NUCLEAR WALLET CARDS

January 2000

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NATIONAL NUCLEAR DATA CENTER

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(Sixth edition)

JANUARY 2000

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for

The U.S. Nuclear Data Program

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U.S. Nuclear Data Program

(http://www.nndc/usndp/)

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INTRODUCTION

This is an updated edition of the 1995 booklet of the same name†.

This booklet presents selected properties of all known nuclides and their known isomeric states. Properties of ionized atoms are not included.

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≥44 and in *Nuclear Physics*[3,4] for A<44. For nuclides for which either there are no data in ENSDF or those data have since been superseded, the half–life and the decay modes are taken either from recent literature[5] or from other sources[*e.g.*, 6,7,8].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 **July 31, 1999**.

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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 subsequent editions, third in 1985, fourth in 1990, and the fifth edition in 1995, were produced by J. K. Tuli, NNDC, 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 with half–life≥1 ms which decay by SF, α or p emissions. A nuclide is included even if only its mass estimate or its production cross section is available. For the latter nuclides $T_{1/2}$ limit or an approximate value is given as estimated from systematics[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 International Union of Pure and Applied Chemistry (1997).

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. As stated above when a limit or an approximate value is given it is based on systematics, mostly from [8].

For $2\beta^-$ and 2ε decay only the lowest value of their several limits (*e.g.*, for 0ν or 2ν, etc.) is given.

If a new measurement of T½ has since become available it is presented in place of the evaluated value in ENSDF.

Explanation of Table (cont.)

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. A "?" indicates an expected but not observed mode of decay[8]. 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

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	10.24 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–	25.9	4.6 MeV *9*	n
		5		36.8	5.7 MeV *21*	n
		6		41.9	1.4 MeV *3*	3n?
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	65 keV *37*	n
		10	0+	48.81	0.17 MeV *11*	2n?
3	**Li**	4	2–	25.3	6.03 MeV	p
		5	3/2–	11.68	≈1.5 MeV	α, p
		6	1+	14.086	**7.59%** ***4***	
		7	3/2–	14.908	**92.41%** ***4***	
		8	2+	20.946	838 ms *6*	β–, β–α
		9	3/2–	24.954	178.3 ms *4*	β–, β–n 50.8%
		10	(1–,2–)	33.05	1.2 MeV *3*	n
		11	3/2–	40.80	8.5 ms *2*	β–, β–nα 0.027%, β–n
		12		50.1s	<10 ns	n?
4	**Be**	5	(1/2+)	38.s		p
		6	0+	18.375	92 keV *6*	α, 2p
		7	3/2–	15.769	53.29 d *7*	ε
		8	0+	4.942	6.8 eV *17*	α
		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	21.3 ms *1*	β–, β–n<1%
		13	(1/2–)	33.7	0.17 MeV *11*	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, α
		8	2+	22.921	770 ms *3*	ε, εα
		9	3/2–	12.416	0.54 keV *21*	p,
		10	3+	12.051	**19.8%** ***3***	
		11	3/2–	8.668	**80.2%** ***3***	
		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	12.3 ms *3*	β–, β–n 6.04%
		15		28.97	9.87 ms *7*	β–, β–n 93.6%, β–2n 0.4%
		16	0–	37.08	<190 ps	n
		17	(3/2–)	43.7	5.08 ms *5*	β–, β–n 63%, β–2n 11%, β–3n 3.5%, β–4n 0.4%
		18	(4–)	52.3s	<26 ns	n?

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Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
5	**B**	19	(3/2–)	59.4s	>200 ns	β– ?
6	**C**	8	0+	35.09	230 keV *50*	p , α
		9	(3/2–)	28.914	126.5 ms *9*	ε , εp 23%, εα 17%
		10	0+	15.699	19.255 s *53*	ε
		11	3/2–	10.651	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– , β–n 99%
		17		21.04	193 ms *13*	β– , β–n 32%
		18	0+	24.92	95 ms *10*	β– , β–n 19%
		19		32.8	49 ms *4*	β–n 61%, β–
		20	0+	37.6	14 ms *+6–5*	β– , β–n 72%
		21	(1/2+)	46.0s	<30 ns	n?
		22	0+	52.6s	>200 ns	β– ?
7	**N**	10	(1–)	39.7s		p?
		11m	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%** ***20***	
		15	1/2–	0.101	**0.366%** ***20***	
		16	2–	5.683	7.13 s *2*	β– , β–α 0.0012%
		17	1/2–	7.87	4.173 s *4*	β– , β–n 95.1%
		18	1–	13.12	624 ms *12*	β– , β–n 14.3%, β–α 12.2%
		19		15.86	290 ms *90*	β– , β–n 62.4%
		20		21.77	142 ms *19*	β– , β–n 66.1%
		21	(1/2–)	25.23	87 ms *6*	β– , β–n 80%
		22		32.1	18 ms *5*	β– , β–n 35%
		23	(1/2–)	37.7s	>200 ns	β– ?
		24		47.0s	<52 ns	n?
8	**O**	12	0+	32.05	0.40 MeV *25*	p
		13	(3/2–)	23.111	8.58 ms *5*	ε , εp≈100%
		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%** ***16***	
		17	5/2+	–0.809	**0.038%** ***1***	
		18	0+	–0.782	**0.200%** ***14***	
		19	5/2+	3.334	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– , β–n<22%
		23	(1/2+)	14.6	82 ms *37*	β– , β–n 31%
		24	0+	19.0	61 ms *26*	β– , β–n 58%
		25	(3/2+)	27.1s	<50 ns	n?
		26	0+	35.2s	<40 ns	n?
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

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Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
9	F	18	1+	0.873	109.77 m *5*	ε
		19	1/2+	−1.487	**100%**	
		20	2+	−0.017	11.163 s *8*	β−
		21	5/2+	−0.048	4.158 s *20*	β−
		22	4+,(3+)	2.79	4.23 s *4*	β−, β−n<11%
		23	(3/2,5/2)+	3.33	2.23 s *14*	β−, β−n<14%
		24	(1,2,3)+	7.54	0.34 s *8*	β−, β−n<11%
		25	(5/2+)	11.27	59 ms *40*	β−, β−n 15%
		26		18.3	190 ms *110*	β−, β−n<32%
		27	(5/2+)	25.0	>200 ns	β−?
		28		33.2s	<40 ns	n?
		29	(5/2+)	40.3s	>200 ns	β−
10	Ne	16	0+	23.99	122 keV *37*	p
		17	1/2−	16.49	109.2 ms *6*	ε, εp≈100%, εα
		18	0+	5.307	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	0.197 s *1*	β−, β−n 0.13%
		27	(3/2+)	7.09	32 ms *2*	β−, β−n 2%
		28	0+	11.3	17 ms *4*	β−, β−n 22%
		29	(3/2+)	18.0	200 ms *100*	β−, β−n?
		30	0+	22.2	>200 ns	β−
		31	(7/2−)	30.8s	>260 ns	β−?, β−n?
		32	0+	37.2s	>200 ns	β−?, β−n?
11	Na	18	(1−)	25.3s		p?, ε?
		19	(5/2+)	12.93	<40 ns	p
		20	2+	6.845	447.9 ms *23*	ε, εα 20.05%
		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	14.9512 h *32*	β−
		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 0.13%
		28	1+	−1.03	30.5 ms *4*	β−, β−n 0.58%
		29	3/2	2.62	44.9 ms *12*	β−, β−n 22%, β−2n 1.2%
		30	2+	8.59	48 ms *2*	β−, β−n 30%, β−2n 0.9%, 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 5.1%
		33		26.	8.2 ms *4*	β−, β−n 52%, β−2n 12%
		34		33.s	5.5 ms *10*	β−, β−n

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Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
11	**Na**	35		41.s	1.5 ms *5*	β−, β−n
12	**Mg**	20	0+	17.57	90.8 ms *24*	ε, εp≈27%
		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%** ***4***	
		25	5/2+	−13.193	**10.00%** ***1***	
		26	0+	−16.215	**11.01%** ***3***	
		27	1/2+	−14.587	9.458 m *12*	β−
		28	0+	−15.019	20.915 h *9*	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 6.2%
		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	(7/2−)	16.3s	70 ms *40*	β−, β−n 52%
		36	0+	20.9s	>200 ns	β−
		37	(7/2−)	29.1s	>260 ns	β−, β−n
13	**Al**	21	(1/2+)	26.1s	<35 ns	p
		22		18.18s	59 ms *3*	ε, εp>0%, ε2p>0%, εα>0%
		23	(5/2+)	6.77	0.47 s *3*	ε, εp
		24	4+	−0.055	2.053 s *4*	ε, εα 0.04%, εp 0.0012%
		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	7.17×10^{5} y *24*	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−, β−n<12%
		33		−8.50	>1 μs	β−, β−n<43%
		34		−2.86	60 ms *18*	β−, β−n 12.5%
		35		−0.1	150 ms *50*	β−, β−n 26%
		36		5.9	90 ms *40*	β−, β−n<31%
		37		9.6		β−
		38		15.7s	>200 ns	β−?
		39	(3/2+)	20.4s	>200 ns	β−
		40			>260 ns	β−, β−n
14	**Si**	22	0+	32.2s	29 ms *2*	ε, εp 32%
		23	(3/2+)	23.8s	>200 ns	ε?
		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+	−12.384	4.16 s *2*	ε
		28	0+	−21.493	**92.230%** ***19***	

Nuclear Wallet Cards

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
14	**Si**	29	1/2+	−21.895	**4.683%** ***8***	
		30	0+	−24.433	**3.087%** ***5***	
		31	3/2+	−22.949	157.3 m *3*	β−
		32	0+	−24.081	172 y *4*	β−
		33		−20.49	6.332 s *29*	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 12.4%
		37	(7/2−)	−6.5	90 ms *60*	β−, β−n 17%
		38	0+	−3.7	>1 μs	β−, β−n
		39	(7/2−)	2.1s	>1 μs	β−
		40	0+	5.4s	>200 ns	β−?
		41		11.8s	>200 ns	β−?
		42	0+	15.0s	>200 ns	β−?
15	**P**	24	(1+)	32.0s		p?, ε?
		25	(1/2+)	18.9s	<30 ns	p
		26	(3+)	11.0s	20 ms *+35−15*	ε, εp 2%, ε2p 2%
		27	(1/2+)	−0.75	260 ms *80*	ε, εp 6%
		28	3+	−7.161	270.3 ms *5*	ε, εp, εα
		29	1/2+	−16.952	4.142 s *15*	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 12%
		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		9.2s	>200 ns	β−
		45		14.1s	>200 ns	β−?
		46		22.2s	>200 ns	β−
16	**S**	26	0+	26.0s	≈10 ms	2p?
		27	(5/2+)	17.5s	21 ms *4*	ε, ε2p
		28	0+	4.1	125 ms *10*	ε, εp
		29	5/2+	−3.16	187 ms *4*	ε, εp
		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	87.38 d *3*	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−

Nuclear Wallet Cards

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
16	**S**	41	(7/2–)	–18.6	2.6 s *14*	β–, β–n
		42	0+	–17.2	0.56 s *6*	β–, β–n < 4%
		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–, β–n 54%
		46	0+	–0.4s	>200 ns	β–
		47		7.1s	>200 ns	β–?
		48	0+	12.1s	>200 ns	β–?
		49		20.5s	<200 ns	n
17	**Cl**	28	(1+)	26.6s		p?
		29	(3/2+)	13.1s	<20 ns	p
		30	(3+)	4.4s	<30 ns	p?
		31		–7.06	150 ms *25*	ε, εp, ε2p, ε3p
		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+	–24.441	1.5264 s *14*	ε
		34m	3+	–24.295	32.00 m *4*	ε 55.4%, IT 44.6%
		35	3/2+	–29.014	**75.77%** ***4***	
		36	2+	–29.522	3.01×10^{5} y *2*	β– 98.1%, ε 1.9%
		37	3/2+	–31.761	**24.23%** ***4***	
		38	2–	–29.798	37.24 m *5*	β–
		38m	5–	–29.127	715 ms *3*	IT
		39	3/2+	–29.801	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	0.56 s *11*	β–, β–n < 8%
		45		–18.9	400 ms *40*	β–, β–n 24%
		46		–14.8s	223 ms *37*	β–, β–n 60%
		47		–11.2s	>200 ns	β–, β–n ≤ 3%
		48		–4.8s	>200 ns	β–
		49		–0.1s	≥170 ns	β–?
		51	(3/2+)	12.6s	>200 ns	β–
18	**Ar**	30	0+	20.1s	<20 ns	p?
		31	(5/2+,3/2+)	11.3s	15.1 ms *12*	ε, εp 55%, ε2p, ε3p
		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–

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Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
18	**Ar**	47		−25.9	≈700 ms	β−, β−n < 1%
		48	0+	−23.2s		β−?
		49		−16.6s	≥170 ns	β−
		50	0+	−13.1s	≥170 ns	β−?
		51		−6.3s	>200 ns	β−?
		52	0+	−1.7s	10 ms	β−
		53	(5/2−)	6.s	3 ms *SY*	β−, β−n
19	**K**	32		20.4s		p?
		33	(3/2+)	6.8s	<25 ns	p
		34	(1+)	−1.5s	<25 ns	p
		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+)	−22.0s	365 ms *5*	β−, β−n 47%
		52	2−	−16.2s	105 ms *5*	β−, β−n ≈ 64%
		53	(3/2+)	−12.0s	30 ms *5*	β−, β−n ≈ 67%, β−2n ≈ 17%
		54		−5.6s	10 ms *5*	β−, β−n > 0%
20	**Ca**	34	0+	13.2s	<35 ns	p
		35		4.44s	25.7 ms *2*	ε, εp, ε2p
		36	0+	−6.44	102 ms *2*	ε, εp 57%
		37	3/2+	−13.16	181.1 ms *11*	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	**96.94%** ***16***	
		41	7/2−	−35.138	1.03×10^{5} y *3*	ε
		42	0+	−38.547	**0.647%** ***23***	
		43	7/2−	−38.408	**0.135%** ***10***	
		44	0+	−41.469	**2.09%** ***11***	
		45	7/2−	−40.813	162.61 d *9*	β−
		46	0+	−43.135	$>0.28\times10^{16}$ y	2β−
					0.004% ***3***	
		47	7/2−	−42.340	4.536 d *3*	β−
		48	0+	−44.215	$>4\times10^{19}$ y	2β−
					0.187% ***21***	
		49	3/2−	−41.290	8.718 m *6*	β−

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Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
20	**Ca**	50	0+	−39.571	13.9 s *6*	β−
		51	(3/2−)	−35.89	10.0 s *8*	β−, β−n
		52	0+	−32.5	4.6 s *3*	β−, β−n < 2%
		53	(3/2−,5/2−)	−27.9s	90 ms *15*	β−, β−n > 30%
		54	0+	−23.6s		β−
		56	0+	−13.2s	10 ms	β−
21	**Sc**	36		13.9s		p?
		37		2.8s		p?
		38	(2−)	−4.9s	< 300 ns	p
		39		−14.17	< 300 ns	p
		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	680.67 ms *28*	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	3.97 h *4*	ε
		44m	6+	−37.545	58.61 h *10*	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+	−40.4	8.2 s *2*	β−
		53	(7/2−)	−38.0s	> 3 s	β−, β−n
		54		−34.5	225 ms *40*	β−
		55	(7/2−)	−30.s	120 ms *40*	β−, β−n
		56	3+	−25.5s	80 ms	β−
		57		−21.4s		β−, β−n
22	**Ti**	38	0+	9.1s	< 120 ns	2p?
		39		1.2s	26 ms *8*	ε, εα?, ε2p?
		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	60.0 y *11*	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+	−45.8	> 1 μs	β−
		55	(3/2−)	−41.8	0.32 s *6*	β−

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Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
22	**Ti**	56	0+	−39.1	0.19 s *4*	β−, β−n
		57		−34.6s	0.18 s *3*	β−, β−n
		58	0+	−31.6s	>150 ns	β−
		61		−16.8s	≈10 ms	β−?
23	**V**	40		10.3s		p?
		41		−0.2s		p?
		42	(2−)	−8.2s	<55 ns	p
		43		−18.0s	>800 ms	ε
		44	(2+)	−23.85s	111 ms *7*	ε, εα
		44m	(6+)	−23.85s	150 ms *3*	ε
		45	7/2−	−31.87	547 ms *6*	ε
		46	0+	−37.074	422.50 ms *11*	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+	−49.217	1.4×10^{17} y *4*	ε 83%,
					0.250% *2*	β− 17%
		51	7/2−	−52.197	**99.750% *2***	
		52	3+	−51.437	3.743 m *5*	β−
		53	7/2−	−51.845	1.60 m *4*	β−
		54	3+	−49.89	49.8 s *5*	β−
		55	(7/2−)	−49.1	6.54 s *15*	β−
		56	3+	−46.2	0.24 s *4*	β−, β−n 0.06%
		57	(7/2−)	−44.4	0.34 s *8*	β−, β−n 0.04%
		58		−40.4	205 ms *20*	β−
		59		−37.9	118 ms *24*	β−
		60	(3+)	−33.1	0.20 s *4*	β−, β−n
		61		−30.4s	>150 ns	β−?
		62	(3+)	−25.0s	>150 ns	β−
		63	(7/2−)	−21.7s	>150 ns	β−
		64			>150 ns	β−
24	**Cr**	42	0+	6.0s	>350 ns	ε, 2p?
		43	(3/2+)	−2.14s	21 ms *+4−3*	ε, εp 18%, ε2p
		44	0+	−13.5s	53 ms *+4−3*	ε, εp>7%
		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−	−45.325	42.3 m *1*	ε
		50	0+	−50.255	$>1.8\times10^{17}$ y	2ε
					4.345% *13*	
		51	7/2−	−51.445	27.7025 d *24*	ε
		52	0+	−55.413	**83.789% *18***	
		53	3/2−	−55.281	**9.501% *17***	
		54	0+	−56.928	**2.365% *7***	
		55	3/2−	−55.103	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		−47.9	0.74 s *24*	β−
		60	0+	−46.8	0.57 s *6*	β−
		61		−42.8	0.27 s *2*	β−

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Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
24	**Cr**	62	0+	−41.2	0.19 s *3*	β−, β−n 1.04%
		63		−35.5s	0.11 s *7*	β−, β−n 1.42%
		64	0+	−33.3s	>1 μs	β−?
		65	(1/2−)	−27.6s	>150 ns	β−
		66	0+		>150 ns	β−
		67			≈50 ms	β−?
25	**Mn**	44	(2−)	6.4s	<105 ns	ε, p
		45	(7/2−)	−5.1s	<70 ns	p
		46	(4+)	−12.4s	41 ms *+7−6*	ε, εp 22%
		47		−22.3s	100 ms *50*	ε, εp 3.4%
		48	4+	−29.00s	158.1 ms *22*	ε, εp 0.28%, εα<6.0×10^{-4}%
		49	5/2−	−37.61	382 ms *7*	ε
		50	0+	−42.621	283.29 ms *8*	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
		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+	−55.551	312.11 d *5*	ε, β−<2.9×10^{-4}%
		55	5/2−	−57.706	**100%**	
		56	3+	−56.906	2.5789 h *1*	β−
		57	5/2−	−57.485	85.4 s *18*	β−
		58	1+	−55.90	3.0 s *1*	β−
		58m	(4)+	−55.83	65.2 s *5*	β−≈80%, IT≈20%
		59	3/2−,5/2−	−55.47	4.6 s *1*	β−
		60	0+	−52.9	51 s *6*	β−, β−n 0.03%
		60m	3+	−52.6	1.77 s *2*	β− 88.5%, IT 11.5%
		61	(5/2)−	−51.7	0.67 s *4*	β−
		62	(3+)	−48.5	671 ms *5*	β−
		63		−46.8	275 ms *4*	β−
		64		−43.1	89 ms *4*	β−, β−n 1.42%
		65		−40.9	88 ms *4*	β−, β−n 6.92%
		66		−36.5s	66 ms *4*	β−, β−n 10.88%
		67	(5/2−)	−33.7s	42 ms *4*	β−, β−n
		68			28 ms *4*	β−, β−n
		69	5/2−		14 ms *4*	β−, β−n 23.6%
26	**Fe**	45	(3/2+)	13.6s	>350 ns	p?, 2p?
		46	0+	0.8s	20 ms *+20−8*	ε, εp
		47		−6.6s	27 ms *+32−10*	ε, εp
		48	0+	−18.1s	44 ms *7*	ε, εp 3.6%
		49	(7/2−)	−24.6s	70 ms *3*	ε, εp 52%
		50	0+	−34.47	155 ms *11*	ε, εp?
		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	2.526 m *24*	IT
		54	0+	−56.248	>3.1×10^{22} y **5.845%** ***35***	2ε
		55	3/2−	−57.475	2.73 y *3*	ε
		56	0+	−60.601	**91.754%** ***36***	

Nuclear Wallet Cards

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
26	**Fe**	57	1/2–	–60.176	**2.119%** ***10***	
		58	0+	–62.149	**0.282%** ***4***	
		59	3/2–	–60.658	44.472 d *8*	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)–	–55.8	6.1 s *6*	β–
		64	0+	–55.1	2.0 s *2*	β–
		65		–51.3	0.4 s *2*	β–
		66	0+	–50.3	0.44 s *6*	β–
		67		–46.6	0.47 s *5*	β–, β–n 1.13%
		68	0+	–44.2s	0.10 s *6*	β–
		69	1/2–	–39.4s	0.17 s *3*	β–, β–n 6.94%
		70	0+		>150 ns	β–
		71	(7/2+)		>150 ns	β–
		72	0+		>150 ns	β–
27	**Co**	48		1.6s		p?
		49		–9.6s	<35 ns	ε, p
		50	(6+)	–17.2s	44 ms *4*	ε, εp 54%
		51	(7/2–)	–27.3s	>200 ns	ε
		52	6+	–33.92s	115 ms *23*	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+	–48.005	193.28 ms *7*	ε
		54m	(7)+	–47.806	1.48 m *2*	ε
		55	7/2–	–54.024	17.53 h *3*	ε
		56	4+	–56.035	77.233 d *27*	ε
		57	7/2–	–59.340	271.74 d *6*	ε
		58	2+	–59.841	70.86 d *7*	ε
		58m	5+	–59.817	9.04 h *11*	IT
		59	7/2–	–62.224	**100%**	
		60	5+	–61.644	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	0.233 s *17*	β–
		67	(7/2–)	–55.3	0.425 s *20*	β–
		68		–51.8	0.18 s *10*	β–
		69	7/2–	–51.0	0.27 s *5*	β–
		70		–46.8s	0.15 s *2*	β–, β–n 2.51%
		71		–45.0s	0.21 s *4*	β–, β–n 2.61%
		72		–40.6s	0.09 s *2*	β–, β–n 4.8%
		73	(7/2–)		>150 ns	β–
		74	0+		>150 ns	β–
		75	(7/2–)		>150 ns	β–
28	**Ni**	49			>350 ns	ε, p
		50	0+	–3.8s	>300 ns	ε
		51	(7/2–)	–11.4s	>200 ns	ε

Nuclear Wallet Cards

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
28	**Ni**	52	0+	−22.65s	38 ms *5*	ε , εp > 17%
		53	(7/2−)	−29.4s	45 ms *15*	ε , εp ≈ 45%
		54	0+	−39.21	143 ms *23*	ε
		55	7/2−	−45.33	204 ms *4*	ε
		56	0+	−53.90	6.075 d *10*	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 *3*	β−
		67	(1/2−)	−63.74	21 s *1*	β−
		68	0+	−63.49	29 s *2*	β−
		69	9/2+	−60.4	11.4 s *3*	β−
		70	0+	−59.5	6.0 s *3*	β−
		71		−55.9	2.56 s *3*	β−
		72	0+	−54.7	1.57 s *50*	β− , β−n
		73		−50.2s	0.84 s *3*	β− , β−n 0.3%
		74	0+	−48.5s	0.9 s *2*	β− , β−n 4.53%
		75	(7/2+)	−43.8s	0.6 s *2*	β− , β−n 8.43%
		76	0+	−41.6s	0.24 s *+55−24*	β− , β−n
		77		−36.5s	>150 ns	β− ?
		78	0+	−34.s	>150 ns	β−
29	**Cu**	52	3+	−2.6s		p
		53	(3/2−)	−13.5s	<300 ns	ε , p
		54	(3+)	−21.7s	<75 ns	p
		55		−31.6s	>200 ns	ε
		56	4+	−38.6s	78 ms *15*	ε
		57	3/2−	−47.31	196.3 ms *7*	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+	−62.794	9.67 m *3*	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	5.120 m *14*	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+)	−60.1s	6.6 s *1*	β−
		73		−59.2s	3.9 s *3*	β−
		74	(1+,3+)	−55.7s	1.594 s *10*	β−

