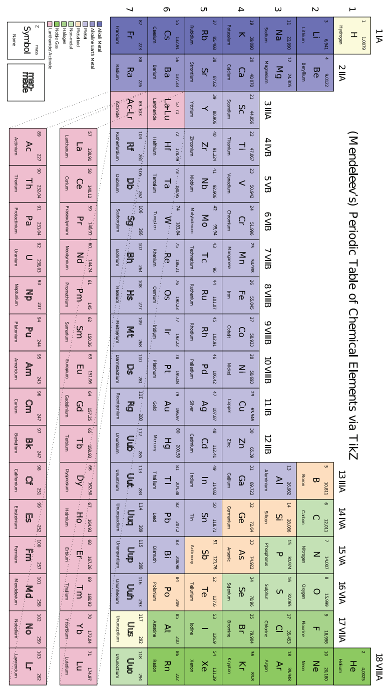
Pocketbook of Data for Nuclear Engineers

rev. 01 - February 2013

(a) For gas; density (liquid) = 0.0708 g/cc at b.p.; density (solid)=0.0706 g/cc at $-262°$C.
(b) For gas; density (liquid)=0.1221 g/cc at b.p.
(c) At 20°C.
(d) For crystal form; density (amorphous)= 2.37 g/cc.
(e) 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.
(f) For gas; density (liquid) = 0.808 g/cc at b.p.; density (solid)= 1.026 g/cc at $-252°$C.
(g) For gas; density (liquid) = 0.808 g/cc at b.p.; density (solid)= 1.026 g/cc at $-252°$C.
(h) At 25°C.
(i) For white phosphorus; density (red)=2.20 g/cc; density (black)=2.25 to 2.69 g/cc.
(j) For rhombic sulfur; melting point (monoclinic)=119.0°C; density (monoclinic)=1.957 g/cc at 20°C.
(k) Depending on allotropic form.
(l) For gray arsenic; density (yellow)=1.97 g/cc.
(m) For gray selenium; density (vitreous)=4.28 g/cc.
(n) Calculated.
(o) For gray tin; density (white)=7.13 g/cc.
(p) For solid at 20°C; 0.01127 g/cc for gas.
(q) For α modification.
(r) For β modification.

Contents

9.4 Periodic Table



9.3 Densities and Atomic Masses

Z	Symbol	Atomic mass [u]	Density [g/cm^3]	Z	Symbol	Atomic mass [u]	Density [g/cm^3]
1	H	1.00794(7)	$8.988 \times 10^{-5\,(a)}$	52	Te	127.60(3)	$6.24^{(c)}$
2	He	4.002602(2)	$1.785 \times 10^{-4\,(b)}$	53	I	126.90447(3)	$4.93^{(p)}$
3	Li	6.941(2)	$0.534^{(c)}$	54	Xe	131.293(6)	0.005887
4	Be	9.012182(3)	$1.848^{(c)}$	55	Cs	132.90545(2)	$1.873^{(c)}$
5	B	10.811(7)	$2.34^{(d)}$	56	Ba	137.327(7)	$3.5^{(c)}$
6	C	12.0107(8)	1.8 to $2.1^{(e)}$	57	La	138.9055(2)	$6.145^{(h)}$
7	N	14.0067(2)	$0.0012506^{(f)}$	58	Ce	140.116	$6.770^{(h)}$
8	O	15.9994(3)	$0.001308^{(g)}$	59	Pr	140.90765(2)	$6.773^{(q)}$, $6.64^{(r)}$
9	F	18.9984032(5)	0.001696	60	Nd	144.24(3)	7.008
10	Ne	20.1797(6)	8.9990×10^{-4}	61	Pm	(145)	$7.264^{(h)}$
11	Na	22.989770(2)	$0.971^{(c)}$	62	Sm	150.36(3)	$7.520^{(q)}$, $7.40^{(r)}$
12	Mg	24.3050(6)	$1.738^{(c)}$	63	Eu	151.964	$5.244^{(h)}$
13	Al	26.981538(2)	$2.6989^{(c)}$	64	Gd	157.25(3)	$7.901^{(h)}$
14	Si	28.0855(3)	$2.33^{(h)}$	65	Tb	158.92534(2)	8.230
15	P	30.973761(2)	$1.82^{(i)}$	66	Dy	162.50(3)	$8.551^{(h)}$
16	S	32.065(5)	$2.07^{(c,j)}$	67	Ho	164.93032(2)	$8.795^{(h)}$
17	Cl	35.453(2)	0.003214	68	Er	167.259(3)	$9.066^{(h)}$
18	Ar	39.948	0.0017837	69	Tm	168.93421(2)	$9.321^{(h)}$
19	K	39.0983	$0.862^{(c)}$	70	Yb	173.04(3)	$6.903^{(q)}$, $6.966^{(r)}$
20	Ca	40.078(4)	$1.55^{(c)}$	71	Lu	174.967	$9.841^{(h)}$
21	Sc	44.955910(8)	$2.989^{(h)}$	72	Hf	178.49(2)	$13.31^{(c)}$
22	Ti	47.867	4.54	73	Ta	180.9479	16.654
23	V	50.9415	6.11(18.7°C)	74	W	183.84	$19.3^{(c)}$
24	Cr	51.9961(6)	7.18 to $7.20^{(c)}$	75	Re	186.207	$21.02^{(c)}$
25	Mn	54.938049(9)	7.21 to $7.44^{(k)}$	76	Os	190.23(3)	22.57
26	Fe	55.845(2)	$7.874^{(c)}$	77	Ir	192.217(3)	22.42(17°)
27	Co	58.933200(9)	$8.9^{(c)}$	78	Pt	195.078(2)	$21.45^{(c)}$
28	Ni	58.6934(2)	$8.902^{(h)}$	79	Au	196.96655(2)	$\approx 19.3^{(c)}$
29	Cu	63.546(3)	$8.96^{(c)}$	80	Hg	200.59(2)	$13.546^{(c)}$
30	Zn	65.39(2)	$7.133^{(h)}$	81	Tl	204.3833(2)	$11.85^{(c)}$
31	Ga	69.723	5.904(29.6°C)	82	Pb	207.2	$11.35^{(c)}$
32	Ge	72.64	$5.323^{(h)}$	83	Bi	208.98038(2)	$9.747^{(c)}$
33	As	74.92160(2)	$5.73^{(l)}$	84	Po	(209)	$9.32^{(q)}$
34	Se	78.96(3)	$4.79^{(m)}$	85	At	(210)	
35	Br	79.904	$3.12^{(n)}$	86	Rn	(222)	0.00973
36	Kr	83.80	0.003733	87	Fr	(223)	
37	Rb	85.4678(3)	$1.532^{(c)}$	88	Ra	(226)	5
38	Sr	87.62	2.54	89	Ac	(227)	$10.07^{(n)}$
39	Y	88.90585(2)	$4.469^{(h)}$	90	Th	232.03801	11.72
40	Zr	91.224(2)	$6.506^{(c)}$	91	Pa	(231)	15.37
41	Nb	92.90638(2)	$8.57^{(c)}$	92	U	238.02891(3)	≈ 18.95
42	Mo	95.94	$10.22^{(c)}$	93	Np	(237)	$20.25^{(c)}$
43	Tc	(98)	$11.50^{(n)}$	94	Pu	(244)	$19.84^{(h)}$
44	Ru	101.07(2)	$12.41^{(c)}$	95	Am	(243)	$13.67^{(c)}$
45	Rh	102.90550(2)	$12.41^{(c)}$	96	Cm	(247)	$13.51^{(n)}$
46	Pd	106.42	$12.02^{(c)}$	97	Bk	(247)	$14^{(n)}$
47	Ag	107.8682(2)	$10.50^{(c)}$	98	Cf	(251)	
48	Cd	112.411(8)	$8.65^{(c)}$	99	Es	(252)	
49	In	114.818(3)	$7.31^{(c)}$	100	Fm	(257)	
50	Sn	118.710(7)	$5.75^{(o)}$	101	Md	(258)	
51	Sb	121.760	$6.691^{(c)}$	102	No	(259)	

9.2 Alphabetical List of Elements

Name	Symbol	Z	Name	Symbol	Z	Name	Symbol	Z
Actinium	Ac	89	Gold	Au	79	Praseodymium	Pr	59
Aluminum	Al	13	Hafnium	Hf	72	Promethium	Pm	61
Americium	Am	95	Hassium	Hs	108	Protactinium	Pa	91
Antimony	Sb	51	Helium	He	2	Radium	Ra	88
Argon	Ar	18	Holmium	Ho	67	Radon	Rn	86
Arsenic	As	33	Hydrogen	H	1	Roentgenium	Rg	111
Astatine	At	85	Indium	In	49	Rhenium	Re	75
Barium	Ba	56	Iodine	I	53	Rhodium	Rh	45
Berkelium	Bk	97	Iridium	Ir	77	Rubidium	Rb	37
Beryllium	Be	4	Iron	Fe	26	Ruthenium	Ru	44
Bismuth	Bi	83	Krypton	Kr	36	Rutherfordium	Rf	104
Bohrium	Bh	107	Lanthanum	La	57	Samarium	Sm	62
Boron	B	5	Lawrencium	Lr	103	Scandium	Sc	21
Bromine	Br	35	Lead	Pb	82	Selenium	Se	34
Cadmium	Cd	48	Lithium	Li	3	Seaborgium	Sg	106
Calcium	Ca	20	Lutetium	Lu	71	Silicon	Si	14
Californium	Cf	98	Magnesium	Mg	12	Silver	Ag	47
Carbon	C	6	Manganese	Mn	25	Sodium	Na	11
Cerium	Ce	58	Meitnerium	Mt	109	Strontium	Sr	38
Cesium	Cs	55	Mendelevium	Md	101	Sulfur	S	16
Chlorine	Cl	17	Mercury	Hg	80	Tantalum	Ta	73
Chromium	Cr	24	Molybdenum	Mo	42	Technetium	Tc	43
Cobalt	Co	27	Neodymium	Nd	60	Tellurium	Te	52
Copper	Cu	29	Neon	Ne	10	Terbium	Tb	65
Curium	Cm	96	Neptunium	Np	93	Thallium	Tl	81
Darmstadtium	Ds	110	Nickel	Ni	28	Thorium	Th	90
Dubnium	Db	105	Niobium	Nb	41	Thulium	Tm	69
Dysprosium	Dy	66	Nitrogen	N	7	Tin	Sn	50
Einsteinium	Es	99	Nobelium	No	102	Titanium	Ti	22
Erbium	Er	68	Osmium	Os	76	Tungsten	W	74
Europium	Eu	63	Oxygen	O	8	Uranium	U	92
Fermium	Fm	100	Palladium	Pd	46	Vanadium	V	23
Fluorine	F	9	Phosphorus	P	15	Xenon	Xe	54
Francium	Fr	87	Platinum	Pt	78	Ytterbium	Yb	70
Gadolinium	Gd	64	Plutonium	Pu	94	Yttrium	Y	39
Gallium	Ga	31	Polonium	Po	84	Zinc	Zn	30
Germanium	Ge	32	Potassium	K	19	Zirconium	Zr	40

Foreword

The *Pocketbook of Data for Nuclear Engineers* is a compilation of nuclear data available from different sources online (NIST, IAEA-NDS, evaluated data libraries). It was conceived as an extension of BNL *Nuclear Data Cards* to include other important nuclear data used in the Nuclear Physics course at Instituto Balseiro and other courses. The document is typeset in 10 pt font to be printed as a A5 or A6 booklet.

This compilation is supplied "as is" with no warranties implied. It is recommended that the data contained in this pocketbook be checked against the sources before used for any important application. If you think data should be corrected, added or removed from this compilation, please contact the author at: `marquezj@cab.cnea.gov.ar`

This pocketbook can be distributed freely, and the data should be used citing the original source.

The latest version of this pocketbook can be found at:

`http://ib.cnea.gov.ar/~moderna/nuclear/pdne.html`

Chapter 1

Physical constants and unit conversions

Wave relationships:

$$E = h\nu,\ p = h/\lambda$$

Speed of light:

$$c = \lambda\nu = 2.99792458 \times 10^{8}\ \mathrm{m/s}$$

Planck's constant:

$$h = 6.626069 \times 10^{-34}\ \mathrm{J\,s} = 4.135667 \times 10^{-15}\ \mathrm{eV\,s}$$
$$\hbar c = 1.97326961 \times 10^{-11}\ \mathrm{MeV\,cm}$$

Electron charge:

$$e = 1.602176 \times 10^{-19}\ \mathrm{C}$$
$$\frac{e^2}{4\pi\epsilon_0} = 1.4399759 \times 10^{-13}\ \mathrm{MeV\,cm}$$

Atomic mass unit:

$$1\ \mathrm{u} = 931.494\ \mathrm{MeV/c^2}$$

Electron mass:

$$m_e = 0.511\ \mathrm{MeV/c^2}$$

Boltzmann's constant:

$$k_B = 8.617 \times 10^{-11}\ \mathrm{MeV/K}$$
$$1\ \mathrm{eV}/k_B = 1.1605 \times 10^{4}\ \mathrm{K}$$

Nuclear Radius:

$$r \approx 1.3\ \mathrm{fm} \times A^{1/3} = 1.3 \times 10^{-15}\ \mathrm{m} \times A^{1/3}$$

Source: NIST CODATA (`http://physics.nist.gov/cuu/Constants/index.html`).

Chapter 9

Elemental Properties and Periodic Table

9.1 List of Elements by Z

Z	Symbol	Name	Z	Symbol	Name	Z	Symbol	Name
1	H	Hydrogen	38	Sr	Strontium	75	Re	Rhenium
2	He	Helium	39	Y	Yttrium	76	Os	Osmium
3	Li	Lithium	40	Zr	Zirconium	77	Ir	Iridium
4	Be	Beryllium	41	Nb	Niobium	78	Pt	Platinum
5	B	Boron	42	Mo	Molybdenum	79	Au	Gold
6	C	Carbon	43	Tc	Technetium	80	Hg	Mercury
7	N	Nitrogen	44	Ru	Ruthenium	81	Tl	Thallium
8	O	Oxygen	45	Rh	Rhodium	82	Pb	Lead
9	F	Fluorine	46	Pd	Palladium	83	Bi	Bismuth
10	Ne	Neon	47	Ag	Silver	84	Po	Polonium
11	Na	Sodium	48	Cd	Cadmium	85	At	Astatine
12	Mg	Magnesium	49	In	Indium	86	Rn	Radon
13	Al	Aluminum	50	Sn	Tin	87	Fr	Francium
14	Si	Silicon	51	Sb	Antimony	88	Ra	Radium
15	P	Phosphorus	52	Te	Tellurium	89	Ac	Actinium
16	S	Sulfur	53	I	Iodine	90	Th	Thorium
17	Cl	Chlorine	54	Xe	Xenon	91	Pa	Protactinium
18	Ar	Argon	55	Cs	Cesium	92	U	Uranium
19	K	Potassium	56	Ba	Barium	93	Np	Neptunium
20	Ca	Calcium	57	La	Lanthanum	94	Pu	Plutonium
21	Sc	Scandium	58	Ce	Cerium	95	Am	Americium
22	Ti	Titanium	59	Pr	Praseodymium	96	Cm	Curium
23	V	Vanadium	60	Nd	Neodymium	97	Bk	Berkelium
24	Cr	Chromium	61	Pm	Promethium	98	Cf	Californium
25	Mn	Manganese	62	Sm	Samarium	99	Es	Einsteinium
26	Fe	Iron	63	Eu	Europium	100	Fm	Fermium
27	Co	Cobalt	64	Gd	Gadolinium	101	Md	Mendelevium
28	Ni	Nickel	65	Tb	Terbium	102	No	Nobelium
29	Cu	Copper	66	Dy	Dysprosium	103	Lr	Lawrencium
30	Zn	Zinc	67	Ho	Holmium	104	Rf	Rutherfordium
31	Ga	Gallium	68	Er	Erbium	105	Db	Dubnium
32	Ge	Germanium	69	Tm	Thulium	106	Sg	Seaborgium
33	As	Arsenic	70	Yb	Ytterbium	107	Bh	Bohrium
34	Se	Selenium	71	Lu	Lutetium	108	Hs	Hassium
35	Br	Bromine	72	Hf	Hafnium	109	Mt	Meitnerium
36	Kr	Krypton	73	Ta	Tantalum	110	Ds	Darmstadtium
37	Rb	Rubidium	74	W	Tungsten	111	Rg	Roentgenium

Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		279	0	151.3 (6)	0.17 +0.81-0.08 s		α 100
		280	0	153.4 (5)	3.6 +4.3-1.3 s		α 100
		281	0	154.6 (9)	26 +25-8 s		SF 100; α
		282	0	156.7 (6)	0.5 +2.5-0.2 s		α 100; SF
112	**Cn**	283	0	160.7 (6)	4.0 +1.3-0.7 s		$\alpha \geq 90.00$; $SF \leq 10.00$; SF 50; α 50
		284	0	161.5 (8)	101 +41-22 ms		SF 100
		285	0	164.1 (7)	30 +30-10 s		α 100
113	**13**	282	0	163.6 (4)	0.07 +0.13-0.03 s		α 100
		283	0	164 (6)	100 $\pm$ 0 ms		α 100
		284	0	166 (5)	0.48 +0.58-0.17 s		α 100
		285	0	166.9 (9)	5.5 +5-1.8 s		α 100; SF
		286	0	168.9 (6)	20 +94-9 s		α 100; SF
114	**14**	286	0+	171 (7)	0.16 +0.07-0.03 s		$SF \approx 60.00$; $\alpha \approx 40.00$
		287	0	173.2 (6)	0.51 +0.18-0.1 s		α 100
		288	0+	174 (8)	0.52 +0.22-0.13 s		α 100
		289	0	176.5 (7)	0.97 +0.97-0.32 s		α 100; α 100
115	**15**	287	0	177.2 (6)	32 $\pm$ 0 ms		α 100
		288	0	179 (6)	87 $\pm$ 0 ms		α 100
		289	0	179.8 (9)	0.22 +0.26-0.08 s		α 100; SF
		290	0	181.6 (6)	16 +76-7 ms		α 100; SF
116	**16**	290	0+	184.4 (7)	15 +26-6 ms		α 100
		291	0	186.6 (6)	6.3 $\pm$ 0 ms		α 100
		292	0+	187.2 (9)	18 +16-6 ms		α 100
		293	0	189.6 (7)	53 +62-19 ms		α 100
117	**17**	293	0	193.4 (9)	14 +11-4 ms		α 100; SF
		294	0	195.1 (7)	0.08 +0.37-0.04 s		α 100

Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}$, Γ	Abundance	Decay Mode
		258	0	101.8 (3)	4.2 +0.4-0.3 s		α 65; ϵ 35; SF < 1.00; ϵ 100
		259	0	101.99 (5)	0.51 ± 0.16 s		α
		260	0	103.36 (9)	1.52 ± 0.13 s		$\alpha \geq 90.40$; $SF \leq 9.60$; ϵ < 2.50
		261	0	104.25 (11)	1.8 ± 0.4 s		$\alpha \geq 82.00$; $SF \leq 18.00$
		262	0	106.28 (18)	35 ± 5 s		$\alpha \approx 67.00$; SF
		263	0	107.11 (17)	27 +10-7 s		SF 55; α 41; ϵ 3
		267	0	114.2 (5)	73 ± 0 m		SF 100
		268	0	117 (5)	32 +11-7 h		SF 100
		270	0	122 (6)	23 ± 0 h		SF 100; α
106	**Sg**	258	0+	105.3 (4)	2.9 +1.3-0.7 ms		$SF \leq 100.00$; α ?
		259	(1/2+)	106.49 (12)	0.32 +0.08-0.06 s		α 96; SF 4; α <100
		260	0+	106.544 (21)	3.6 ± 0.9 ms		α 50; SF 50; SF 71; α 29
		261	0	108.007 (19)	0.23 ± 0.06 s		α 100; SF < 1.00
		262	0+	108.37 (20)	6.9 +3.8-1.8 ms		$SF \geq 78.00$; $\alpha \leq 22.00$
		263	0	110.19 (10)	1.0 ± 0.2 s		α > 70.00; SF < 30.00; IT ; α
		264	0+	110.8 (3)	37 +27-11 ms		SF 100; α < 36.00
		265	0	112.81 (12)	16.2 +4.7-3.5 s		$\alpha \geq 65.00$; $SF \leq 35.00$;
		266	0+	113.7 (3)	21 +20-12 s		SF > 50.00; α > 18.00
		271	0	124.4 (6)	2.4 +4.3-1 m		$\alpha \approx 50.00$; $SF \approx 50.00$
107	**Bh**	260	0	113.3 (3)	35 +19-9 ms		$\alpha \leq 100.00$
		261	0	113.22 (23)	11.8 +3.9-2.4 ms		α 100
		262	0	114.5 (3)	22 ± 4 ms		α < 100.00; α < 100.00
		264	0	115.75 (18)	0.44 +0.6-0.16 s		$\alpha \leq 100.00$
		265	0	116.36 (23)	0.9 +0.7-0.3 s		α
		266	0	118.23 (20)	1.7 +8.2-0.8 s		α 100
		267	0	118.9 (3)	17 +14-6 s		α 100
		270	0	124.2 (4)	6E+1 +29E+1-3E+1 s		α
		272	0	128.6 (5)	10 +12-4 s		α 100
		274	0	133.3 (6)	0.9 +4.2-0.4 m		α 100; SF
108	**Hs**	265	0	121.17 (5)	1.9 ± 0.2 ms		$SF \leq 1.00$; α < 100.00
		266	0+	121.13 (20)	2.3 +1.3-0.6 ms		α 100; SF < 1.40
		267	(3/2+)	122.65 (10)	52 +13-8 ms		$\alpha \geq 80.00$; SF < 20.00; α 100
		268	0+	122.8 (3)	0.4 +1.8-0.2 s		α
		269	0	124.61 (12)	3.6 +0.8-1.4 s		α 100; α 100
		270	0+	125.1 (3)	22 ± 0 s		α 100
		275	0	136.3 (6)	0.15 +0.27-0.06 s		α 100
109	**Mt**	266	0	128 (3)	1.7 +1.8-1.6 ms		$\alpha \leq 100.00$
		268	0	128.91 (23)	21 +8-5 ms		α 100
		270	0	130.84 (20)	5.0 +2.4-0.3 ms		α 100
		274	0	137.1 (4)	0.44 +0.81-0.17 s		α 100; SF
		275	0	138.4 (6)	9.7 ± 0 ms		α 100
		276	0	140.9 (5)	0.72 +0.87-0.25 s		α 100
		278	0	145.1 (6)	8 +37-4 s		α 100; SF
110	**Ds**	270m	0	135.88 (21)	6.0 +8.2-2.2 ms		α > 70.00; $IT \leq 30.00$
		271	0	135.95 (10)	1.63 +0.44-0.29 ms		α 100; α > 0.00; IT ?
		279	0	148.6 (6)	0.18 +0.05-0.03 s		$SF \approx 90.00$; $\alpha \approx 10.00$
		281	0	152.4 (7)	20 +20-7 s		SF 85; α 15; SF 100
111	**Rg**	272	0	142.8 (3)	3.8 +1.4-0.8 ms		α 100
		274	0	144.74 (21)	6.4 ± 0 ms		α 100
		278	0	150.4 (4)	4.2 +7.6-1.7 ms		α 100; SF

Continued on next page

Chapter 2

Mass attenuation and mass energy absorption coefficients

In the following figures the total (μ/ρ) and partial mass attenuation coefficients are plotted for Hydrogen, Carbon, Nitrogen, Oxygen, Copper, Tin, Lead, and Uranium. Partial mass attenuation coefficients are plotted for photoelectric absorption, coherent and incoherent (Compton) scattering, and pair production. The mass absorption energy coefficient (μ_{en}/ρ) is also plotted for the same materials.

Sources:
NIST X-COM Database (`http://www.nist.gov/pml/data/xcom/index.cfm/`)
NIST X-Ray Mass Attenuation Coefficients (`http://www.nist.gov/pml/data/xraycoef/index.cfm/`)
NIST also distributes a program (XCOM) to tabulate and plot mass attenuation coefficients.

Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}$, Γ	Abundance	Decay Mode
		256	0+	87 (3)	12.3 ± 1.2 m		SF 100; β^- < 1.00; $\alpha \approx$ 1.0E-6
99	**Es**	241	0	63.84 (23)	8 +6-5 s		ϵ ; α
		242	0	64.9 (3)	17.8 ± 1.6 s		α 57; ϵ 43
		243	(7/2+)	64.75 (21)	23 ± 3 s		α 61; ϵ 39; SF < 1.00
		244	0	66.02 (18)	37 ± 4 s		ϵ 96; α 4
		245	(3/2-)	66.44 (20)	1.1 ± 0.1 m		α 40; ϵ 60
		246	0	67.9 (22)	7.5 ± 0.5 m		ϵ 90.1; α 9.9
		247	(7/2+)	68.578 (19)	4.55 ± 0.26 m		$\epsilon \approx 93.00$; $\alpha \approx 7.00$; α
		248	(2-,0+)	70.3 (5)	27 ± 5 m		ϵ 99.7; $\alpha \approx 0.25$
		249	7/2+	71.18 (3)	102.2 ± 0.6 m		ϵ 99.43; α 0.57
		250	(6+)	73.23 (10)	8.6 ± 0.1 h		ϵ > 97.00; α < 3.00; $\epsilon \leq$ 100.00
		251	(3/2-)	74.514 (6)	33 ± 1 h		ϵ 99.5; α 0.5
		252	(5-)	77.3 (5)	471.7 ± 1.9 d		α 78; ϵ 22
		253	7/2+	79.015 (3)	20.47 ± 0.03 d		SF 8.7e-06; α 100
		254	(7+)	81.993 (4)	275.7 ± 0.5 d		SF < 3.0E-6; α 100; β^- 0.00017
		254m	2+	82.077 (4)	39.3 ± 0.2 h		β^- 98; IT < 3.00; α 0.32; ϵ 0.08; SF < 0.05
		255	(7/2+)	84.091 (11)	39.8 ± 1.2 d		β^- 92; α 8; SF 0.0041
		256	(1+,0-)	87.19 (10)	25.4 ± 2.4 m		β^- 100; β^- 100
		257	0	89.4 (4)	7.7 ± 0.2 d		β^- ; SF
100	**Fm**	243	(7/2+)	69.26 (22)	231 ± 9 ms		ϵ < 10.00; α 91; SF 9
		244	0+	68.98 (20)	3.12 ± 0.08 ms		SF > 97.00; ϵ < 2.00; α < 1.00
		245	0	70.19 (20)	4.2 ± 1.3 s		$\alpha \leq 100.00$
		246	0+	70.187 (15)	1.54 ± 0.04 s		α 93.2; SF 6.8; $\epsilon \leq 1.30$
		247	(7/2+)	71.58 (12)	31 ± 1 s		$\alpha \geq 84.00$; $\epsilon \leq 16.00$
		247m	(1/2+)	71.63 (12)	5.1 ± 0.2 s		α 84
		248	0+	71.894 (9)	36 ± 2 s		α 93; ϵ 7; SF 0.1
		249	(7/2+)	73.521 (6)	2.6 ± 0.7 m		ϵ 67; α 33
		250	0+	74.074 (8)	30 ± 3 m		α > 90.00; ϵ < 10.00; SF 0.0069; IT 100
		251	(9/2-)	75.954 (15)	5.30 ± 0.08 h		ϵ 98.2; α 1.8
		252	0+	76.819 (6)	25.39 ± 0.04 h		SF 0.0023; α 100
		253	(1/2)+	79.35 (3)	3.00 ± 0.12 d		ϵ 88; α 12
		254	0+	80.905 (3)	3.240 ± 0.002 h		α 99.94; SF 0.06
		255	7/2+	83.802 (5)	20.07 ± 0.07 h		α 100; SF 2.4e-05
		256	0+	85.487 (7)	157.6 ± 1.3 m		SF 91.9; α 8.1
		257	(9/2+)	88.591 (6)	100.5 ± 0.2 d		α 99.79; SF 0.21
		259	0	93.7 (3)	1.5 ± 0.3 s		SF 100
		260	0+	95.8 (5)	≈ 4 ms		SF 100
101	**Md**	245m	(7/2)	75.6 (3)	0.35 +0.23-0.16 s		ϵ ; α
		246	0	76.2 (3)	0.9 ± 0.2 s		α < 23.00; SF ?; ϵ ?; α 100; ϵ > 77.00
		247	(7/2-)	75.94 (21)	1.2 ± 0.1 s		α 99.9; SF < 0.10; α 79; SF 21
		248	0	77.14 (24)	13 +15-4 s		α 58; ϵ 42
		249	(7/2-)	77.32 (22)	21.7 ± 2 s		α > 60.00; $\epsilon \leq 40.00$; α ?
		250	0	78.6 (3)	25 +10-5 s		ϵ 93; α 7
		251	(7/2-)	78.967 (19)	4.3 ± 0.6 m		ϵ 90; α 10
		252	0	80.51 (13)	2.3 ± 0.8 m		$\epsilon \leq 100.00$
		253	(7/2-)	81.18 (3)	6 +12-3 m		$\epsilon \leq 100.00$; α

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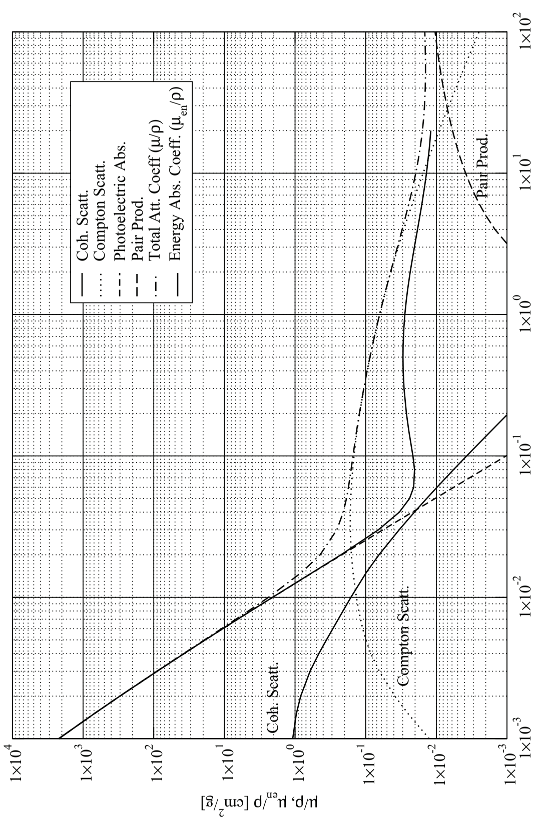

Figure 2.2: Mass attenuation (μ/ρ) and mass energy absorption coefficients (μ_{en}/ρ) for Carbon, $Z = 6$.

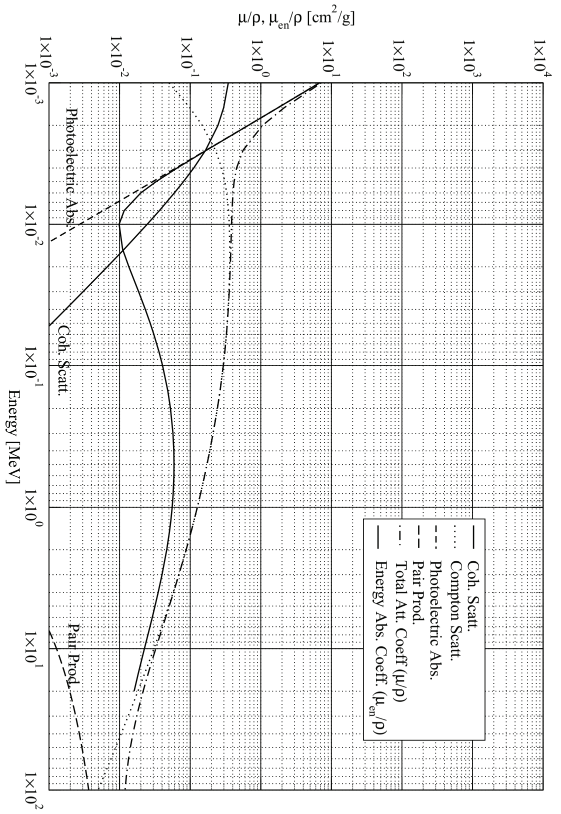

Figure 2.1: Mass attenuation (μ/ρ) and mass energy absorption coefficient (μ_{en}/ρ) for Hydrogen, $Z = 1$.

Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		254	0	83.52 (10)	28 ± 8 m		$\epsilon \leq 100.00; \epsilon \leq 100.00$
		255	(7/2-)	84.844 (7)	27 ± 2 m		ϵ 92; α 8; $SF < 0.15$
		256	(1-)	87.61 (7)	77 ± 2 m		ϵ 90.8; α 9.2; $SF < 3.00$
		257	(7/2-)	88.998 (3)	5.52 ± 0.05 h		ϵ 85; α 15; $SF < 1.00$
		258	0	91.689 (5)	51.5 ± 0.3 d		α 100; SF ; $\epsilon \geq 70.00$; SF
		259	0	93.63 (20)	96 ± 3 m		SF 100; $\alpha < 1.30$
		260	0	96.6 (3)	31.8 ± 0.5 d		$SF \geq 42.00$; $\alpha \leq 25.00$; $\epsilon \leq 23.00$; $\beta^- \leq 10.00$
102	**No**	251	(7/2+)	82.76 (11)	0.80 ± 0.01 s		α 84; $SF < 0.30$; ϵ
		251m	(1/2+)	82.87 (11)	1.02 ± 0.03 s		α 100
		252	0+	82.868 (9)	2.47 ± 0.02 s		$\epsilon < 1.10$; α 70.7; SF 29.3; IT 100.1
		253	(9/2-)	84.361 (7)	1.62 ± 0.15 m		$\alpha \approx 80.00$; ϵ
		254	0+	84.725 (10)	51 ± 10 s		α 90; ϵ 10; SF 0.17; $IT >$ 80.00
		255	1/2+	86.807 (15)	3.52 ± 0.21 m		ϵ 70; α 30
		256	0+	87.825 (8)	2.91 ± 0.05 s		SF 0.53; α 99.47
		257	(7/2+)	90.251 (7)	25 ± 3 s		$\alpha \leq 100.00$; $SF \leq 1.50$
		258	0+	91.48 (20)	1.2 ± 0.2 ms		$SF \leq 100.00$
		259	0	94.11 (10)	58 ± 5 m		α 75; ϵ 25; $SF < 10.00$
		260	0+	95.61 (20)	106 ± 8 ms		SF 100
		262	0+	100.1 (4)	≈ 5 ms		SF 100
103	**Lr**	252	0	88.7 (3)	0.27 +0.18-0.08 s		α 100; ϵ
		253	(7/2-)	88.67 (23)	0.57 +0.07-0.06 s		$\alpha \approx 98.70$; $SF \approx 1.30$; α 92; SF 8
		254	0	89.9 (3)	18.4 ± 1.8 s		α 71.7; ϵ 28.3
		255	1/2-	89.947 (18)	31.1 ± 1.3 s		α 85; ϵ 15
		255m	7/2-	89.984 (18)	2.53 ± 0.13 s		IT 60; α 40
		256	0	91.75 (8)	27 ± 3 s		α 85; ϵ 15; $SF < 0.03$
		257	0	92.61 (4)	≈ 4 s		$\alpha \leq 100.00$
		258	0	94.85 (10)	4.1 ± 0.3 s		$SF < 5.00$; $\alpha > 95.00$
		259	0	95.85 (7)	6.2 ± 0.3 s		α 78; SF 22
		260	0	98.27 (12)	180 ± 30 s		α 80; $\epsilon < 40.00$; $SF <$ 10.00
		261	0	99.56 (20)	39 ± 12 m		SF 100
		262	0	101.96 (20)	≈ 4 h		$SF < 10.00$; ϵ ; α
104	**Rf**	255	(9/2-)	94.24 (12)	2.3 +0.8-0.5 s		α 52; SF 48; ϵ ? 1.00
		256	0+	94.218 (18)	6.4 ± 0.2 ms		SF 99.68; α 0.32
		257	(1/2+)	95.868 (11)	4.7 ± 0.3 s		$\alpha < 100.00$; $SF \leq 1.40$; $\epsilon > 0.00$; $\epsilon > 0.00$; $\alpha <$ 100.00; $SF \leq 1.40$
		258	0+	96.34 (3)	14.7 +1.2-1 ms		SF 69; α 31
		259	0	98.36 (7)	3.2 ± 0.6 s		α 92; SF 8; ϵ 15
		260	0+	99.15 (20)	21 ± 1 ms		$SF \leq 100.00$; α ?
		261	0	101.32 (4)	1.9 ± 0.4 s		$\epsilon < 15.00$; $SF < 11.00$; SF 73; α 27; $\alpha > 74.00$
		262	0+	102.4 (3)	2.3 ± 0.4 s		$SF \leq 100.00$; $\alpha < 3.00$
		263	0	104.84 (18)	10 ± 2 m		SF 100; α
105	**Db**	255	0	99.7 (4)	1.6 +0.6-0.4 s		α 80; $SF \approx 20.00$
		256	0	100.5 (3)	1.9 ± 0.4 s		$\alpha \approx 70.00$; $\epsilon \approx 30.00$; $SF \approx 0.02$
		257	(9/2+)	100.3 (23)	1.82 +0.27-0.21 s		α 94; $SF \approx 6.00$; SF ; α 100

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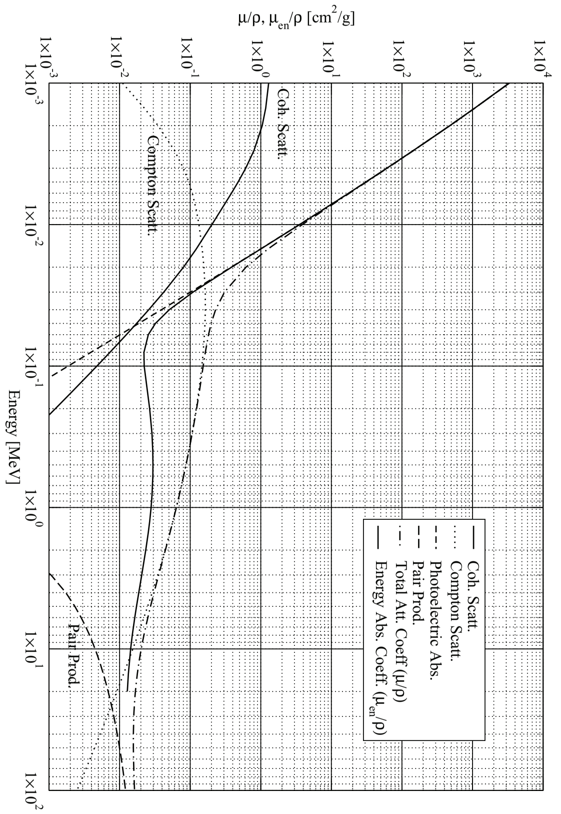

Figure 2.3: Mass attenuation (μ/ρ) and mass energy absorption coefficients (μ_{en}/ρ) for Nitrogen, $Z = 7$.

Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		240	0+	51.7195 (23)	27 ± 1 d		SF 3.9e-06; $\alpha > 99.50$; $\epsilon < 0.50$
		241	1/2+	53.7047 (22)	32.8 ± 0.2 d		ϵ 99; α 1
		242	0+	54.8066 (18)	162.8 ± 0.2 d		α 100; SF 6.2e-06; ^{34}Si 1e-14
		243	5/2+	57.1849 (21)	29.1 ± 0.1 y		ϵ 0.29; SF 5.3e-09; α 99.71
		244	0+	58.455 (18)	18.1 ± 0.1 y		α 100; SF 0.00014
		244m	6+	59.4952 (18)	34 ± 2 ms		IT 100
		245	7/2+	61.006 (21)	8423 ± 74 y		α 100; SF 6.1e-07
		246	0+	62.6197 (21)	4706 ± 40 y		α 99.97; SF 0.03
		247	9/2-	65.535 (4)	1.56E+7 $\pm$ 0.05E+7 y		α 100
		248	0+	67.394 (5)	3.48E+5 $\pm$ 0.06E+5 y		SF 8.39; α 91.61
		249	1/2+	70.751 (5)	64.15 ± 0.03 m		β^- 100
		250	0+	72.99 (11)	$\approx$ 8.3E+3 y		$SF \approx 74.00$; $\alpha \approx 18.00$; $\beta^- \approx 8.00$
		251	(1/2+)	76.65 (23)	16.8 ± 0.2 m		β^- 100
		252	0+	79.1 (3)	< 2 d		
97	**Bk**	234	0	()	1.4E2 +1.4E2-0.5E2 s		$\alpha \geq 80.00$; $\epsilon \leq 20.00$
		237	0	53.1 (22)	≈ 1 m		ϵ ?; α ?
		238	0	54.3 (3)	144 ± 5 s		ϵ 100; ϵSF 0.048
		240	0	55.66 (15)	4.8 ± 0.8 m		ϵ ; ϵSF 0.002
		241	(7/2+)	56.11 (20)	4.6 ± 0.4 m		α ; ϵ
		242	0	57.74 (20)	7.0 ± 1.3 m		$\epsilon \leq 100.00$
		243	(3/2-)	58.692 (5)	4.5 ± 0.2 h		$\epsilon \approx 99.85$; $\alpha \approx 0.15$
		244	(4-)	60.717 (14)	4.35 ± 0.15 h		ϵ 99.99; α 0.006
		245	3/2-	61.8168 (23)	4.95 ± 0.03 d		ϵ 99.88; α 0.12
		246	2(-)	63.97 (6)	1.80 ± 0.02 d		ϵ 100
		247	(3/2-)	65.492 (6)	1380 ± 250 y		$\alpha \leq 100.00$
		248	0	68.08 (7)	> 9 y		α ; β^- 70; ϵ 30
		249	7/2+	69.851 (3)	330 ± 4 d		β^- 100; α 0.0014; SF 4.7e-08
		250	2-	72.953 (4)	3.212 ± 0.005 h		β^- 100
		251	(3/2-)	75.23 (11)	55.6 ± 1.1 m		β^- 100
98	**Cf**	237	(3/2+)	57.94 (9)	0.8 ± 0.2 s		SF 70; α 30
		238	0+	57.2 (4)	21 ± 2 ms		SF 100
		239	0	58.14 (21)	39 +37-12 s		ϵ ; α
		240	0+	58.01 (3)	64 ± 9 s		α 98.5; SF 1.5
		241	(7/2-)	59.33 (17)	3.78 ± 0.7 m		$\epsilon \approx 75.00$; $\alpha \approx 25.00$
		242	0+	59.386 (13)	3.7 ± 0.5 m		ϵ 20; $SF \leq 0.01$; α 80
		243	(1/2+)	60.9 (11)	10.7 ± 0.5 m		$\epsilon \approx 86.00$; $\alpha \approx 14.00$
		244	0+	61.473 (3)	19.4 ± 0.6 m		$\alpha \leq 100.00$
		245	1/2+	63.388 (3)	45.0 ± 1.5 m		ϵ 64.7; α 35.3
		246	0+	64.0931 (21)	35.7 ± 0.5 h		α 100; $\epsilon <$ 4.0E-3; SF 0.00024
		247	(7/2+)	66.104 (15)	3.11 ± 0.03 h		ϵ 99.97; α 0.04
		248	0+	67.241 (5)	333.5 ± 2.8 d		α 100; SF 0.0029
		249	9/2-	69.7269 (22)	351 ± 2 y		α 100; SF 5e-07
		250	0+	71.173 (21)	13.08 ± 0.09 y		α 99.92; SF 0.08
		251	1/2+	74.137 (4)	898 ± 44 y		α 100; SF
		252	0+	76.035 (5)	2.645 ± 0.008 y		α 96.91; SF 3.09
		253	(7/2+)	79.302 (6)	17.81 ± 0.08 d		β^- 99.69; α 0.31
		254	0+	81.342 (12)	60.5 ± 0.2 d		SF 99.69; α 0.31
		255	(7/2+)	84.81 (20)	85 ± 18 m		β^- 100

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		242	(1+)	57.42 (20)	2.2 ± 0.2 m		β^- 100; β^- 100
		243	(5/2-)	59.88 (3)	1.85 ± 0.15 m		β^- 100
		244	(7-)	63.2 (3)	2.29 ± 0.16 m		β^- 100
94	**Pu**	228	0+	36.08 (3)	1.1 +2-0.5 s		α 100
		229	(3/2+)	37.39 (5)	67 +41-19 s		ϵ 50; α 50; $SF < 7.00$
		230	0+	36.933 (15)	102 ± 10 s		$\alpha \leq 100.00$
		231	(3/2+)	38.28 (3)	8.6 ± 0.5 m		$\epsilon \leq 99.80$; $\alpha > 0.20$
		232	0+	38.365 (18)	33.8 ± 0.7 m		ϵ 90; α 10
		233	0	40.05 (5)	20.9 ± 0.4 m		ϵ 99.88; α 0.12
		234	0+	40.349 (7)	8.8 ± 0.1 h		$\alpha \approx 6.00$; $\epsilon \approx 94.00$
		235	(5/2+)	42.184 (21)	25.3 ± 0.5 m		ϵ 100; α 0.0028
		236	0+	42.8968 (22)	2.858 ± 0.008 y		α 100; SF 1.9e-07
		237	7/2-	45.0946 (22)	45.64 ± 0.04 d		ϵ 100; α 0.0042
		237m	1/2+	45.2406 (22)	0.18 ± 0.02 s		IT
		238	0+	46.1661 (18)	87.7 ± 0.1 y		α 100; SF 1.9e-07
		239	1/2+	48.5912 (18)	24110 ± 30 y		SF 3e-10; α 100
		240	0+	50.1283 (18)	6561 ± 7 y		α 100; SF 5.7e-06
		241	5/2+	52.9581 (18)	14.325 ± 0.006 y		β^- 100; α 0.0025; $SF <$ 2E-14
		242	0+	54.7196 (19)	3.75E+5 ± 0.02E+5 y		α 100; SF 0.00055
		243	7/2+	57.757 (3)	4.956 ± 0.003 h		β^- 100
		244	0+	59.807 (5)	8.00E+7 ± 0.09E+7 y		SF 0.12; α 99.88
		245	(9/2-)	63.179 (14)	10.5 ± 0.1 h		β^- 100
		246	0+	65.396 (15)	10.84 ± 0.02 d		β^- 100
		247	0	69.11 (20)	2.27 ± 0.23 d		β^- 100
95	**Am**	230	0	()	≈ 17 s		ϵ 100
		232	0	43.4 (3)	79 ± 2 s		$\epsilon \approx 97.00$; $\alpha \approx 3.00$
		233	0	43.17 (10)	3.2 ± 0.8 m		$\alpha > 3.00$; ϵ
		234	0	44.53 (21)	2.32 ± 0.08 m		ϵ 100; α
		235	5/2-	44.63 (5)	10.3 ± 0.6 m		ϵ 99.6; α 0.4
		236	5-	46.04 (11)	3.6 ± 0.2 m		α ; ϵ ; α ; ϵ
		237	5/2(-)	46.57 (6)	73.6 ± 0.8 m		ϵ 99.97; α 0.03
		238	1+	48.42 (5)	98 ± 2 m		α 0.0001; ϵ 100
		239	(5/2)-	49.3931 (24)	11.9 ± 0.1 h		ϵ 99.99; α 0.01
		240	(3-)	51.513 (14)	50.8 ± 0.3 h		ϵ 100; α 0.00019
		241	5/2-	52.9373 (18)	432.6 ± 0.6 y		α 100; SF 4e-10
		242	1-	55.471 (18)	16.02 ± 0.02 h		β^- 82.7; ϵ 17.3
		242m	5-	55.5196 (18)	141 ± 2 y		IT 99.55; α 0.45; $SF <$ 4.7E-9
		242m2	(2+,3-)	57.671 (18)	14.0 ± 1 ms		SF 100; IT ; $\alpha <$ 5.0E-3
		243	5/2-	57.1774 (23)	7370 ± 40 y		α 100; SF 3.7e-09
		244	(6-)	59.8823 (21)	10.1 ± 0.1 h		β^- 100; $SF \leq 100.00$
		244m	1+	59.9684 (21)	26 ± 1 m		ϵ 0.04; β^- 99.96
		245	(5/2)+	61.901 (3)	2.05 ± 0.01 h		β^- 100
		246	(7-)	64.996 (18)	39 ± 3 m		β^- 100; β^- 100; $IT <$ 0.02
		247	(5/2)	67.16 (10)	23.0 ± 1.3 m		β^- 100
		248	0	70.56 (20)	≈ 10 m		β^- 100
96	**Cm**	233	(3/2+)	47.29 (7)	23 +13-6 s		ϵ 80; α 20
		234	0+	46.723 (18)	51 ± 12 s		$SF \approx 40.00$; $\epsilon \approx 20.00$; $\alpha \approx 40.00$
		238	0+	49.444 (12)	2.4 ± 0.1 h		$\epsilon \geq 90.00$; $\alpha \leq 10.00$
		239	(7/2-)	51.15 (5)	≈ 2.9 h		ϵ 100; $\alpha < 0.10$

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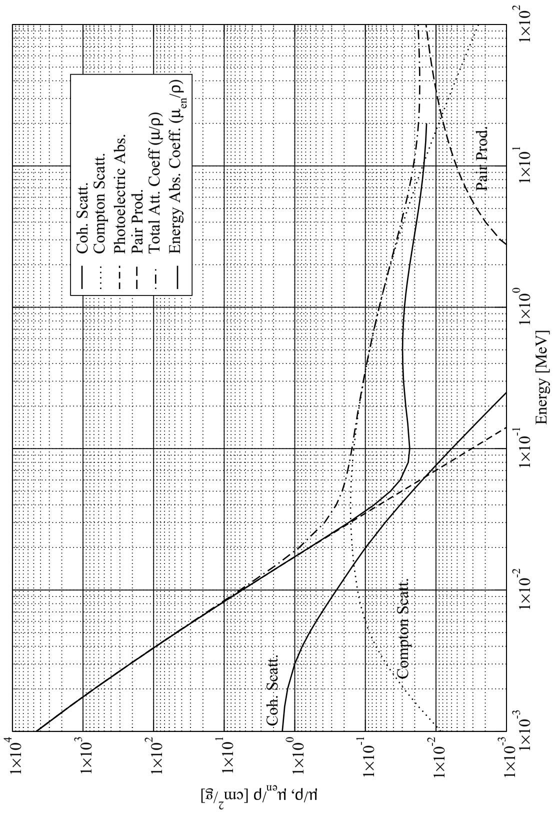

Figure 2.4: Mass attenuation (μ/ρ) and mass energy absorption coefficients (μ_{en}/ρ) for Oxygen, $Z = 8$.

Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		225	(3/2-)	21.638 (5)	10.0 ± 0.1 d		α 100; ^{14}C 4e-12
		226	(1)	24.31 (3)	29.37 ± 0.12 h		β^- 83; ϵ 17; α 0.006
		227	3/2-	25.8512 (24)	21.772 ± 0.003 y		β^- 98.62; α 1.38
		228	3+	28.9 (3)	6.15 ± 0.02 h		β^- 100
		229	(3/2+)	30.75 (3)	62.7 ± 0.5 m		β^- 100
		230	(1+)	33.8 (3)	122 ± 3 s		β^- 100; $\beta^- SF$ 1.2e-06
		231	(1/2+)	35.92 (10)	7.5 ± 0.1 m		β^- 100
		232	(1+)	39.15 (10)	119 ± 5 s		β^- 100
		233	(1/2+)	41.48 (10)	145 ± 10 s		β^- 100
		234	0	45.05 (20)	44 ± 7 s		β^- 100
		235	0	47.6 (3)	60 ± 4 s		β^- 100
90	**Th**	208	0+	16.68 (3)	1.7 +1.7-0.6 ms		α 100
		209	(5/2-)	16.54 (9)	2.5 +1.7-0.7 ms		α
		210	0+	14.059 (19)	16 ± 4 ms		α 99; $\epsilon \approx 1.00$
		211	0	13.91 (7)	0.04 +0.03-0.01 s		α
		212	0+	12.097 (16)	31.7 ± 1.3 ms		α 100; $\epsilon \approx 0.30$
		213	0	12.12 (7)	144 ± 21 ms		$\alpha \leq 100.00$
		214	0+	10.711 (16)	87 ± 10 ms		α 100
		215	(1/2-)	10.922 (9)	1.2 ± 0.2 s		α 100
		216	0+	10.294 (12)	26.0 ± 0.2 ms		α 100; $\epsilon \approx 0.01$
		221	(7/2+)	16.937 (9)	1.68 ± 0.06 ms		α 100
		222	0+	17.202 (12)	2.8 ± 0.3 ms		α 100
		223	(5/2)+	19.385 (9)	0.60 ± 0.02 s		α 100
		224	0+	19.995 (11)	0.81 ± 0.1 s		α 100
		225	(3/2+)	22.309 (5)	8.75 ± 0.04 m		$\alpha \approx 90.00$; $\epsilon \approx 10.00$
		226	0+	23.196 (5)	30.57 ± 0.1 m		α 100
		227	1/2+	25.806 (3)	18.68 ± 0.09 d		α 100
		228	0+	26.7663 (22)	1.9116 ± 0.0016 y		α 100; ^{20}O 1e-11
		229	5/2+	29.588 (3)	7932 ± 28 y		α 100
		229m	(3/2+)	29.588 (3)	2 ± 1 m		IT ?
		230	0+	30.8633 (18)	7.54E+4 ± 0.03E+4 y		α 100; ^{24}Ne 6e-11; $SF \leq$ 4E-12
		231	5/2+	33.8166 (18)	25.52 ± 0.01 h		β^- 100; $\alpha \approx$ 4E-11
		232	0+	35.4526 (22)	1.40E10 ± 0.01E10 y	100%	α 100; SF 1.1e-09
		233	1/2+	38.7376 (22)	21.83 ± 0.04 m		β^- 100
		234	0+	40.615 (4)	24.10 ± 0.03 d		β^- 100
		235	(1/2+)	44.26 (5)	7.2 ± 0.1 m		β^- 100
		236	0+	46.45 (20)	37.3 ± 1.5 m		β^- 100
		237	(5/2+)	50.2 (4)	4.7 ± 0.6 m		β^- 100
		238	0+	52.6 (3)	9.4 ± 2 m		β^- 100
91	**Pa**	212	0	21.61 (7)	5.1 +6.1-1.9 ms		α 100
		213	0	19.66 (7)	5.3 +4-1.6 ms		α 100
		214	0	19.49 (8)	17 ± 3 ms		$\alpha \leq 100.00$
		215	0	17.87 (9)	14 ± 2 ms		α 100
		216	0	17.8 (7)	0.15 +0.06-0.04 s		$\alpha \approx 98.00$; $\epsilon \approx 2.00$
		217	0	17.07 (5)	3.6 ± 0.8 ms		α 100
		217m	0	18.92 (5)	1.2 ± 0.2 ms		α 73; IT 27
		222	0	22.12 (7)	2.9 +0.6-0.4 ms		α 100
		223	0	22.32 (7)	5.1 ± 0.6 ms		α 100
		224	0	23.861 (8)	0.85 ± 0.02 s		α 100
		225	0	24.34 (7)	1.7 ± 0.2 s		α 100
		226	0	26.032 (11)	1.8 ± 0.2 m		α 74; ϵ 26
		227	(5/2-)	26.831 (7)	38.3 ± 0.3 m		α 85; ϵ 15

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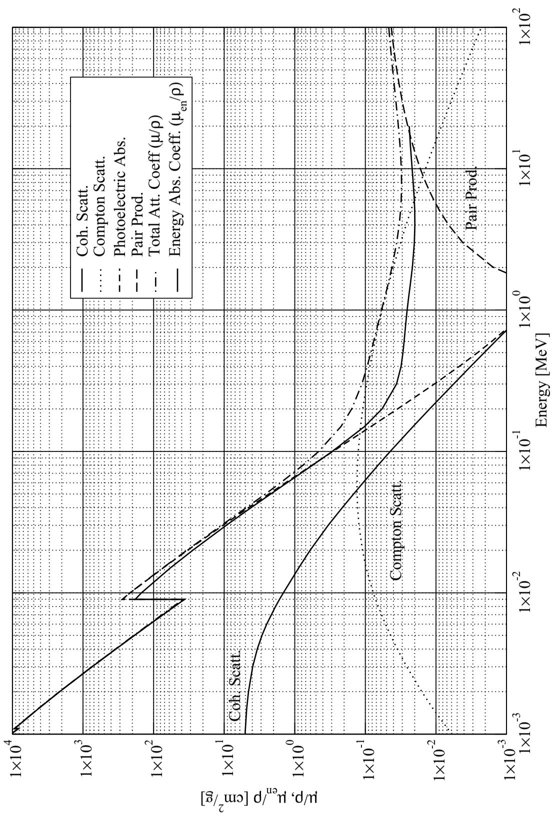

Figure 2.6: Mass attenuation (μ/ρ) and mass energy absorption coefficients (μ_{en}/ρ) for Copper, $Z = 29$.

