GUEST.

•**Contents:** See pages *ii* through *v*.

Nuclear Energy Agency Data Bank (NEADB), OECD, France

Terminal Access

•**TELNET: db.nea.fr**. User name: **NEADB**. No password. At the prompt for assigned authorization code, enter the assigned code or GUEST.

•**Contents:** See next entry.

World Wide Web

•**http://www.nea.fr/html/dbdata/dbdata.html**

•**Contents:** General Information, evaluated nuclear structure data (NSR, ENSDF, NUDAT), evaluated nuclear data files (EVA, JEF), experimental data on nuclear reactions (EXFOR, CINDA, WRENDA), and the Audi-Wapstra Atomic Mass Evaluations. Most searches and retrievals of the data base are by TELNET connections.

Center for Nuclear Information Technology (CNIT), San Jose State University, USA

•MacNuclide—Contact C.A. Stone (**STONE.C@APPLELINK.APPLE.COM**)

Isotopes Project (IP), E.O. Lawrence Berkeley National Laboratory, USA

World Wide Web

•**http://csa5.lbl.gov/~fchu/ip.html**

•**Contents:** General information; ENSDF; EHSDF (***E***valuated ***H***igh ***S***pin ***D***ata ***F***ile); EDDF (***E***valuated ***D***ecay ***D***ata ***F***ile); VuENSDF, *Table of Isotopes* (not yet available), Papyrus NSR, and GAMQUEST.

CD-ROM Distribution

Nuclear Data on CD-ROM (In preparation)—Includes Papyrus NSR and PCNUDAT. Contact: E. Browne (**EBROWNE@CSA3.LBL.GOV**)

Lund Nuclear Data Services, University of Lund, Sweden

Anonymous FTP

•**OUTIS.LUCAS.LU.SE**. User name: **anonymous**. No password. Directory: /pub/nsr

•**Contents:** Papyrus NSR and updates, PCNUDAT, and VuENSDF

World Wide Web

•**http://www.fysik.lu.se/NuclearData/**

•**Contents:** General information, Papyrus NSR, ENSDF Status, PCNUDAT, *Table of Isotopes*, EHSDF and EDDF, MIRD, The Radioactivity Gammas Database, the Nuclear Wallet Cards, VuENSDF, GCORR, Programs for evaluators, Local services and file transfer, Local Area Network services for Sweden. A CD-ROM user interface is planned.

CD-ROM Distribution

Nuclear Data on CD-ROM (In preparation)—Includes Papyrus NSR and PCNUDAT. Contact: L.P. Ekström (**PETER.EKSTROM@NUCLEAR.LU.SE**)

Nuclear Data Evaluation Project, Triangle Universities Nuclear Laboratory, USA

World Wide Web

•**http://www.tunl.duke.edu/NuclData**

•**Contents:** Preprints of "Energy Levels of Light Nuclei, A=19" and "Energy Levels of Light Nuclei, A=18"; an abridged version of "Energy Levels of Light Nuclei A=16-17"; a list of preprints and reprints available by standard mail; Energy Level Diagrams for A=4-20 nuclei; and information on A=3-20 nuclei from ENSDF in Postscript.

Nuclear Data Project (NDP), Oak Ridge National Laboratory, USA

World Wide Web

•**http://www.phy.ornl.gov/ndp/ndp.html**

•**Contents:** A description of the project's activities.

Glossary of Nuclear Data Evaluation and WWW Jargon

Following is an abridged, modified version of definitions of terms and abbreviations used by nuclear data evaluators prepared by L.P. Ekström. Some computer terms—relevant to the nuclear structure software—also are included. The original version, including links to more detailed information, is available on the Lund Nuclear Data Services Web home page.

•Adopted levels, gammas—In ENSDF, there is an Adopted levels' data set for each known nuclide. It contains adopted properties of levels and gammas. If a nuclide has only one data set, this set is considered as the Adopted levels, gammas data set.

•Anonymous FTP—A method of using FTP without having to have an account on the server system. On systems offering an anonymous FTP service, the name "anonymous" and, very often, the more easily spelled "ftp" are recognized and allow access using the user's e-mail address as a password.

•Band—In ENSDF and VuENSDF a band is a set of levels that share some nuclear-structure property, *e.g.*, a rotational band, vibrational states or simple shell model configurations. In ENSDF, levels belonging to a band are marked with a BAND comment.