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
29	**Cu**	*75*	(3/2–)	–54.3s	1.224 s *3*	β–, β–n 3.5%
		76m		–50.3s	0.641 s *6*	β–, β–n 3%
		76m		–50.3s	1.27 s *30*	β–
		77		–48.5s	0.469 s *8*	β–
		78		–44.0s	342 ms *11*	β–
		79		–41.7s	188 ms *25*	β–, β–n 55%
		80		–35.5s	>150 ns	β–
30	**Zn**	54	0+	–6.6s		2p?
		55		–14.9s		ε?, 2p?
		56	0+	–25.7s	36 ms *10*	ε
		57	(7/2–)	–32.7s	40 ms *10*	ε, εp≥65%
		58	0+	–42.29	86 ms *18*	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
		61m	1/2–	–56.25	<430 ms	IT
		61m	3/2–	–55.92	0.14 s *7*	IT
		61m	5/2–	–55.59	<0.13 s	IT
		62	0+	–61.17	9.186 h *13*	ε
		63	3/2–	–62.209	38.47 m *5*	ε
		64	0+	–65.999	**48.63%** ***60***	
		65	5/2–	–65.908	244.26 d *26*	ε
		66	0+	–68.896	**27.90%** ***27***	
		67	5/2–	–67.877	**4.10%** ***13***	
		68	0+	–70.004	**18.75%** ***51***	
		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+	–69.559	$>5\times10^{14}$ y	2β–
					0.62% ***3***	
		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+	–68.128	46.5 h *1*	β–
		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	>150 ns	β–
		83	(5/2+)		>150 ns	β–
31	**Ga**	56		–4.7s		p?
		57		–15.9s		p?
		58		–24.0s		p?
		59		–34.1s		p?
		60		–40.0s	>1.2 μs	ε?
		61	3/2–	–47.3s	0.15 s *3*	ε
		62	0+	–52.00	116.12 ms *30*	ε

Nuclear Wallet Cards

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
31	**Ga**	63	3/2–,5/2–	–56.7	32.4 s *5*	ε
		64	0+	–58.835	2.627 m *12*	ε
		65	3/2–	–62.653	15.2 m *2*	ε
		66	0+	–63.721	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% *9***	
		70	1+	–68.905	21.14 m *3*	β– 99.59%, ε 0.41%
		71	3/2–	–70.137	**39.892% *9***	
		72	3–	–68.587	14.10 h *2*	β–
		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	1.217 s *5*	β–, β–n 11.9%
		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	0.085 s *10*	β–, β–n 70%
		85	(3/2–)		>150 ns	β–
		86			>150 ns	β–
32	**Ge**	58	0+	–8.4s		2p?
		59		–17.0s		2p?
		60	0+	–27.8s	≈30 ms	ε?, 2p?
		61	(3/2–)	–33.7s	40 ms *15*	ε, εp≈80%
		62	0+	–42.2s	>150 ns	ε?
		63		–46.9s	95 ms *+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
		67	1/2–	–62.654	18.9 m *3*	ε
		68	0+	–66.977	270.8 d *3*	ε
		69	5/2–	–67.094	39.05 h *10*	ε
		70	0+	–70.560	**20.37% *18***	
		71	1/2–	–69.905	11.43 d *3*	ε
		72	0+	–72.586	**27.31% *26***	
		73	9/2+	–71.297	**7.76% *8***	
		73m	1/2–	–71.230	0.499 s *11*	IT
		74	0+	–73.422	**36.73% *15***	
		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	0.8×10^{25} y	2β–
					7.83% *7*	
		77	7/2+	–71.214	11.30 h *1*	β–
		77m	1/2–	–71.054	52.9 s *6*	β– 81%, IT 19%
		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%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
32	**Ge**	*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+	–65.6	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	535 ms *47*	β– , β–n 14%
		86	0+	–50.0s	>150 ns	β– ?, β–n ?
		87	(5/2+)		>150 ns	β–
		88	0+		>150 ns	β–
		89			>150 ns	β–
33	**As**	60		–6.4s		p ?
		61		–18.1s		p ?
		62		–25.0s		p ?
		63		–33.8s		p ?
		64		–39.5s	>1.2 µs	ε ?
		65		–47.1s	0.19 s *+11–7*	ε
		66		–51.8s	95.77 ms *23*	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–	–67.892	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–	–70.860	17.77 d *2*	ε 66%, β– 34%
		75	3/2–	–73.033	**100%**	
		76	2–	–72.290	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+)	–70.3	19.1 s *5*	β–
		*82*m	(5–)	–70.3	13.6 s *4*	β–
		83	(5/2–,3/2–)	–69.9	13.4 s *3*	β–
		84	(3–)	–66.1s	3.24 s *26*	β– , β–n 0.28%
		85	(3/2–)	–63.5s	2.021 s *10*	β– , β–n 59.4%
		86		–59.4s	0.945 s *8*	β– , β–n 33%
		87	(3/2–)	–56.3s	0.48 s *4*	β– , β–n 15.4%
		88		–51.6s	>150 ns	β– ?, β–n ?
		89		–47.3s		β– ?
		90			>150 ns	β– ?
		91			>150 ns	β–
		92			>150 ns	β–
34	**Se**	65		–32.9s	<50 ms	ε
		66	0+	–41.7s	>1.2 µs	ε
		67		–46.5s	60 ms *+17–11*	ε , εp 0.5%
		68	0+	–54.1s	35.5 s *7*	ε
		69	(1/2–,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

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
34	**Se**	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%** ***4***	
		75	5/2+	−72.169	119.779 d *4*	ε
		76	0+	−75.252	**9.37%** ***29***	
		77	1/2−	−74.599	**7.63%** ***16***	
		77m	7/2+	−74.437	17.36 s *5*	IT
		78	0+	−77.026	**23.77%** ***28***	
		79	7/2+	−75.917	1.1×10^{6} y *2*	β−
		79m	1/2−	−75.821	3.92 m *1*	IT 99.94%, β− 0.06%
		80	0+	−77.759	**49.61%** ***41***	
		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	0.83×10^{20} y *12*	2β−
					8.73% ***22***	
		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	3.10 m *10*	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+	−63.88	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	β−?
		91		−50.9s	0.27 s *5*	β−, β−n 21%
		92	0+	−47.2s	>150 ns	β−
		93	(1/2+)		>150 ns	β−
		94	0+		>150 ns	β−
35	**Br**	67		−32.8s		p?
		68		−38.9s	<1.2 µs	p?
		69		−46.4s	<24 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−	−63.5	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−	−70.289	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
		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***	

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
35	**Br**	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–	–79.009	2.40 h *2*	β–
		84	2–	–77.78	31.80 m *8*	β–
		*84*m	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–	–73.86	55.60 s *15*	β–, β–n 2.52%
		88	(1,2–)	–70.73	16.29 s *6*	β–, β–n 6.58%
		89	(3/2–,5/2–)	–68.57	4.40 s *3*	β–, β–n 13.8%
		90		–64.61	1.91 s *1*	β–, β–n 25.2%
		91		–61.51	0.541 s *5*	β–, β–n 20%
		92	(2–)	–56.58	0.343 s *15*	β–, β–n 33.1%
		93	(5/2–)	–53.0s	102 ms *10*	β–, β–n 10%
		94		–47.8s	70 ms *20*	β–, β–n 30%
		95	(3/2–)		>150 ns	β–
		96			>150 ns	β–
		97	(3/2–)		>150 ns	β–
36	**Kr**	69		–32.3s	32 ms *10*	ε, εp
		70	0+	–41.0s	>1.2 μs	ε?
		71	(5/2)–	–46.1s	100 ms *3*	ε, εp 5.2%
		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	4.29 m *17*	ε
		76	0+	–68.98	14.8 h *1*	ε
		77	5/2+	–70.171	74.4 m *6*	ε
		78	0+	–74.160	$\geq 0.9\times10^{20}$ y	2ε
					0.35% ***1***	
		79	1/2–	–74.442	35.04 h *10*	ε
		79m	7/2+	–74.312	50 s *3*	IT
		80	0+	–77.893	**2.28%** ***6***	
		81	7/2+	–77.694	2.29×10^{5} y *11*	ε
		81m	1/2–	–77.503	13.10 s *3*	IT, ε 2.5×10^{-3}%
		82	0+	–80.589	**11.58%** ***14***	
		83	9/2+	–79.982	**11.49%** ***6***	
		83m	1/2–	–79.940	1.83 h *2*	IT
		84	0+	–82.431	**57.00%** ***4***	
		85	9/2+	–81.481	3934.4 d *14*	β–
		*85*m	1/2–	–81.176	4.480 h *8*	β– 78.6%, IT 21.4%
		86	0+	–83.266	**17.30%** ***22***	
		87	5/2+	–80.710	76.3 m *6*	β–
		88	0+	–79.69	2.84 h *3*	β–
		89	3/2(+)	–76.72	3.15 m *4*	β–
		90	0+	–74.96	32.32 s *9*	β–
		91	5/2(+)	–71.31	8.57 s *4*	β–
		92	0+	–68.79	1.840 s *8*	β–, β–n 0.03%
		93	1/2+	–64.0	1.286 s *10*	β–, β–n 1.95%
		94	0+	–61.1s	0.20 s *1*	β–, β–n 5.7%
		95	1/2	–56.0s	0.78 s *3*	β–
		96	0+	–53.0s	>50 ms	β–?
		97		–47.9s	>150 ns	β–

Nuclear Wallet Cards

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
36	**Kr**	*98*	0+		>150 ns	β−?
		99	(3/2+)		>150 ns	β−
		100	0+		>150 ns	β−
37	**Rb**	71		−32.3s		p?
		72	(3+)	−38.1s	<1.2 µs	p
		73	(5/2−)	−46.2s	<30 ns	p
		74	(0+)	−51.7	64.9 ms *5*	ε
		75	(3/2−)	−57.222	19.0 s *12*	ε
		76	1(−)	−60.480	36.5 s *6*	ε , εα 3.8×10^{-7}%
		77	3/2−	−64.826	3.77 m *4*	ε
		78	0(+)	−66.936	17.66 m *8*	ε
		78m	4(−)	−66.833	5.74 m *5*	ε 90%, IT 10%
		79	5/2+	−70.797	22.9 m *5*	ε
		80	1+	−72.173	33.4 s *7*	ε
		81	3/2−	−75.456	4.576 h *5*	ε
		81m	9/2+	−75.370	30.5 m *3*	IT 97.6%, ε 2.4%
		82	1+	−76.189	1.273 m *2*	ε
		82m	5−	−76.120	6.472 h *6*	ε , IT<0.33%
		83	5/2−	−79.073	86.2 d *1*	ε
		84	2−	−79.750	32.77 d *14*	ε 96.2%, β− 3.8%
		84m	6−	−79.286	20.26 m *4*	IT
		85	5/2−	−82.168	**72.17%** ***2***	
		86	2−	−82.747	18.631 d *18*	β− 99.99%, ε 5.2×10^{-3}%
		86m	6−	−82.191	1.017 m *3*	IT
		87	3/2−	−84.595	4.75×10^{10} y *4* **27.83%** ***2***	β−
		88	2−	−82.606	17.78 m *11*	β−
		89	3/2−	−81.711	15.15 m *12*	β−
		90	0−	−79.355	158 s *5*	β−
		*90*m	3−	−79.248	258 s *4*	β− 97.4%, IT 2.6%
		91	3/2(−)	−77.748	58.4 s *4*	β−
		92	0−	−74.775	4.492 s *20*	β− , β−n 0.01%
		93	5/2−	−72.626	5.84 s *2*	β− , β−n 1.39%
		94	3(−)	−68.551	2.702 s *5*	β− , β−n 10.01%
		95	5/2−	−65.84	377.5 ms *8*	β− , β−n 8.73%
		96	2+	−61.21	202.8 ms *33*	β− , β−n 14%
		97	3/2+	−58.36	169.9 ms *7*	β− , β−n 25.1%
		98	(1,0)	−54.30	114 ms *5*	β− , β−n 13.8%, β−2n 0.05%
		99	(5/2+)	−50.8	50.3 ms *7*	β− , β−n 15.9%
		100		−46.7s	51 ms *8*	β− , β−n 6%, β−2n 0.16%
		101	(3/2+)	−43.6	32 ms *5*	β− , β−n 28%
38	**Sr**	73		−31.7s		ε , εp
		74	0+	−40.7s	>1.2 µs	ε
		75	(3/2−)	−46.6s	71 ms *+71−24*	ε , εp 6.5%
		76	0+	−54.4s	8.9 s *3*	ε
		77	5/2+	−58.0	9.0 s *2*	ε , εp<0.25%
		78	0+	−63.174	2.5 m *3*	ε
		79	3/2(−)	−65.477	2.25 m *10*	ε
		80	0+	−70.305	106.3 m *15*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
38	**Sr**	81	1/2–	–71.526	22.3 m *4*	ε
		82	0+	–76.009	25.55 d *15*	ε
		83	7/2+	–76.797	32.41 h *3*	ε
		83m	1/2–	–76.538	4.95 s *12*	IT
		84	0+	–80.644	**0.56%** ***1***	
		85	9/2+	–81.103	64.84 d *2*	ε
		85m	1/2–	–80.864	67.63 m *4*	IT 86.6%, ε 13.4%
		86	0+	–84.522	**9.86%** ***1***	
		87	9/2+	–84.878	**7.00%** ***1***	
		87m	1/2–	–84.490	2.811 h *27*	IT 99.7%, ε 0.3%
		88	0+	–87.920	**82.58%** ***1***	
		89	5/2+	–86.207	50.53 d *7*	β–
		90	0+	–85.942	28.79 y *6*	β–
		91	5/2+	–83.639	9.63 h *5*	β–
		92	0+	–82.875	2.71 h *1*	β–
		93	5/2+	–80.088	7.423 m *24*	β–
		94	0+	–78.842	75.3 s *2*	β–
		95	1/2+	–75.117	23.90 s *14*	β–
		96	0+	–72.95	1.07 s *1*	β–
		97	1/2+	–68.79	429 ms *5*	β–, β–n≤0.05%
		98	0+	–66.63	0.653 s *2*	β–, β–n 0.25%
		99	3/2+	–62.1	0.269 s *1*	β–, β–n 0.1%
		100	0+	–60.2	202 ms *3*	β–, β–n 0.78%
		101	(5/2–)	–55.4	118 ms *3*	β–, β–n 2.37%
		102	0+	–53.1	69 ms *6*	β–, β–n 4.8%
		103		–47.6s	>150 ns	β–
		104	0+	–44.4s	>150 ns	β–
		105			>150 ns	β–
39	**Y**	77		–46.9s	<1.2 μs	ε, εp
		78	(0+)	–52.6s	55 ms *12*	ε
		78m	(5+)	–52.1s	5.8 s *6*	ε
		79	(5/2+)	–58.4	14.8 s *6*	ε, εp
		80	4–	–61.2s	30.1 s *5*	ε
		80m	1–	–60.9s	4.7 s *3*	ε, IT
		81	(5/2+)	–66.02	70.4 s *10*	ε
		82	1+	–68.2	8.3 s *2*	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+	–74.16	4.6 s *2*	ε
		84m	(5–)	–74.16	39.5 m *8*	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 0.7%
		87	1/2–	–83.017	79.8 h *3*	ε
		87m	9/2+	–82.636	13.37 h *3*	IT 98.43%, ε 1.57%
		88	4–	–84.297	106.65 d *13*	ε
		89	1/2–	–87.702	**100%**	
		89m	9/2+	–86.793	15.28 s *17*	IT
		90	2–	–86.488	64.00 h *21*	β–
		90m	7+	–85.806	3.19 h *6*	IT, β– 1.8×10^{-3}%
		91	1/2–	–86.346	58.51 d *6*	β–

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
39	**Y**	*91*m	9/2+	–85.791	49.71 m *4*	IT, β– < 1.5%
		92	2–	–84.815	3.54 h *1*	β–
		93	1/2–	–84.22	10.18 h *8*	β–
		*93*m	7/2+	–83.47	0.82 s *4*	IT
		94	2–	–82.350	18.7 m *1*	β–
		95	1/2–	–81.204	10.3 m *1*	β–
		96	0–	–78.34	5.34 s *5*	β–
		*96*m	(8)+	–78.34	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)–	–72.45	0.548 s *2*	β–, β–n 0.33%
		*98*m	(4,5)	–72.04	2.0 s *2*	β– 90%, IT < 20%, β–n 3.4%
		99	(5/2+)	–70.20	1.470 s *7*	β–, β–n 2.5%
		100	1–,2–	–67.29	735 ms *7*	β–, β–n 0.92%
		100m	(3,4,5)	–67.29	0.94 s *3*	β–
		101	(5/2+)	–64.91	0.45 s *2*	β–, β–n 1.5%
		102m		–61.89	0.30 s *1*	β–, β–n 4%
		102m		–61.89	0.36 s *4*	β–, β–n 4%
		103	(5/2+)	–58.7s	0.19 s *5*	β–, β–n 8%
		104		–54.5s	180 ms *60*	β–, β–n
		105		–51.1s	>150 ns	β–?
		106		–46.4s	>150 ns	β–
		107	(5/2+)		30 ms	β–
		108			>150 ns	β–, β–n
40	**Zr**	79		–47.4s	56 ms *30*	ε
		80	0+	–55.4s	3.9 s *5*	ε
		81	(3/2–)	–58.9	5.3 s *5*	ε, εp 0.12%
		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 *7*	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)+	–79.348	1.68 h *1*	ε
		87m	(1/2)–	–79.012	14.0 s *2*	IT
		88	0+	–83.62	83.4 d *3*	ε
		89	9/2+	–84.869	78.41 h *12*	ε
		89m	1/2–	–84.282	4.161 m *17*	IT 93.77%, ε 6.23%
		90	0+	–88.768	**51.45%** ***40***	
		90m	5–	–86.449	809.2 ms *20*	IT
		91	5/2+	–87.891	**11.22%** ***5***	
		92	0+	–88.455	**17.15%** ***8***	
		93	5/2+	–87.117	1.53×10^{6} y *10*	β–
		94	0+	–87.266	**17.38%** ***28***	
		95	5/2+	–85.658	64.02 d *5*	β–
		96	0+	–85.441	$>2.2\times10^{19}$ y **2.80%** ***9***	2β–
		97	1/2+	–82.949	16.744 h *11*	β–
		98	0+	–81.28	30.7 s *4*	β–