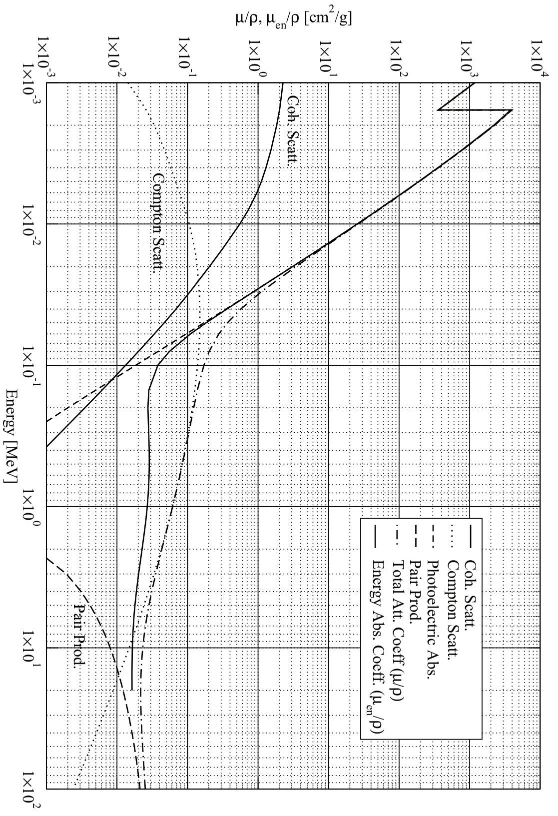

Figure 2.5: Mass attenuation (μ/ρ) and mass energy absorption coefficients (μ_{en}/ρ) for Aluminum, $Z = 13$.

Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		228	3+	28.921 (4)	22.4 ± 1 h		α 1.85; ϵ 98.15
		229	(5/2+)	29.898 (3)	1.50 ± 0.05 d		ϵ 99.52; α 0.48
		230	(2-)	32.174 (3)	17.4 ± 0.5 d		ϵ 92.2; β^- 7.8; α 0.0032
		231	3/2-	33.4259 (22)	3.276E+4 ± 0.011E+4 y		α 100; $SF \leq$ 2E-11
		232	(2-)	35.942 (8)	1.32 ± 0.02 d		β^- 100; ϵ
		233	3/2-	37.4915 (21)	26.975 ± 0.013 d		β^- 100
		234	4+	40.342 (5)	6.70 ± 0.05 h		β^- 100
		234m	(0-)	40.416 (5)	1.159 ± 0.011 m		β^- 99.84; IT 0.16
		235	(3/2-)	42.33 (5)	24.44 ± 0.11 m		β^- 100
		236	1(-)	45.35 (20)	9.1 ± 0.1 m		β^- 100
		237	(1/2+)	47.64 (10)	8.7 ± 0.2 m		β^- 100
		238	(3-)	50.77 (6)	2.27 ± 0.09 m		β^- 100
		239	(3/2)	53.34 (20)	1.8 ± 0.5 h		β^- 100
92	**U**	217	0	22.71 (9)	16 +21-6 ms		$\alpha \leq$ 100.00
		225	0	27.376 (12)	95 ± 15 ms		α 100
		226	0+	27.328 (13)	0.35 ± 0.15 s		α 100
		227	(3/2+)	29.021 (17)	1.1 ± 0.1 m		α 100
		228	0+	29.224 (15)	9.1 ± 0.2 m		$\alpha >$ 95.00; $\epsilon <$ 5.00
		229	(3/2+)	31.21 (6)	58 ± 3 m		$\epsilon \approx$ 80.00; $\alpha \approx$ 20.00
		230	0+	31.614 (5)	20.8 ± 0 d		α 100; $SF <$ 1E-10; ^{22}Ne 5e-12
		231	(5/2-)	33.808 (3)	4.2 ± 0.1 d		ϵ 100; $\alpha \approx$ 4.0E-3
		232	0+	34.6048 (22)	68.9 ± 0.4 y		α 100; SF 3e-12
		233	5/2+	36.921 (3)	1.592E+5 ± 0.002E+5 y		α 100; ^{24}Ne 9e-10; $SF <$ 6E-11; $^{28}Mg <$ 1.E-13
		234	0+	38.148 (18)	2.455E+5 ± 0.006E+5 y	0.0054% ± 0.0005%	Ne 9e-12; α 100; SF 1.6e-09; Mg 1e-11
		235	7/2-	40.9218 (18)	7.04E+8 ± 0.01E+8 y	0.7204% ± 0.0006%	α 100; SF 7e-09; ^{28}Mg 8e-10; $Ne \approx$ 8.E-10
		235m	1/2+	40.9219 (18)	≈ 26 m		IT 100
		236	0+	42.4476 (18)	2.342E7 ± 0.004E7 y		α 100; SF 9.4e-08
		237	1/2+	45.3932 (19)	6.75 ± 0.01 d		β^- 100
		238	0+	47.31 (19)	4.468E9 ± 0.003E9 y	99.2742% ± 0.001%	α 100; SF 5.5e-05
		239	5/2+	50.575 (19)	23.45 ± 0.02 m		β^- 100
		240	0+	52.716 (5)	14.1 ± 0.1 h		β^- 100
		242	0+	58.62 (20)	16.8 ± 0.5 m		β^- 100
93	**Np**	226	0	32.74 (9)	35 ± 10 ms		α 100
		227	0	32.56 (7)	0.51 ± 0.06 s		α 100
		228	0	33.59 (5)	61.4 ± 1.4 s		ϵ 60; α 40
		229	0	33.78 (9)	4.0 ± 0.2 m		α 68; ϵ 32
		230	0	35.24 (5)	4.6 ± 0.3 m		$\epsilon \leq$ 97.00; $\alpha \geq$ 3.00
		231	(5/2)	35.62 (5)	48.8 ± 0.2 m		ϵ 98; α 2
		232	(4+)	37.35 (10)	14.7 ± 0.3 m		ϵ 100; α 0.0002
		233	(5/2+)	37.95 (5)	36.2 ± 0.1 m		ϵ 100; $\alpha \leq$ 1.0E-3
		234	(0+)	39.958 (9)	4.4 ± 0.1 d		ϵ 100
		235	5/2+	41.0458 (20)	396.1 ± 1.2 d		ϵ 100; α 0.0026
		236	(6-)	43.37 (5)	153E+3 ± 5E+3 y		ϵ 86.3; β^- 13.5; α 0.16; β^- 50; ϵ 50
		237	5/2+	44.8746 (18)	2.144E+6 ± 0.007E+6 y		α 100; $SF \leq$ 2E-10
		238	2+	47.4576 (18)	2.117 ± 0.002 d		β^- 100
		239	5/2+	49.3137 (21)	2.356 ± 0.003 d		β^- 100
		240	(5+)	52.316 (15)	61.9 ± 0.2 m		β^- 100; β^- 99.88; IT 0.12
		241	5/2+	54.26 (7)	13.9 ± 0.2 m		β^- 100

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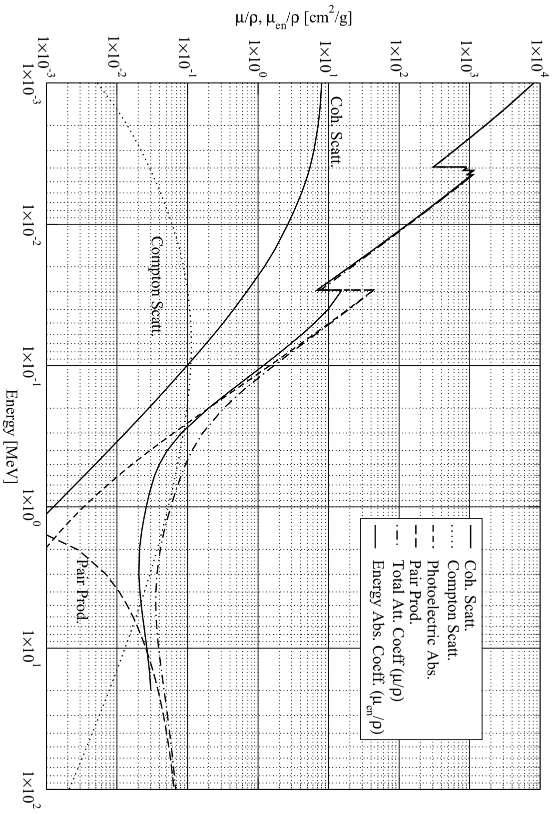

Figure 2.7: Mass attenuation (μ/ρ) and mass energy absorption coefficients (μ_{en}/ρ) for Tin, $Z = 50$.

Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		231	(1/2+)	42.3 (3)	17.6 ± 0.6 s		β^- 100
		232	(5)	46.1 (21)	5.5 ± 0.6 s		β^- 100
88	**Ra**	201	(13/2+)	11.84 (12)	1.6 +7.7-0.7 ms		α 100; ϵ
		202	0+	9.09 (24)	16 +30-7 ms		α 100
		203	(3/2-)	8.66 (8)	31 +17-9 ms		α 100; α 100
		204	0+	6.056 (15)	57 +11-5 ms		α 100
		205	(3/2-)	5.84 (7)	210 +60-40 ms		$\alpha \leq$ 100.00; ϵ ; $\alpha \leq$ 100.00; ϵ
		206	0+	3.565 (18)	0.24 ± 0.02 s		α 100
		207	(3/2- ,5/2-)	3.54 (6)	1.35 +0.22-0.13 s		$\alpha \approx$ 86.00; $\epsilon \approx$ 14.00
		207m	(13/2+)	4.09 (6)	59 ± 4 ms		$IT \geq$ 85.00; $\alpha \leq$ 15.00
		208	0+	1.714 (15)	1.3 ± 0.2 s		α 95; ϵ 5
		209	5/2-	1.85 (5)	4.6 ± 0.2 s		$\alpha \approx$ 90.00; $\epsilon \approx$ 10.00
		210	0+	0.459 (15)	3.7 ± 0.2 s		$\alpha \approx$ 96.00; $\epsilon \approx$ 4.00
		211	5/2(-)	0.832 (8)	13 ± 2 s		$\epsilon <$ 7.00; $\alpha >$ 93.00
		212	0+	-0.204 (11)	13.0 ± 0.2 s		$\alpha \approx$ 85.00; $\epsilon \approx$ 15.00
		213	1/2-	0.358 (20)	2.73 ± 0.05 m		α 80; ϵ 20
		213m	(17/2-)	2.128 (20)	2.20 ± 0.05 ms		$IT \approx$ 99.40; $\alpha \approx$ 0.60
		214	0+	0.096 (5)	2.46 ± 0.03 s		α 99.94; ϵ 0.06
		215	(9/2+)	2.533 (8)	1.55 ± 0.07 ms		α 100
		219	(7/2)+	9.393 (8)	10 ± 3 ms		α 100
		220	0+	10.272 (9)	18 ± 2 ms		α 100
		221	5/2+	12.963 (5)	28 ± 2 s		α 100; ^{14}C 1e-12
		222	0+	14.32 (5)	38.0 ± 0.5 s		α 100; ^{14}C 3e-08
		223	3/2+	17.235 (3)	11.43 ± 0.05 d		^{14}C 8.9e-08; α 100
		224	0+	18.8213 (22)	3.6319 ± 0.0023 d		α 100; ^{14}C 4e-09
		225	1/2+	21.995 (3)	14.9 ± 0.2 d		β^- 100
		226	0+	23.6686 (23)	1600 ± 7 y		α 100; ^{14}C 3.2e-09
		227	3/2+	27.1785 (23)	42.2 ± 0.5 m		β^- 100
		228	0+	28.946 (3)	5.75 ± 0.03 y		β^- 100
		229	5/2+	32.555 (15)	4.0 ± 0.2 m		β^-
		230	0+	34.516 (10)	93 ± 2 m		β^- 100
		231	(5/2+)	38.226 (20)	104.1 ± 0.8 s		β^- 100
		232	0+	40.498 (12)	4.2 ± 0.8 m		β^- 100
		233	0	44.6 (4)	30 ± 5 s		β^- 100
		234	0+	47.2 (5)	30 ± 10 s		β^- 100
89	**Ac**	206	(3+)	13.53 (5)	22 +9-5 ms		α 100; α 100
		207	(9/2-)	11.15 (5)	27 +11-6 ms		α 100
		208	(3+)	10.76 (6)	95 +24-16 ms		$\alpha \approx$ 99.00; $\epsilon \approx$ 1.00
		208m	(10-)	11.27 (6)	25 +9-5 ms		$\epsilon \approx$ 10.00; $\alpha \approx$ 90.00
		209	(9/2-)	8.84 (5)	0.10 ± 0.05 s		$\alpha \approx$ 99.00; $\epsilon \approx$ 1.00
		210	0	8.79 (6)	0.35 ± 0.05 s		α 91; $\epsilon \approx$ 9.00
		211	0	7.2 (7)	0.21 ± 0.03 s		α 100
		212	0	7.27 (7)	0.93 ± 0.05 s		$\alpha \approx$ 57.00; $\epsilon \approx$ 43.00
		213	0	6.16 (5)	738 ± 16 ms		$\alpha \leq$ 100.00
		214	(5+)	6.445 (15)	8.2 ± 0.2 s		$\alpha \geq$ 89.00; $\epsilon \leq$ 11.00
		215	9/2-	6.031 (12)	0.17 ± 0.01 s		α 99.91; ϵ 0.09
		220	(3-)	13.743 (6)	26.4 ± 0.2 ms		α 100; ϵ 0.0005
		221	(3/2-)	14.52 (5)	52 ± 2 ms		α 100
		222	1-	16.621 (5)	5.0 ± 0.5 s		α 99; ϵ 1; $\alpha \geq$ 88.00; $IT \leq$ 10.00; $\epsilon \geq$ 0.70
		223	(5/2-)	17.826 (7)	2.10 ± 0.05 m		α 99; ϵ 1
		224	0-	20.232 (4)	2.78 ± 0.17 h		ϵ 90.9; α 9.1; $\beta^- <$ 1.60