•Browser—A program that sends requests for resources across networks and displays those resources when they are received. Another name for the WWW client program. Examples are Mosaic and Netscape.
•CINDA—See pages *ii* through *iv*.
•Client—A computer program which by some communication protocol is in contact with a server program.
•Client-server or Client-server architecture—A basic idea used in computer networking, wherein servers retrieve information requested by clients, and clients display that information to the user. On the WWW, the client is a WWW browser program. The server is a special program running on any computer on the Internet.
•COMTRANS—A computer program, written at the NNDC, to translate ENSDF comments (using the ENSDF dictionary into an extended-code character set).
•CSISRS—See pages *ii* through *iv*.
•Data set—ENSDF is divided into several data sets. A data set either contains adopted properties (the Adopted levels, gammas data set), data from a radioactive decay (decay data sets), or from a nuclear reaction (reaction data sets).
•EDDF—Evaluated Decay Data File - A computer file (based on ENSDF) with the decay data used for generating the *Table of Isotopes*.
•EHSDF—Evaluated High Spin Data File - A computer file (based on ENSDF) with the high-spin data used for the generating the *Table of Isotopes*.
•ENDF—See pages *ii* through *iv*.
•ENDF format—An internationally accepted format for exchanging evaluated files of nuclear reaction and decay data. ENDF-6 is the latest version.
•ENSDF—See pages *ii* through *iv*.

•ENSDF/2 Format—A modified version of the ENSDF format. The main difference between this and the original is that all levels are labeled, and transitions between levels are defined unambiguously with these labels.
•ENSDF Dictionary—A translation table to convert 7 bit ASCII text from ENSDF comments into an extended character set containing Greek letters, superscripts, and subscripts.
•FMTCHK—ForMaT CHecK - A computer program used by evaluators to check that data sets comply with the ENSDF format.
•FTP—File Transfer Protocol. A standard Internet protocol that allows files to be transmitted from one computer to another across a network.
•GIF—Graphics Interchange Format. A standard graphics-file format developed by CompuServe, Inc.
•Host—A computer attached to the Internet.
•HTML—HyperText Markup Language. The markup language used for WWW documents.
•HTTP—HyperText Transfer Protocol. The Internet protocol that is used to allow WWW clients to retrieve information from WWW servers.
•IP address—Internet Protocol address. A standardized method of identifying a particular computer connected to a network. The IP address is expressed as four numbers less than 256, separated by periods. It provides a unique identifier for every computer connected to the network.
•JPEG—Joint Photographic Experts Group; also refers to the graphics-file format developed by that body.
•Mass chain—The collection of data sets in ENSDF containing information on nuclides with a particular mass number.
•MASSES—Files containing information on atomic masses provided by G. Audi and A. Wapstra. These tables are published in Nuclear Physics A.

•MIME type—Multipurpose Internet Mail Extensions type—a piece of information on the type of file that is transferred from a server to a client.
•Mosaic—A free program from NCSA used for browsing the World Wide Web.
•Netscape—A program from Netscape Communications used for browsing the World Wide Web.
•NSR—See pages *ii* through *iv*.
•NUDAT—See pages *ii* through *iv*.
•PCNUDAT—See pages *ii* through *iv*.
•PDF—Portable Document Format. A format defined by Adobe, Inc. for platform-independent documents. To read files in PDF format a free Acrobat Reader is required for the computer used.
•Server—A program that responds to requests from a client program. The term also is used to refer to the computer system on which the server program runs.
•TELNET—A standard Internet protocol providing a remote login service.
•URL—Uniform Resource Locator. The current addressing scheme for resources on the WWW. The URL gives the location of a particular copy of a resource.
•VuENSDF—A computer code for displaying decay scheme drawings and tabular listings of nuclear structure and decay data from ENSDF. VuENSDF is written at the Isotopes Project.
•Viewer-application (also, a helper-application)—A program used by Mosaic or Netscape to handle specialized file formats.
•XRAY—See pages *ii* through *iv.*

Directory of Nuclear Physics Laboratories, 6th Edition

A new version of the Directory of Nuclear Physics Laboratories is being prepared at the National Superconducting Cyclotron Laboratory (NSCL), Michigan State University, under the sponsorship of the Division of Nuclear Physics, American Physical Society (APS). The current (5th) edition will be placed on the WWW by October 1, 1995. Suggestions for new or changed listings should be sent to Shari Conroy, Cyclotron Laboratory, Michigan State University, East Lansing MI 48824 (**conroy@nscl.msu.edu**). The directory will appear on the World Wide Web with pointers to it on the Division's home page found on the APS home page (**http://aps.org**) and on the NSCL home page (**http://pads1.pa.msu.edu/nuclear/NSCL.htm**).

Division of Nuclear Physics, US Department of Energy

The Division of Nuclear Physics supports a broad program of basic research in nuclear physics. At the Division's World Wide Web site: (**http://www.er.doe.gov/production/henp/nucphys.html**) will be found an overview of its research program, programmatic activities, links to research facilities at universities and national laboratories, links to some major experiments, and links to research publications. One of the Division's sub-programs, Low Energy Nuclear Physics, supports information services on critical nuclear data, and the compilation and dissemination of accurate and complete nuclear data information that is readily accessible and user oriented.