Nuclear Wallet Cards

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
40	**Zr**	*99*	(1/2+)	–77.77	2.1 s *1*	β–
		100	0+	–76.60	7.1 s *4*	β–
		101	(3/2+)	–73.46	2.3 s *1*	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	0.6 s *1*	β–
		106	0+	–59.7s	>150 ns	β–?
		107		–55.1s	150 ms	β–?
		108	0+	–51.9s	>150 ns	β–, β–n
		109			>150 ns	β–, β–n
		110	0+		>150 ns	β–
41	**Nb**	81		–47.5s	≈0.8 s	ε?, εp?, p?
		82		–53.0s	50 ms *4*	ε
		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
		86m		–69.83	56 s *8*	ε
		87	(9/2+)	–74.18	2.6 m *1*	ε
		87m	(1/2–)	–74.18	3.7 m *1*	ε
		88	(8+)	–76.4s	14.5 m *1*	ε
		88m	(4–)	–76.4s	7.8 m *1*	ε
		89	(9/2+)	–80.58	2.03 h *7*	ε
		89m	(1/2)–	–80.54	66 m *2*	ε
		90	8+	–82.657	14.60 h *5*	ε
		90m	4–	–82.532	18.81 s *6*	IT
		91	9/2+	–86.638	6.8×10^{2} y *13*	ε
		91m	1/2–	–86.533	60.86 d *22*	IT 96.6%, ε 3.4%
		92	(7)+	–86.449	3.47×10^{7} y *24*	ε, β– <0.05%
		92m	(2)+	–86.314	10.15 d *2*	ε
		93	9/2+	–87.209	**100%**	
		93m	1/2–	–87.178	16.13 y *14*	IT
		94	(6)+	–86.365	2.03×10^{4} y *16*	β–
		94m	3+	–86.324	6.263 m *4*	IT 99.5%, β– 0.5%
		95	9/2+	–86.783	34.997 d *6*	β–
		95m	1/2–	–86.547	86.6 h *8*	IT 94.4%, β– 5.6%
		96	6+	–85.604	23.35 h *5*	β–
		97	9/2+	–85.607	72.1 m *7*	β–
		*97*m	1/2–	–84.864	58.7 s *18*	IT
		98	1+	–83.526	2.86 s *6*	β–
		*98*m	(5+)	–83.442	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+)	–79.44	2.99 s *11*	β–
		101	(5/2+)	–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	4.9 s *3*	β–, β–n 0.06%
		*104*m		–72.0	0.92 s *4*	β–, β–n 0.05%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
41	**Nb**	*105*	(5/2+)	−70.86	2.95 s *6*	β−, β−n 1.7%
		106		−66.9s	1.02 s *5*	β−, β−n 4.5%
		107		−64.9s	330 ms *50*	β−, β−n 6%
		108	(2+)	−60.5s	0.193 s *17*	β−, β−n 6.2%
		109	(5/2)	−58.1s	0.19 s *3*	β−, β−n 31%
		110		−53.4s	0.17 s *2*	β−, β−n 40%
		111	(5/2+)		>150 ns	β−
		112	(2+)		>150 ns	β−
		113			>150 ns	β−
42	**Mo**	83		−47.7s	≈0.4 s	ε ?
		84	0+	−55.8s	>150 ns	ε
		85	(1/2−)	−59.1s	3.2 s *2*	ε, εp 0.14%
		86	0+	−64.6	19.6 s *11*	ε
		87	(7/2+)	−67.7	13.6 s *11*	ε, εp 15%
		88	0+	−72.70	8.0 m *2*	ε
		89	(9/2+)	−75.00	2.11 m *10*	ε
		89m	(1/2−)	−74.62	190 ms *15*	IT
		90	0+	−80.168	5.56 h *9*	ε
		91	9/2+	−82.20	15.49 m *1*	ε
		91m	1/2−	−81.55	64.6 s *6*	ε 50%, IT 50%
		92	0+	−86.805	$>1.9\times10^{20}$ y	2ε
					14.84% ***35***	
		93	5/2+	−86.804	4.0×10^{3} y *8*	ε
		93m	21/2+	−84.379	6.85 h *7*	IT 99.88%, ε 0.12%
		94	0+	−88.410	**9.25%** ***12***	
		95	5/2+	−87.708	**15.92%** ***13***	
		96	0+	−88.791	**16.68%** ***2***	
		97	5/2+	−87.541	**9.55%** ***8***	
		98	0+	−88.112	**24.13%** ***31***	
		99	1/2+	−85.966	65.94 h *1*	β−
		100	0+	−86.185	0.95×10^{19} y *11*	2β−
					9.63% ***23***	
		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	(7/2−)	−72.9	3.5 s *5*	β−
		108	0+	−71.2s	1.09 s *2*	β−
		109	(7/2−)	−67.2s	0.53 s *6*	β−
		110	0+	−65.5s	0.30 s *4*	β−, β−n 0.04%
		111		−61.0s	>150 ns	β−?
		112	0+	−58.8s	>150 ns	β−?
		113		−54.0s	>150 ns	β−, β−n
		114	0+		>150 ns	β−
		115			>150 ns	β−, β−n
43	**Tc**	85		−47.6s	≈0.5 s	ε ?
		86		−53.2s	47 ms *12*	ε
		87	(9/2+)	−59.1s	>150 ns	ε ?
		88	(3+)	−62.6s	5.8 s *2*	ε
		88m	(6+)	−62.6s	6.4 s *8*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
43	**Tc**	89	(9/2+)	−67.5	12.8 s *9*	ε
		89m	(1/2−)	−67.4	12.9 s *8*	ε
		90m	1+	−71.2	8.7 s *2*	ε
		90m	(6+)	−70.7	49.2 s *4*	ε
		91	(9/2)+	−76.0	3.14 m *2*	ε
		91m	(1/2)−	−75.8	3.3 m *1*	ε , IT < 1%
		92	(8)+	−78.94	4.23 m *15*	ε
		93	9/2+	−83.603	2.75 h *5*	ε
		93m	1/2−	−83.211	43.5 m *10*	IT 76.6%, ε 23.4%
		94	7+	−84.155	293 m *1*	ε
		94m	(2)+	−84.080	52.0 m *10*	ε , IT < 0.1%
		95	9/2+	−86.017	20.0 h *1*	ε
		95m	1/2−	−85.979	61 d *2*	ε 96.12%, IT 3.88%
		96	7+	−85.818	4.28 d *7*	ε
		96m	4+	−85.784	51.5 m *10*	IT 98%, ε 2%
		97	9/2+	−87.221	4.21×10^{6} y *16*	ε
		97m	1/2−	−87.124	91.4 d *8*	IT , ε 3.94%
		98	(6)+	−86.428	4.2×10^{6} y *3*	β−
		99	9/2+	−87.323	2.111×10^{5} y *12*	β−
		99m	1/2−	−87.180	6.01 h *1*	IT , β− 3.7×10^{-3}%
		100	1+	−86.016	15.8 s *1*	β− , ε 1.8×10^{-3}%
		101	9/2+	−86.34	14.22 m *1*	β−
		102	1+	−84.568	5.28 s *15*	β−
		*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	(3/2−)	−79.1	21.2 s *2*	β−
		108	(2)+	−75.9	5.17 s *7*	β−
		109	(5/2+)	−74.9s	0.86 s *4*	β− , β−n 0.08%
		110	(1+,2+)	−71.4s	0.92 s *3*	β− , β−n 0.04%
		111		−69.8s	0.30 s *3*	β− , β−n 0.85%
		112		−65.9s	0.29 s *2*	β− , β−n 1.5%
		113		−64.0s	0.17 s *2*	β− , β−n 2.1%
		114		−59.7s	0.15 s *3*	β− , β−n 1.3%
		115		−57.5s	>150 ns	β− , β−n
		116			>150 ns	β−
		117	(5/2+)		>150 ns	β−
		118			>150 ns	β−
44	**Ru**	87		−47.3s	>1.5 μs	ε ?
		88	0+	−55.5s	>150 ns	ε ?
		89		−59.5s		ε ?
		90	0+	−65.4s	11 s *3*	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 0.03%
		94	0+	−82.57	51.8 m *6*	ε
		95	5/2+	−83.45	1.643 h *14*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
44	**Ru**	96	0+	−86.072	**5.54%** ***14***	
		97	5/2+	−86.112	2.791 d *4*	ε
		98	0+	−88.225	**1.87%** ***3***	
		99	5/2+	−87.617	**12.76%** ***14***	
		100	0+	−89.219	**12.60%** ***7***	
		101	5/2+	−87.950	**17.06%** ***2***	
		102	0+	−89.098	**31.55%** ***14***	
		103	3/2+	−87.259	39.26 d *2*	β−
		104	0+	−88.091	**18.62%** ***27***	
		105	3/2+	−85.930	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	0.53 s *6*	β−
		115		−66.8s	740 ms *80*	β−, β−n
		116	0+	−65.1s	>150 ns	β−?
		117		−60.7s	>150 ns	β−?
		118	0+	−58.7s	>150 ns	β−?
		119			>150 ns	β−
		120	0+		>150 ns	β−
45	**Rh**	89		−47.2s	>1.5 μs	ε?
		90		−53.2s	>150 ns	ε?
		91		−59.1s	>0.1 μs	ε?
		92		−63.4s	>100 ns	ε
		93	(9/2+)	−69.2s		ε
		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+)	−79.63	9.90 m *10*	ε
		96m	(3+)	−79.57	1.51 m *2*	IT 60%, ε 40%
		97	9/2+	−82.59	30.7 m *6*	ε
		97m	1/2−	−82.33	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−	−85.574	16.1 d *2*	ε
		99m	9/2+	−85.510	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 92.8%, IT 7.2%
		102	(1−,2−)	−86.775	207 d *3*	ε 80%, β− 20%
		102m	6(+)	−86.634	≈2.9 y	ε 99.77%, IT 0.23%
		103	1/2−	−88.022	**100%**	
		103m	7/2+	−87.982	56.114 m *9*	IT
		104	1+	−86.950	42.3 s *4*	β− 99.55%, ε 0.45%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
45	**Rh**	104m	5+	−86.821	4.34 m *3*	IT 99.87%, β− 0.13%
		105	7/2+	−87.847	35.36 h *6*	β−
		105m	1/2−	−87.717	43.0 s *3*	IT
		106	1+	−86.364	29.80 s *8*	β−
		106m	(6)+	−86.227	131 m *2*	β−
		107	7/2+	−86.86	21.7 m *4*	β−
		108	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	(>3)	−82.9	28.5 s *15*	β−
		111	(7/2+)	−82.3s	11 s *1*	β−
		112m	1+	−79.5s	3.45 s *37*	β−
		112m	(4,5,6)	−79.5s	6.73 s *15*	β−
		113	(7/2+)	−78.8s	2.80 s *12*	β−
		114	1+	−75.6s	1.85 s *5*	β−
		114m	(>3)	−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	0+	−65.7s	>150 ns	β−?
		119		−63.9s	>150 ns	β−?
		120		−59.8s	>150 ns	β−?
		121		−57.7s	>150 ns	β−?
		122			≈50 ms	β−?
46	**Pd**	91		−47.1s	>1 μs	ε?
		92	0+	−55.5s	>150 ns	ε?
		93		−59.7s	60 s *20*	ε
		94	0+	−66.3s	9.0 s *5*	ε
		95		−70.2s	≈10 s	ε?
		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+	−81.30	17.7 m *3*	ε
		99	(5/2)+	−82.19	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+	−87.479	16.991 d *19*	ε
		104	0+	−89.391	**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−	−88.158	21.3 s *5*	IT
		108	0+	−89.522	**26.46%** ***9***	
		109	5/2+	−87.604	13.7012 h *24*	β−
		109m	11/2−	−87.415	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%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
46	**Pd**	*112*	0+	−86.34	21.03 h *5*	β−
		113	(5/2+)	−83.69	93 s *5*	β−
		113m	(9/2−)	−83.61	0.3 s *1*	IT
		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+	−79.96	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	β−?
		122	0+	−65.4s	>150 ns	β−?
		123		−61.2s	>150 ns	β−?
		124	0+		≈0.2 s	β−?
47	**Ag**	93				ε
		94	0+	−53.3s	15 ms *CA*	ε
		94m	(9+)	−53.3s	0.42 s *5*	ε, εp
		95		−60.1s	2.0 s *1*	ε, εp
		96	(8+,9+)	−64.6s	5.1 s *4*	ε, εp 12%
		97	(9/2+)	−70.8s	25.3 s *3*	ε
		98	(6+)	−72.9	46.7 s *9*	ε, εp 1.1×10^{-3}%
		99	(9/2)+	−76.8	124 s *3*	ε
		99m	(1/2−)	−76.3	10.5 s *5*	IT
		100	(5)+	−78.18	2.01 m *9*	ε
		100m	(2)+	−78.17	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+	−81.97	12.9 m *3*	ε
		102m	2+	−81.96	7.7 m *5*	ε 51%, IT 49%
		103	7/2+	−84.79	65.7 m *7*	ε
		103m	1/2−	−84.66	5.7 s *3*	IT
		104	5+	−85.112	69.2 m *10*	ε
		104m	2+	−85.105	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+	−86.940	23.96 m *4*	ε 99.5%, β−<1%
		106m	6+	−86.850	8.28 d *2*	ε
		107	1/2−	−88.405	**51.839%** ***8***	
		107m	7/2+	−88.312	44.3 s *2*	IT
		108	1+	−87.604	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−	−88.720	**48.161%** ***8***	
		109m	7/2+	−88.632	39.6 s *2*	IT
		110	1+	−87.457	24.6 s *2*	β− 99.7%, ε 0.3%
		110m	6+	−87.340	249.76 d *4*	β− 98.64%, IT 1.36%
		111	1/2−	−88.217	7.45 d *1*	β−
		111m	7/2+	−88.158	64.8 s *8*	IT 99.3%, β− 0.7%
		112	2(−)	−86.63	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−

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
47	**Ag**	*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)−	−82.57	2.68 m *10*	β−
		*116*m	(5+)	−82.49	8.6 s *3*	β− 94%, IT 6%
		117	(1/2−)	−82.27	72.8 s *+20−7*	β−
		*117*m	(7/2+)	−82.24	5.34 s *5*	β− 94%, IT 6%
		118	1(−)	−79.57	3.76 s *15*	β−
		*118*m	4(+)	−79.44	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(+)	−75.65	1.23 s *4*	β−, β−n < 3.0×10^{-3}%
		*120*m	6(−)	−75.44	0.32 s *4*	β− ≈ 63%, IT ≈ 37%
		121	(7/2+)	−74.7	0.78 s *1*	β−, β−n 0.08%
		122	(3+)	−71.4s	0.520 s *14*	β−, β−n 0.186%
		123	(7/2+)	−70.0s	0.293 s *7*	β−, β−n 0.55%
		124		−66.6s	0.172 s *5*	β−, β−n > 0.1%
		125	(7/2+)	−64.7s	166 ms *7*	β−, β−n
		126		−61.0s	107 ms *12*	β−
		127	(1/2−)	−58.8s	79 ms *3*	β−
		128			58 ms *5*	β−, β−n
		129			46 ms *5*	β−, β−n
48	**Cd**	96	0+	−56.1s	≈1 s	ε ?
		97		−60.6s	2.8 s *6*	ε, εp
		98	0+	−67.5s	9.2 s *3*	ε, εp < 0.03%
		99	(5/2+)	−69.9s	16 s *3*	ε, εp 0.17%, εα < 1.0×10^{-4}%
		100	0+	−74.31	49.1 s *5*	ε
		101	(5/2+)	−75.7	1.36 m *5*	ε
		102	0+	−79.38	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
		106	0+	−87.134	≥2.6×10^{17} y	2ε
					1.25% ***6***	
		107	5/2+	−86.988	6.50 h *2*	ε
		108	0+	−89.253	**0.89%** ***3***	
		109	5/2+	−88.505	461.4 d *12*	ε
		110	0+	−90.350	**12.49%** ***18***	
		111	1/2+	−89.254	**12.80%** ***12***	
		111m	11/2−	−88.858	48.30 m *15*	IT
		112	0+	−90.581	**24.13%** ***21***	
		113	1/2+	−89.050	7.7×10^{15} y *3*	β−
					12.22% ***12***	
		113m	11/2−	−88.786	14.1 y *5*	β− 99.86%, IT 0.14%
		114	0+	−90.021	**28.73%** ***42***	
		115	1/2+	−88.091	53.46 h *5*	β−
		115m	(11/2)−	−87.910	44.56 d *24*	β−
		116	0+	−88.720	≥3.75×10^{19} y	2β−
					7.49% ***18***	
		117	1/2+	−86.426	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−

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
48	**Cd**	*119*	3/2+	–83.91	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+)	–81.06	13.5 s *3*	β–
		*121*m	(11/2–)	–80.84	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–)	–76.99	1.82 s *3*	β–, IT
		124	0+	–76.71	1.25 s *2*	β–
		125	(3/2+)	–73.36	0.65 s *2*	β–
		125m	(11/2–)	–73.31	0.48 s *3*	β–
		126	0+	–72.33	0.506 s *15*	β–
		127	(3/2+)	–68.53	0.37 s *7*	β–
		128	0+	–67.3	0.34 s *3*	β–
		129	(3/2+)	–63.1s	0.27 s *4*	β–
		130	0+	–61.5s	0.20 s *4*	β–, β–n ≈ 4%
		131			≈0.18 s	β–
49	**In**	98		–53.8s		ε ?
		99	(9/2+)	–60.9s	>150 ns	ε
		100		–64.1	7.0 s *8*	ε, εp > 3.9%
		101		–68.4s	15.1 s *3*	ε ≈ 100%, εp
		102	(6+)	–70.1	22 s *1*	ε, εp 9.3×10^{-3}%
		103	(9/2)+	–74.60	60 s *1*	ε
		103m	(1/2–)	–73.97	34 s *2*	ε, IT ≈ 30%
		104	5(+)	–76.1	1.80 m *3*	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, ε ≈ 25%
		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+	–84.10	58.0 m *12*	ε
		108m	2+	–84.07	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
		109m	(19/2+)	–84.384	0.209 s *6*	IT
		110	7+	–86.47	4.9 h *1*	ε
		110m	2+	–86.41	69.1 m *5*	ε
		111	9/2+	–88.389	2.8047 d *5*	ε
		111m	1/2–	–87.852	7.7 m *2*	IT
		112	1+	–87.995	14.97 m *10*	ε 56%, β– 44%
		112m	4+	–87.839	20.56 m *6*	IT
		113	9/2+	–89.366	**4.29%** ***5***	
		113m	1/2–	–88.975	99.476 m *23*	IT
		114	1+	–88.570	71.9 s *1*	β– 99.5%, ε 0.5%
		114m	5+	–88.379	49.51 d *1*	IT 96.75%, ε 3.25%
		115	9/2+	–89.537	4.41×10^{14} y *25*	β–
					95.71% ***5***	
		115m	1/2–	–89.201	4.486 h *4*	IT 95%, β– 5%
		116	1+	–88.250	14.10 s *3*	β– 99.97%, ε < 0.06%
		116m	5+	–88.123	54.29 m *17*	β–

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
49	**In**	116m	8–	–87.960	2.18 s *4*	IT
		117	9/2+	–88.943	43.2 m *3*	β–
		117m	1/2–	–88.628	116.2 m *3*	β– 52.9%, IT 47.1%
		118	1+	–87.230	5.0 s *5*	β–
		118m	5+	–87.170	4.45 m *5*	β–
		118m	8–	–87.030	8.5 s *3*	IT 98.6%, β– 1.4%
		119	9/2+	–87.704	2.4 m *1*	β–
		119m	1/2–	–87.392	18.0 m *3*	β– 94.4%, IT 5.6%
		120	1+	–85.73	3.08 s *8*	β–
		120	(8–)	–85.73	47.3 s *5*	β–
		*120*m	(5)+	–85.66	46.2 s *8*	β–
		121	9/2+	–85.84	23.1 s *6*	β–
		*121*m	1/2–	–85.53	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	3.11 s *10*	β–
		*124*m	(8–)	–80.83	3.7 s *2*	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	3.67 s *4*	β–, β–n 0.69%
		128	(3+)	–74.36	0.84 s *6*	β–
		*128*m	(8–)	–74.02	0.72 s *10*	β–
		129	(9/2+)	–73.0	0.61 s *1*	β–, β–n 0.25%
		*129*m	(1/2–)	–72.6	1.23 s *3*	β–>99.7%, β–n 2.5%, IT<0.3%
		130	1(–)	–70.00	0.32 s *2*	β–, β–n 0.9%
		*130*m	(10–)	–69.95	0.55 s *1*	β–, β–n<1.67%
		*130*m	(5+)	–69.60	0.542 s *9*	β–, β–n≤1.65%
		131	(9/2+)	–68.22	0.28 s *3*	β–, β–n≤2%
		*131*m	(1/2–)	–67.85	0.35 s *5*	β–≥99.98%, β–n≤2%, IT≤0.02%
		*131*m	(21/2+)	–63.95	0.32 s *6*	β–>99%, IT<1%, β–n 0.03%
		132	(7–)	–62.49	0.201 s *13*	β–, β–n 6.2%
		133	(9/2+)	–57.4s	180 ms *15*	β–, β–n 85%
		134		–51.5s	138 ms *8*	β–, β–n 65%
		135			≈0.1 s	β–?
50	**Sn**	100	0+	–56.9s	0.94 s *+54–27*	ε, εp<17%
		101		–59.6s	3 s *1*	ε, εp
		102	0+	–64.7s	4.5 s *7*	ε
		103		–66.9s	7 s *3*	ε
		104	0+	–71.6	20.8 s *5*	ε
		105		–73.22	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+	–82.00	10.30 m *8*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
50	**Sn**	109	5/2(+)	−82.636	18.0 m *2*	ε
		110	0+	−85.83	4.11 h *10*	ε
		111	7/2+	−85.944	35.3 m *6*	ε
		112	0+	−88.659	**0.97%** ***1***	
		113	1/2+	−88.330	115.09 d *4*	ε
		113m	7/2+	−88.253	21.4 m *4*	IT 91.1%, ε 8.9%
		114	0+	−90.558	**0.66%** ***1***	
		115	1/2+	−90.033	**0.34%** ***1***	
		116	0+	−91.525	**14.54%** ***9***	
		117	1/2+	−90.398	**7.68%** ***7***	
		117m	11/2−	−90.083	13.60 d *4*	IT
		118	0+	−91.653	**24.22%** ***9***	
		119	1/2+	−90.067	**8.59%** ***4***	
		119m	11/2−	−89.978	293.1 d *7*	IT
		120	0+	−91.103	**32.58%** ***9***	
		121	3/2+	−89.203	27.06 h *4*	β−
		121m	11/2−	−89.197	55 y *5*	IT 77.6%, β− 22.4%
		122	0+	−89.945	**4.63%** ***3***	
		123	11/2−	−87.820	129.2 d *4*	β−
		*123*m	3/2+	−87.795	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−, IT < 2.0×10^{-3}%
		130	0+	−80.25	3.72 m *4*	β−
		*130*m	(7−)	−78.30	1.7 m *1*	β−
		131	(3/2+)	−77.39	56.0 s *5*	β−
		*131*m	(11/2−)	−77.15	58.4 s *5*	β−, IT ≤ 4.0×10^{-4}%
		132	0+	−76.62	39.7 s *5*	β−
		133	(7/2−)	−70.97	1.45 s *3*	β−, β−n 0.08%
		134	0+	−66.6	1.12 s *8*	β−, β−n 17%
		135		−60.8s	>150 ns	β−, β−n
		136	0+	−56.5s	>150 ns	β−?, β−n?
		137		−50.5s	>150 ns	β−?
51	**Sb**	103		−55.8s	>1.5 μs	ε?
		104		−59.3s	0.44 s *+15−11*	ε, εp < 7%, p < 1%
		105		−63.8	1.12 s *16*	ε, p ≈ 1%
		106	(4+)	−66.4s	0.6 s *2*	ε
		107	(5/2+)	−70.7s	4.6 s *8*	ε, α
		108	(4+)	−72.5s	7.4 s *3*	ε
		109	(5/2+)	−76.26	17.0 s *7*	ε
		110	(4+)	−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+	−84.41	6.67 m *7*	ε
		114	3+	−84.7	3.49 m *3*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
51	**Sb**	115	5/2+	−87.00	32.1 m *3*	ε
		116	3+	−86.818	15.8 m *8*	ε
		116m	8−	−86.435	60.3 m *6*	ε
		117	5/2+	−88.641	2.80 h *1*	ε
		118	1+	−87.996	3.6 m *1*	ε
		118m	8−	−87.746	5.00 h *2*	ε
		119	5/2+	−89.473	38.19 h *22*	ε
		119m	(27/2+)	−86.632	0.85 s *9*	IT
		120	1+	−88.423	15.89 m *4*	ε
		120m	8−	−88.272	5.76 d *2*	ε
		121	5/2+	−89.593	**57.21%** ***5***	
		122	2−	−88.328	2.7238 d *2*	β− 97.59%, ε 2.41%
		122m	(8)−	−88.164	4.191 m *3*	IT
		123	7/2+	−89.223	**42.79%** ***5***	
		124	3−	−87.619	60.20 d *3*	β−
		124m	5+	−87.608	93 s *5*	IT 75%, β− 25%
		124m	(8)−	−87.582	20.2 m *2*	IT
		125	7/2+	−88.261	2.75856 y *25*	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	IT
		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−)	−82.78	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+)	−79.72	2.79 m *5*	β−
		*132*m	(8−)	−79.72	4.10 m *5*	β−
		133	(7/2+)	−78.96	2.5 m *1*	β−
		*134*m	(0−)	−74.01	0.78 s *6*	β−
		*134*m	(7−)	−74.01	10.22 s *9*	β−, β−n 0.091%
		135	(7/2+)	−69.7	1.68 s *2*	β−, β−n 17.6%
		136		−64.6s	0.82 s *2*	β−, β−n 24%
		137		−60.3s	>150 ns	β−?, β−n?
		138		−55.0s	>150 ns	β−?, β−n?
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%, εp 2.4%
		109	(5/2+)	−67.57	4.6 s *3*	ε 96.1%, εp 9.4%, α 3.9%, εα < 5.0×10^{-3}%
		110	0+	−72.28	18.6 s *8*	ε ≈ 100%, α ≈ 3.0×10^{-3}%
		111	(5/2+)	−73.48	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