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Z	El	A	J^{π}	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		208	0+	-9.66 (11)	24.35 ± 0.14 m		α 62; ϵ 38
		209	5/2-	-8.929 (20)	28.5 ± 1 m		ϵ 83; α 17
		210	0+	-9.601 (4)	2.4 ± 0.1 h		α 96; ϵ 4
		211	1/2-	-8.756 (7)	14.6 ± 0.2 h		ϵ 72.6; α 27.4
		212	0+	-8.66 (3)	23.9 ± 1.2 m		α 100
		213	(9/2+)	-5.699 (6)	19.5 ± 0.1 ms		α 100
		218	0+	5.2166 (24)	35 ± 5 ms		α 100
		219	5/2+	8.831 (3)	3.96 ± 0.01 s		α 100
		220	0+	10.6075 (22)	55.6 ± 0.1 s		α 100
		221	7/2+	14.474 (6)	25 ± 2 m		β^- 78; α 22
		222	0+	16.3731 (23)	3.8235 ± 3.0E-4 d		α 100
		223	7/2	20.396 (10)	24.3 ± 0.4 m		β^- 100
		224	0+	22.435 (15)	107 ± 3 m		β^- 100
		225	7/2-	26.556 (21)	4.66 ± 0.04 m		β^- 100
		226	0+	28.739 (16)	7.4 ± 0.1 m		β^- 100
		227	0	32.875 (18)	20.8 ± 0.7 s		β^- 100
		228	0+	35.249 (22)	65 ± 2 s		β^- 100
		229	0	39.362 (13)	12.0 +1.2-1.3 s		β^- 100
87	**Fr**	199	0	6.76 (4)	12 +10-4 ms		$\alpha > 0.00$; ϵ
		200	(3+)	6.12 (8)	49 ± 4 ms		α 100
		201	(9/2-)	3.6 (7)	62 ± 5 ms		α 100; α 100
		202	(3+)	3.163 (15)	0.30 ± 0.05 s		α 100; α 100
		203	(9/2-)	0.877 (6)	0.55 ± 0.01 s		$\alpha \leq 100.00$
		204	(3+)	0.607 (25)	1.8 ± 0.3 s		ϵ 8; α 92
		204m	(7+)	0.648 (25)	1.6 +0.5-0.3 s		α 90; ϵ 10
		204m2	(10-)	0.923 (25)	0.8 ± 0.2 s		α 74; ϵ 26
		205	(9/2-)	-1.31 (8)	3.97 ± 0.04 s		α 98.5; ϵ 1.5
		206	(2+,3+)	-1.24 (3)	≈ 16 s		$\alpha \approx 84.00$; $\epsilon \approx 16.00$; $\alpha \approx 84.00$; $\epsilon \approx 16.00$
		206m	(10-)	-0.71 (3)	0.7 ± 0.1 s		IT 95; α 5
		207	9/2-	-2.84 (5)	14.8 ± 0.1 s		α 95; ϵ 5
		208	7+	-2.67 (5)	59.1 ± 0.3 s		α 89; ϵ 11
		209	9/2-	-3.769 (15)	50.5 ± 0.7 s		α 89; ϵ 11
		210	6+	-3.332 (15)	3.18 ± 0.06 m		α 71; ϵ 29
		211	9/2-	-4.14 (12)	3.10 ± 0.02 m		α 87; ϵ 13
		212	5+	-3.516 (9)	20.0 ± 0.6 m		ϵ 57; α 43
		213	9/2-	-3.553 (5)	34.82 ± 0.14 s		α 99.44; ϵ 0.56
		214	(1-)	-0.959 (9)	5.0 ± 0.2 ms		α 100
		214m	(8-)	-0.837 (9)	3.35 ± 0.05 ms		α 100
		218	1-	7.058 (5)	1.0 ± 0.6 ms		α 100
		218m	0	7.144 (5)	22.0 ± 0.5 ms		$\alpha \leq 100.00$; IT
		219	9/2-	8.618 (7)	20 ± 2 ms		α 100
		220	1+	11.48 (4)	27.4 ± 0.3 s		α 99.65; β^- 0.35
		221	5/2-	13.278 (5)	286.1 ± 1 s		α 100; $\beta^- < 0.10$
		222	2-	16.349 (21)	14.2 ± 0.3 m		β^- 100
		223	3/2(-)	18.384 (24)	22.00 ± 0.07 m		β^- 99.99; α 0.006
		224	1-	21.65 (5)	3.33 ± 0.1 m		β^- 100
		225	3/2-	23.82 (3)	3.95 ± 0.14 m		β^- 100
		226	1-	27.37 (10)	49 ± 1 s		β^- 100
		227	1/2+	29.65 (10)	2.47 ± 0.03 m		β^- 100
		228	2-	33.29 (20)	38 ± 1 s		$\beta^- \leq 100.00$
		229	(1/2+)	35.82 (4)	50.2 ± 2 s		β^- 100
		230	0	39.5 (3)	19.1 ± 0.5 s		β^- 100

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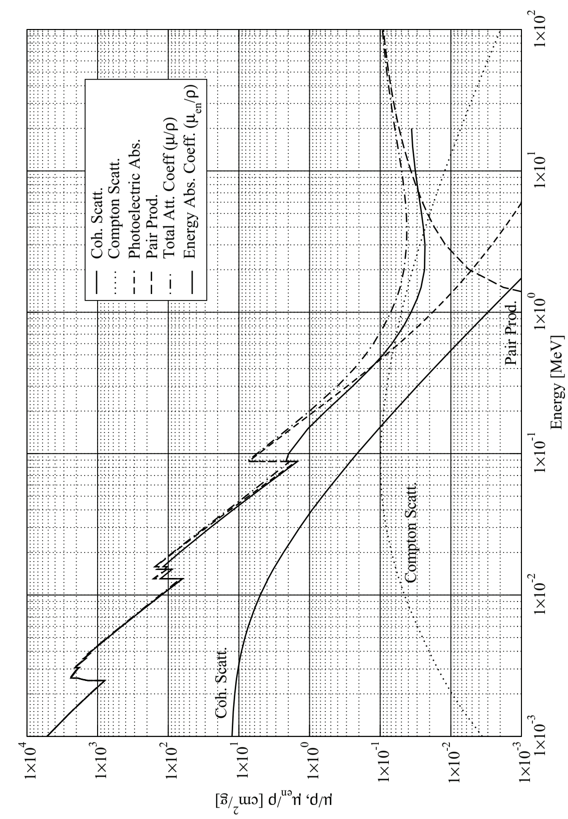

Figure 2.8: Mass attenuation (μ/ρ) and mass energy absorption coefficients (μ_{en}/ρ) for Lead, $Z = 82$.

Table 8.1 – *Continued from previous page*

Z	El	A	J^{π}	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		215	(9/2-)	1.649 (15)	7.6 ± 0.2 m		β^- 100
		215m	>23/2-	2.996 (15)	36.9 ± 0.6 s		IT 76.2; β^- 23.8
		216	(6-,7-)	5.874 (11)	2.25 ± 0.05 m		$\beta^- \leq 100.00$; $\beta^- \leq 100.00$
		217	(9/2-)	8.89 (20)	98.5 ± 0.8 s		β^- 100
		218	0	13.2 (4)	33 ± 1 s		β^- 100
84	**Po**	187	(1/2-,5/2-)	2.83 (3)	1.40 ± 0.25 ms		α 100
		189	(7/2-)	-1.42 (19)	3.5 ± 0.5 ms		α 100
		190	0+	-4.564 (13)	2.46 ± 0.05 ms		α 100
		191	(3/2-)	-5.055 (12)	22 ± 1 ms		α 99
		191m	(13/2+)	-5.015 (12)	93 ± 3 ms		α 96
		192	0+	-8.071 (11)	32.2 ± 0.3 ms		$\alpha \approx 99.50$; $\epsilon \approx 0.50$
		193	(13/2+)	-8.36 (3)	245 ± 22 ms		$\alpha \leq 100.00$; $\alpha \leq 100.00$
		194	0+	-11.006 (13)	0.392 ± 0.004 s		α 100; ϵ
		195	(3/2-)	-11.07 (4)	4.64 ± 0.09 s		α 75; ϵ 25
		195m	(13/2+)	-10.84 (4)	1.92 ± 0.02 s		$\alpha \approx 90.00$; $\epsilon \approx 10.00$; $IT < 0.01$
		196	0+	-13.474 (13)	5.8 ± 0.2 s		$\alpha \approx 98.00$; $\epsilon \approx 2.00$
		197	(3/2-)	-13.36 (5)	84 ± 16 s		ϵ 56; α 44
		197m	(13/2+)	-13.15 (5)	32 ± 2 s		α 84; ϵ 16; IT 0.01
		198	0+	-15.474 (17)	1.77 ± 0.03 m		α 57; ϵ 43
		199	(3/2-)	-15.215 (23)	5.47 ± 0.15 m		ϵ 92.5; α 7.5
		199m	(13/2+)	-14.905 (23)	4.17 ± 0.05 m		IT 2.5; ϵ 73.5; α 24
		200	0+	-16.955 (14)	11.51 ± 0.08 m		ϵ 88.9; α 11.1
		201	3/2-	-16.525 (6)	15.6 ± 0.1 m		ϵ 98.87; α 1.13
		201m	13/2+	-16.101 (6)	8.96 ± 0.12 m		IT 56.2; ϵ 41.4; α 2.4
		202	0+	-17.925 (15)	44.6 ± 0.4 m		ϵ 98.08; α 1.92
		203	5/2-	-17.311 (9)	36.7 ± 0.5 m		ϵ 99.89; α 0.11
		203m	13/2+	-16.669 (9)	45 ± 2 s		IT 100; ϵ
		204	0+	-18.346 (11)	3.519 ± 0.012 h		ϵ 99.33; α 0.67
		205	5/2-	-17.509 (20)	1.74 ± 0.08 h		ϵ 99.96; α 0.04
		205m2	19/2-	-16.048 (20)	57.4 ± 0.9 ms		IT 100
		206	0+	-18.185 (3)	8.8 ± 0.1 d		α 5.45; ϵ 94.55
		207	5/2-	-17.146 (7)	5.80 ± 0.02 h		ϵ 99.98; α 0.02
		207m	19/2-	-15.763 (7)	2.79 ± 0.08 s		IT 100
		208	0+	-17.4703 (18)	2.898 ± 0.002 y		α 100; ϵ 0.004
		209	1/2-	-16.3667 (18)	102 ± 5 y		α 99.52; ϵ 0.48
		210	0+	-15.9538 (12)	138.376 ± 0.002 d		α 100
		211	9/2+	-12.4333 (13)	0.516 ± 0.003 s		α 100
		211m	(25/2+)	-10.9713 (13)	25.2 ± 0.6 s		IT 0.02; α 99.98
		212m	(18+)	-7.4482 (13)	45.1 ± 0.6 s		α 99.93; IT 0.07
		215	9/2+	-0.54 (3)	1.781 ± 0.004 ms		α 100; β^- 0.00023
		216	0+	1.778 (22)	0.145 ± 0.002 s		α 100
		217	(9/2+)	5.886 (6)	1.53 ± 0.05 s		α
		218	0+	8.3578 (23)	3.098 ± 0.012 m		α 99.98; β^- 0.02
		221	0	19.78 (6)	112 +58-28 s		β^- ?
		222	0+	22.48 (7)	550 ± 430 s		β^- ?
85	**At**	191	(1/2+)	3.862 (16)	1.7 +1.1-0.5 ms		α 100
		191m	(7/2-)	3.917 (16)	2.1 +0.4-0.3 ms		α 100
		192	0	2.92 (6)	11.5 ± 0.6 ms		α 100; α 100
		193	(1/2+)	-0.07 (5)	28 +5-4 ms		α 100
		193m	(7/2-)	-0.06 (5)	21 ± 5 ms		α 100
		193m2	(13/2+)	0 (AP)	27 +4-3 ms		IT 76; α 24

Continued on next page

Chapter 3

Energy diagrams

Compound nucleus reaction can be understood as a three stage process on which an excited nucleus is formed by the absorption of the incident particle, followed by the decay of this nucleus.

Conservation of mass-energy in these processes can be visualized in the following diagram. Below the diagram, the *Q equation* for non-relativistic collisions is shown. This equation combines conservation of energy and linear momentum for collisions for a target that is at rest in the laboratory system.

Source: Meyerhof, W. Elements of Nuclear Physics. McGraw-Hill, 1967.

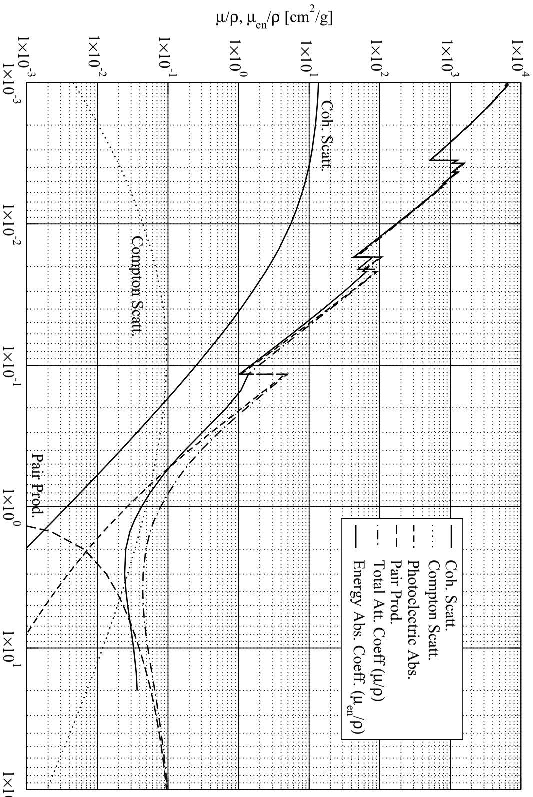

Figure 2.9: Mass attenuation (μ/ρ) and mass energy absorption coefficients (μ_{en}/ρ) for Uranium, $Z = 92$.

Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		194	(9-10-)	-0.7 (3)	310 ± 8 ms		α ; α
		195	1/2+	-3.476 (9)	328 ± 20 ms		α 100; α 100
		196	(3+)	-3.92 (6)	0.388 ± 0.007 s		$\alpha \approx 95.10$; $\epsilon \approx 4.90$
		197	(9/2-)	-6.34 (5)	0.388 ± 0.006 s		α 96.1; ϵ 3.9
		197m	(1/2+)	-6.29 (5)	2.0 ± 0.2 s		$\alpha \leq 100.00$; ϵ ; $IT \leq$ 4.0E-3
		198	(3+)	-6.65 (15)	3.8 ± 0.4 s		α 90; ϵ 10
		198m	(10-)	-6.548 (15)	1.04 ± 0.15 s		α 84; ϵ 16
		199	(9/2-)	-8.822 (6)	7.03 ± 0.15 s		α 90; ϵ 10
		200	(3+)	-8.988 (24)	43 ± 1 s		α 52; ϵ 48
		200m	(7+)	-8.876 (24)	47 ± 1 s		$\epsilon \leq 57.00$; α 43
		200m2	(10-)	-8.644 (24)	7.3 +2.6-1.5 s		$\epsilon < 89.50$; $IT < 89.50$; $\alpha \approx 10.50$
		201	(9/2-)	-10.789 (8)	85.2 ± 1.6 s		α 71; ϵ 29
		202	(2+,3+)	-10.59 (3)	184 ± 1 s		ϵ 63; α 37; ϵ 91.3; α 8.7
		202m	(10-)	-10.2 (3)	0.46 ± 0.05 s		IT 99.9; α 0.1
		203	9/2-	-12.164 (12)	7.4 ± 0.2 m		ϵ 69; α 31
		204	7+	-11.876 (24)	9.12 ± 0.11 m		α 3.91; ϵ 96.09
		204m	10-	-11.289 (24)	108 ± 10 ms		IT 100
		205	9/2-	-12.971 (15)	26.9 ± 0.8 m		ϵ 90; α 10
		206	(5)+	-12.429 (15)	30.6 ± 0.8 m		ϵ 99.1; α 0.9
		207	9/2-	-13.227 (12)	1.81 ± 0.03 h		ϵ 91.4; α 8.6
		208	6+	-12.47 (9)	1.63 ± 0.03 h		ϵ 99.45; α 0.55
		209	9/2-	-12.883 (5)	5.41 ± 0.05 h		ϵ 95.9; α 4.1
		210	(5)+	-11.973 (8)	8.1 ± 0.4 h		ϵ 99.82; α 0.18
		211	9/2-	-11.648 (3)	7.214 ± 0.007 h		ϵ 58.2; α 41.8
		212	(1-)	-8.6289 (24)	0.314 ± 0.002 s		α 100; $\epsilon < 0.03$; $\beta^- <$ 2.0E-6
		212m	(9-)	-8.4059 (24)	0.119 ± 0.003 s		$\alpha > 99.00$; $IT < 1.00$
		217	9/2-	4.396 (5)	32.3 ± 0.4 ms		α 99.99; β^- 0.007
		218	0	8.098 (12)	1.5 ± 0.3 s		α 99.9; β^- 0.1
		219	0	10.397 (4)	56 ± 3 s		$\beta^- \approx 3.00$; $\alpha \approx 97.00$
		220	3	14.35 (5)	3.71 ± 0.04 m		β^- 92; α 8
		221	0	16.81 (20)	2.3 ± 0.2 m		β^- 100
		222	0	20.6 (3)	54 ± 10 s		β^- 100
		223	0	23.4 (4)	50 ± 7 s		β^- 100
		224	0	27.71 (6)	76 ± 0 s		β^- ?
86	**Rn**	193	(3/2-)	9.045 (23)	1.15 ± 0.27 ms		α 100
		195	3/2-	5.06 (5)	6 +3-2 ms		α 100
		195m	13/2+	5.12 (5)	5 +3-2 ms		α 100
		196	0+	1.97 (14)	4.4 +1.3-0.9 ms		α 99.9; $\epsilon \approx 0.10$
		197	(3/2-)	1.48 (6)	53 +7-5 ms		α 100; α 100
		198	0+	-1.231 (13)	65 ± 3 ms		α ; ϵ
		199	(3/2-)	-1.51 (6)	0.59 ± 0.03 s		α 94; ϵ 6
		199m	(13/2+)	-1.33 (6)	0.31 ± 0.02 s		α 97; ϵ 3
		200	0+	-4.005 (13)	1.03 +0.2-0.11 s		α 86; ϵ 14
		201	(3/2-)	-4.07 (5)	7.0 ± 0.4 s		α ; ϵ ; α ; ϵ
		202	0+	-6.275 (18)	9.7 ± 0.1 s		α 78; ϵ 22
		203	(3/2-)	-6.16 (24)	44 ± 2 s		α 66; ϵ 34
		203m	(13/2+)	-5.798 (24)	26.9 ± 0.5 s		α 75; ϵ 25
		204	0+	-7.984 (15)	74.5 ± 1.4 s		α 72.4; ϵ 27.6
		205	5/2-	-7.71 (5)	170 ± 4 s		α 24.6; ϵ 75.4
		206	0+	-9.116 (15)	5.67 ± 0.17 m		α 62; ϵ 38
		207	5/2-	-8.635 (8)	9.25 ± 0.17 m		ϵ 79; α 21

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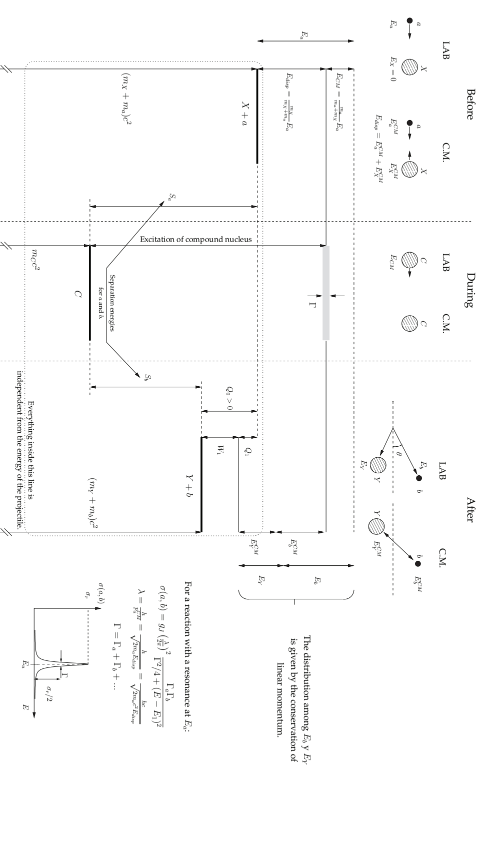

$Q_0 = Q_1 + W_1$

$Q_1 = E_b + E_Y - E_a$

$m_X + m_a = m_Y + m_b + Q_0/c^2$

$Q_0 = \Delta(m_X) + \Delta(m_a) - \Delta(m_Y) - \Delta(m_b)$

$$Q_1 = \left(1 + \frac{m_b}{m_Y}\right) E_b - \left(1 - \frac{m_a}{m_Y}\right) E_a - \frac{2\sqrt{m_a m_b}}{m_Y}\sqrt{E_a}\sqrt{E_b}\, cos\, \theta$$

Diagram for the exoergic reaction $X(a,b)Y^*$ in which particle a impinges with energy E_a on target X, which is at rest. The reaction produces an energy Q_1, emits particle b with energy E_b at an angle θ and leaves nucleus Y with excitation W_1. Nucleus Y recoils with energy E_Y.

Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		213	(9/2+)	-3.201 (7)	10.2 ± 0.3 m		β^- 100
		214	0+	-0.1816 (23)	26.8 ± 0.9 m		β^- 100
		215	0	4.5 (3)	147 ± 12 s		β^-
83	**Bi**	184	0	1.19 (8)	13 ± 2 ms		α 100; α 100
		186	(3+)	-3.17 (8)	15.0 ± 1.7 ms		α 100; α 100
		187	(9/2-)	-6.385 (10)	37 ± 2 ms		α 100
		188	(10-)	-7.2 (5)	265 ± 15 ms		α 100; ϵ ?; α 100; ϵ ?
		189	(9/2-)	-10.06 (5)	674 ± 11 ms		$\alpha > 50.00$; $\epsilon < 50.00$
		189m	(1/2+)	-9.88 (5)	5.0 ± 0.1 ms		$\alpha > 50.00$; $\epsilon < 50.00$
		190	(3+)	-10.59 (3)	6.3 ± 0.1 s		α 90; ϵ 10; α 70; ϵ 30
		191	(9/2-)	-13.24 (7)	12.4 ± 0.3 s		α 51; ϵ 49
		191m	(1/2+)	-12.999 (7)	125 ± 13 ms		α 68; IT 32; ϵ
		192	(3+)	-13.55 (3)	34.6 ± 0.9 s		ϵ 88; α 12
		192m	(10-)	-13.4 (3)	39.6 ± 0.4 s		ϵ 90; α 10
		193	(9/2-)	-15.873 (10)	63.6 ± 3 s		ϵ 96.5; α 3.5
		193m	(1/2+)	-15.565 (10)	3.2 ± 0.5 s		α 84; ϵ 16
		194	(3+)	-15.968 (15)	95 ± 3 s		ϵ 99.54; α 0.46; ϵ 100; ϵ 99.8; α 0.2
		195	(9/2-)	-18.026 (5)	183 ± 4 s		ϵ 99.97; α 0.03
		195m	(1/2+)	-17.625 (5)	87 ± 1 s		ϵ 67; α 33
		196	(3+)	-18.009 (24)	308 ± 12 s		ϵ 100; α 0.0012
		196m	(7+)	-17.84 (24)	0.6 ± 0.5 s		ϵ ; IT
		196m2	(10-)	-17.738 (24)	240 ± 3 s		ϵ 74.2; IT 25.8; α 0.00038
		197	(9/2-)	-19.687 (8)	9.33 ± 0.5 m		ϵ 100; α 0.0001
		197m	(1/2+)	-19.187 (8)	5.04 ± 0.16 m		α 55; ϵ 45; $IT < 0.30$
		198	(2+,3+)	-19.37 (3)	10.3 ± 0.3 m		ϵ 100; ϵ 100
		198m	10-	-19.12 (3)	7.7 ± 0.5 s		IT 100
		199	9/2-	-20.799 (12)	27 ± 1 m		ϵ 100
		199m	(1/2+)	-20.132 (12)	24.70 ± 0.15 m		ϵ 99; $IT \leq 2.00$; $\alpha \approx 0.01$
		200	7+	-20.371 (24)	36.4 ± 0.5 m		ϵ 100; $\epsilon \leq 100.00$
		200m	(10-)	-19.943 (24)	0.40 ± 0.05 s		IT 100
		201	9/2-	-21.416 (15)	103 ± 3 m		ϵ 100
		201m	1/2+	-20.569 (15)	57.5 ± 2.1 m		$\epsilon > 91.10$; $IT \leq 8.60$; $\alpha \approx 0.30$
		202	5+	-20.742 (15)	1.71 ± 0.04 h		ϵ 100
		203	9/2-	-21.524 (13)	11.76 ± 0.05 h		ϵ 100
		203m	1/2+	-20.426 (13)	305 ± 5 ms		IT 100
		204	6+	-20.646 (9)	11.22 ± 0.1 h		ϵ 100
		204m	10-	-19.84 (9)	13.0 ± 0.1 ms		IT 100
		204m2	17+	-17.812 (9)	1.07 ± 0.03 ms		IT 100
		205	9/2-	-21.065 (5)	15.31 ± 0.04 d		ϵ 100
		206	6+	-20.029 (8)	6.243 ± 0.003 d		ϵ 100
		207	9/2-	-20.0553 (24)	31.55 ± 0.04 y		ϵ 100
		208	5+	-18.8709 (24)	3.68E+5 ± 0.04E+5 y		ϵ 100
		208m	10-	-17.2998 (24)	2.58 ± 0.04 ms		IT 100
		209	9/2-	-18.2593 (15)	**stable**	100%	
		210	1-	-14.7926 (14)	5.012 ± 0.005 d		β^- 100; α 0.00013
		210m	9-	-14.5213 (14)	3.04E+6 ± 0.06E+6 y		α 100
		211	9/2-	-11.859 (5)	2.14 ± 0.02 m		α 99.72; β^- 0.28
		212	1(-)	-8.1201 (20)	60.55 ± 0.06 m		β^- 64.06; α 35.94
		212m	(8-,9-)	-7.8701 (20)	25.0 ± 0.2 m		α 67; β^- 33; $\beta^-\alpha$ 30
		212m2	—>16	-6.2101 (20)	7.0 ± 0.3 m		β^- 100
		213	9/2-	-5.23 (5)	45.59 ± 0.06 m		β^- 97.8; α 2.2
		214	1-	-1.201 (11)	19.9 ± 0.4 m		β^- 99.98; α 0.02

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		207	1/2+	-21.034 (5)	4.77 ± 0.03 m		β^- 100
		207m	11/2-	-19.686 (5)	1.33 ± 0.11 s		IT 100
		208	5+	-16.7523 (20)	3.053 ± 0.004 m		β^- 100
		209	(1/2+)	-13.638 (8)	2.161 ± 0.007 m		β^- 100
		210	(5+)	-9.247 (12)	1.30 ± 0.03 m		β^- 100; $\beta^- n$ 0.007
		213	0	1.76 (6)	101 ± 0 s		β^-
82	**Pb**	179	(9/2-)	2.05 (8)	3.5 +1.4-0.8 ms		α 100
		180	0+	-1.935 (13)	4.2 ± 0.5 ms		α 100
		181	(9/2-)	-3.1 (8)	36 ± 2 ms		α 100; $\alpha < 100.00$
		182	0+	-6.821 (13)	55 ± 5 ms		$\epsilon \approx 2.00$; $\alpha \approx 98.00$
		183	(3/2-)	-7.57 (3)	535 ± 30 ms		$\alpha \approx 90.00$
		183m	(13/2+)	-7.47 (3)	415 ± 20 ms		α 100
		184	0+	-11.052 (13)	490 ± 25 ms		α 80; ϵ 20
		185	3/2-	-11.541 (16)	6.3 ± 0.4 s		ϵ ; α 34; α 50; ϵ
		186	0+	-14.682 (11)	4.82 ± 0.03 s		ϵ 60; α 40
		187	(13/2+)	-14.99 (6)	18.3 ± 0.3 s		ϵ 88; α 12
		187m	(3/2-)	-14.957 (6)	15.2 ± 0.3 s		ϵ 90.5; α 9.5
		188	0+	-17.816 (11)	25.1 ± 0.1 s		ϵ 90.7; α 9.3
		189	(3/2-)	-17.88 (3)	39 ± 8 s		ϵ 100; $\alpha < 1.00$
		189m	(13/2+)	-17.84 (3)	50 ± 3 s		ϵ 100; $\alpha < 1.00$
		190	0+	-20.418 (12)	71 ± 1 s		α 0.4; ϵ 99.6
		191	(3/2-)	-20.25 (4)	1.33 ± 0.08 m		ϵ 99.99; α 0.01; ϵ 100; $\alpha \approx$ 0.02
		192	0+	-22.556 (13)	3.5 ± 0.1 m		ϵ 99.99; α 0.0059
		194	0+	-24.209 (17)	10.7 ± 0.6 m		α 7.3e-06; ϵ 100
		195	3/2-	-23.714 (23)	≈ 15 m		ϵ 100
		195m	13/2+	-23.511 (23)	15.0 ± 1.2 m		ϵ 100
		196	0+	-25.361 (14)	37 ± 3 m		ϵ ; $\alpha \leq 3.0$E-5
		197	3/2-	-24.749 (6)	8.1 ± 1.7 m		ϵ 100
		197m	13/2+	-24.429 (6)	42.9 ± 0.9 m		ϵ 81; IT 19
		198	0+	-26.051 (15)	2.4 ± 0.1 h		ϵ 100
		199	3/2-	-25.232 (10)	90 ± 10 m		ϵ 100
		199m	(13/2+)	-24.807 (10)	12.2 ± 0.3 m		$\epsilon \approx 7.00$; $IT \approx 93.00$
		200	0+	-26.256 (11)	21.5 ± 0.4 h		ϵ 100
		201	5/2-	-25.258 (22)	9.33 ± 0.03 h		ϵ 100
		201m	13/2+	-24.629 (22)	60.8 ± 1.8 s		IT 100
		202	0+	-25.937 (3)	52.5E+3 $\pm$ 2.8E+3 y		ϵ 100
		202m	9-	-23.767 (3)	3.54 ± 0.02 h		IT 90.5; ϵ 9.5
		203	5/2-	-24.787 (7)	51.92 ± 0.03 h		ϵ 100
		203m	13/2+	-23.962 (7)	6.21 ± 0.11 s		IT 100
		203m2	29/2-	-21.838 (7)	480 ± 7 ms		IT 100
		204	0+	-25.1105 (12)	$\geq$ 1.4E+17 y	1.4% $\pm$ 0.1%	α
		204m	9-	-22.9246 (12)	66.93 ± 0.1 m		IT 100
		205	5/2-	-23.7709 (12)	1.73E+7 $\pm$ 0.07E+7 y		ϵ 100
		205m	13/2+	-22.7571 (12)	5.55 ± 0.02 ms		IT 100
		206	0+	-23.7862 (12)	**stable**	24.1% $\pm$ 0.1%	
		207	1/2-	-22.4527 (12)	**stable**	22.1% $\pm$ 0.1%	
		207m	13/2+	-20.8193 (12)	0.806 ± 0.005 s		IT 100
		208	0+	-21.7492 (12)	**stable**	52.4% $\pm$ 0.1%	
		209	9/2+	-17.6153 (18)	3.253 ± 0.014 h		β^- 100
		210	0+	-14.7291 (15)	22.20 ± 0.22 y		β^- 100; α 1.9e-06
		211	9/2+	-10.491 (3)	36.1 ± 0.2 m		β^- 100
		212	0+	-7.553 (22)	10.64 ± 0.01 h		β^- 100

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Chapter 4

X-ray and gamma standards

The following table presents the recommended values of decay parameters of many common radionuclides routinely used for X-ray and gamma-ray detector calibration. For each radionuclide the following parameters are listed:

- Decay mode.
- Half life ($T_{1/2}$)) in days.
- ID of the spectral line, in the case of X-rays.
- Energy of the γ or X-ray in keV.
- Emission probability (# of photons emitted per parent decay).

Source: X-ray and gamma-ray standards for detector calibration. IAEA-TECDOC-619 (1991). (`http://www-nds.iaea.org/publications/tecdocs/iaea-tecdoc-0619.pdf`).
Note: it must be noted that for technical applications, the information contained in this chapter has been superseded by new IAEA-NDS X Ray and Gamma standards
(`http://www-nds.iaea.org/xgamma_standards/`)

Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		197	3/2+	-31.1409 (7)	**stable**	100%	
		197m	11/2-	-30.7317 (7)	7.73 ± 0.06 s		IT 100
		198	2-	-29.5819 (7)	2.6948 ± 0.0012 d		β^- 100
		198m	(12-)	-28.7702 (7)	2.272 ± 0.016 d		IT 100
		199	3/2+	-29.0948 (7)	3.139 ± 0.007 d		β^- 100
		200	(1-)	-27.27 (5)	48.4 ± 0.3 m		β^- 100
		200m	12-	-26.31 (5)	18.7 ± 0.5 h		β^- 84; IT 16
		201	3/2+	-26.401 (3)	26.0 ± 0.8 m		β^- 100
		202	(1-)	-24.4 (17)	28.4 ± 1.2 s		β^- 100
		203	3/2+	-23.143 (3)	60 ± 6 s		β^- 100
		204	(2-)	-20.75 (20)	39.8 ± 0.9 s		β^- 100
		205	(3/2+)	-18.9 (3)	32.5 ± 1.4 s		β^- 100
		205m	(11/2-)	-18 (3)	6 ± 2 s		IT ; β^-
80	**Hg**	174	0+	-6.646 (20)	2.1 +1.8-0.7 ms		α 99.6
		175	(7/2-)	-7.97 (7)	10.6 ± 0.4 ms		α 100
		176	0+	-11.778 (12)	20.3 ± 1.4 ms		α 94
		177	(7/2-)	-12.78 (8)	118 ± 8 ms		α 100
		178	0+	-16.311 (12)	266.5 ± 2.4 ms		$\alpha \approx 70.00$; $\epsilon \approx 30.00$
		179	(7/2-)	-16.92 (3)	1.05 ± 0.03 s		$\epsilon p \approx 0.15$; α 55; ϵ 45
		180	0+	-20.251 (13)	2.58 ± 0.01 s		ϵ 52; α 48
		181	1/2-	-20.661 (15)	3.6 ± 0.1 s		ϵ 73; α 27; ϵp 0.01; $\epsilon\alpha$ 9e-06
		182	0+	-23.577 (10)	10.83 ± 0.06 s		ϵ 84.8; α 15.2
		183	1/2-	-23.806 (7)	9.4 ± 0.7 s		ϵp 0.00026; ϵ 88.3; α 11.7
		184	0+	-26.349 (10)	30.87 ± 0.26 s		ϵ 98.89; α 1.11
		185	1/2-	-26.176 (16)	49.1 ± 1 s		ϵ 94; α 6
		185m	13/2+	-26.076 (16)	21.6 ± 1.5 s		IT 54; ϵ 46; $\alpha \approx 0.03$
		186	0+	-28.54 (11)	1.38 ± 0.06 m		ϵ 99.98; α 0.02
		187	3/2(-)	-28.118 (14)	2.4 ± 0.3 m		ϵ 100; $\alpha <$ 3.7E-4; ϵ 100; $\alpha <$ 3.7E-4
		188	0+	-30.202 (12)	3.25 ± 0.15 m		ϵ 100; α 3.7e-05
		189	3/2-	-29.63 (3)	7.6 ± 0.1 m		ϵ 100; $\alpha <$ 3.0E-5; ϵ 100; $\alpha <$ 3.0E-5
		190	0+	-31.371 (16)	20.0 ± 0.5 m		$\alpha <$ 3.4E-7; ϵ 100
		191	3/2(-)	-30.594 (23)	49 ± 10 m		ϵ 100; α 5e-06; ϵ 100
		192	0+	-32.012 (16)	4.85 ± 0.2 h		ϵ 100
		193	3/2(-)	-31.063 (16)	3.80 ± 0.15 h		ϵ 100
		193m	13/2(+)	-30.922 (16)	11.8 ± 0.2 h		ϵ 92.8; IT 7.2
		194	0+	-32.193 (13)	444 ± 77 y		ϵ 100
		195	1/2-	-31 (23)	10.53 ± 0.03 h		ϵ 100
		195m	13/2+	-30.824 (23)	41.6 ± 0.8 h		ϵ 45.8; IT 54.2
		196	0+	-31.827 (3)	**stable**	0.15% $\pm$ 0.01%	
		197	1/2-	-30.541 (3)	64.14 ± 0.05 h		ϵ 100
		197m	13/2+	-30.242 (3)	23.8 ± 0.1 h		IT 91.4; ϵ 8.6
		198	0+	-30.9548 (5)	**stable**	9.97% $\pm$ 0.2%	
		199	1/2-	-29.5464 (4)	**stable**	16.87% $\pm$ 0.22%	
		199m	13/2+	-29.0139 (4)	42.67 ± 0.09 m		IT 100
		200	0+	-29.5035 (4)	**stable**	23.1% $\pm$ 0.19%	
		201	3/2-	-27.6629 (6)	**stable**	13.18% $\pm$ 0.09%	
		202	0+	-27.3456 (6)	**stable**	29.86% $\pm$ 0.26%	
		203	5/2-	-25.2698 (17)	46.594 ± 0.012 d		β^- 100
		204	0+	-24.6902 (5)	**stable**	6.87% $\pm$ 0.15%	
		205	1/2-	-22.288 (4)	5.14 ± 0.09 m		β^- 100
		205m	13/2+	-20.731 (4)	1.09 ± 0.04 ms		IT 100

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Table 4.1 – *Continued from previous page*

Nuclide	Decay Mode	$T_{1/2}$	XR ID	E [keV]	Emission Prob.
				1332.502(5)	0.99983(6)
65Zn	EC	244.26(26)	CuKa	8.03 - 8.05	0.341(6)
			CuKx	8.03 - 8.91	0.387(6)
			CuKβ	8.91	0.046(1)
				1115.546(4)	0.5060(24)
75Se	EC	119.64(24)	AsKa	10.51 - 10.54	0.493(11)
			AsKx	10.51 - 11.95	0.568(13)
			AsKβ	11.72 - 11.95	0.075(2)
				96.7344(10)	0.0341(4)
				121.1171(14)	0.171(1)
				136.0008(6)	0.588(3)
				264.6580(17)	0.590(2)
				279.5431(22)	0.250(1)
				400.6593(13)	0.115(1)
85Sr	EC	64.849(4)	RbKx	13.34 - 15.29	0.587(4)
			RbKa	13.34 - 13.40	0.500(3)
			RbKβ	14.96 - 15.29	0.087(2)
				514.0076(22)	0.984(4)
88Y	EC	106.63(25)	SrKx	14.10 - 16.19	0.616(7)
			SrKa	14.10 - 14.17	0.522(6)
			SrKβ	15.83 - 16.19	0.094(2)
				898.042(4)	0.940(3)
				1836.063(13)	0.9936(3)
93mNb	IT	5890(50)	NbKx	16.52 - 19.07	0.1104(35)
			NbKa	16.52 - 16.62	0.0925(30)
			NbKβ	18.62 - 19.07	0.0179(7)
94Nb	β^-	7.3(9) $\times$ 106		702.645(6)	0.9979(5)
				871.119(4)	0.9986(5)
95Nb	β^-	34.975(7)		765.807(6)	0.9981(3)
109Cd	EC	462.6(7)	AgKa	21.99 - 22.16	0.821(9)
			AgKx	21.99 - 25.60	0.994(10)
			AgKβ	24.93 - 25.60	0.173(3)
				88.0341(11)	0.0363(2)
111In	EC	2.8047(5)	CdKa	22.98 - 23.17	0.684(5)
			CdKx	22.98 - 26.80	0.830(5)
			CdKβ	26.09 - 26.80	0.146(3)
				171.28(3)	0.9078(10)
				245.35(4)	0.9416(6)
113Sn	EC	115.09(4)	InKx	24.00 - 28.02	0.968(6)
			InKa	24.00 - 24.21	0.796(6)
			InKβ	27.27 - 28.02	0.172(3)

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Table 4.1: X-ray and gamma standards.