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
52	**Te**	115m	(1/2)+	−82.3	6.7 m *4*	ε ≤ 100%, IT
		116	0+	−85.31	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+	−87.180	16.03 h *5*	ε
		119m	11/2−	−86.919	4.70 d *4*	ε , IT 8.0×10^{-3}%
		120	0+	−89.40	**0.09%** ***1***	
		121	1/2+	−88.56	19.16 d *5*	ε
		121m	11/2−	−88.26	154 d *7*	IT 88.6%, ε 11.4%
		122	0+	−90.311	**2.55%** ***12***	
		123	1/2+	−89.169	>6×10^{14} y	ε
					0.89% ***3***	
		123m	11/2−	−88.921	119.7 d *1*	IT
		124	0+	−90.523	**4.74%** ***14***	
		125	1/2+	−89.028	**7.07%** ***15***	
		125m	11/2−	−88.883	57.40 d *15*	IT
		126	0+	−90.070	**18.84%** ***25***	
		127	3/2+	−88.289	9.35 h *7*	β−
		127m	11/2−	−88.201	109 d *2*	IT 97.6%, β− 2.4%
		128	0+	−88.994	7.7×10^{24} y *4*	2β−
					31.74% ***8***	
		129	3/2+	−87.006	69.6 m *3*	β−
		129m	11/2−	−86.900	33.6 d *1*	IT 63%, β− 37%
		130	0+	−87.353	>5.6×10^{22} y	2β−
					34.08% ***62***	
		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+	−82.40	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		−60.8s	>150 ns	β−?, β−n?
		140	0+	−57.1s	>150 ns	β−?, β−n?
		141		−51.8s	>150 ns	β−?, β−n?
		142	0+	−48.0s		β−?
53	**I**	108	(1)	−52.8s	36 ms *6*	α 91%, ε 9%, p< 1%
		109	(5/2+)	−57.6	100 μs *5*	p ≈ 100%, α< 0.5%
		110		−60.3s	0.65 s *2*	ε 83%, α 17%, εp 11%, εα 1.1%
		111	(5/2+)	−64.9s	2.5 s *2*	ε 99.9%, α ≈ 0.1%
		112		−67.1s	3.42 s *11*	ε , α ≈ 1.2×10^{-3}%
		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 *5*	ε ≤ 100%, IT ≤ 100%
		115	(5/2+)	−76.5s	1.3 m *2*	ε
		116	1+	−77.6	2.91 s *15*	ε
		117	(5/2)+	−80.44	2.22 m *4*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
53	**I**	118	2–	–80.69	13.7 m *5*	ε
		118m	(7–)	–80.59	8.5 m *5*	ε < 100%, IT > 0%
		119	5/2+	–83.67	19.1 m *4*	ε
		120	2–	–83.79	81.0 m *6*	ε
		120m	(7–)	–83.47	53 m *4*	ε
		121	5/2+	–86.29	2.12 h *1*	ε
		122	1+	–86.077	3.63 m *6*	ε
		123	5/2+	–87.935	13.27 h *8*	ε
		124	2–	–87.364	4.1760 d *3*	ε
		125	5/2+	–88.842	59.400 d *10*	ε
		126	2–	–87.915	13.11 d *5*	ε 56.3%, β– 43.7%
		127	5/2+	–88.987	**100%**	
		128	1+	–87.742	24.99 m *2*	β– 93.1%, ε 6.9%
		129	7/2+	–88.504	1.57×10^{7} y *4*	β–
		130	5+	–86.933	12.36 h *3*	β–
		130m	2+	–86.893	9.0 m *1*	IT 84%, β– 16%
		131	7/2+	–87.445	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)–	–83.63	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)	–64.1s	0.86 s *4*	β–, β–n 9.3%
		141		–60.7s	0.43 s *2*	β–, β–n 22%
		142		–55.7s	≈0.2 s	β–
		143		–52.1s	>150 ns	β–?
		144		–46.9s	>150 ns	β–?
54	**Xe**	110	0+	–51.7s	≈0.2 s	α, ε
		111		–54.4s	0.74 s *20*	ε, α
		112	0+	–59.9	2.7 s *8*	ε 99.16%, α 0.84%
		113		–62.05	2.74 s *8*	ε ≈ 100%, εp 7%, α ≈ 0.01%, εα ≈ 7.0×10^{-3}%
		114	0+	–66.9s	10.0 s *4*	ε
		115	(5/2+)	–68.4s	18 s *4*	ε, εp 0.34%
		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+	–81.83	40 m *1*	ε
		121	5/2(+)	–82.54	40.1 m *20*	ε
		122	0+	–85.19	20.1 h *1*	ε
		123	(1/2)+	–85.26	2.08 h *2*	ε
		124	0+	–87.658	≥1.1×10^{17} y **0.095%** ***3***	2ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
54	**Xe**	125	1/2(+)	−87.189	16.9 h *2*	ε
		125m	9/2(−)	−86.937	56.9 s *9*	IT
		126	0+	−89.173	**0.089%** ***1***	
		127	1/2+	−88.325	36.4 d *1*	ε
		127m	9/2−	−88.027	69.2 s *9*	IT
		128	0+	−89.861	**1.910%** ***22***	
		129	1/2+	−88.697	**26.40%** ***18***	
		129m	11/2−	−88.461	8.88 d *2*	IT
		130	0+	−89.882	**4.071%** ***53***	
		131	3/2+	−88.416	**21.232%** ***62***	
		131m	11/2−	−88.252	11.934 d *21*	IT
		132	0+	−89.280	**26.909%** ***68***	
		133	3/2+	−87.648	5.243 d *1*	β−
		*133*m	11/2−	−87.415	2.19 d *1*	IT
		134	0+	−88.124	**10.436%** ***29***	
		*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 > 99.4%, β− < 0.6%
		136	0+	−86.424	$>3.6\times10^{20}$ y **8.857%** ***33***	2β−
		137	7/2−	−82.379	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(−)	−68.33	1.73 s *1*	β−, β−n 0.04%
		142	0+	−65.5	1.22 s *2*	β−, β−n 0.41%
		143	5/2−	−60.7s	0.30 s *3*	β−
		144	0+	−57.5s	1.15 s *20*	β−
		145	(3/2−)	−52.5s	900 ms *300*	β−
		145		−52.5s	0.9 s *3*	β−n
		146	0+	−49.1s		β−
		147		−43.8s	>150 ns	β−?, β−n?
55	**Cs**	112		−46.3s	500 μs *100*	p?, α?
		113	(5/2+)	−51.7	16.7 μs *7*	p ≈ 100%, ε ≈ 0.03%
		114	(1+)	−54.6s	0.57 s *2*	ε ≈ 100%, εp 8.6%, εα 0.16%, α 0.02%
		115		−59.7s	1.4 s *8*	ε, εp ≈ 0.07%
		116m	(1+)	−62.5	0.70 s *4*	ε, εα > 0%, εp > 0%
		116m	≥5+	−62.5	3.85 s *13*	ε, εα > 0%, εp > 0%
		117	(9/2+)	−66.47	8.4 s *6*	ε
		117m	(3/2+)	−66.32	6.5 s *4*	ε
		118	2	−68.41	14 s *2*	ε, εp < 0.04%, εα < 2.4×10^{-3}%
		118m	6,7,8	−68.41	17 s *3*	ε, εp < 0.04%, εα < 2.4×10^{-3}%
		119	9/2+	−72.31	43.0 s *2*	ε
		119m	3/2(+)	−72.31	30.4 s *1*	ε
		120	2	−73.888	64 s *3*	ε, εα 2.0×10^{-5}%, εp 7.0×10^{-6}%
		120m	(7)	−73.888	57 s *6*	ε
		121	3/2(+)	−77.14	155 s *4*	ε
		121m	9/2(+)	−77.07	122 s *3*	ε 83%, IT 17%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
55	**Cs**	122	1+	−78.13	21.0 s *7*	ε
		122m	8−	−78.06	3.70 m *11*	ε
		122m	(5)−	−78.00	0.36 s *2*	IT
		123	1/2+	−81.05	5.87 m *5*	ε
		123m	(11/2)−	−80.89	1.64 s *12*	IT
		124	1+	−81.74	30.8 s *5*	ε
		124m	(7)+	−81.28	6.3 s *2*	IT
		125	1/2(+)	−84.091	46.7 m *1*	ε
		126	1+	−84.35	1.63 m *3*	ε
		127	1/2+	−86.240	6.25 h *10*	ε
		128	1+	−85.932	3.66 m *2*	ε
		129	1/2+	−87.501	32.06 h *6*	ε
		130	1+	−86.903	29.21 m *4*	ε 98.4%, β− 1.6%
		130m	5−	−86.740	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+	−88.076	**100%**	
		134	4+	−86.896	754.5 d *2*	β−, ε 3.0×10^{-4}%
		134m	8−	−86.757	2.903 h *8*	IT
		135	7/2+	−87.587	2.3×10^{6} y *3*	β−
		*135*m	19/2−	−85.954	53 m *2*	IT
		136	5+	−86.344	13.16 d *3*	β−
		*136*m	8−	−86.344	19 s *2*	β−, IT>0%
		137	7/2+	−86.551	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+	−80.707	9.27 m *5*	β−
		140	1−	−77.056	63.7 s *3*	β−
		141	7/2+	−74.48	24.94 s *6*	β−, β−n 0.035%
		142	0−	−70.52	1.684 s *14*	β−, β−n 0.09%
		143	3/2+	−67.69	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+	−60.19	0.594 s *13*	β−, β−n 14.3%
		146	1−	−55.74	0.321 s *2*	β−, β−n 14.2%
		147	(3/2+)	−52.3	0.235 s *3*	β−, β−n 43%
		148		−47.6	158 ms *7*	β−, β−n 25.1%
		149		−44.0s	>50 ms	β−?, β−n?
		150		−39.2s	>50 ms	β−, β−n
		151		−35.4s	>50 ms	β−?, β−n?
56	**Ba**	114	0+	−45.7s	0.43 s *+30−15*	ε≈100%, εp 20%, α
		115	(3/2−)	−48.7s	0.45 s *5*	ε, εp>15%
		116	0+	−54.3s	1.3 s *2*	ε, εp 3%
		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<25%
		120	0+	−68.9	24 s *2*	ε
		121	5/2(+)	−70.3	29.7 s *15*	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	11.0 m *5*	ε
		125	1/2(+)	−79.5	3.5 m *4*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
56	**Ba**	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	2.16 h *2*	ε≤100%, IT
		130	0+	−87.271	$\geq 3.5\times10^{14}$ y	2ε
					0.106% ***1***	
		131	1/2+	−86.693	11.50 d *6*	ε
		131m	9/2−	−86.506	14.6 m *2*	IT
		132	0+	−88.440	**0.101%** ***1***	
		133	1/2+	−87.558	3848.9 d *7*	ε
		133m	11/2−	−87.270	38.9 h *1*	IT 99.99%, ε 9.6×10^{-3}%
		134	0+	−88.954	**2.417%** ***18***	
		135	3/2+	−87.856	**6.592%** ***12***	
		135m	11/2−	−87.588	28.7 h *2*	IT
		136	0+	−88.892	**7.854%** ***24***	
		136m	7−	−86.861	0.3084 s *19*	IT
		137	3/2+	−87.727	**11.232%** ***24***	
		*137*m	11/2−	−87.065	2.552 m *1*	IT
		138	0+	−88.267	**71.698%** ***42***	
		139	7/2−	−84.919	83.06 m *28*	β−
		140	0+	−83.276	12.752 d *3*	β−
		141	3/2−	−79.730	18.27 m *7*	β−
		142	0+	−77.828	10.6 m *2*	β−, β−n 0.09%
		143	5/2−	−73.94	14.33 s *8*	β−
		144	0+	−71.78	11.5 s *2*	β−, β−n 3.6%
		145	5/2−	−68.07	4.31 s *16*	β−
		146	0+	−65.11	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		−53.6s	0.344 s *7*	β−, β−n 0.43%
		150	0+	−50.7s	0.3 s	β−
		151		−45.9s	>150 ms	β−?
		152	0+	−42.7s	≈0.1 s	β−?
		153		−37.6s	≈0.08 s	β−?
57	**La**	117		−46.6s	≈0.5 s	ε?
		118		−49.8s	≈1 s	ε?
		119		−55.0s	≈2 s	ε?
		120		−57.7s	2.8 s *2*	ε, εp>0%
		121		−62.4s	5.3 s *2*	ε
		122		−64.5s	8.7 s *7*	ε, εp
		123		−68.7s	17 s *3*	ε
		124m	low	−70.3s	<1 s	ε
		124m	(7,8−)	−70.3s	29 s *1*	ε
		125		−73.9s	64.8 s *12*	ε
		125m		−73.8s	0.4 s *2*	IT
		126	low	−75.1s	<50 s	ε
		126	high	−75.1s	54 s *2*	ε
		127	(11/2−)	−78.1s	5.1 m *1*	ε
		127m	(3/2+)	−78.1s	3.7 m *4*	ε, IT

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
57	**La**	128	(5+)	–78.8	5.23 m *15*	ε
		128m	(1+,2–)	–78.8	<1.4 m	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+	–86.66	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%,
					0.090% ***1***	β– 33.6%
		139	7/2+	–87.236	**99.910%** ***1***	
		140	3–	–84.326	1.6781 d *3*	β–
		141	(7/2+)	–82.943	3.92 h *3*	β–
		142	2–	–80.039	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	(5/2+)	–72.99	24.8 s *20*	β–
		146	2–	–69.21	6.27 s *10*	β–
		*146*m	(6–)	–69.21	10.0 s *1*	β–
		147	(5/2+)	–67.24	4.015 s *8*	β–, β–n 0.04%
		148	(2–)	–63.2	1.05 s *1*	β–, β–n 0.15%
		149		–61.1s	1.05 s *3*	β–, β–n 1.4%
		150	(3–)	–57.2s	0.51 s *3*	β–, β–n 2.7%
		151		–54.4s	>150 ns	β–?
		152		–50.2s	>150 ns	β–?
		153		–47.1s	>150 ns	β–?
		154		–42.5s	≈0.1 s	β–?
		155		–39.0s	≈0.06 s	β–?
58	**Ce**	119		–44.0s	≈0.2 s	ε?
		120	0+	–49.7s	≈0.25 s	ε?
		121		–52.5s	1.1 s *1*	ε, εp≈1%
		122	0+	–57.7s	≈2 s	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	10.2 s *4*	ε, εp
		126	0+	–70.7s	50 s *3*	ε
		127	(5/2+)	–72.0s	31 s *2*	ε
		128	0+	–75.6s	3.93 m *2*	ε
		129	5/2+	–76.3s	3.5 m *5*	ε>0%
		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	1/2+	–82.4s	97 m *4*	ε
		133m	9/2–	–82.4s	4.9 h *4*	ε
		134	0+	–84.7	3.16 d *4*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
58	**Ce**	135	1/2(+)	−84.63	17.7 h *3*	ε
		135m	(11/2−)	−84.18	20 s *1*	IT
		136	0+	−86.50	**0.185%** ***2***	
		137	3/2+	−85.90	9.0 h *3*	ε
		137m	11/2−	−85.65	34.4 h *3*	IT 99.22%, ε 0.78%
		138	0+	−87.57	**0.251%** ***2***	
		139	3/2+	−86.958	137.640 d *23*	ε
		139m	11/2−	−86.204	56.54 s *13*	IT
		140	0+	−88.088	**88.450%** ***18***	
		141	7/2−	−85.445	32.501 d *5*	β−
		142	0+	−84.543	$>5\times10^{16}$ y	2β−
					11.114% ***17***	
		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+	−75.74	13.52 m *13*	β−
		147	(5/2−)	−72.18	56.4 s *10*	β−
		148	0+	−70.4	56 s *1*	β−
		149	(3/2−)	−66.80	5.3 s *2*	β−
		150	0+	−65.0	4.0 s *6*	β−
		151		−61.4s	1.02 s *6*	β−
		152	0+	−59.3s	1.4 s *2*	β−
		153		−55.3s	>150 ns	β−?
		154	0+	−52.8s	>150 ns	β−?
		155		−48.4s	>150 ns	β−?
		156	0+	−45.4s	≈0.15 s	β−?
		157		−40.7s	≈0.05 s	β−?
59	**Pr**	121		−41.6s	1.4 s *8*	p, ε?
		122		−45.0s	≈0.5 s	ε?
		123		−50.3s	≈0.8 s	ε?
		124		−53.1s	1.2 s *2*	ε, εp
		125		−57.9s	3.3 s *7*	ε, εp
		126	(3,4,5)	−60.3s	3.14 s *22*	ε, εp
		127		−64.4s	4.2 s *3*	ε
		128	4,5,6	−66.3s	3.1 s *2*	ε
		129	(11/2−)	−70.0s	32 s *3*	ε>0%
		130		−71.4s	40.0 s *4*	ε
		131	(3/2+)	−74.5	94 s *4*	ε
		131m	(11/2−)	−74.3	5.7 s *2*	IT 96.4%, ε 3.6%
		132		−75.3s	1.6 m *3*	ε
		133	(3/2+)	−78.1s	6.5 m *3*	ε
		134	2−	−78.6s	17 m *2*	ε
		134m	(5−)	−78.6s	≈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+	−84.829	4.41 h *4*	ε
		140	1+	−84.700	3.39 m *1*	ε
		141	5/2+	−86.026	**100%**	
		142	2−	−83.797	19.12 h *4*	β− 99.98%, ε 0.02%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
59	**Pr**	142m	5–	–83.794	14.6 m *5*	IT
		143	7/2+	–83.078	13.57 d *2*	β–
		144	0–	–80.760	17.28 m *5*	β–
		144m	3–	–80.701	7.2 m *3*	IT 99.93%, β– 0.07%
		145	7/2+	–79.636	5.984 h *10*	β–
		146	(2)–	–76.77	24.15 m *18*	β–
		147	(3/2+)	–75.47	13.4 m *4*	β–
		148	1–	–72.49	2.29 m *2*	β–
		*148*m	(4)	–72.40	2.01 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–)	–66.86	18.90 s *7*	β–
		152	(4–)	–63.7s	3.63 s *12*	β–
		153		–61.8s	4.28 s *11*	β–
		154	(3+,2+)	–58.3s	2.3 s *1*	β–
		155		–55.9s	>300 ns	β–?
		156		–52.1s	>300 ns	β–?
		157		–49.2s	≈0.3 s	β–?
		158		–44.9s	≈0.2 s	β–?
		159		–41.7s	≈0.1 s	β–?
60	**Nd**	126	0+	–53.0s	≈1 s	ε?
		127		–55.4s	1.8 s *4*	ε, εp
		128	0+	–60.2s		ε
		129	(5/2+)	–62.2s	7 s *1*	ε, εp
		130	0+	–66.3s	28 s *3*	ε
		131	(5/2)	–67.9	33 s *3*	ε, εp
		132	0+	–71.6s	80 s *7*	ε
		133	(7/2+)	–72.5s	70 s *10*	ε
		133m	(1/2)+	–72.3s	≈70 s	ε
		134	0+	–75.8s	8.5 m *15*	ε
		135	9/2(–)	–76.2s	12.4 m *6*	ε
		135m	(1/2+)	–76.1s	5.5 m *5*	ε>99.97%, IT<0.03%
		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+	–84.203	2.49 h *3*	ε
		141m	11/2–	–83.446	62.0 s *8*	IT, ε<0.05%
		142	0+	–85.960	**27.2%** ***5***	
		143	7/2–	–84.012	**12.2%** ***2***	
		144	0+	–83.757	2.29×10^{15} y *16*	α
					23.8% ***3***	
		145	7/2–	–81.442	**8.3%** ***1***	
		146	0+	–80.936	**17.2%** ***3***	
		147	5/2–	–78.156	10.98 d *1*	β–
		148	0+	–77.418	**5.7%** ***1***	
		149	5/2–	–74.385	1.728 h *1*	β–

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
60	**Nd**	*150*	0+	−73.694	>6.8×10^{18} y **5.6%** *2*	2β−
		151	3/2+	−70.957	12.44 m *7*	β−
		152	0+	−70.16	11.4 m *2*	β−
		153	(3/2)−	−67.35	31.6 s *10*	β−
		154	0+	−65.7	25.9 s *2*	β−
		155		−62.8	8.9 s *2*	β−
		156	0+	−60.4s	5.49 s *7*	β−
		157		−56.6s	≈2 s	β− ?
		158	0+	−54.1s	≈0.7 s	β− ?
		159		−49.9s	≈0.7 s	β− ?
		160	0+	−47.1s	≈0.3 s	β− ?
		161		−42.5s	≈0.2 s	β− ?
61	**Pm**	128		−48.2s	≈0.8 s	ε ?
		129		−52.9s	≈1 s	ε ?
		130		−55.5s	2.2 s *5*	ε , εp
		131		−59.8s	≈4 s	ε ?, εp ?
		132	(3+)	−61.7s	6.3 s *7*	ε , εp≈5.0×10^{-5}%
		133	(11/2−)	−65.5s	15 s *3*	ε
		134	(2+)	−66.6s	≈5 s	ε
		134m	(5+)	−66.6s	22 s *1*	ε
		135m	(11/2−)	−70.2s	45 s *4*	ε
		135m	(3/2+,5/2+)	−70.2s	49 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+	−75.0s	10 s *2*	ε
		138m	(3+)	−75.0s	3.24 m *5*	ε
		138m	(5−)	−75.0s	3.24 m	ε
		139	(5/2)+	−77.54	4.15 m *5*	ε
		139m	(11/2)−	−77.35	180 ms *20*	IT , ε ?
		140	1+	−78.43	9.2 s *2*	ε
		140m	8−	−78.43	5.95 m *5*	ε
		141	5/2+	−80.47	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−	−81.426	363 d *14*	ε
		145	5/2+	−81.279	17.7 y *4*	ε , α 3×10^{-7}%
		146	3−	−79.464	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− 95.8%, IT 4.2%
		149	7/2+	−76.076	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)	−71.12	13.8 m *2*	β− ≤ 100%, IT ≥ 0%
		153	5/2−	−70.69	5.25 m *2*	β−
		154	(3,4)	−68.42	2.68 m *7*	β−
		*154*m	(0,1)	−68.42	1.73 m *10*	β−
		155	(5/2−)	−66.98	41.5 s *2*	β−

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
61	**Pm**	*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		–56.7s	2 s *1*	β–
		160		–53.1s	≈2 s	β– ?
		161		–50.4s	≈0.7 s	β– ?
		162		–46.3s	≈0.5 s	β– ?
		163		–43.3s	≈0.2 s	β– ?
62	**Sm**	130	0+	–47.9s	≈0.5 s	ε ?
		131		–50.4s	1.2 s *2*	ε , εp > 0%
		132	0+	–55.1s	4.0 s *3*	ε , εp
		133		–57.1s	3.7 s *7*	ε , εp
		134	0+	–61.5s	10 s *1*	ε
		135	(3/2+,5/2+)	–63.0s	10.3 s *5*	ε , εp 0.02%
		136	0+	–66.8s	47 s *2*	ε
		137	(9/2–)	–68.0	45 s *1*	ε
		138	0+	–71.2s	3.1 m *2*	ε
		139	(1/2)+	–72.38	2.57 m *10*	ε
		139m	(11/2)–	–71.92	10.7 s *6*	IT 93.7%, ε 6.3%
		140	0+	–75.46	14.82 m *12*	ε
		141	1/2+	–75.95	10.2 m *2*	ε
		141m	11/2–	–75.77	22.6 m *2*	ε 99.69%, IT 0.31%
		142	0+	–79.00	72.49 m *5*	ε
		143	3/2+	–79.528	8.83 m *1*	ε
		143m	11/2–	–78.774	66 s *2*	IT 99.76%, ε 0.24%
		144	0+	–81.976	**3.07%** ***7***	
		145	7/2–	–80.662	340 d *3*	ε
		146	0+	–81.006	10.3×10^{7} y *5*	α
		147	7/2–	–79.276	1.06×10^{11} y *2*	α
					14.99% ***18***	
		148	0+	–79.347	7×10^{15} y *3*	α
					11.24% ***10***	
		149	7/2–	–77.147	$>2\times10^{15}$ y	α ?
					13.82% ***7***	
		150	0+	–77.061	**7.38%** ***1***	
		151	5/2–	–74.586	90 y *8*	β–
		152	0+	–74.773	**26.75%** ***16***	
		153	3/2+	–72.569	46.284 h *4*	β–
		154	0+	–72.465	$\geq2.3\times10^{18}$ y	2β–
					22.75% ***29***	
		155	3/2–	–70.201	22.3 m *2*	β–
		156	0+	–69.372	9.4 h *2*	β–
		157	(3/2–)	–66.74	482 s *4*	β–
		158	0+	–65.22	5.30 m *3*	β–
		159	(5/2–)	–62.2s	11.37 s *15*	β–
		160	0+	–60.4s	9.6 s *3*	β–
		161		–57.0s	4.8 s *8*	β–
		162	0+	–54.8s	≈2 s	β– ?
		163		–50.9s	≈1 s	β– ?
		164	0+	–48.2s	≈0.5 s	β– ?
		165		–43.8s	≈0.2 s	β–
63	**Eu**	131	(3/2)+		26 ms *6*	p