Nuclide	Decay Mode	$T_{1/2}$	XR ID	E [keV]	Emission Prob.
22Na	EC	950.8(9)		1274.542(7)	0.99935(15)
		[major 511.033 annihiliation radiation]			
24Na	β^-	0.62356(17)		1368.633(6)	0.999936(15)
				2754.030(14)	0.99855(5)
26Sc	β^-	83.79(4)		889.277(3)	0.999844(16)
				1120.545(4)	0.999874(11)
51Cr	EC	27.706(7)	VKa	4.95	0.201(3)
			VKx	4.95 - 5.43	0.228(3)
			VKβ	5.43	0.027(1)
				320.0842(9)	0.0986(5)
54Mn	EC	312.3(4)	CrKa	5.41	0.226(7)
			CrKx	5.41 - 5.95	0.256(8)
			CrKβ	5.95	0.030(1)
				834.843(6)	0.999758(24)
55Fe	EC	999(8)	MnKx	5.89 - 6.49	0.283(10)
			MnKa	5.89	0.249(9)
			MnKβ	6.49	0.034(1)
56Co	EC	77.31(19)		846.764(6)	0.99933(7)
				1037.884(4)	0.1413(5)
				1175.099(8)	0.02239(11)
				1238.287(6)	0.6607(19)
				1360.206(6)	0.04256(15)
				1771.350(15)	0.1549(5)
				2015.179(11)	0.03029(13)
				2034.759(11)	0.07771(27)
				2598.460(10)	0.1696(6)
				3201.954(14)	0.0313(9)
				3253.417(14)	0.0762(24)
				3272.998(14)	0.0178(6)
				3451.154(13)	0.0093(4)
				3548.27(10)	0.00178(9)
57Co	EC	271.79(9)	FeKa	6.4	0.510(7)
			FeKx	6.40 - 7.06	0.579(8)
			FeKβ	7.06	0.069(1)
				14.4127(4)	0.0916(15)
				122.0614(3)	0.8560(17)
				136.4743(5)	0.1068(8)
58Co	EC	70.86(7)	FeKx	6.40 - 7.06	0.267(3)
			FeKa	6.4	0.235(3)
			FeKβ	7.06	0.032(1)
				810.775(9)	0.9945(1)
60Co	β^-	1925.5(5)		1173.238(4)	0.99857(22)

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		206	0+	-20.946 (20)	8.32 ± 0.07 m		β^- 100
		207	(9/2+)	-16.22 (15)	2.9 ± 0.2 m		β^- 100
		208	0+	-13.27 (3)	41 +5-4 m		β^- 100
		209	0	-8.54 (15)	35 +9-6 s		β^- 100
81	**Tl**	176	(3-,4-,5-)	0.58 (8)	5.2 +3-1.4 ms		p 100
		177	(1/2+)	-3.33 (23)	18 ± 5 ms		α 73; p 27
		178	0	-4.79 (10)	254 +11-9 ms		$\alpha \approx 53.00$; $\epsilon \approx 47.00$
		179	(1/2+)	-8.3 (4)	0.23 ± 0.04 s		$\alpha < 100.00$; ϵ ; p ; ϵ ; IT ; $\alpha \leq 100.00$; p
		180	(4-,5-)	-9.26 (6)	1.09 ± 0.01 s		ϵ 94; α 6; $\epsilon SF \approx$ 1.0E-4
		181	(1/2+)	-12.799 (9)	3.2 ± 0.3 s		ϵ ; $\alpha \leq 10.00$
		181m	(9/2-)	-11.963 (9)	1.40 ± 0.03 ms		IT 99.6; α 0.4
		182	(7+)	-13.35 (8)	3.1 ± 1 s		ϵ 97.5; $\alpha < 5.00$
		183	(1/2+)	-16.589 (9)	6.9 ± 0.7 s		α ; $\epsilon > 0.00$
		183m	(9/2-)	-15.959 (9)	53.3 ± 0.3 ms		IT ; ϵ ; α 2
		184	0	-16.89 (5)	10.1 ± 0.5 s		ϵ 97.9; α 2.1
		185	(1/2+)	-19.76 (5)	19.5 ± 0.5 s		ϵ
		185m	(9/2-)	-19.3 (5)	1.93 ± 0.08 s		α ; IT
		186	(7+)	-19.87 (3)	27.5 ± 1 s		$\alpha \approx$ 6.0E-3; ϵ 100
		186m	(10-)	-19.5 (3)	2.9 ± 0.2 s		IT 100
		187	(1/2+)	-22.443 (8)	≈ 51 s		ϵ 100; $\alpha \approx 0.03$
		187m	(9/2-)	-22.109 (8)	15.60 ± 0.12 s		$\epsilon < 99.90$; $IT < 99.90$; α 0.15
		188	(2-)	-22.35 (3)	71 ± 2 s		ϵ 100; ϵ 100
		188m	(9-)	-22.08 (3)	41 ± 4 ms		ϵ ; IT 100
		189	(1/2+)	-24.602 (11)	2.3 ± 0.2 m		ϵ 100
		189m	(9/2-)	-24.344 (11)	1.4 ± 0.1 m		$\epsilon < 100.00$; $IT < 4.00$
		190	2(-)	-24.311 (14)	2.6 ± 0.3 m		ϵ 100; ϵ 100
		192	(2-)	-25.87 (3)	9.6 ± 0.4 m		ϵ 100
		192m	(7+)	-25.72 (3)	10.8 ± 0.2 m		ϵ 100
		193	1/2(+)	-27.3 (8)	21.6 ± 0.8 m		ϵ 100
		193m	(9/2-)	-26.93 (8)	2.11 ± 0.15 m		$IT \leq 75.00$; $\epsilon \geq 25.00$
		194	2-	-26.83 (14)	33.0 ± 0.5 m		ϵ 100; $\alpha <$ 1.0E-7; ϵ 100
		195	1/2+	-28.155 (14)	1.16 ± 0.05 h		ϵ 100
		195m	9/2-	-27.673 (14)	3.6 ± 0.4 s		IT 100
		196	2-	-27.497 (12)	1.84 ± 0.03 h		ϵ 100
		196m	(7+)	-27.102 (12)	1.41 ± 0.02 h		ϵ 96.2; IT 3.8
		197	1/2+	-28.341 (16)	2.84 ± 0.04 h		ϵ 100
		197m	9/2-	-27.733 (16)	0.54 ± 0.01 s		IT 100
		198	2-	-27.49 (8)	5.3 ± 0.5 h		ϵ 100
		198m	7+	-26.95 (8)	1.87 ± 0.03 h		ϵ 55.9; IT 44.1
		198m2	(10-)	-26.75 (8)	32.1 ± 1 ms		IT 100
		199	1/2+	-28.06 (3)	7.42 ± 0.08 h		ϵ 100
		199m	9/2-	-27.31 (3)	28.4 ± 0.2 ms		IT 100
		200	2-	-27.047 (6)	26.1 ± 0.1 h		ϵ 100
		200m	7+	-26.294 (6)	34.0 ± 0.9 ms		IT 100
		201	1/2+	-27.183 (15)	3.0421 ± 0.0017 d		ϵ 100
		201m	(9/2-)	-26.264 (15)	2.01 ± 0.07 ms		IT 100
		202	2-	-25.985 (14)	12.31 ± 0.08 d		ϵ 100
		203	1/2+	-25.762 (13)	**stable**	29.524% ± 0.001%	
		204	2-	-24.3468 (13)	3.783 ± 0.012 y		β^- 97.08; ϵ 2.92
		205	1/2+	-23.8215 (13)	**stable**	70.48% ± 0.01%	
		206	0-	-22.254 (14)	4.202 ± 0.011 m		β^- 100
		206m	(12-)	-19.6109 (14)	3.74 ± 0.03 m		IT 100

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Table 4.1 – *Continued from previous page*

Nuclide	Decay Mode	$T_{1/2}$	XR ID	E [keV]	Emission Prob.
				391.702(4)	0.6489(13)
125Sb	β^-	1007.7(6)		176.313(1)	0.0685(7)
				380.452(8)	0.01518(16)
				427.875(6)	0.297(3)
				463.365(5)	0.1048(11)
				600.600(4)	0.1773(18)
				606.718(3)	0.0500(5)
				635.954(5)	0.1121(12)
125I	EC	59.43(6)	TeKa	27.20 - 27.47	1.135(21)
			TeKx	27.20 - 31.88	1.390(25)
			TeKβ	30.98 - 31.88	0.255(6)
				35.4919(5)	0.0658(8)
134Cs	β^-	754.28(22)		475.364(3)	0.0149(2)
				563.240(4)	0.0836(3)
				569.328(3)	0.1539(6)
				604.720(3)	0.9763(6)
				795.859(5)	0.854(3)
				801.948(5)	0.0869(3)
				1038.610(7)	0.00990(5)
				1167.968(5)	0.01792(7)
				1365.185(7)	0.03016(11)
137Cs	β^-	1.102(6) × 104	BaKa	31.82 - 32.19	0.0566(16)
			BaKx	31.82 - 37.45	0.0700(20)
			BaKβ	36.36 - 37.45	0.0134(5)
				661.660(3)	0.851(2)
133Ba	EC	3862(15)	CsKa	30.63 - 30.97	0.980(14)
			CsKx	30.63 - 36.01	1.210(16)
			CsKβ	34.97 - 36.01	0.230(5)
				80.998(5)	0.3411(28)
				276.398(1)	0.07147(30)
				302.853(1)	0.1830(6)
				356.017(2)	0.6194(14)
				383.851(3)	0.08905(29)
139Ce	EC	137.64(23)	LaKa	33.03 - 33.44	0.643(18)
			LaKx	33.03 - 38.93	0.797(22)
			LaKβ	37.78 - 38.93	0.154(5)
				165.857(6)	0.7987(6)
152Eu	EC	4933(11)	SmKx	39.52 - 46.82	0.740(12)
			(Sm+Gd)Kx	39.52 - 50.21	0.748(12)
			SmKa	39.52 - 40.12	0.591(12)
			GdKa	42.31 - 43.00	0.00648(22)
			GdKx	42.31 - 50.21	0.00824(28)
			SmKβ	45.38 - 46.82	0.149(3)
			GdKβ	48.65 - 50.21	0.00176(18)
				121.7824(4)	0.2837(13)

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		194	0+	-34.7625 (9)	**stable**	32.86% ± 0.4%	
		195	1/2-	-32.7962 (9)	**stable**	33.78% ± 0.24%	
		195m	13/2+	-32.5369 (9)	4.010 ± 0.005 d		IT 100
		196	0+	-32.6468 (9)	**stable**	25.21% ± 0.34%	
		197	1/2-	-30.4219 (9)	19.8915 ± 0.0019 h		β^- 100
		197m	13/2+	-30.0223 (9)	95.41 ± 0.18 m		IT 96.7; β^- 3.3
		198	0+	-29.9056 (22)	**stable**	7.36% ± 0.13%	
		199	5/2-	-27.3903 (22)	30.80 ± 0.21 m		β^- 100
		199m	(13/2)+	-26.9663 (22)	13.6 ± 0.4 s		IT 100
		200	0+	-26.601 (20)	12.6 ± 0.3 h		β^- 100
		201	(5/2-)	-23.74 (5)	2.5 ± 0.1 m		β^- 100
		202	0+	-22.6 (20)	44 ± 15 h		β^- 100
		203	(1/2-)	-19.7 (3)	10 ± 3 s		β^- 100
		204	0+	-18.1 (4)	10.3 ± 1.4 s		β^- 100
79	**Au**	171m	(11/2-)	-7.317 (21)	1.02 ± 0.1 ms		α 54; p 46
		172	0	-9.37 (8)	22 +6-4 ms		α 100; ϵ ; p ; $p < 0.02$; ϵ ; α 100
		173	(1/2+)	-12.822 (24)	25 ± 1 ms		α 94; ϵ ; p
		173m	(11/2-)	-12.608 (24)	14.0 ± 0.9 ms		α 92; p ; ϵ
		174	0	-14.24 (9)	139 ± 3 ms		$\alpha > 0.00$
		177	(1/2+,3/2+)	-21.547 (11)	1.53 ± 0.07 s		α 40; ϵ
		177m	11/2-	-21.389 (11)	1.00 ± 0.2 s		α 66; ϵ
		178	0	-22.33 (6)	2.6 ± 0.5 s		$\alpha \geq 40.00$; $\epsilon \leq 60.00$
		179	(1/2+,3/2+)	-24.98 (13)	7.1 ± 0.3 s		ϵ 78; α 22
		180	0	-25.596 (21)	8.1 ± 0.3 s		$\epsilon \leq 98.20$; $\alpha \geq 1.80$
		181	(3/2-)	-27.871 (20)	13.7 ± 1.4 s		ϵ 97.3; α 2.7
		182	(2+)	-28.301 (20)	15.5 ± 0.4 s		ϵ 99.87; α 0.13
		183	(5/2)-	-30.187 (10)	42.8 ± 1 s		α 0.55; ϵ 99.45
		184	5+	-30.319 (22)	20.6 ± 0.9 s		ϵ 100; $\alpha \leq 0.02$
		184m	2+	-30.25 (22)	47.6 ± 1.4 s		ϵ 70; IT 30; $\alpha \leq 0.02$
		185	5/2-	-31.87 (3)	4.25 ± 0.06 m		ϵ 99.74; α 0.26; $\epsilon < 100.00$; IT
		186	3-	-31.715 (21)	10.7 ± 0.5 m		α 0.0008; ϵ 100
		187	1/2(+)	-33.01 (3)	8.3 ± 0.2 m		ϵ 100; α 0.003
		187m	9/2(-)	-32.88 (3)	2.3 ± 0.1 s		IT 100
		188	1(-)	-32.301 (20)	8.84 ± 0.06 m		ϵ 100
		189	1/2+	-33.582 (20)	28.7 ± 0.3 m		ϵ 100; $\alpha <$ 3.0E-5
		189m	11/2-	-33.335 (20)	4.59 ± 0.11 m		ϵ 100
		190	1-	-32.883 (16)	42.8 ± 1 m		ϵ 100; $\alpha <$ 1.0E-6; IT 100
		191	3/2+	-33.81 (4)	3.18 ± 0.08 h		ϵ 100
		191m	(11/2-)	-33.55 (4)	0.92 ± 0.11 s		IT 100
		192	1-	-32.776 (16)	4.94 ± 0.09 h		ϵ 100
		192m	(5)+	-32.64 (16)	29 ± 0 ms		IT 100
		192m2	(11-)	-32.344 (16)	160 ± 20 ms		IT 100
		193	3/2+	-33.406 (9)	17.65 ± 0.15 h		ϵ 100
		193m	11/2-	-33.116 (9)	3.9 ± 0.3 s		IT 99.97; $\epsilon \approx 0.03$
		194	1-	-32.262 (10)	38.02 ± 0.1 h		ϵ 100
		194m	(5+)	-32.154 (10)	600 ± 8 ms		IT 100
		194m2	(11-)	-31.786 (10)	420 ± 10 ms		IT 100
		195	3/2+	-32.5694 (14)	186.098 ± 0.047 d		ϵ 100
		195m	11/2-	-32.2508 (14)	30.5 ± 0.2 s		IT 100
		196	2-	-31.14 (3)	6.1669 ± 6.0E-4 d		ϵ 93; β^- 7
		196m	5+	-31.055 (3)	8.1 ± 0.2 s		IT 100
		196m2	12-	-30.544 (3)	9.6 ± 0.1 h		IT 100