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
63	**Eu**	132		–42.7s	≈0.4 s	ε ?
		133		–47.6s	≈1 s	ε ?
		134		–50.0s	0.5 s *2*	ε , εp > 0%
		135		–54.3s	1.5 s *2*	ε , εp
		136m	(7+)	–56.4s	3.3 s *3*	ε , εp 0.09%
		136m	(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+	–66.99	1.51 s *2*	ε
		140m	(5–)	–66.80	125 ms *2*	IT , ε < 1%
		141	5/2+	–69.97	40.7 s *5*	ε
		141m	11/2–	–69.87	2.7 s *3*	IT 87% , ε 13%
		142	1+	–71.35	2.34 s *12*	ε
		142m	8–	–71.35	1.223 m *8*	ε
		143	5/2+	–74.25	2.59 m *2*	ε
		144	1+	–75.66	10.2 s *1*	ε
		145	5/2+	–78.002	5.93 d *4*	ε
		146	4–	–77.128	4.61 d *3*	ε
		147	5/2+	–77.555	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+	–76.451	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	**47.81%** ***3***	
		152	3–	–72.898	13.516 y *6*	ε 72.1% , β– 27.9%
		152m	0–	–72.853	9.3116 h *13*	β– 72% , ε 28%
		152m	8–	–72.750	96 m *1*	IT
		153	5/2+	–73.377	**52.19%** ***3***	
		154	3–	–71.748	8.592 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–
		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		–56.6s		β– ?
		164		–53.1s	≈2 s	β– ?
		165		–50.6s	≈1 s	β– ?
		166		–46.6s	≈0.4 s	β–
		167		–43.7s	≈0.2 s	β– ?
64	**Gd**	135			1.1 s *2*	ε , εp ≈ 2%
		136	0+	–49.3s	≈1 s	ε ?
		137		–51.6s	7 s *3*	ε
		138	0+	–55.9s	≈5 s	ε ?
		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%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
64	**Gd**	141m	(11/2–)	–62.8s	24.5 s *5*	ε 89%, IT 11%
		142	0+	–66.9s	70.2 s *6*	ε
		143	(1/2)+	–68.2	39 s *2*	ε
		143m	(11/2–)	–68.1	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+	–76.098	48.27 d *10*	ε
		147	7/2–	–75.368	38.06 h *12*	ε
		148	0+	–76.280	74.6 y *30*	α
		149	7/2–	–75.138	9.28 d *10*	ε , α 4.3×10^{-4}%
		150	0+	–75.772	1.79×10^{6} y *8*	α
		151	7/2–	–74.199	124 d *1*	ε , α≈8.0×10^{-7}%
		152	0+	–74.717	1.08×10^{14} y *8*	α
					0.20% ***1***	
		153	3/2–	–72.893	240.4 d *10*	ε
		154	0+	–73.716	**2.18%** ***3***	
		155	3/2–	–72.080	**14.80%** ***12***	
		156	0+	–72.545	**20.47%** ***9***	
		157	3/2–	–70.834	**15.65%** ***2***	
		158	0+	–70.700	**24.84%** ***7***	
		159	3/2–	–68.572	18.479 h *4*	β–
		160	0+	–67.952	≥1.3×10^{21} y	2β–
					21.86% ***19***	
		161	5/2–	–65.516	3.66 m *5*	β–
		162	0+	–64.291	8.4 m *2*	β–
		163	(5/2–,7/2+)	–61.5s	68 s *3*	β–
		164	0+	–59.7s	45 s *3*	β–
		165		–56.5s	10.3 s *16*	β–
		166	0+	–54.4s	≈7 s	β–
		167		–50.7s	≈3 s	β– ?
		168	0+	–48.1s	≈0.3 s	β– ?
		169		–43.9s	≈1 s	β– ?
65	**Tb**	138		–43.9s	≈0.4 s	ε ?
		139		–48.4s	≈0.7 s	ε ?
		140	5	–50.7s	2.4 s *2*	ε , εp 0.26%
		141	(5/2–)	–54.8s	3.5 s *2*	ε
		141m		–54.8s	7.9 s *6*	ε
		142	1+	–57.0s	597 ms *17*	ε , εp 2.2×10^{-3}%
		142m	(5–)	–56.7s	303 ms *17*	IT , ε<0.5%
		143	(11/2–)	–60.8s	12 s *1*	ε
		143m	(5/2+)	–60.8s	<21 s	IT
		144	(1+)	–62.8s	≈1 s	ε
		144m	(6–)	–62.5s	4.25 s *15*	IT 66%, ε 34%
		145	(3/2+)	–66.2s	≈20 m	ε ?
		145m	(11/2–)	–66.2s	30.9 s *7*	ε
		146	1+	–67.83	8 s *4*	ε
		146m	5–	–67.83	23 s *2*	ε
		147	(1/2+)	–70.76	1.7 h *1*	ε
		147m	(11/2)–	–70.71	1.83 m *6*	ε
		148	2–	–70.52	60 m *1*	ε
		148m	9+	–70.43	2.20 m *5*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
65	**Tb**	149	1/2+	–71.500	4.118 h *25*	ε 83.3%, α 16.7%
		149m	11/2–	–71.464	4.16 m *4*	ε 99.98%, α 0.02%
		150	(2–)	–71.116	3.48 h *16*	ε, α<0.05%
		150m	9+	–70.642	5.8 m *2*	ε
		151	1/2(+)	–71.634	17.609 h *1*	ε, α 9.5×10^{-3}%
		151m	(11/2–)	–71.534	25 s *3*	IT 93.8%, ε 6.2%
		152	2–	–70.73	17.5 h *1*	ε, α $<7.0\times10^{-7}$%
		152m	8+	–70.23	4.2 m *1*	IT 78.8%, ε 21.2%
		153	5/2+	–71.324	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	71 y *7*	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+	–67.472	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	21 s *6*	β–
		167		–55.8s	19.4 s *27*	β–
		168	(4–)	–52.5s	8.2 s *13*	β–
		169		–50.1s	≈2 s	β–?
		170		–46.3s	≈3 s	β–?
		171		–43.5s	≈0.5 s	β–
66	**Dy**	139			≈0.2 s	ε?
		141	(9/2–)	–45.5s	0.9 s *2*	ε, εp
		142	0+	–50.1s	2.3 s *3*	ε, εp 0.06%
		143		–52.3s	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+	–62.7	29 s *3*	ε
		146m	(10+)	–59.7	150 ms *20*	IT
		147	1/2+	–64.39	40 s *10*	ε, εp>0%
		147m	11/2–	–63.64	55.7 s *7*	ε 65%, IT 35%
		148	0+	–67.83	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+	–69.322	7.17 m *5*	ε 64%, α 36%
		151	7/2(–)	–68.763	17.9 m *3*	ε 94.4%, α 5.6%
		152	0+	–70.129	2.38 h *2*	ε 99.9%, α 0.1%
		153	7/2(–)	–69.153	6.4 h *1*	ε 99.99%, α 9.4×10^{-3}%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
66	**Dy**	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
		158	0+	−70.417	**0.10%** ***1***	
		159	3/2−	−69.177	144.4 d *2*	ε
		160	0+	−69.682	**2.34%** ***8***	
		161	5/2+	−68.065	**18.91%** ***24***	
		162	0+	−68.190	**25.51%** ***26***	
		163	5/2−	−66.390	**24.90%** ***16***	
		164	0+	−65.977	**28.18%** ***37***	
		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−
		170	0+	−53.4s	≈30 s	β−?
		171		−49.9s	≈6 s	β−
		172	0+	−47.4s	≈3 s	β−
		173		−43.4s	≈2 s	β−?
67	**Ho**	140			6 ms *3*	p
		141	(7/2−)		4.1 ms *3*	p
		142		−37.4s	≈0.3 s	ε?
		143		−42.2s	≈0.3 s	ε?
		144		−45.0s	0.7 s *1*	ε, εp
		145		−49.5s	2.4 s *1*	ε
		146	(10+)	−52.1s	3.6 s *3*	ε
		147	(11/2−)	−56.0s	5.8 s *4*	ε, εp
		148	1+	−58.4s	2.2 s *11*	ε
		148m	6−	−58.4s	9.59 s *15*	ε, εp 0.08%
		149	(11/2−)	−61.67	21.1 s *2*	ε
		149m	(1/2+)	−61.63	56 s *3*	ε
		150	2−	−62.1s	72 s *4*	ε
		150m	(9)+	−61.3s	23.3 s *3*	ε
		151	(11/2−)	−63.64	35.2 s *1*	ε 78%, α 22%
		151m	(1/2+)	−63.60	47.2 s *10*	α 80%, ε 20%
		152	2−	−63.58	161.8 s *3*	ε 88%, α 12%
		152m	9+	−63.42	50.0 s *4*	ε 89.2%, α 10.8%
		153	11/2−	−65.023	2.01 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−	−64.649	11.76 m *19*	ε 99.98%, α 0.02%
		154m	8+	−64.649	3.10 m *14*	ε, $\alpha<1.0\times10^{-3}$%, 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+	−66.19	11.3 m *4*	ε
		158m	2−	−66.12	28 m *2*	IT>81%, ε<19%
		158m	(9+)	−66.01	21.3 m *23*	ε≥93%, IT≤7%
		159	7/2−	−67.339	33.05 m *11*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
67	**Ho**	159m	1/2+	−67.133	8.30 s *8*	IT
		160	5+	−66.39	25.6 m *3*	ε
		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	*STABLE*	
		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		−51.4s	25 s *3*	β−
		173		−49.1s	≈10 s	β− ?
		174		−45.5s	≈8 s	β− ?
		175		−42.8s	≈5 s	β− ?
68	**Er**	144	0+	−36.7s	≈0.4 s	ε ?
		145	(11/2−)	−39.6s	0.9 s *3*	ε , εp
		146	0+	−44.6s	1.7 s *6*	ε , εp
		147	(11/2−)	−47.2s	2.5 s *2*	ε , εp > 0%
		147m	(1/2+)	−47.2s	≈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−)	−53.1s	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−)	−58.3s	23.5 s *13*	ε
		151m	(27/2−)	−55.7s	0.58 s *2*	IT 95.3%, ε 4.7%
		152	0+	−60.47	10.3 s *1*	α 90%, ε 10%
		153	(7/2−)	−60.46	37.1 s *2*	α 53%, ε 47%
		154	0+	−62.618	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+	−64.26	19.5 m *10*	ε , $\alpha\ 5\times10^{-6}$%
		157	3/2−	−63.39	18.65 m *10*	ε ≈ 100%, α < 0.02%
		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+	−66.346	**0.139%** ***5***	
		163	5/2−	−65.177	75.0 m *4*	ε
		164	0+	−65.953	**1.601%** ***3***	

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
68	**Er**	165	5/2–	–64.531	10.36 h *4*	ε
		166	0+	–64.935	**33.503%** ***36***	
		167	7/2+	–63.299	**22.869%** ***9***	
		167m	1/2–	–63.091	2.269 s *6*	IT
		168	0+	–62.999	**26.978%** ***18***	
		169	1/2–	–60.931	9.40 d *2*	β–
		170	0+	–60.118	$\geq 3.2\times10^{17}$ y	2β–
					14.910% ***36***	
		171	5/2–	–57.729	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+	–51.8s	3.2 m *2*	β–
		175	(9/2+)	–48.5s	1.2 m *3*	β–
		176	0+	–46.3s	≈20 s	β– ?
		177		–42.5s	≈3 s	β– ?
69	**Tm**	145	(11/2–)		3.5 μs *10*	p
		146	(5–,6–)	–31.2s	62 ms *+19–14*	p
		146m	(10+)	–31.2s	206 ms *25*	p
		147	(11/2–)	–36.3s	0.559 s *26*	ε ≈ 90%, p ≈ 10%
		148m	(10+)	–39.5s	0.7 s *2*	ε
		149	(11/2–)	–44.1s	0.9 s *2*	ε , εp 0.2%
		150	(6–)	–46.9s	2.2 s *2*	ε
		151	(11/2–)	–50.8s	4.17 s *10*	ε
		151m	(1/2+)	–50.8s	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 92%, ε 8%
		154	(2–)	–54.6s	8.1 s *3*	α 54%, ε 46%
		154m	(9+)	–54.6s	3.30 s *7*	α 58%, ε 42%, 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–	–56.81	83.8 s *18*	ε 99.94%, α 0.06%
		156m		–56.81	19 s *3*	α
		157	1/2+	–58.9	3.63 m *9*	ε
		158	2–	–58.7s	3.98 m *6*	ε
		159	5/2+	–60.72	9.13 m *16*	ε
		160	1–	–60.5	9.4 m *3*	ε
		160m	5	–60.4	74.5 s *15*	IT 85%, ε 15%
		161	7/2+	–62.04	33 m *3*	ε
		162	1–	–61.51	21.70 m *19*	ε
		162m	5+	–61.51	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+	–62.939	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– 99.87%, ε 0.13%
		171	1/2+	–59.219	1.92 y *1*	β–

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
69	**Tm**	172	2–	–57.384	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+	–52.32	15.2 m *5*	β–
		176	(4+)	–49.4	1.9 m *1*	β–
		177	(1/2+)	–47.5s	85 s *+10–15*	β–
		178		–44.1s	≈30 s	β– ?
		179		–41.6s	≈20 s	β– ?
70	**Yb**	148	0+	–31.0s	≈0.25 s	ε ?
		149		–34.0s	≈0.6 s	ε ?
		150	0+	–39.1s	≈0.7 s	ε ?
		151	(1/2+)	–41.7s	1.6 s *1*	ε , εp
		151m	(11/2–)	–41.7s	1.6 s *1*	ε ≈ 100%, εp, IT ?
		152	0+	–46.4s	3.04 s *6*	ε , εp
		153	7/2–	–47.3s	4.2 s *2*	α 50%, ε 50%
		154	0+	–50.1s	0.409 s *2*	α 92.6%, ε 7.4%
		155	(7/2–)	–50.5s	1.800 s *20*	α 89%, ε 11%
		156	0+	–53.24	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+	–56.022	1.49 m *13*	ε , α ≈ 2.1×10^{-3}%
		159	5/2(–)	–55.75	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 *35*	ε
		164	0+	–61.0s	75.8 m *17*	ε
		165	5/2–	–60.18	9.9 m *3*	ε
		166	0+	–61.591	56.7 h *1*	ε
		167	5/2–	–60.597	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–	–60.349	46 s *2*	IT
		170	0+	–60.772	≥ 1.6×10^{17} y	2β–
					3.04% ***15***	
		171	1/2–	–59.315	**14.28%** ***57***	
		172	0+	–59.264	**21.83%** ***67***	
		173	5/2–	–57.560	**16.13%** ***27***	
		174	0+	–56.953	**31.83%** ***92***	
		175	7/2–	–54.704	4.185 d *1*	β–
		176	0+	–53.497	**12.76%** ***41***	
		176m	(8)–	–52.447	11.4 s *3*	IT ≥ 90%, β– ≤ 10%
		177	(9/2+)	–50.993	1.911 h *3*	β–
		177m	(1/2–)	–50.662	6.41 s *3*	IT
		178	0+	–49.70	74 m *3*	β–
		179	(1/2–)	–46.4s	8.0 m *4*	β–
		180	0+	–44.4s	2.4 m *5*	β–
		181		–40.8s	≈1 m	β– ?
71	**Lu**	150		–25.5s	35 ms *10*	p 80%
		151	(11/2–)	–30.6s	80 ms *2*	p 70%
		152	(5–,6–)	–33.9s	0.7 s *1*	ε , εp 15%
		153	11/2–	–38.5s	0.9 s *2*	α ≈ 70%, ε ≈ 30%
		154	(2–)	–40.0s	≈2 s	ε ?

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
71	**Lu**	154m	(9+)	–40.0s	1.12 s *8*	ε
		155	(11/2–)	–42.6s	70 ms *1*	α 79%, ε 21%
		155m	(1/2+)	–42.6s	136 ms *9*	ε , α
		155m	(25/2–)	–40.8s	2.71 ms *3*	α
		156m		–43.9s	198 ms *2*	α ≥ 75%, ε ≤ 25%
		156m		–43.9s	494 ms *12*	α ≈ 95%, ε 5%
		157	(1/2+,3/2+)	–46.48	6.8 s *18*	α > 0%
		157m	(11/2–)	–46.45	4.79 s *12*	ε 94%, α 6%
		158		–47.3s	10.6 s *3*	ε 99.09%, α 0.91%
		159		–49.73	12.1 s *10*	ε , α 0.04%
		160		–50.3s	36.1 s *3*	ε , α ≤ 1.0×10^{-4}%
		160m		–50.3s	40 s *1*	ε ≤ 100%, α
		161	(5/2+)	–52.6s	72 s	ε
		162	(1–)	–52.9s	1.37 m *2*	ε ≤ 100%
		162m	(4–)	–52.9s	1.5 m	ε ≤ 100%
		162m		–52.9s	1.9 m	ε ≤ 100%
		163	1/2(+)	–54.8	3.97 m *13*	ε
		164		–54.8s	3.14 m *3*	ε
		165	1/2+	–56.26	10.74 m *10*	ε
		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+	–58.080	34.06 h *5*	ε
		169m	1/2–	–58.051	160 s *10*	IT
		170	0+	–57.31	2.012 d *20*	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–	–56.703	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 *1*	β–
					2.59% ***2***	
		176m	1–	–53.268	3.664 h *19*	β– 99.9%, 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–
		180	(3)+	–46.69	5.7 m *1*	β–
		181	(7/2+)	–44.7s	3.5 m *3*	β–
		182	(0,1,2)	–41.7s	2.0 m *2*	β–
		183	(7/2+)	–39.5s	58 s *4*	β–
		184	(3+)	–36.2s	20 s *3*	β–
72	**Hf**	154	0+	–33.3s	2 s *1*	ε ≈ 100%, α ≈ 0%
		155		–34.7s	0.89 s *12*	ε , α

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
72	**Hf**	156	0+	–38.0s	23 ms *1*	α
		157	7/2–	–39.0s	115 ms *1*	α 86%, ε 14%
		158	0+	–42.2s	2.85 s *7*	ε 56%, α 44%
		159		–42.8s	5.2 s *1*	ε 59%, α 41%
		160	0+	–45.91	13.6 s *2*	ε 99.3%, α 0.7%
		161		–46.27	18.7 s *1*	ε 99%, α 1%
		162	0+	–49.18	39.4 s *9*	ε 99.99%, α 8.0×10^{-3}%
		163		–49.3s	40.0 s *6*	ε , α< 1.0×10^{-4}%
		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
		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+	–55.852	2.0×10^{15} y *4* **0.16%** ***1***	α
		175	5/2–	–54.490	70 d *2*	ε
		176	0+	–54.584	**5.26%** ***7***	
		177	7/2–	–52.890	**18.60%** ***9***	
		177m	23/2+	–51.575	1.08 s *6*	IT
		177m	37/2–	–50.150	51.4 m *5*	IT
		178	0+	–52.445	**27.28%** ***7***	
		178m	8–	–51.298	4.0 s *2*	IT
		178m	16+	–49.999	31 y *1*	IT
		179	9/2+	–50.473	**13.62%** ***2***	
		179m	1/2–	–50.098	18.67 s *4*	IT
		179m	25/2–	–49.367	25.05 d *25*	IT
		180	0+	–49.790	**35.08%** ***16***	
		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		–38.4s	3.5 m *6*	β–
		186	0+	–36.4s	2.6 m *12*	β–
73	**Ta**	155	(11/2–)		12 μs *+4–3*	p
		156	(2–)	–26.4s	144 ms *24*	p
		156m	(7,8,9)+	–26.3s	375 ms *54*	ε , p 4.2%
		157	(1/2+)	–29.7s	10.1 ms *4*	α 96.6%, p 3.4%
		157m	high	–29.7s	1.7 ms *1*	α
		157m		–29.7s	4.3 ms *1*	α
		158	(2–)	–31.3s	72 ms *12*	α
		158m	(9+)	–31.2s	37.7 ms *15*	α 93%, ε 7%
		159	(1/2+)	–34.5s	0.544 s *16*	α 80%, ε 20%
		159m	(11/2–)	–34.5s	1.1 s *1*	α

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
73	Ta	160		−36.0s	1.55 s *4*	ε 66%, α 34%
		161		−38.78	4.9 s *8*	ε ≈ 95%, α 5%
		162		−39.9s	3.57 s *12*	ε 99.93%, α 0.07%
		163		−42.55	10.6 s *18*	ε ≈ 99.8%, α ≈ 0.2%
		164	(3+)	−43.2s	14.2 s *3*	ε
		165		−45.8s	31.0 s *15*	ε
		166	(2)+	−46.1s	34.4 s *5*	ε
		167	(3/2+)	−48.5s	80 s *4*	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−	−52.6s	3.14 h *13*	ε
		174	3+	−52.01	1.14 h *8*	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
		178	(7)−	−50.5	2.36 h *8*	ε
		179	7/2+	−50.362	1.82 y *3*	ε
		180	1+	−48.935	8.152 h *6*	ε 86%, β− 14%
		180m	9−	−48.860	$>1.2\times10^{15}$ y	β−?,
					0.012% ***2***	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	≈2 m	β−?
		188		−33.8s	≈20 s	β−?
74	W	158	0+	−24.3s	0.9 ms *3*	α
		159		−25.8s	8.2 ms *7*	α ≈ 92%, ε
		160	0+	−29.5s	91 ms *5*	α 87%
		161		−30.7s	409 ms *18*	α ≈ 73%, ε
		162	0+	−34.1s	1.36 s *7*	ε 54.8%, α 45.2%
		163		−34.9s	2.8 s *2*	ε 87%, α 13%
		164	0+	−38.21	6.0 s *3*	ε 97.4%, α 2.6%
		165	(5/2−)	−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*	ε 99.96%, α 0.04%
		168	0+	−44.8s	53 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−)	−47.1s	2.38 m *4*	ε
		172	0+	−49.0s	6.6 m *9*	ε
		173	5/2−	−48.6s	7.6 m *2*	ε
		174	0+	−50.2s	33.2 m *21*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
74	**W**	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+	–49.643	$>7.4\times10^{16}$ y	α
					0.12% ***1***	
		181	9/2+	–48.253	121.2 d *2*	ε
		182	0+	–48.246	$>8.3\times10^{18}$ y	α
					26.50% ***16***	
		183	1/2–	–46.366	$>1.9\times10^{18}$ y	α
					14.31% ***4***	
		183m	11/2+	–46.056	5.2 s *3*	IT
		184	0+	–45.706	$>4\times10^{18}$ y	α
					30.64% ***2***	
		185	3/2–	–43.388	75.1 d *3*	β–
		185m	11/2+	–43.191	1.67 m *3*	IT
		186	0+	–42.511	$>6.5\times10^{18}$ y	α
					28.43% ***19***	
		187	3/2–	–39.907	23.72 h *6*	β–
		188	0+	–38.669	69.4 d *5*	β–
		189	(3/2–)	–35.5	10.8 m *3*	β–
		190	0+	–34.3	30.0 m *15*	β–
75	**Re**	160		–17.2s	0.79 ms *16*	p 91%, α 9%
		161	(1/2+)	–20.8s	0.37 ms *4*	p
		161m	(11/2–)	–20.7s	16 ms *1*	p 4.8%, α
		162	(2–)	–22.6s	107 ms *13*	α 94%, ε 6%
		162m	(9+)	–22.5s	77 ms *9*	α 91%, ε 9%
		163	(1/2+)	–26.1s	390 ms *72*	ε 68%, α 32%
		163m	(11/2–)	–26.0s	214 ms *5*	α 66%, ε 34%
		164		–27.6s	0.38 s *16*	α≈58%, ε≈42%
		165	(1/2+)	–30.69	≈1 s	ε , α
		165m	(11/2–)	–30.64	2.1 s *3*	ε 87%, α 13%
		166		–31.9s	2.8 s *3*	α
		167	(9/2–)	–34.9s	5.9 s *3*	ε≈99%, α≈1%
		167m		–34.9s	3.4 s *4*	α
		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
		170	(5+)	–39.0s	9.2 s *2*	ε
		171	(9/2–)	–41.4s	15.2 s *4*	ε
		172m	(5)	–41.7s	15 s *3*	ε
		172m	(2)	–41.7s	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

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
75	**Re**	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+	−43.821	**37.40%** ***2***	
		186	1−	−41.930	3.7183 d *11*	β− 92.53%, ε 7.47%
		186m	(8+)	−41.781	2.0×10^{5} y	IT
		187	5/2+	−41.218	4.35×10^{10} y *13*	β−,
					62.60% ***2***	α < 1.0×10^{-4}%
		188	1−	−39.018	17.005 h *4*	β−
		188m	(6)−	−38.846	18.6 m *1*	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−
76	**Os**	162	0+	−15.1s	1.7 ms *5*	α
		163		−16.7s	5.5 ms *6*	α ≈ 100%, ε
		164	0+	−20.6s	27 ms *4*	α ≈ 98%, ε ≈ 2%
		165	(7/2−)	−21.9s	71 ms *3*	α > 60%, ε < 40%
		166	0+	−25.6s	220 ms *7*	α 72%, ε 18%
		167		−26.5s	0.81 s *6*	α 57%, ε 43%
		168	0+	−29.96	2.1 s *1*	ε, α 40%
		169		−30.67	3.6 s *2*	ε 89%, α 11%
		170	0+	−33.93	7.3 s *2*	ε 88%, α 12%
		171	(5/2−)	−34.4s	8.3 s *2*	ε 98.2%, α 1.8%
		172	0+	−37.2s	19.2 s *5*	ε, α 1.1%
		173	(5/2−)	−37.5s	22.4 s *9*	ε, α 0.4%
		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+	−42.0s	3.6 m *5*	ε
		177	(1/2−)	−41.9s	2.8 m *3*	ε
		178	0+	−43.5	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−	−43.5	105 m *3*	ε
		181m	(7/2)−	−43.5	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	> 5.6×10^{13} y	α
					0.02% ***1***	
		185	1/2−	−42.809	93.6 d *5*	ε
		186	0+	−42.999	2.0×10^{15} y *11*	α
					1.59% ***3***	
		187	1/2−	−41.221	**1.6%** ***3***	
		188	0+	−41.139	**13.29%** ***8***	
		189	3/2−	−38.988	**16.21%** ***5***	

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
76	**Os**	189m	9/2–	–38.957	5.8 h *1*	IT
		190	0+	–38.708	**26.36%** ***2***	
		190m	(10)–	–37.003	9.9 m *1*	IT
		191	9/2–	–36.395	15.4 d *1*	β–
		191m	3/2–	–36.321	13.10 h *5*	IT
		192	0+	–35.882	**40.93%** ***19***	
		192m	(10–)	–33.867	5.9 s *1*	IT > 87%, β– < 13%
		193	3/2–	–33.396	30.11 h *1*	β–
		194	0+	–32.435	6.0 y *2*	β–
		195		–29.7	≈9 m	β– ?
		196	0+	–28.30	34.9 m *2*	β–
77	**Ir**	164			≈1 ms	p ?, α ?
		165		–11.6s	< 1 μs	p ?, α ?
		166	(2–)	–13.5s	10.5 ms *22*	α 93.1%, p 6.9%
		166m	(9+)	–13.3s	15.1 ms *9*	α 98.2%, p 1.8%
		167	(1/2+)	–17.2s	35.2 ms *20*	α 48%, p 32%, ε
		167m	(11/2–)	–17.0s	30.0 ms *6*	α 80%, ε 20%, p 0.4%
		168		–18.7s	0.161 ms *21*	α 82%
		169	(1/2+)	–21.99	0.6 ms *+5–2*	α 50%
		169m	(11/2–)	–21.84	0.32 s *+9–7*	α 84%, ε, p
		170		–23.3s	0.83 s *3*	α 63%, ε
		171	(11/2–)	–26.3s	1.46 s *9*	α 58%, ε ≤ 42%
		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	(11/2–)	–30.1s	2.4 s *9*	ε, α 7%
		173m	(3/2+,5/2+)	–30.1s	9.0 s *8*	ε > 93%, α < 7%
		174	(3+)	–30.9s	7.9 s *6*	ε 99.5%, α 0.5%
		174m	(7+)	–30.7s	4.9 s *3*	ε 97.5%, α 2.5%
		175	(5/2–)	–33.3s	9 s *2*	ε 99.15%, α 0.85%
		176		–34.0s	8.3 s *6*	ε 96.9%, α 3.1%
		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)–	–39.5	4.90 m *15*	ε
		182	(5+)	–39.0	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	1.90 h *5*	ε ≈ 75%, IT ≈ 25%
		187	3/2+	–39.718	10.5 h *3*	ε
		188	1–	–38.329	41.5 h *5*	ε
		189	3/2+	–38.46	13.2 d *1*	ε
		190	(4–)	–36.7	11.78 d *10*	ε
		190m	(1–)	–36.7	1.120 h *3*	IT
		190m	(11)–	–36.3	3.087 h *12*	ε 91.4%, IT 8.6%
		191	3/2+	–36.709	**37.3%** ***2***	
		191m	11/2–	–36.538	4.94 s *3*	IT
		191m		–34.662	5.5 s *7*	IT
		192	4+	–34.836	73.827 d *13*	β– 95.13%, ε 4.87%
		192m	1–	–34.779	1.45 m *5*	IT 99.98%, β– 0.02%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
77	**Ir**	192m	(11–)	–34.668	241 y *9*	IT
		193	3/2+	–34.536	**62.7%** ***2***	
		193m	11/2–	–34.456	10.53 d *4*	IT
		194	1–	–32.532	19.28 h *13*	β–
		194m	(10,11)	–32.342	171 d *11*	β–
		195	3/2+	–31.692	2.5 h *2*	β–
		195m	11/2–	–31.592	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–
		199		–24.42	≈20 s	β– ?
78	**Pt**	166	0+		0.3 ms *1*	α
		167	(7/2–)		0.7 ms *2*	α
		168	0+	–11.1s	2.0 ms *4*	α ≤ 100%
		169		–12.6s	5 ms *3*	α ≤ 100%
		170	0+	–16.5s	13.8 ms *5*	α 98%
		171		–17.5s	34 ms *9*	α ≈ 98%, ε 2%
		172	0+	–21.07	0.096 s *3*	α 94%, ε 6%
		173		–21.9	376 ms *11*	α 83%, ε
		174	0+	–25.33	0.889 s *17*	α 76%, ε 24%
		175		–25.8s	2.4 s *3*	α 56%, ε
		176	0+	–28.9s	6.7 s *7*	ε , α 42%
		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–	–32.2s	21.2 s *4*	ε 99.76%, α 0.24%
		180	0+	–34.3s	52 s *3*	ε , α ≈ 0.3%
		181	1/2–	–34.3s	52.0 s *22*	ε , α ≈ 0.08%
		182	0+	–36.1	3.0 m *2*	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 ≈ 100%, α < 4.0×10^{-4}% , IT
		184	0+	–37.4s	17.3 m *2*	ε , α ≈ 0.001%
		185	9/2+	–36.6	70.9 m *24*	ε , α ?
		185m	1/2–	–36.5	33.0 m *8*	ε > 98%, IT < 2%, α ?
		186	0+	–37.79	2.08 h *5*	ε , α ≈ 1.4×10^{-4}%
		187	3/2–	–36.7s	2.35 h *3*	ε
		188	0+	–37.823	10.2 d *3*	ε , α 2.6×10^{-5}%
		189	3/2–	–36.48	10.87 h *12*	ε
		190	0+	–37.325	6.5×10^{11} y *3*	α
					0.014% ***1***	
		191	3/2–	–35.690	2.802 d *25*	ε
		192	0+	–36.296	**0.782%** ***7***	
		193	1/2–	–34.480	50 y *6*	ε
		193m	13/2+	–34.330	4.33 d *3*	IT
		194	0+	–34.779	**32.967%** ***99***	
		195	1/2–	–32.812	**33.832%** ***10***	
		195m	13/2+	–32.553	4.02 d *1*	IT
		196	0+	–32.663	**25.242%** ***41***	
		197	1/2–	–30.438	19.8915 h *19*	β–
		197m	13/2+	–30.038	95.41 m *18*	IT 96.7%, β– 3.3%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
78	**Pt**	198	0+	−29.923	**7.163%** *55*	
		199	5/2−	−27.408	30.80 m *21*	β−
		199m	(13/2)+	−26.984	13.6 s *4*	IT
		200	0+	−26.62	12.5 h *3*	β−
		201	(5/2−)	−23.76	2.5 m *1*	β−
		202	0+	−22.6s	44 h *15*	β−
79	**Au**	171	(1/2+)	−7.7s	17 μs *+9−5*	p
		171m	(11/2−)	−7.4s	1.02 ms *10*	α 54%, p 46%
		172		−9.2s	6.3 ms *15*	α ≤ 100%, p < 2%
		173	(1/2+)	−12.7	20 ms *+9−6*	α 94%
		173m	(11/2−)	−12.5	12 ms *+3−2*	α 92%
		174		−14.1s	120 ms *20*	α > 0%
		175		−17.2s	185 ms *30*	α 94%, ε 6%
		176		−18.4s	1.08 s *17*	ε , α
		177		−21.2s	1.3 s *2*	ε ≥ 60%, α ≤ 40%
		178		−22.4s	2.6 s *5*	ε ≤ 60%, α ≥ 40%
		179		−24.8s	3.3 s *13*	ε 78%, α 22%
		180		−25.7s	8.1 s *3*	ε ≤ 98.2%, α ≥ 1.8%
		181	(3/2−)	−28.0s	13.7 s *14*	ε 97.3%, α 2.7%
		182		−28.3s	15.6 s *4*	ε 99.87%, α 0.13%
		183	(5/2)−	−30.2s	42.8 s *10*	ε 99.45%, α 0.55%
		184	5+	−30.3s	21 s *1*	ε
		184m	2+	−30.2s	48 s *1*	ε 99.98%, α 0.02%, IT
		185	5/2−	−31.9	4.25 m *6*	ε 99.74%, α 0.26%
		185m		−31.9	6.8 m *3*	ε < 100%, IT
		186	3−	−31.7	10.7 m *5*	ε , $\alpha\ 8.0\times10^{-4}$%
		187	1/2+	−33.0s	8.4 m *3*	ε , $\alpha\ 3.0\times10^{-3}$%
		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 , $\alpha < 3.0\times10^{-5}$%
		189m	11/2−	−33.4s	4.59 m *11*	ε , IT > 0%
		190	1−	−32.88	42.8 m *10*	ε , $\alpha < 1.0\times10^{-6}$%
		190m	(11−)	−32.88	125 ms *20*	IT ≈ 100%, ε
		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−)	−32.35	160 ms *20*	IT
		193	3/2+	−33.411	17.65 h *15*	ε
		193m	11/2−	−33.121	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	186.098 d *47*	ε
		195m	11/2−	−32.267	30.5 s *2*	IT
		196	2−	−31.157	6.183 d *10*	ε 92.8%, β− 7.2%
		196m	5+	−31.073	8.1 s *2*	IT
		196m	12−	−30.562	9.6 h *1*	IT
		197	3/2+	−31.157	**100%**	
		197m	11/2−	−30.748	7.73 s *6*	IT
		198	2−	−29.598	2.69517 d *21*	β−
		198m	(12−)	−28.786	2.27 d *2*	IT

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
79	**Au**	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+	–26.416	26 m *1*	β–
		202	(1–)	–24.4	28.8 s *19*	β–
		203	3/2+	–23.160	60 s *6*	β–
		204	(2–)	–20.8s	39.8 s *9*	β–
		205	3/2+	–19.0s	31 s *2*	β–
80	**Hg**	172	0+		0.25 ms *+35–9*	α
		173			0.93 ms *+57–36*	α
		174	0+		2.1 ms *+18–7*	α 99.6%
		175		–8.0s	8 ms *8*	α
		176	0+	–11.72	34 ms *+18–9*	α
		177		–12.7	0.114 s *15*	α 85%, ε 15%
		178	0+	–16.32	0.287 s *23*	α≈70%, ε≈30%
		179		–17.0s	0.93 s *11*	α≈53%, ε≈47%, εp≈0.15%
		180	0+	–20.2s	2.6 s *8*	ε 52%, α 48%
		181	1/2(–)	–20.7s	3.6 s *1*	ε 69%, α 31%, εp 0.02%, εα 1.1×10^{-5}%
		182	0+	–23.5s	10.83 s *6*	ε 84.8%, α 15.2%
		183	1/2–	–23.7s	9.4 s *7*	ε 74.5%, α 25.5%, εp 5.6×10^{-4}%
		184	0+	–26.2s	30.9 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 *6*	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}%
		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 92.8%, IT 7.2%
		194	0+	–32.25	444 y *77*	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+	–31.843	**0.15%** ***1***	
		197	1/2–	–30.557	64.14 h *5*	ε
		197m	13/2+	–30.258	23.8 h *1*	IT 91.4%, ε 8.6%
		198	0+	–30.971	**9.97%** ***20***	
		199	1/2–	–29.563	**16.87%** ***22***	
		199m	13/2+	–29.031	42.6 m *2*	IT
		200	0+	–29.520	**23.10%** ***19***	
		201	3/2–	–27.679	**13.18%** ***9***	
		202	0+	–27.362	**29.86%** ***26***	

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
80	**Hg**	203	5/2–	–25.283	46.612 d *18*	β–
		204	0+	–24.707	**6.87%** ***15***	
		205	1/2–	–22.304	5.2 m *1*	β–
		206	0+	–20.96	8.15 m *10*	β–
		207	(9/2+)	–16.2	2.9 m *2*	β–
		208	0+	–13.1s	41 m *+5–4*	β–
81	**Tl**	177	(1/2+)	–2.9s	18 ms *5*	α 73%, p 27%
		178		–4.4s	≈60 ms	α?, ε?
		179	(11/2–)	–7.9s	0.43 s *35*	α
		179m	(9/2–)	–7.9s	1.5 ms *3*	α≈100%
		180		–9.1s	1.5 s *3*	εSF≈1×10^{-4}%, ε, α
		181	(1/2+)	–12.2s	3.2 s *3*	ε, α
		181m		–12.2s	1.4 s *5*	α
		182	(7+)	–13.4s	3.1 s *10*	ε>96%, α<4%
		183	(1/2+)	–16.1s	6.9 s *7*	ε>0%
		183m	(9/2–)	–15.6s	60 ms *15*	α<0.01%, IT?
		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
		186m	(7+)	–20.0s	27.5 s *10*	ε, α≈6.0×10^{-3}%
		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<99.9%, IT<99.9%, α 0.15%
		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
		192	(2–)	–25.9s	9.6 m *4*	ε
		192m	(7+)	–25.8s	10.8 m *2*	ε
		193	1/2+	–27.4s	21.6 m *8*	ε
		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+	–28.38	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
		202	2–	–26.00	12.23 d *2*	ε
		203	1/2+	–25.775	**29.524%** ***14***	
		204	2–	–24.360	3.78 y *2*	β– 97.1%, ε 2.9%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
81	**Tl**	205	1/2+	−23.835	**70.476%** ***14***	
		206	0−	−22.267	4.200 m *17*	β−
		206m	(12−)	−19.624	3.74 m *3*	IT
		207	1/2+	−21.044	4.77 m *2*	β−
		207m	11/2−	−19.696	1.33 s *11*	IT
		208	5(+)	−16.763	3.053 m *4*	β−
		209	(1/2+)	−13.647	2.161 m *7*	β−
		210	(5+)	−9.25	1.30 m *3*	β−, β−n 7.0×10^{-3}%
82	**Pb**	180	0+		4 s *+4−2*	α
		181	(13/2+)	−3.1s	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 > 0%, ε ?
		185		−11.6s	4.1 s *3*	α ≤ 100%
		186	0+	−14.6s	4.82 s *3*	ε, α 38%
		187m		−14.9s	15.2 s *3*	ε, α
		187m	(13/2+)	−14.9s	18.3 s *3*	ε > 90%, α < 10%
		188	0+	−17.6s	24 s *2*	ε, α 9.3%
		189m		−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 5.9×10^{-3}%
		193	(3/2−)	−22.3s		ε
		193m	(13/2+)	−22.3s	5.8 m *2*	ε
		194	0+	−24.3s	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
		197m	13/2+	−24.5s	43 m *1*	ε 81%, IT 19%
		198	0+	−26.10s	2.40 h *10*	ε
		199	3/2−	−25.23	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+	−23.975	6.3 s *2*	IT
		203m	29/2−	−21.851	0.48 s *2*	IT
		204	0+	−25.124	≥1.4×10^{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***	

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
82	Pb	209	9/2+	−17.629	3.253 h *14*	β−
		210	0+	−14.743	22.3 y *3*	β−, α 1.9×10⁻⁶%
		211	9/2+	−10.497	36.1 m *2*	β−
		212	0+	−7.557	10.64 h *1*	β−
		213	(9/2+)	−3.3s	10.2 m *3*	β−
		214	0+	−0.188	26.8 m *9*	β−
83	Bi	186	(3+)	−3.3s	15.0 ms *17*	α
		186m	(10−)	−3.3s	9.8 ms *13*	α≈100%
		187	(9/2−)	−6.1s	32 ms *3*	α 53%
		188m		−7.3s	44 ms *3*	ε, α
		188m		−7.3s	218 ms *50*	ε, α
		189	(9/2−)	−9.8s	728 ms *40*	α>50%, ε<50%
		189m	(1/2+)	−9.7s	4.8 ms *5*	α>50%, ε<50%
		190m	(10−)	−10.7s	6.2 s *1*	α 70%, ε 30%
		190m	(3+)	−10.7s	6.3 s *1*	α≈90%, ε≈10%
		191	(9/2−)	−13.0s	12.3 s *5*	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−)	−13.6s	39.6 s *4*	ε 90%, α 10%
		193	(9/2−)	−15.8s	67 s *3*	ε 96.5%, α 3.5%
		193m	(1/2+)	−15.5s	3.2 s *6*	α 90%, ε 10%
		194	(3+)	−16.1s	95 s *3*	ε 99.54%, α 0.46%
		194m	(10−)	−16.1s	115 s *4*	ε 99.8%, α 0.2%
		194m	(6+,7+)	−16.1s	125 s *2*	ε
		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+)	−18.1s	308 s *12*	ε≈100%, α 1.2×10⁻³%
		196m	(7+)	−17.9s	0.6 s *5*	IT, ε
		196m	(10−)	−17.8s	240 s *3*	ε 74.2%, IT 25.8%, α 3.8×10⁻⁴%
		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−	−20.9	27 m *1*	ε
		199m	(1/2+)	−20.2	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+	−20.61	59.1 m *6*	ε>93%, IT≤6.8%, α≈0.3%
		202	5+	−20.80	1.72 h *5*	ε, α<1.0×10⁻⁵%
		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+	−20.67	11.22 h *10*	ε
		205	9/2−	−21.075	15.31 d *4*	ε
		206	6(+)	−20.043	6.243 d *3*	ε

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
83	**Bi**	207	9/2–	–20.069	31.55 y *5*	ε
		208	(5)+	–18.885	3.68×10^{5} y *4*	ε
		209	9/2–	–18.273	**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(–)	–8.130	60.55 m *6*	β– 64.06%, α 35.94%, β–α 0.014%
		212m	(9–)	–7.880	25.0 m *2*	α 67%, β– 33%
		212m		–6.220	7.0 m *3*	β–
		213	9/2–	–5.240	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	(1–)	5.8s	2.17 m *5*	β– ≤ 100%
		217			97 s *3*	β– ?
84	**Po**	190	0+	–4.6s	2.53 ms *33*	α, ε 0.1%
		191	(3/2–)	–5.0s	22 ms *1*	α
		191m	(13/2+)	–4.9s	98 ms *8*	α
		192	0+	–7.9s	33.2 ms *14*	α ≈ 99.5%, ε ≈ 0.5%
		193m	(13/2+)	–8.3s	0.24 s *1*	α ≤ 100%
		193m	(3/2–)	–8.3s	0.42 s *4*	α ≤ 100%
		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	1.4 m *2*	ε 56%, α 44%
		197m	(13/2+)	–13.2s	31 s *2*	α 84%, ε 16%, IT 0.01%
		198	0+	–15.5s	1.87 m *10*	α 57%, ε 43%
		199	(3/2–)	–15.3s	4.58 m *52*	ε 92.5%, α 7.5%
		199m	13/2+	–15.0s	4.13 m *43*	ε 73.5%, α 24%, IT 2.5%
		200	0+	–17.0s	10.9 m *11*	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 98.08%, α 1.92%
		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+	–15.968	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+	–10.384	0.299 μs *2*	α
		212m	(18+)	–7.463	45.1 s *6*	α 99.93%, IT 0.07%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
84	**Po**	213	9/2+	−6.667	3.65 μs *4*	α
		214	0+	−4.484	164.3 μs *20*	α
		215	9/2+	−0.545	1.781 ms *4*	α, β− 2.3×10^{-4}%
		216	0+	1.775	0.145 s *2*	α
		217		5.8s	1.47 s *5*	α > 95%, β− < 5%
		218	0+	8.352	3.10 m *2*	α 99.98%, β− 0.02%
		219			≈2 m	α?, β−?
85	**At**	193		0.2s	40 ms	α
		193m		0.2s	≈40 ms	α
		194m		−1.0s	≈40 ms	α
		194m		−1.0s	≈250 ms	α
		195		−3.2s	146 ms *+21−17*	α > 75%, ε < 25%
		195m		−3.2s	385 ms *+69−51*	ε, α
		196		−4.0s	0.253 s *9*	α > 0%
		197	(9/2−)	−6.3s	0.37 s *+9−6*	α 96%, ε 4%
		197m	(1/2+)	−6.2s	3.7 s *25*	α ≤ 100%, ε
		198	(3+)	−6.8s	4.6 s *+18−10*	α 90%, ε 10%
		198m	(10−)	−6.6s	1.3 s *+8−3*	α 84%, ε 16%
		199	(9/2−)	−8.7s	7.2 s *5*	α 90%, ε 10%
		200	(3+)	−9.0s	43 s *1*	α 57%, ε 43%
		200m	(7+)	−8.9s	47 s *1*	ε ≤ 57%, α 43%
		200m	(10−)	−8.7s	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 82%, α 18%
		202m	(7+)	−10.8	182 s *2*	ε 91.3%, α 8.7%
		202m	(10−)	−10.4	0.46 s *5*	IT 99.7%, ε 0.25%, α 0.1%
		203	9/2−	−12.3	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	30.6 m *13*	ε 99.11%, α 0.89%
		207	9/2−	−13.25	1.80 h *4*	ε 91.4%, α 8.6%
		208	6+	−12.50	1.63 h *3*	ε 99.45%, α 0.55%
		209	9/2−	−12.893	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−	−11.662	7.214 h *7*	ε 58.2%, α 41.8%
		212	(1−)	−8.631	0.314 s *2*	α, ε < 0.03%, β− < 2.0×10^{-6}%
		212m	(9−)	−8.409	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
		215	9/2−	−1.266	0.10 ms *2*	α
		216	1−	2.244	0.30 ms *3*	α, β− < 6.0×10^{-3}%, ε < 3.0×10^{-7}%
		217	9/2−	4.387	32.3 ms *4*	α 99.99%, β− 0.01%
		218		8.09	1.5 s *3*	α 99.9%, β− 0.1%
		219		10.52	56 s *3*	α ≈ 97%, β− ≈ 3%
		220	3	14.3s	3.71 m *4*	β− 92%, α 8%
		221		16.9s	2.3 m *2*	β−
		222		20.8s	54 s *10*	β−

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
85	**At**	223		23.6s	50 s *7*	β–
86	**Rn**	196m	0+	2.2s	3 ms *+7–2*	α > 0%
		197	(3/2–)	1.5s	65 ms *+25–14*	α
		197m	(13/2+)	1.5s	19 ms *+8–4*	α
		198	0+	–1.1	84 ms *+16–12*	ε , α
		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	0.96 s *3*	α ≈ 98%, ε ≈ 2%
		201	(3/2–)	–4.2s	7.1 s *8*	α ≈ 80%, ε ≈ 20%
		201m	(13/2+)	–3.9s	3.8 s *1*	α ≈ 90%, ε ≈ 10%, IT ≈ 0%
		202	0+	–6.3s	10.0 s *3*	α 86%, ε 14%
		203	(3/2,5/2)–	–6.2s	42 s *3*	α 66%, ε 34%
		203m	(13/2+)	–5.9s	26.7 s *5*	α ≈ 80%, ε ≈ 20%, IT < 0.1%
		204	0+	–8.0s	1.17 m *18*	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 72.6%, α 27.4%
		212	0+	–8.673	23.9 m *12*	α
		213	(9/2+)	–5.712	25.0 ms *2*	α
		214	0+	–4.335	0.27 µs *2*	α
		215	9/2+	–1.184	2.30 µs *10*	α
		216	0+	0.241	45 µs *5*	α
		217	9/2+	3.646	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(+)	14.4s	25.7 m *5*	β– 78%, α 22%
		222	0+	16.367	3.8235 d *3*	α
		223	7/2	20.3s	23.2 m *4*	β–
		224	0+	22.4s	107 m *3*	β–
		225	7/2–	26.5s	4.66 m *4*	β–
		226	0+	28.8s	7.4 m *1*	β–
		227	5/2	33.0s	22.5 s *7*	β–
		228	0+	35.5s	65 s *2*	β–
87	**Fr**	199			12 ms *+10–4*	α
		200	(3+)	6.1s	19 ms *+13–6*	α
		200m	(10–)	6.3s	0.57 s *+27–14*	α
		201	(9/2–)	3.7s	69 ms *+16–11*	α , ε < 1%
		202	(3+)	3.1s	0.23 s *+8–4*	α ≈ 97%, ε ≈ 3%
		202m	(10–)	3.2s	0.23 s *+14–5*	α ≈ 97%, ε ≈ 3%
		203	(9/2–)	1.0s	0.55 s *2*	α ≈ 95%, ε ≈ 5%
		204	(3+)	0.6s	1.7 s *3*	α ≈ 80%, ε ≈ 20%
		204m	(7+)	0.6s	2.6 s *3*	α ≤ 100%
		204m	(10–)	0.9s	≈1 s	α ≤ 100%, IT
		205	(9/2–)	–1.2	3.85 s *10*	α , ε < 1%
		206	(2+,3+)	–1.4	≈16 s	α ≈ 84%, ε ≈ 16%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
87	**Fr**	206m	(7+)	−1.4	15.9 s *1*	α 84%, ε 16%
		206m	(10−)	−0.9	0.7 s *1*	IT, α ≈ 12%
		207	9/2−	−2.9	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+	−3.54	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−)	−0.974	5.0 ms *2*	α
		214m	(8−)	−0.852	3.35 ms *5*	α
		215	9/2−	0.304	86 ns *5*	α
		216	(1−)	2.97	0.70 μs *2*	α, ε < 2.0×10⁻⁷%
		217	9/2−	4.300	22 μs *5*	α
		218	1−	7.045	1.0 ms *6*	α
		218m		7.131	22.0 ms *5*	α ≤ 100%, IT
		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−	13.270	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	3.33 m *10*	β−
		225	3/2−	23.85	4.0 m *2*	β−
		226	1−	27.33	49 s *1*	β−
		227	1/2+	29.65	2.47 m *3*	β−
		228	2−	33.3s	38 s *1*	β− ≤ 100%
		229	(1/2+)	35.8s	50.2 s *4*	β−
		230		39.6s	19.1 s *5*	β−
		231		42.3s	17.5 s *8*	β−
		232		46.3s	5 s *1*	β−
88	**Ra**	202	0+		0.7 ms *+33−3*	α
		203	(3/2−)	8.6s	1.1 ms *+50−5*	α
		203m	(13/2+)	8.6s	33 ms *+22−10*	α
		204	0+	6.0s	59 ms *+12−9*	α
		205	(3/2−)	5.8s	0.21 s *+6−4*	ε, α
		205m	(13/2+)	5.8s	0.17 s *+6−4*	α
		206	0+	3.5s	0.24 s *2*	α
		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%
		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 < 1.0×10⁻⁸%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
88	Ra	217	(9/2+)	5.874	1.6 μs *2*	α
		218	0+	6.64	25.6 μs *11*	α
		219	(7/2)+	9.379	10 ms *3*	α
		220	0+	10.26	18 ms *2*	α
		221	5/2+	12.955	28 s *2*	α, ^{14}C 1×10^{-12}%
		222	0+	14.309	38.0 s *5*	α, ^{14}C 3.0×10^{-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, ^{14}C 4.0×10^{-9}%
		225	1/2+	21.987	14.9 d *2*	β–
		226	0+	23.662	1600 y *7*	α, ^{14}C 3.2×10^{-9}%
		227	3/2+	27.172	42.2 m *5*	β–
		228	0+	28.936	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+)	38.4s	103 s *3*	β–
		232	0+	40.7s	250 s *50*	β–
		233	(1/2+)	44.7s	30 s *5*	β–
		234	0+	47.1s	30 s *10*	β–
89	Ac	206m			11 ms *+9–3*	α
		206m	(3+)		22 ms *+9–5*	α
		206m	(10–)		33 ms *+22–9*	α
		207	(9/2–)	11.3s	27 ms *+11–6*	α
		208	(3+)	10.7s	95 ms *+24–16*	α, ε 1%
		208m	(10–)	11.2s	25 ms *+9–5*	IT<10%, ε 1%, α
		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		7.1	0.25 s *5*	α
		212		7.28	0.93 s *5*	α≈97%, ε≈3%
		213		6.12	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–)	8.12	≈0.33 ms	α
		217	9/2–	8.69	69 ns *4*	α, ε≤2%
		218	(1–)	10.83	1.08 μs *9*	α
		219	9/2–	11.56	11.8 μs *15*	α
		220	(3–)	13.74	26.4 ms *2*	α, ε 5.0×10^{-4}%
		221		14.51	52 ms *2*	α
		222	1–	16.608	5.0 s *5*	α 99%, ε 1%
		222m		16.608	63 s *3*	α≥88%, IT≤10%, ε≥0.7%
		223	(5/2–)	17.816	2.10 m *5*	α 99%, ε 1%
		224	0–	20.221	2.78 h *17*	ε 90.9%, α 9.1%, β–<1.6%
		225	(3/2–)	21.630	10.0 d *1*	α, ^{14}C 6×10^{-10}%
		226	(1)	24.302	29.37 h *12*	β– 83%, ε 17%, α 6.0×10^{-3}%
		227	3/2–	25.846	21.773 y *3*	β– 98.62%, α 1.38%
		228	3+	28.890	6.15 h *2*	β–
		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–

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
89	**Ac**	233	(1/2+)	41.5s	145 s *10*	β–
		234		45.1s	44 s *7*	β–
		235		47.6s	≈40 s	β– ?
		236		51.4s	≈2 m	β– ?
90	**Th**	209	(5/2–)		3.8 ms *+69–15*	α
		210	0+	14.0s	9 ms *+17–4*	α
		211		13.8s	37 ms *+28–11*	ε , 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 ≈ 0.01%
		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+	14.66	9.7 μs *6*	α , ε 2.0×10^{-7}%
		221	(7/2+)	16.93	1.68 ms *6*	α
		222	0+	17.19	2.8 ms *3*	α
		223	(5/2)+	19.371	0.60 s *2*	α
		224	0+	19.99	1.05 s *2*	α
		225	(3/2)+	22.301	8.72 m *4*	α ≈ 90% , ε ≈ 10%
		226	0+	23.185	30.57 m *10*	α
		227	(1/2+)	25.801	18.72 d *2*	α
		228	0+	26.763	1.9116 y *16*	α , ^{20}O 1×10^{-11}%
		229	5/2+	29.580	7340 y *160*	α
		230	0+	30.857	7.538×10^{4} y *30*	α , SF < $4.\times10^{-11}$%
		231	5/2+	33.811	25.52 h *1*	β– , α ≈ 1.0×10^{-8}%
		232	0+	35.444	1.405×10^{10} y *6* **100%**	α , SF 1.2×10^{-8}% , Ne
		233	1/2+	38.729	22.3 m *1*	β–
		234	0+	40.609	24.10 d *3*	β–
		235	(1/2+)	44.25	7.1 m *2*	β–
		236	0+	46.3s	37.5 m *2*	β–
		237	(5/2+)	50.2s	5.0 m *9*	β–
		238	0+	52.4s	≈20 m	β– ?
91	**Pa**	212			5.1 ms *+61–19*	α
		213	(9/2–)	19.7	5.3 ms *+40–16*	α
		214		19.3	17 ms *3*	α
		215	(9/2–)	17.8	15 ms *4*	α
		216		17.8	105 ms *12*	α ≈ 98% , ε ≈ 2%
		217	(9/2–)	17.04	2.3 ms *+5–3*	α
		217m	(29/2+)	18.89	1.5 ms *+9–4*	α
		218		18.64	0.11 ms *2*	α
		219	9/2–	18.52	53 ns *10*	α
		221	9/2–	20.37	4.9 μs *8*	α
		222		22.10s	3.3 ms *3*	α
		223		22.32	5 ms *1*	α
		224		23.86	0.85 s *2*	α
		225		24.33	1.7 s *2*	α
		226		26.02	1.8 m *2*	α 74% , ε 26%
		227	(5/2–)	26.821	38.3 m *3*	α 85% , ε 15%
		228	3+	28.911	22 h *1*	ε 98% , α 2%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
91	**Pa**	229	(5/2+)	29.890	1.50 d *5*	ε 99.52%, α 0.48%
		230	(2–)	32.167	17.4 d *5*	ε 91.6%, β– 8.4%, α 3.2×10^{-3}%
		231	3/2–	33.421	32760 y *110*	α, Ne 13×10^{-10}%, SF < 2×10^{-11}%
		232	(2–)	35.939	1.31 d *2*	β–, ε 3.0×10^{-3}%
		233	3/2–	37.484	26.967 d *2*	β–
		234	4+	40.336	6.70 h *5*	β–
		234m	(0–)	40.410	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}%
		239	(1/2+)	53.2s	106 m *30*	β–
		240		56.8s	≈2 m	β–?
92	**U**	218	0+	21.88s	1.5 ms *+73–7*	α
		219	(9/2+)	23.21	42 µs *+34–13*	α
		220	0+	23.0s	≈60 ns	α?, ε?
		221		24.5s	≈0.7 µs	α?, ε?
		222	0+	24.3s	1.0 µs *+10–4*	α
		223	(7/2+)	25.82	55 µs *10*	α
		224	0+	25.70	0.9 ms *3*	α
		225		27.37	60 ms *10*	α
		226	0+	27.33	0.35 s *15*	α
		227	(3/2+)	29.01	1.1 m *1*	α
		228	0+	29.22	9.1 m *2*	α > 95%, ε < 5%
		229	(3/2+)	31.201	58 m *3*	ε ≈ 80%, α ≈ 20%
		230	0+	31.603	20.8 d	α, SF < 1×10^{-10}%
		231	(5/2–)	33.803	4.2 d *1*	ε
		231	(3/2+,5/2+)	33.803	4.2 d *1*	α ≈ 4×10^{-3}%
		232	0+	34.602	68.9 y *4*	α, Ne 9×10^{-10}%, SF < 1×10^{-12}%
		233	5/2+	36.913	1.592×10^{5} y *2*	α, SF < 6×10^{-11}%, Ne 7×10^{-11}%
		234	0+	38.141	2.455×10^{5} y *6* **0.0054% *5***	α, SF 1.6×10^{-9}%, Mg 1×10^{-11}%, Ne 9×10^{-12}%
		235	7/2–	40.914	703.8×10^{6} y *5* **0.7204% *6***	α, SF 7.0×10^{-9}%, Ne 8×10^{-10}%
		235m	1/2+	40.914	≈25 m	IT
		236	0+	42.441	2.342×10^{7} y *3*	α, SF 9.4×10^{-8}%, ^{30}Mg
		237	1/2+	45.386	6.75 d *1*	β–
		238	0+	47.304	4.468×10^{9} y *3* **99.2742% *10***	α, SF 5.4×10^{-5}%
		239	5/2+	50.569	23.45 m *2*	β–
		240	0+	52.709	14.1 h *1*	β–
		241		56.2s	≈5 m	β–?
		242	0+	58.6s	16.8 m *5*	β–
93	**Np**	225	(9/2–)	31.58	>2 µs	α

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
93	**Np**	226		32.72s	35 ms *10*	α
		227		32.56	0.51 s *6*	α
		228		33.7s	61.4 s *14*	ε 60%, α 40%
		229		33.76	4.0 m *2*	α > 50%, ε < 50%
		230		35.22	4.6 m *3*	ε ≤ 97%, α ≥ 3%
		231	(5/2)	35.61	48.8 m *2*	ε 98%, α 2%
		232	(4+)	37.4s	14.7 m *3*	ε
		233	(5/2+)	37.94	36.2 m *1*	ε , α ≤ 1.0×10^{-3}%
		234	(0+)	39.950	4.4 d *1*	ε
		235	5/2+	41.038	396.1 d *12*	ε , α 2.6×10^{-3}%
		236	(6–)	43.37	154×10^{3} y *6*	ε 87.3%, β– 12.5%, α 0.16%
		236m	1	43.43	22.5 h *4*	ε 52%, β– 48%
		237	5/2+	44.868	2.144×10^{6} y *7*	α , SF ≤ 2×10^{-10}%
		238	2+	47.451	2.117 d *2*	β–
		239	5/2+	49.305	2.3565 d *4*	β–
		240	1(+)	52.32	7.22 m *2*	β– 99.89%
		240	(5+)	52.32	61.9 m *2*	β–
		241	(5/2+)	54.26	13.9 m *2*	β–
		242m	(1+)	57.4s	2.2 m *2*	β–
		242m	(6)	57.4s	5.5 m *1*	β–
		243	(5/2–)	59.87s	1.85 m *15*	β–
		244	(7–)	63.2s	2.29 m *16*	β–
94	**Pu**	228	0+	36.07	≈0.2 s	α
		229	(3/2+)	37.39	> 2 μs	α
		230	0+	36.93	≈200 s	α ≤ 100%
		231	(3/2+)	38.4s	8.6 m *5*	ε 90%, α 10%
		232	0+	38.36	34.1 m *7*	ε 80%, α 20%
		233		40.04	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+)	42.18	25.3 m *5*	ε , α 2.7×10^{-3}%
		236	0+	42.894	2.858 y *8*	α , SF 1.9×10^{-7}%
		237	7/2–	45.088	45.2 d *1*	ε , α 4.2×10^{-3}%
		237m	1/2+	45.234	0.18 s *2*	IT
		238	0+	46.159	87.7 y *3*	α , SF 1.8×10^{-7}%
		239	1/2+	48.583	24110 y *30*	α , SF 3×10^{-10}%
		240	0+	50.121	6564 y *11*	α , SF 5.7×10^{-6}%
		241	5/2+	52.951	14.290 y *6*	β– , α 2.5×10^{-3}%, SF > $2.\times10^{-14}$%
		242	0+	54.713	3.733×10^{5} y *12*	α , SF 5.5×10^{-4}%
		243	7/2+	57.750	4.956 h *3*	β–
		244	0+	59.800	8.00×10^{7} y *9*	α 99.88%, SF 0.12%
		245	(9/2–)	63.10	10.5 h *1*	β–
		246	0+	65.39	10.84 d *2*	β–
		247		69.0s	2.27 d *23*	β–
95	**Am**	231		42.4s	≈10 s	ε ?, α ?
		232		43.4s	79 s *2*	ε ≈ 98%, α ≈ 2%
		233		43.3s	≈2 m	ε ?, α ?
		234		44.5s	2.32 m *8*	ε 99.96%, α 0.04%
		235		44.7s	15 ms *5*	ε
		236		46.2s	4.4 m *8*	ε
		237	5/2(–)	46.55	73.0 m *10*	ε 99.98%, α 0.03%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
95	**Am**	238	1+	48.42	98 m *2*	ε > 99.99%, α 1.0×10^{-4}%
		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–	52.930	432.2 y *7*	α , SF 4×10^{-10}%
		242	1–	55.464	16.02 h *2*	β– 82.7%, ε 17.3%
		242m	5–	55.513	141 y *2*	IT 99.54%, α 0.46%, SF < 4.7×10^{-9}%
		242m		57.664	14.0 ms *10*	SF ≈ 100%, α < 1.5%, IT > 0%
		243	5/2–	57.168	7370 y *40*	α , SF 3.7×10^{-9}%
		244	(6–)	59.876	10.1 h *1*	β–
		244m	1+	59.964	≈26 m	β– 99.96%, ε 0.04%
		245	(5/2)+	61.894	2.05 h *1*	β–
		246	(7–)	64.99	39 m *3*	β–
		246m	2(–)	64.99	25.0 m *2*	β– , IT < 0.02%
		247	(5/2)	67.1s	23.0 m *13*	β–
		248		70.6s	≈10 m	β–
		249		73.1s	≈2 m	β– ?
96	**Cm**	232	0+		1 m *?*	SF < 30.3%
		233		47.3s	≈1 m	ε ?, α ?
		234	0+	46.8s	≈2 m	ε ?, α ?
		235		48.1s	≈5 m	ε ?, α ?
		236	0+	47.9s	≈10 m	ε , α
		237		49.3s	≈20 m	ε ?, α ?
		238	0+	49.38	2.4 h *1*	ε ≥ 90%, α ≤ 10%
		239	(7/2–)	51.2s	≈2.9 h	ε , α < 0.1%
		240	0+	51.716	27 d *1*	α > 99.5%, ε < 0.5%, SF 3.9×10^{-6}%
		241	1/2+	53.698	32.8 d *2*	ε 99%, α 1%
		242	0+	54.799	162.8 d *2*	α , SF 6.4×10^{-6}% , ^{34}Si
		243	5/2+	57.177	29.1 y *1*	α 99.71%, ε 0.29%, SF 5.3×10^{-9}%
		244	0+	58.448	18.10 y *2*	α , SF 1.4×10^{-4}%
		245	7/2+	60.999	8500 y *100*	α , SF 6.1×10^{-7}%
		246	0+	62.613	4760 y *40*	α 99.97%, SF 2.6×10^{-2}%
		247	9/2–	65.528	1.56×10^{7} y *5*	α
		248	0+	67.386	3.48×10^{5} y *6*	α 91.61%, SF 8.39%
		249	1/2(+)	70.744	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+	79.1s	< 2 d	β–
97	**Bk**	235		52.7s	≈20 s	ε ?, α ?
		236		53.4s	≈1 m	α ?, ε ?
		237		53.2s	≈1 m	ε ?, α ?
		238		54.3s	144 s *5*	ε , εSF 0.048%, α
		239	(7/2+)	54.4s	≈3 m	ε ?
		240		55.7s	4.8 m *8*	ε ≈ 100%, εSFw
		241	(7/2+)	56.1s	≈3 m	α ?, ε ?

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
97	Bk	242		57.8s	7.0 m *13*	ε
		243	(3/2–)	58.686	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}%
		245	3/2–	61.810	4.94 d *3*	ε 99.88%, α 0.12%
		246m	2(–)	63.96	1.80 d *2*	ε , α < 0.2%
		247	(3/2–)	65.483	1380 y *250*	α ≤ 100%
		248		68.07s	>9 y	α
		248m	1(–)	68.07s	23.7 h *2*	β– 70%, ε 30%
		249	7/2+	69.843	330 d *4*	β– , α 1.4×10^{-3}%, SF 4.7×10^{-8}%
		250	2–	72.946	3.217 h *5*	β–
		251	(3/2–)	75.22	55.6 m *11*	β–
		252		78.5s	≈2 m	β– ?, α ?
		253		80.9s	≈10 m	β– ?
		254		84.4s	≈2 m	β– ?
98	Cf	237		57.8s	2.1 s *3*	α ?, SF ≈ 10%
		238	0+	57.2s	21. ms *2*	SF
		239		58.3s	39 s *+37–12*	ε , α
		240	0+	58.0s	1.06 m *15*	SF ≈ 2.1%, α
		241		59.4s	3.78 m *70*	ε ≈ 75%, α ≈ 25%
		242	0+	59.33	3.4 m *2*	SF ≤ 0.014%, α
		243	(1/2+)	60.9s	10.7 m *5*	ε ≈ 86%, α ≈ 14%
		244	0+	61.470	19.4 m *6*	α
		245	(5/2+)	63.4s	45.0 m *15*	ε 64%, α 36%
		246	0+	64.086	35.7 h *5*	α , ε < 4.0×10^{-3}%, SF 2.3×10^{-4}%
		247	(7/2+)	66.129	3.11 h *3*	ε 99.97%, α 0.04%
		248	0+	67.233	333.5 d *28*	α , SF 2.9×10^{-3}%
		249	9/2–	69.719	351 y *2*	α , SF 5.0×10^{-7}%
		250	0+	71.166	13.08 y *9*	α 99.92%, SF 0.08%
		251	1/2+	74.128	898 y *44*	α , SF
		252	0+	76.028	2.645 y *8*	α 96.91%, SF 3.09%
		253	(7/2+)	79.295	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	(7/2+)	84.8s	85 m *18*	β–
		256	0+	87.0s	12.3 m *12*	SF , β– < 1%, α ≈ 1.0×10^{-6}%
99	Es	241	(3/2–)	64.0s	8 s *+6–4*	α
		242		64.9s	23.9 s *28*	ε , α , εSF
		243		64.9s	19 s *4*	ε ≤ 70%, α ≥ 30%
		244		66.1s	37 s *4*	ε 96%, α 4%
		245	(3/2–)	66.4s	1.1 m *1*	ε 60%, α 40%
		246m		68.0s	7.7 m *5*	ε 90.1%, α 9.9%, ε 3.0×10^{-3}%
		247	(7/2+)	68.60s	4.55 m *26*	ε ≈ 93%, α ≈ 7%
		248	(2–,0+)	70.29s	27 m *5*	ε 99.7%, α ≈ 0.25%
		249	7/2+	71.17s	102.2 m *6*	ε 99.43%, α 0.57%
		250	1(–)	73.3s	2.22 h *5*	ε ≥ 99%, α ≤ 1%
		250	(6+)	73.3s	8.6 h *1*	ε > 97%, α < 3%
		251	(3/2–)	74.504	33 h *1*	ε 99.5%, α 0.5%
		252	(5–)	77.29	471.7 d *19*	α 78%, ε 22%, β– ≈ 0.01%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
99	Es	253	7/2+	79.007	20.47 d *3*	α, SF 8.7×10⁻⁶%
		254	(7+)	81.986	275.7 d *5*	α, ε < 1.0×10⁻⁴%, SF < 3.0×10⁻⁶%, β− 1.7×10⁻⁶%
		254m	2+	82.064	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+,0−)	87.2s	25.4 m *24*	β−
		256m	(8+)	87.2s	7.6 h	β−
		257		89.4s	7.7 d *2*	β−, SF
100	Fm	242	0+	68.4s	0.8 ms *2*	SF
		243		69.4s	0.18 s *+8−4*	α ≤ 100%, SF ≤ 0.4%
		244	0+	69.0s	3.3 ms *4*	SF ≤ 100%
		245		70.2s	4.2 s *13*	α ≤ 100%, SF ≤ 0.1%
		246	0+	70.12	1.1 s *2*	α 92%, SF 8%, ε ≤ 1%
		247?		71.6s	35 s *4*	α ≥ 50%, ε ≤ 50%
		247m		71.6s	9.2 s *23*	α ≤ 100%
		248	0+	71.90	36 s *3*	α 97%, ε 3%, SF 0.1%
		249	(7/2+)	73.6s	2.6 m *7*	ε 67%, α 33%
		250	0+	74.07	33 m *3*	α > 90%, ε < 10%, SF 7.1×10⁻³%
		250m		75.07	1.8 s *1*	IT > 80%, SF ≤ 0.8×10⁻⁴%
		251	(9/2−)	75.979	5.30 h *8*	ε 98.2%, α 1.8%
		252	0+	76.811	25.39 h *4*	α, SF 2.3×10⁻³%
		253	(1/2)+	79.341	3.00 d *12*	ε 88%, α 12%
		254	0+	80.898	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+	85.480	157.6 m *13*	SF 91.9%, α 8.1%
		257	(9/2+)	88.584	100.5 d *2*	α 99.79%, SF 0.21%
		258	0+	90.4s	360 µs *20*	SF
		259		93.7s	1.5 s *3*	SF
		260	0+		≈4 ms	SF
101	Md	245	(1/2−)	75.5s	900 µs *250*	SF, α 0.26%
		245m		75.6s	0.35 s *+23−16*	ε, α
		246m		76.3s	1.0 s *4*	α > 0%, ε > 0%, SF
		247		76.2s	0.38 s *8*	SF ≈ 55%, α 45%
		248		77.2s	7 s *3*	ε 80%, α 20%, SF ≤ 0.05%
		249		77.3s	24 s *4*	α > 60%, ε ≤ 40%
		250		78.7s	52 s *6*	ε 93%, α 7%
		251		79.1s	4.0 m *5*	ε ≥ 90%, α ≤ 10%
		252		80.7s	2.3 m *8*	ε ≤ 100%
		253	(1/2−)	81.3s	6 m *+12−3*	ε ≤ 100%, α
		254		83.6s	10 m *3*	ε ≤ 100%
		254		83.6s	28 m *8*	ε ≤ 100%
		255	(7/2−)	84.836	27 m *2*	ε 92%, α 8%, SF < 0.15%
		256	(1−)	87.61	77 m *2*	ε 90.8%, α 9.2%, SF < 3%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
101	**Md**	257	(7/2–)	88.990	5.52 h *5*	ε 85%, α 15%, SF < 1%
		258	(8–)	91.683	51.5 d *3*	α, SF ≤ 0.003%
		258m	(1–)	91.683	57.0 m *9*	ε ≥ 70%, SF ≤ 30%, α 1.2%
		259		93.6s	96 m *3*	SF ≈ 100%, α < 1.3%
		260		96.5s	31.8 d *5*	SF ≥ 42%, α ≤ 25%, ε ≤ 23%, β– ≤ 10%
102	**No**	249		81.8s		ε ?, α ?
		250	0+	81.5s	0.25 ms *5*	SF, α ≈ 0.05%
		251	(7/2+)	82.9s	0.8 s *3*	α ≤ 100%, ε, SF ≤ 8%
		252	0+	82.87	2.27 s *14*	α 58%, ε 23%, SF 19%
		253	(9/2–)	84.4s	1.62 m *15*	α ≤ 100%, ε
		254	0+	84.72	54 s *3*	α 90%, ε 10%, SF 0.19%
		254m		85.22	0.28 s *4*	IT > 80%, SF ≥ 0.2%
		255	(1/2+)	86.85	3.1 m *2*	α 61%, ε 39%
		256	0+	87.817	2.91 s *5*	α 99.47%, SF 0.53%
		257	(7/2+)	90.22	25 s *2*	α ≤ 100%, SF ≤ 1.5%
		258	0+	91.5s	1.2 ms *2*	SF, α 0.001%
		259		94.1s	58 m *5*	α 75%, ε 25%, SF < 10%
		260	0+	95.6s	106 ms *8*	SF
		261		98.5s		β–, α
		262	0+	100.2s	5 ms *1*	SF
103	**Lr**	251		87.9s		ε ?, α ?
		252		88.8s	0.36 s *+11–7*	α ≈ 90%, ε ≈ 10%, SF < 1%
		253m		88.7s	0.57 s *+7–6*	α 90%, ε, SF < 2%
		253m		88.7s	1.5 s *+3–2*	α 90%, ε, SF < 2%
		254		90.0s	13 s *2*	α 78%, ε 22%, SF < 0.1%
		255		90.1s	22 s *4*	α 85%, ε < 30%, SF ≤ 0.1%
		256		92.0s	27 s *3*	α 85%, ε 15%, SF < 0.03%
		257		92.8s	0.646 s *25*	α ≤ 100%, SF ≤ 0.03%
		258		94.9s	3.9 s *4*	α > 95%, ε < 5%, SF < 5%
		259		95.93s	6.2 s *3*	α 78%, SF 22%
		260		98.3s	180 s *30*	α 80%, ε < 40%, SF < 10%
		261		99.6s	39 m *12*	SF
		262		102.2s	3.6 h *2*	ε, SF < 10%
		263		103.8s		
104	**Rf**	253m		93.8s	48 μs *+17–10*	SF ≤ 100%, α
		253m		93.8s	≈1.8 s	SF ≈ 50%, α ≈ 50%
		254	0+	93.3s	23 μs *3*	SF ≈ 100%, α ≈ 0.3%
		255	(9/2–)	94.5s	1.5 s *2*	α 52%, SF 48%
		255m		94.5s	0.8 s *+5–2*	α ≤ 100%
		256	0+	94.25	6.4 ms *2*	SF 99.68%, α 0.32%
		257	(1/2+)	96.0s	4.7 s *3*	α < 100%, SF ≤ 1.4%, ε > 0%

Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
104	**Rf**	257m		96.0s	3.9 s *4*	α < 100%, SF ≤ 1.4%, ε > 0%
		258	0+	96.5s	12 ms *2*	SF ≈ 87%, α ≈ 13%
		259		98.39s	3.2 s *6*	α 92%, SF 8%
		260	0+	99.1s	21 ms *1*	SF ≤ 100%, α ?
		261		101.3s	65 s *10*	α > 80%, ε < 15%, SF < 10%
		262	0+	102.4s	2.1 s *2*	SF
		263		104.8s	10 m *2*	SF ≈ 100%, α
		264	0+	106.2s		
105	**Db**	255		100.0s	1.6 s *+6–4*	α ≈ 80%, SF ≈ 20%
		256		100.7s	1.9 s *+5–3*	α ≤ 90%, SF ≤ 40%, ε ≈ 35%
		257		100.5s	0.76 s *+15–11*	α ≥ 94%, SF ≤ 6%
		257m		100.5s	1.50 s *+19–15*	α ≥ 81%, SF 19%
		258		101.9s	4.4 s *+9–6*	α 67%, ε 33%, SF < 1%
		258m		101.9s	20 s *10*	ε
		259		102.2s		
		260		103.8s	1.52 s *13*	α ≥ 90.4%, SF ≤ 9.6%, ε < 2.5%
		261		104.4s	1.8 s *4*	α ≥ 82%, SF ≤ 18%
		262		106.3s	34 s *4*	α 64%, SF 33%, ε ≈ 3%
		263		107.2s	27 s *+10–7*	SF 57%, α 43%
		264		109.4s		
		265		110.5s		
106	**Sg**	258	0+	105.4s	2.9 ms *+13–7*	SF ≈ 100%, α
		259	(1/2+)	106.8s	0.48 s *+28–13*	α 90%, SF < 20%
		260	0+	106.60	3.6 ms *9*	α 50%, SF 50%
		261		108.2s	0.23 s *6*	α ≈ 100%, SF < 1%
		262	0+	108.5s		
		263		110.2s	1.0 s *2*	α > 70%, SF < 30%
		263m		110.2s	0.12 s	α, IT
		264	0+	110.8s		
		265	(9/2+)	112.8s	8 s *3*	SF ≤ 57%, α ≥ 43%
		266	0+	113.6s	21 s *+20–12*	α 50%, SF
		269			?	α
107	**Bh**	260		113.5s		α ≤ 100%
		261		113.5s	12 ms *+5–3*	α 95%, SF < 10%
		262		114.6s	102 ms *26*	α ≥ 89%, SF ≤ 11%
		262m		114.9s	8.0 ms *21*	α ≥ 89%, SF ≤ 11%
		263		114.7s		
		264		116.2s	0.44 s *+60–16*	α ≤ 100%
		265		116.6s		
		266		118.3s		
108	**Hs**	263		119.9s		α ≤ 100%
		264	0+	119.61	≈0.8 ms	α ≈ 50%, SF ≈ 50%
		265		121.1s	2.0 ms *+3–2*	α ≈ 100%, SF ≤ 1%
		266	0+	121.1s		
		267	(9/2+)	122.7s	26 ms *+20–10*	α, SF ?
		269	(3/2+)	124.9s	9 s *4*	α
		273			1.2 s *+17–6*	α

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Isotope Z	El	A	Jπ	Δ (MeV)	T½, Γ, or Abundance	Decay Mode
108	**Hs**	277			16.5 m	SF
109	**Mt**	266		128.5s	0.8 ms *2*	α, SF ?
		266m		128.9s	3.8 ms *8*	α
		267		128.1s		
		268	(5+,6+)	129.3s	0.07 s *+10–3*	α
110		267	(11/2–)	134.1s	3 μs *+6–2*	α
		269	(1/2+)	135.2s	0.17 ms *+17–6*	α
		271	(3/2+)	136.1s	0.06 s *+27–3*	α
		271m	(9/2+)	136.1s	1.1 ms *+6–3*	α
		272	0+	136.3s	≈8.6 ms	SF
		273	(3/2+)	139.0s	≈0.18 ms	α
		273m	(13/2–)	139.2s	≈120 ms	α
		277			3.0 ms *+47–15*	α
		281			1.6 m	α
111		272	(5+,6+)	143.0s	1.5 ms *+20–5*	α
112		277	(3/2+)		0.24 ms *+43–9*	α
		281			0.89 ms *+130–45*	α
		283			81 s *+147–32*	SF
		285			15.4 m	α
114		285			0.58 ms *+87–29*	α
		287			5.5 s *+10–2*	α
		289			30.4 s	α
116		289			0.60 ms *+86–30*	α
118		293			0.12 ms *+18–6*	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 (5 mm)	+2
5	B	10.811 *5*	2.34[h]	2075	4000 (subl.)	+3
6	C	12.011	1.8 to 2.1[i]	≈3550	4827	+2,+4,–4
7	N	14.0067 *2*	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	32.065 *5*	2.07[cm]	115.21[m]	444.60	+4,+6,–2
17	Cl	35.453 *2*	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	72.64 *1*	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	131.293 *6*	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	167.259 *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	238.02891 *3*	≈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, priv. comm. (12/1999), to be published in *Handbook of Chemistry and Physics* (2000). 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 following 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 *CODATA Values of Fundamental Physical Constants: 1998.*[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]
$a_0=r_e/\alpha^2$	Bohr radius	5.29177249 *24*	10^{-11} m
$\alpha=e^2/\hbar c[4\pi\varepsilon_0]$ $1/\alpha$	Fine structure constant	0.00729735308 *33* 137.0359895 *61*	
c	Speed of light in vacuum	2.99792458[(e)]	10^8 m s^{-1}
$c_1=2\pi hc^2$	First radiation constant	3.7417749 *22*	10^{-16} W m^2
$c_2=hc/k$	Second radiation constant	1.438769 *12*	10^{-2} m K
e	Elementary charge	4.8032068 *15* 1.60217733 *49*	10^{-10} esu 10^{-19} C
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}
$F=N_Ae$	Faraday constant	9.6485309 *29*	10^4 C mol^{-1}
γ_p	Gyromagnetic ratio of proton	2.67522128 *81*	10^8 s^{-1} T^{-1}
γ_p'	Gyromagnetic ratio of proton (uncorrected for diamagnetism of H_2O)	2.67515255 *81*	10^8 s^{-1} T^{-1}
G	Gravitational constant	6.67259 *85*	10^{-11} m^3 kg^{-1}

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 constant	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}
$r_e=\hbar\alpha/m_ec$	$^-$ radius	Classical 2.8179403 *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 = 3.1558150×10^7 s, 1 year (tropical) = 3.15569×10^7 s

a) J. Mohr and B. N. Taylor, *Jl. of Phys. and Chem. Reference Data* (to be published); data taken from http://physics.nist.gov/constants (September 1, 1999).

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 1995 update to the atomic mass evaluation, G. Audi and A. H. Wapstra, computerized list of recommended values based on authors' publication *Nuclear Physics* A595, 409 (1995).

d) C. Caso *et al.* Review of Particle Physics, *Eur. Physical Journal* C3, 1 (1998); http://pdg.lbl.gov/.

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

(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..$\times 10^{-12}$ erg = 1.073..$\times 10^{-9}$ u= 3.829..$\times 10^{-20}$ cal

e/h = 2.417..$\times 10^{14}$ s^{-1}, $e/(hc)$ = 8.0654..$\times 10^{3}$ cm^{-1}

e/c^2 = 1.782..$\times 10^{-33}$ g, e/mc^2 = 1.073..$\times 10^{-9}$ u

e/k = 1.160..$\times 10^{4}$ deg K

Appendix–IV Energy–Equivalent Factors†

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

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

Example: $1u \equiv 1.492..\times10^{-3}$ erg = $9.314..\times10^{8}$ eV = $3.567..\times10^{-11}$ cal, etc.

† From CODATA Values of Fundamental Physical Constants:1998, J. Mohar and B.N. Taylor, *Jour. of Physical and Chemical Reference Data* (to be published), http://physics.nist.gov/constants (September 1, 1999).

Appendix–V Observed Λ Hypernuclides†

El	A	J(g.s.)	B_Λ(g.s.)*	Excited (bound) states (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	E = 8.3, 18.3
	7	1/2+	5.58 *3*	E = 0.692 *4* 3/2+[a], 2.050 *2* 5/2+[a], 8.3, 20.2
	8	1	6.80 *3*	E = 0.442?[b], 1.22 4
	9		8.50 *12*	
Be	7	1/2	5.16 *8*	
	8		6.84 *5*	
	9	1/2	6.71 *4*	E[b] = 3.079 *4*[#], 5.98 84, 10.59 72, 16.55 69, 22.93 71, 27.90 72
	10		9.11 *22*	
B	9		8.29 *18*	
	10		8.89 *12*	E[c] = 2.5 *2*, 6.2 *2*, 9.5 *3*
	11	5/2	10.24 *5*	
	12	1	11.37 *6*[d]	
C	12	1	10.80 *18*[d]	E[e] = 2.71 *13* 1–, 6.05 *18* 1–, 8.10 *38*, 10.97 *5* 2+, 12.0 *3*[b], 16.2 *2*[b]
	13	1/2+	11.69 *12*	E[e] = 4.9 *1* 3/2+, 9.6 *3* 3/2–, 11.6 *2* 1/2+, 15.4 *1*[#]
	14		12.17 *33*	
N	14		12.17	E = 10.5, 19, 22
	15		13.59 *15*	
O	16	1–[e]	12.5	E[e] = 6.3 *1* 1–, 10.6 *1* 2+, 0–, 16.7 *1* 2+, 0+, 20.0 *4*[b], 23.3 5[b]
	18			E = 13, 20, 24, 30
Al	27			E = 7, 18[b]
Si	28		16.6[c]	E[c] = 4.7 *4*, 9.6 *3*, 12.3 *3*, 17.6 *8*, 23.2 *5*[b]
S	32		17.5 *5*	E = 11.5, 22.5
Ca	40		20.0 *5*	E[b] = 2.9 *13*, 6.1 *13*, 8.3 *11*, 13.9 *11*, 16.7 *11*, 19.8 *11*, 22.9 *13*
V	51		19.5[f]	E[b] = 3.5 *16*, 5.7 *10*, 8.4 *10*, 12.1 *11*, 15.0 *10*, 18.3 *11*, 21.8 *10*, 26.0 *10*
Fe	56		21	
Y	89		23 *2*	E[b,c] = 6.9 *16*, 13.4 *16*, 19.8 *16*, 27.2 *16*
La	139		23.8 *10*[c]	E[c] = 3.8 *11*
Pb	208		26.5 *5*[c]	E[c] = 5.2 *9*
Bi	209			E = 32, 40

Appendix–V Observed Λ Hypernuclides†

Footnotes and References

† This table has been prepared by R. Chrien (BNL). The data are mostly from D. Davis and J. Pniewski, *Contemp. Phys.* 27, 91 (1986), and H. Bando, T. Motoba, and J. Zofka, *Int. J. Mod. Phys.* A5, 4021 (1990), except where indicated otherwise.

Almost all recent data have come from (π^+,K^+) reactions using magnetic spectrometers and Ge detectors at BNL and KFK. The early work is emulsion data while the later work is derived from magnetic spectrometers using $(K^\pm,\pi^\pm)$ data.

The only confirmed example of a bound Σ hypernuclide is the T=1/2 isospin state in ^{4}He reported by Nagae et al., *Phys. Rev. Lett.* 80, 1605 (1998).

* Λ binding energy.

\# Possibly complex.

a K. Tanida et al. Proc. of APCTP workshop (1999), to be published.

b R. Chrien, BNL, priv. comm. and results of BNL–AGS 798.

c T. Hasegawa et al., *Phys. Rev* C53, 1210 (1996).

d P. Dluzewski et al., *Nucl. Phys.* A484 520 (1988).

e O. Hashimoto, Proc. of APCTP workshop (1999), to be published.

f Calculated.

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	Db 105	Sg 106	Bh 107	Hs 108	Mt 109	110	111	112	113	114	115	116	117	118
*	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	Mendelevium	Md	101
Aluminum	Al	13	Mercury	Hg	80
Americium	Am	95	Molybdenum	Mo	42
Antimony	Sb	51	Neodymium	Nd	60
Argon	Ar	18	Neon	Ne	10
Arsenic	As	33	Neptunium	Np	93
Astatine	At	85	Nickel	Ni	28
Barium	Ba	56	Niobium	Nb	41
Berkelium	Bk	97	Nitrogen	N	7
Beryllium	Be	4	Nobelium	No	102
Bismuth	Bi	83	Osmium	Os	76
Bohrium	Bh	107	Oxygen	O	8
Boron	B	5	Palladium	Pd	46
Bromine	Br	35	Phosphorus	P	15
Cadmium	Cd	48	Platinum	Pt	78
Calcium	Ca	20	Plutonium	Pu	94
Californium	Cf	98	Polonium	Po	84
Carbon	C	6	Potassium	K	19
Cerium	Ce	58	Praseodymium	Pr	59
Cesium	Cs	55	Promethium	Pm	61
Chlorine	Cl	17	Protactinium	Pa	91
Chromium	Cr	24	Radium	Ra	88
Cobalt	Co	27	Radon	Rn	86
Copper	Cu	29	Rhenium	Re	75
Curium	Cm	96	Rhodium	Rh	45
Dubnium	Db	105	Rubidium	Rb	37
Dysprosium	Dy	66	Ruthenium	Ru	44
Einsteinium	Es	99	Rutherfordium	Rf	104
Erbium	Er	68	Samarium	Sm	62
Europium	Eu	63	Scandium	Sc	21
Fermium	Fm	100	Selenium	Se	34
Fluorine	F	9	Seaborgium	Sg	106
Francium	Fr	87	Silicon	Si	14
Gadolinium	Gd	64	Silver	Ag	47
Gallium	Ga	31	Sodium	Na	11
Germanium	Ge	32	Strontium	Sr	38
Gold	Au	79	Sulfur	S	16
Hafnium	Hf	72	Tantalum	Ta	73
Hassium	Hs	108	Technetium	Tc	43
Helium	He	2	Tellurium	Te	52
Holmium	Ho	67	Terbium	Tb	65
Hydrogen	H	1	Thallium	Tl	81
Indium	In	49	Thorium	Th	90
Iodine	I	53	Thulium	Tm	69
Iridium	Ir	77	Tin	Sn	50
Iron	Fe	26	Titanium	Ti	22
Krypton	Kr	36	Tungsten	W	74
Lanthanum	La	57	Uranium	U	92
Lawrencium	Lr	103	Vanadium	V	23
Lead	Pb	82	Xenon	Xe	54
Lithium	Li	3	Ytterbium	Yb	70
Lutetium	Lu	71	Yttrium	Y	39
Magnesium	Mg	12	Zinc	Zn	30
Manganese	Mn	25	Zirconium	Zr	40
Meitnerium	Mt	109			

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	Db	Dubnium
106	Sg	Seaborgium
107	Bh	Bohrium
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: D. W. Muir

National Nuclear Data Center
Brookhaven National Laboratory
Upton, NY 11973, USA
Contact: C. L. Dunford

Nuclear Data Project
Oak Ridge National Laboratory
Oak Ridge, TN 37831, USA
Contact: Y. A. Akovali

Isotopes Project
Lawrence Berkeley National Laboratory
Berkeley, CA 94720, USA
Contact: E. B. Norman

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
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Center for Nuclear Information Technology, Dept. of Chemistry
San Jose State University
San Jose, CA 95192–0101
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46 Ulitsa Kurchatov 123 182
Moscow, Russia
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St. Petersburg Nucl. Phys. Inst.
Gatchina, Leningrad Region
188 350, Russia
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Cedex No. 85
F–38041 Grenoble Cedex, France
Contact: J. Blachot

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JAERI
Tokai–Mura, Naka–Gun
Ibaraki–Ken 319–11, Japan
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Kuwait, Kuwait
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Laboratorium voor Kernfysica
Proeftuinstraat 86
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Canada
Contact: J. C. Waddington

Institute of Atomic Energy
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People's Republic of China
Contact: Zhuang, Youxiang

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

Appendix–VIII
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: C. Nordborg

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

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
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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: Zhuang, Youxiang

Japan Atomic Energy
Research Institute–
Nuclear Data Center
2–4 Shirakata Shirane
Tokai–mura, Naka–gun
Ibaraki–ken 319–11, Japan
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RIKEN Nuclear Data Group
RIKEN
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Wako–shi
Saitama 351–01, Japan
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Japan Charged–Particle Nuclear
Reaction Data Group
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ATOMKI Charged–Particle Nuclear
Reaction Data Group
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Bem ter 18/c, P.O. Box 51
H–4001 Debrecen, Hungary
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Institut Yadernykh Issledovanig
Prospekt Nauky, 47
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Nuclear Data Evaluation Lab.
Korea Atomic Energy Research Inst.
P.O. Box 105 Yusung
Taejon, 305–600, Rep. of Korea
Contact: J. Chang

Electronic Nuclear Data Access

Introduction

The National Nuclear Data Center (NNDC) and other members of the IAEA-sponsored International Nuclear Structure and Decay Data (NSDD) and Nuclear Reaction Data (NRDC) Networks and the U.S. Nuclear Data Program (USNDP) provide electronic access to many of the bibliographic and numeric databases maintained by members of these groups. Access is available by anonymous FTP, TELNET, and the World Wide Web (W^3). Some databases or programs also are available on CD-ROM from individual Centers.

The contents of these various services are changing and growing continually, as are the methods of accessing them. Most of the W^3 home pages listed below contain current links. If you have problems or questions, please contact the NNDC at services@bnlnd2.dne.bnl.gov.

The NNDC, the International Atomic Energy Agency Nuclear Data Section (NDS), the OECD Nuclear Energy Agency Data Bank (NEADB) and the Russian Nuclear Data Center (RNDC) maintain databases and provide services covering a wide range of nuclear science. The databases and services available from these centers are listed first followed by the methods of electronic access to these centers. Next, other members of the NSDD, NRDC, and USNDP providing electronic access to nuclear data are listed in alphabetical order.

Other data centers and Web sites of interest may be accessed through the NNDC W^3 site or the other Web sites listed below. The USNDP home page (http://www.nndc.bnl.gov/usndp/) also contains this information organized by subject or discipline and from the viewpoints of various user communities.

Members of the USNDP receive some or all of their funding from the Division of Nuclear Physics, Office of High Energy and Nuclear Physics, US Department of Energy (see page *viii*). http://www.pixe.lth.se/glossary/index.asp?gloss=ndgloss contains a useful glossary of Internet and nuclear data terminology.

Databases and Services at the NNDC, NDS, NEADB, and RNDC

The NNDC, NDS, NEADB, and RNDC mirror the information available at these four core centers although there are some differences in the contents and version dates of the databases. Current major systems common to the four 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, RNDC]

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,RNDC]

Documentation—Includes the NNDC (NDS) On-line Data Service Manual [NDS, NNDC], the **E**valuated **N**uclear **D**ata **F**ile, **E**valuated **N**uclear **S**tructure **D**ata **F**ile, and **N**uclear **S**cience **R**eferences manuals, and the ENDF/B-VI Summary Documentation [NDS, NEADB, NNDC, RNDC].

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

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

Libraries—Includes the 1995 Update to the Atomic Mass Evaluation [AMDC (Atomic Mass Data Center), 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. [NDS, NNDC, RNDC]

NSR (*N*uclear *S*cience *R*eferences) —Bibliographic information on nuclear structure, nuclear reactions, and radioactive decay. Some papers on atomic physics are included that are relevant to the physics of nuclear structure. [IP, NDS, NNDC, RNDC]

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

PCNuDat—An MS-DOS clone of NuDat. [NDS, NNDC]

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

XUNDL (E*x*perimental *U*nevaluated *N*uclear *D*ata *L*ist)—Experimental nuclear structure and decay data compiled in the ENSDF format. [IP, 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, and **FILES** to view and electronically transfer data files.

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

Anonymous FTP

- ftp.nndc.bnl.gov
- Contents: Codes, documentation, and libraries as described above. 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), PCNuDat, and the 5th edition of the Nuclear Wallet Cards.

Terminal Access

- telnet.nndc.bnl.gov. User name: NNDC (no password). At the prompt for assigned authorization code, enter the assigned code or GUEST.
- Contents: See above. Also includes a test database of experimental relativistic heavy-ion reaction data.

World Wide Web

- http://www.nndc.bnl.gov
- Contents: General information. Nuclear decay data in the MIRD format. Codes, documentation, and libraries as described above. Mirror site for the Korean Atomic Energy Research Institute's *Table of the Nuclides*. 5th edition of the Nuclear Wallet Cards. Experimental relativistic heavy-ion reaction data. Thermal neutron capture γ's. CINDA, CSISRS, ENDF, ENSDF, NSR, NuDat, and XUNDL. Interactive calculation of log *ft*'s and internal conversion coefficients.

Nuclear Data Section (NDS), IAEA, Austria

Anonymous FTP

- iaeand.iaea.or.at. User name: anonymous. Password: Your e-mail address.
- Contents: Codes, documentation, and libraries as described above. 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), PCNuDat, the

1995 Atomic Mass Evaluation, and the 5th edition of the Nuclear Wallet Cards.

CD-ROM Distribution

- EXFOR
- Evaluated nuclear reaction data in the ENDF format and associated preprocessing and utility codes
- Multigroup cross section libraries

Terminal Access

- iaeand.iaea.or.at. User name: IAEANDS (No password). At the prompt for assigned authorization code, enter the assigned code or GUEST.
- Contents: See above.

World Wide Web

- http://www-nds.iaea.or.at
- Contents: General information, Nuclear decay data in the MIRD format. Codes, documentation, and libraries as described above and the FENDL-2 library (*F*usion *E*valuated *N*uclear *D*ata *L*ibrary. 5th edition of the Nuclear Wallet Cards. Thermal neutron capture γ's. CINDA, CSISRS, ENDF, ENSDF, EXFOR, NGATLAS (Atlas of neutron capture cross sections), Reference Input Parameter Library (RIPL), NMF-90 (Neutron Metrology File), and NuDat.

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

CD-ROM distribution

- JENDL-3.2 Plots on CD-ROM
- JEF-PC. Software for Graphical Display of Nuclear Data

World Wide Web

- http://www.nea.fr/html/databank/
- Contents: General Information. Evaluated nuclear reaction data (EVA, JEF). CINDA, EXFOR. Format manuals. Preprocessed reaction data. Atomic masses. Computer codes.

Russian Nuclear Data Center (RNDC), Russia

Terminal Access

- rndc.ippe.obninsk.ru. User name: CJD (no password). At the prompt for assigned authorization code, enter the assigned code or GUEST.
- Contents: See above.

World Wide Web

- http://rndc.ippe.obninsk.ru/
- Contents: General Information. BROND-2, RRDF-98 (Russian Radiation Dosimetry File), ADL-3 (Activation Data Library), MENDL (Medium Energy Neutron Data Library).

Astrophysics Program, Oak Ridge National Laboratory, USA

World Wide Web

- http://www.phy.ornl.gov/astrophysics/astro.html
- Contents: Nuclear reaction rates and nuclear astrophysics bibliography.

Atomic Mass Data Center (AMDC), Centre de Spectrométrie Nucléaire et de Spectrométrie de Masse, France

Anonymous FTP

- csnftp.in2p3.fr. Change directory to pub/AMDC.
- Contents: General information. The NUBASE database. PC-NUCLEUS program. ENSDF. JvNubase.

World Wide Web

- http://www-csnsm.in2p3.fr/amdc/
- Contents: General information. The 1995 Update to the Atomic Mass Evaluation and the 1993 Atomic Mass Evaluation. NUBASE and jvNubase.

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

World Wide Web

- http://www.best.com/~sdv/MacNuclide2/MacNukeb.html
- Contents: MacNuclide 1.0 (MacOS/Windows), MacNuclide 2.x (MacOS), and cross-platform Java MacNuclide (β release).

Center for Photonuclear Experiments Data (CDFE), Moscow State University, Russia

World Wide Web

- http://depni.npi.msu.su/cdfe/
- Contents: General information. Photonuclear reaction cross-sections, parameters of the Giant Dipole Resonance and photonuclear reaction thresholds. Photonuclear data index.

γ-ray Spectrometry Center, Idaho Falls National Engineering and Environmental Laboratory, USA

World Wide Web

- http://id.inel.gov/gamma/
- Contents: General information. NaI (Tl) and Ge(Li)-Si(Li) Gamma Spectrum Catalogues.

Isotopes Project (IP), Ernest Orlando Lawrence Berkeley National Laboratory, USA

World Wide Web

- http://ie.lbl.gov/
- Contents: General information. Isotope Explorer and VuENSDF. NSR, ENSDF, and XUNDL. Table of Super-Deformed Bands and Fission Isomers. Atomic masses and Q-value calculator. Nuclear Astrophysics Data Reference List and Reaction Rates. Thermal neutron capture γ data. Table of Radioactive Isotopes. GAMQUEST.

Nuclear Data Center,
Japan Atomic Research Institute, Japan

CD-ROM distribution

- CD-ROM Storing JENDL-3.2 Plots and Data

World Wide Web

- http://wwwndc.tokai.jaeri.go.jp/index.html
- Contents: General information. JENDL-3.2. Documentation. Graphs of evaluated cross section data. Tables of Nuclear Data. Chart of the Nuclides. JNDC Nuclear Data Library (fission product decay data).

Nuclear Data Evaluation Project,
Triangle Universities Nuclear Laboratory, USA

World Wide Web

- http://www.tunl.duke.edu/NuclData
- Contents: General information. Revised post-publication manuscripts for A=3, 4, and 16-20 and preprints for A=5 and 6 (PDF). Modified versions of A=5-10, 11, 13, and 14 (PDF). Energy level diagrams for A=4-20 (GIF, PDF, EPS). Extract of the Table of Isotopes for A=1-20 (PDF, PS). Reference update lists for A=6-10.

T-2 Nuclear Information Service,
Los Alamos National Laboratory, USA

Anonymous FTP

- t2.lanl.gov.
- Contents: Similar to the Web site.

World Wide Web

- http://t2.lanl.gov
- Contents: General information. Neutron kerma data. High-energy data for accelerator applications. Reaction Q-value and threshold energy calculator. Nuclear reaction rates and astrophysical S-factors. Nuclear Data Viewer. ENDF. Codes (TRANSX 2.15, NJOY, *etc*.).

Division of Nuclear Physics,
Office of High Energy and Nuclear Physics,
US Department of Energy

The Division of Nuclear Physics supports a broad program of basic research in nuclear physics. The Division's World Wide Web site (http://www.er.doe.gov/production/henp/nucphys.html) provides an overview of its research program, programmatic activities, and links to research facilities at universities and national laboratories, to some major experiments, and 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.

Additional Copies Of These Wallet Cards May Be Obtained From

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