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		190	4-	-36.7555 (20)	11.78 ± 0.1 d		ϵ 100
		190m	(1-)	-36.7294 (20)	1.120 ± 0.003 h		IT 100
		190m2	(11)-	-36.3791 (20)	3.087 ± 0.012 h		ϵ 91.4; IT 8.6
		191	3/2+	-36.7107 (19)	**stable**	$37.3\% \pm 0.2\%$	
		191m	11/2-	-36.5394 (19)	4.899 ± 0.023 s		IT 100
		191m2	0	-34.664 (19)	5.5 ± 0.7 s		IT 100
		192	4+	-34.8375 (19)	73.829 ± 0.011 d		β^- 95.24; ϵ 4.76
		192m	1-	-34.7808 (19)	1.45 ± 0.05 m		β^- 0.02; IT 99.98
		192m2	(11-)	-34.6694 (19)	241 ± 9 y		IT 100
		193	3/2+	-34.5382 (19)	**stable**	$62.7\% \pm 0.2\%$	
		193m	11/2-	-34.458 (19)	10.53 ± 0.04 d		IT 100
		194	1-	-32.5337 (19)	19.28 ± 0.13 h		β^- 100
		194m	4+	-32.3866 (19)	31.85 ± 0.24 ms		IT 100
		194m2	(10,11)	-32.3437 (19)	171 ± 11 d		β^- 100
		195	3/2+	-31.6942 (19)	2.5 ± 0.2 h		β^- 100
		195m	11/2-	-31.5942 (19)	3.8 ± 0.2 h		β^- 95; IT 5
		196	(0-)	-29.44 (4)	52 ± 1 s		β^- 100
		196m	(10,11-)	-29.03 (4)	1.40 ± 0.02 h		β^- 100; $IT < 0.30$
		197	3/2+	-28.266 (20)	5.8 ± 0.5 m		β^- 100
		197m	11/2-	-28.151 (20)	8.9 ± 0.3 m		β^- 99.75; IT 0.25
		198	0	-25.82 (20)	8 ± 1 s		β^- 100
		199	0	-24.4 (4)	6 +5-4 s		β^-
		202	(1-,2-)	-17 (4)	11 ± 3 s		β^- 100
78	**Pt**	168	0+	-11.04 (21)	2.02 ± 0.1 ms		α 100
		169	(7/2-)	-12.36 (20)	7.0 ± 0.2 ms		α 100
		170	0+	-16.304 (19)	13.8 ± 0.5 ms		α 98; ϵ
		171	(7/2-)	-17.47 (7)	45.5 ± 2.5 ms		α 90; ϵ 10
		172	0+	-21.103 (11)	97.6 ± 1.3 ms		ϵ 6; α 94
		173	(5/2-)	-21.94 (6)	382 ± 2 ms		α 100; ϵ ?
		174	0+	-25.313 (11)	0.889 ± 0.017 s		α 76; ϵ 24
		175	7/2-	-25.69 (19)	2.53 ± 0.06 s		α 64; ϵ 36
		176	0+	-28.935 (13)	6.33 ± 0.15 s		ϵ 60; α 40
		177	5/2-	-29.371 (15)	10.6 ± 0.4 s		α 5.7; ϵ 94.3
		178	0+	-31.999 (11)	20.7 ± 0.7 s		ϵ 92.3; α 7.7
		179	1/2-	-32.27 (8)	21.2 ± 0.4 s		ϵ 99.76; α 0.24
		180	0+	-34.436 (11)	56 ± 2 s		ϵ 100; $\alpha \approx 0.30$
		181	1/2-	-34.375 (15)	52.0 ± 2.2 s		ϵ 100; $\alpha \approx 0.08$
		182	0+	-36.17 (16)	2.67 ± 0.12 m		ϵ 99.96; α 0.04
		183	1/2-	-35.773 (16)	6.5 ± 1 m		ϵ 100; $\alpha \approx$ 1.3E-3
		183m	(7/2)-	-35.738 (16)	43 ± 5 s		ϵ 100; $\alpha <$ 4.0E-4; IT
		184	0+	-37.332 (18)	17.3 ± 0.2 m		ϵ 100; $\alpha \approx$ 1.0E-3
		184m	8-	-35.492 (18)	1.01 ± 0.05 ms		IT 100
		185	9/2+	-36.68 (4)	70.9 ± 2.4 m		$\epsilon < 100.00$
		185m	1/2-	-36.58 (4)	33.0 ± 0.8 m		ϵ 99; $IT < 2.00$
		186	0+	-37.864 (22)	2.08 ± 0.05 h		ϵ 100; $\alpha \approx$ 1.4E-4
		187	3/2-	-36.71 (3)	2.35 ± 0.03 h		ϵ 100
		188	0+	-37.829 (6)	10.2 ± 0.3 d		ϵ 100; α 2.6e-05
		189	3/2-	-36.485 (11)	10.87 ± 0.12 h		ϵ 100
		190	0+	-37.325 (6)	6.5E+11 $\pm$ 0.3E+11 y	$0.012\% \pm 0.002\%$	α 100
		191	3/2-	-35.701 (5)	2.83 ± 0.02 d		ϵ 100
		192	0+	-36.292 (3)	**stable**	$0.782\% \pm 0.024\%$	
		193	1/2-	-34.4816 (20)	50 ± 6 y		ϵ 100
		193m	13/2+	-34.3318 (20)	4.33 ± 0.03 d		IT 100

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Table 4.1 – *Continued from previous page*

Nuclide	Decay Mode	$T_{1/2}$	XR ID	E [keV]	Emission Prob.
				244.6989(10)	0.0753(4)
				344.2811(19)	0.2657(11)
				411.126(3)	0.02238(10)
				443.965(4)	0.03125(14)
				778.903(6)	0.1297(6)
				867.390(6)	0.04214(25)
				964.055(4)	0.1463(6)
				1085.842(4)	0.1013(5)
				1089.767(14)	0.01731(9)
				1112.087(6)	0.1354(6)
				1212.970(13)	0.01412(8)
				1299.152(9)	0.01626(11)
				1408.022(4)	0.2085(9)
154Eu	β^-	3136.8(29)	GdKx	42.31 - 50.21	0.256(6)
			GdKa	42.31 - 43.00	0.205(6)
			GdKβ	48.65 - 50.21	0.051(2)
				123.071(1)	0.412(5)
				247.930(1)	0.0695(9)
				591.762(5)	0.0499(6)
				692.425(4)	0.0180(3)
				723.305(5)	0.202(2)
				756.804(5)	0.0458(6)
				873.190(5)	0.1224(15)
				996.262(6)	0.1048(13)
				1004.725(7)	0.182(2)
				1274.436(6)	0.350(4)
				1494.048(9)	0.0071(2)
				1596.495(18)	0.0181(2)
155Eu	β^-	1770(50)			
198Au	β^-	2.6943(8)	HgKx	68.89 - 82.78	0.0280(10)
			HgKa	68.89 - 70.82	0.0219(8)
			HgKβ	80.12 - 82.78	0.0061(3)
				411.8044(11)	0.9557(47)
204Hg	β^-	46.595(13)	TlLx	8.95 - 14.40	0.060(12)
			TlKa2	70.83 0.038(2)	
			TlKx	70.83 - 85.19	0.130(4)
			TlKa1	72.87 0.064(2)	
			TlKβ'1	82.43 0.022(1)	
			TlKβ'2	85.19 0.0063(3)	
				279.1967(12)	0.8148(8)
207Bi	EC	$1.16(7) \times 104$	PbLx	9.19 - 14.91	0.325(13)
			PbKx	72.80 - 87.63	0.777(26)
			PbKa2	72.8	0.226(12)
			PbKa1	74.97	0.382(20)
			PbKβ'1	84.79	0.130(10)
			PbKβ'2	87.63	0.039(3)
				569.702(2)	0.9774(3)
				1063.662(4)	0.745(2)

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		176	(3+)	-45.06 (3)	5.3 ± 0.3 m		ϵ 100
		177	5/2-	-46.27 (3)	14 ± 1 m		ϵ 100
		178	(3+)	-45.65 (3)	13.2 ± 0.2 m		ϵ 100
		179	5/2+	-46.585 (24)	19.5 ± 0.1 m		ϵ 100
		180	(1)-	-45.837 (21)	2.44 ± 0.06 m		ϵ 100
		181	5/2+	-46.523 (13)	19.9 ± 0.7 h		ϵ 100
		182	7+	-45.45 (10)	64.0 ± 0.5 h		ϵ 100; ϵ 100
		183	5/2+	-45.811 (8)	70.0 ± 1.4 d		ϵ 100
		183m	(25/2)+	-43.903 (8)	1.04 ± 0.04 ms		IT 100
		184	3(-)	-44.225 (4)	35.4 ± 0.7 d		ϵ 100
		184m	8(+)	-44.037 (4)	169 ± 8 d		IT 74.5; ϵ 25.5
		185	5/2+	-43.8225 (12)	**stable**	$37.4\% \pm 0.02\%$	
		186	1-	-41.9306 (12)	3.7186 $\pm$ 5.0E-4 d		ϵ 7.47; β^- 92.53
		186m	(8+)	-41.7816 (12)	2.0E+5 $\pm$ 0 y		IT 100
		187	5/2+	-41.2184 (15)	4.33E+10 $\pm$ 0.07E+10 y	$62.6\% \pm 0.02\%$	β^- 100; $\alpha <$ 1.0E-4
		188	1-	-39.0189 (15)	17.003 ± 0.003 h		β^- 100
		188m	(6)-	-38.8468 (15)	18.59 ± 0.04 m		IT 100
		189	5/2+	-37.981 (8)	24.3 ± 0.4 h		β^- 100
		190	(2)-	-35.57 (15)	3.1 ± 0.3 m		β^- 100
		190m	(6-)	-35.36 (15)	3.2 ± 0.2 h		β^- 54.4; IT 45.6
		191	(3/2+,1/2+)	-34.352 (10)	9.8 ± 0.5 m		β^- 100
		192	0	-31.77 (20)	16 ± 1 s		β^- 100
		194	0	-27.4 (3)	5 ± 1 s		β^- 100; β^- 100; β^- 100
		195	0	-25.6 (4)	6 ± 1 s		β^-
		196	0	-22.5 (5)	3 +1-2 s		β^- 100
76	**Os**	162	0+	-14.5 (5)	2.1 ± 0.1 ms		$\alpha \approx 99.00$
		163	(7/2-)	-16.1 (4)	5.5 ± 0.6 ms		α 100; ϵ
		164	0+	-20.46 (21)	21 ± 1 ms		α 98; ϵ 2
		165	(7/2-)	-21.65 (20)	71 ± 3 ms		$\alpha > 60.00$; $\epsilon < 40.00$
		166	0+	-25.437 (18)	199 ± 3 ms		α 72; ϵ 18
		167	(7/2-)	-26.5 (7)	0.81 ± 0.06 s		α 57; ϵ 43
		168	0+	-29.992 (10)	2.1 ± 0.1 s		α 43; ϵ 57
		169	(5/2-)	-30.72 (3)	3.43 ± 0.14 s		ϵ 86.3; α 13.7
		170	0+	-33.921 (11)	7.37 ± 0.18 s		ϵ 90.5; α 9.5
		171	(5/2-)	-34.293 (19)	8.3 ± 0.2 s		ϵ 98.2; α 1.8
		172	0+	-37.245 (13)	19.2 ± 0.9 s		ϵ 99.8; α 0.2
		173	(5/2-)	-37.438 (15)	22.4 ± 0.9 s		ϵ ; α 0.4
		174	0+	-39.997 (11)	44 ± 4 s		ϵ 99.98; α 0.02
		175	(5/2-)	-40.111 (13)	1.4 ± 0.1 m		ϵ 100
		176	0+	-42.1 (3)	3.6 ± 0.5 m		ϵ 100
		177	1/2-	-41.949 (16)	3.0 ± 0.2 m		ϵ 100
		178	0+	-43.547 (16)	5.0 ± 0.4 m		ϵ 100; α
		179	1/2-	-43.02 (18)	6.5 ± 0.3 m		ϵ 100
		180	0+	-44.355 (20)	21.5 ± 0.4 m		ϵ 100
		181	1/2-	-43.55 (3)	105 ± 3 m		ϵ 100
		181m	7/2-	-43.5 (3)	2.7 ± 0.1 m		ϵ 100; $IT \leq 3.00$
		182	0+	-44.609 (22)	21.84 ± 0.2 h		ϵ 100
		183	9/2+	-43.66 (5)	13.0 ± 0.5 h		ϵ 100
		183m	1/2-	-43.49 (5)	9.9 ± 0.3 h		ϵ 85; IT 15
		184	0+	-44.2566 (13)	$>$ 5.6E13 y	$0.02\% \pm 0.01\%$	α
		185	1/2-	-42.8098 (13)	93.6 ± 0.5 d		ϵ 100
		186	0+	-43.0023 (15)	2.0E+15 $\pm$ 1.1E+15 y	$1.59\% \pm 0.03\%$	α 100
		187	1/2-	-41.2209 (15)	**stable**	$1.96\% \pm 0.02\%$	

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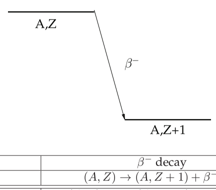
Chapter 5

Beta decay

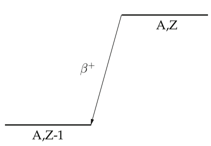
Source: Meyerhof, W. Elements of Nuclear Physics. McGraw-Hill, 1967.

5.1 Energetics of beta decay



	β^- decay
	$(A, Z) \rightarrow (A, Z+1) + \beta^- + \bar{\nu}$
Atomic mass (Mass Excess Δ)	$M_A(A, Z) = M_A(A, Z+1) + m_e + Q - m_e$ $Q = \Delta(A, Z) - \Delta(A, Z+1)$

* * *



	β^+ decay
	$(A, Z) \rightarrow (A, Z-1) + \beta^+ + \nu$
Atomic mass (Mass Excess Δ)	$M_A(A, Z) = M_A(A, Z-1) + m_e + Q + m_e$ $Q = \Delta(A, Z) - \Delta(A, Z-1) - 2m_e$

* * *

Table 4.1 – *Continued from previous page*

Nuclide	Decay Mode	$T_{1/2}$	XR ID	E [keV]	Emission Prob.
				1770.237(9)	0.0687(4)
228Th	α	698.2(6)		84.373(3)	0.0122(2)
				238.632(2) *	0.435(4)
				240.987(6) *	0.0410(5)
				277.358(10) *	0.0230(3)
				300.094(10) *	0.0325(3)
				510.77(10) *	0.0818(10)
				583.191(2) *	0.306(2)
				727.330(9) *	0.0669(9)
				860.564(5) *	0.0450(4)
				1620.735(10) *	0.0149(5)
				2614.533(13) *	0.3586(6)
		* Indicates daughter in equilibrium with the parent radionuclide			
239Np	β^-	2.35(4)		106.123(2)	0.267(4)
				228.183(1)	0.1112(15)
				277.599(2)	0.1431(20)
241Am	α	1.5785(24) × 105	NpLl	11.871	0.0085(3)
			NpLa	13.927	0.132(4)
			NpLβ'	17.611	0.194(6)
			NpLh	-20.997	0.049(2)
				26.345(1)	0.024(1)
				59.537(1)	0.360(4)
243Am	α	2.69(8) × 106		43.53(1)	0.0594(11)
				74.66(1)	0.674(10)

Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		188	0+	-41.1392 (15)	**stable**	13.24% $\pm$ 0.08%	
		189	3/2-	-38.9883 (16)	**stable**	16.15% $\pm$ 0.05%	
		189m	9/2-	-38.9575 (16)	5.81 $\pm$ 0.06 h		IT 100
		190	0+	-38.7093 (16)	**stable**	26.26% $\pm$ 0.02%	
		190m	(10)-	-37.0039 (16)	9.9 $\pm$ 0.1 m		IT 100
		191	9/2-	-36.3967 (16)	15.4 $\pm$ 0.1 d		β^- 100
		191m	3/2-	-36.3223 (16)	13.10 $\pm$ 0.05 h		IT 100
		192	0+	-35.884 (3)	**stable**	40.78% $\pm$ 0.19%	
		192m	(10-)	-33.868 (3)	5.9 $\pm$ 0.1 s		$IT > 87.00$; $\beta^- < 13.00$
		193	3/2-	-33.396 (3)	30.11 $\pm$ 0.01 h		β^- 100
		194	0+	-32.437 (3)	6.0 $\pm$ 0.2 y		β^- 100
		195	0	-29.7 (5)	$\approx$ 9 m		β^-
		196	0+	-28.28 (4)	34.9 $\pm$ 0.2 m		β^- 100
		197	0	-25.31 (20)	2.8 $\pm$ 0.6 m		β^- 100
		199	0	-20.5 (4)	5 +4-2 s		β^- 100
		200	0+	-18.9 (5)	6 +4-3 s		β^- 100
77	**Ir**	166	(2-)	-13.2 (20)	10.5 $\pm$ 2.2 ms		α 93; p 7
		166m	(9+)	-13.03 (20)	15.1 $\pm$ 0.9 ms		α 98.2; p 1.8
		167	1/2+	-17.078 (19)	35.2 $\pm$ 2 ms		p 32; ϵ 20; α 48
		167m	11/2-	-16.903 (19)	25.7 $\pm$ 0.8 ms		α 80; ϵ 20; p 0.4
		168	0	-18.72 (7)	222 +60-40 ms		$\alpha \leq 100.00$; ϵ ; p ; α 77; $\epsilon \leq 23.00$; p
		169	(1/2+)	-22.083 (24)	0.353 $\pm$ 0.004 s		α 45; ϵ ; p
		169m	(11/2-)	-21.93 (24)	0.281 $\pm$ 0.004 s		α 72; ϵ ; p
		170	(3-)	-23.36 (9)	0.87 +0.18-0.12 s		ϵ 94.8; α 5.2; α 38; $IT \leq 62.00$; $\epsilon \leq 62.00$
		171	(1/2+)	-26.43 (4)	3.2 +1.3-0.7 s		$\alpha > 0.00$; p ; ϵ ; α 58; $p \leq 42.00$; $\epsilon \leq 42.00$
		172	(3+)	-27.38 (3)	4.4 $\pm$ 0.3 s		ϵ 98; $\alpha \approx 2.00$
		172m	(7+)	-27.24 (3)	2.0 $\pm$ 0.1 s		ϵ 77; α 23
		173	(3/2+,5/2+)	-30.27 (12)	9.0 $\pm$ 0.8 s		$\epsilon > 93.00$; $\alpha < 7.00$
		173m	(11/2-)	-30.044 (12)	2.4 $\pm$ 0.9 s		ϵ ; α 7
		174	(3+)	-30.87 (3)	7.9 $\pm$ 0.6 s		ϵ 99.5; α 0.5
		174m	(7+)	-30.68 (3)	4.9 $\pm$ 0.3 s		ϵ 97.5; α 2.5
		175	(5/2-)	-33.386 (13)	9 $\pm$ 2 s		ϵ 99.15; α 0.85
		176	0	-33.861 (20)	8.7 $\pm$ 0.5 s		α 3.1; ϵ 96.9
		177	5/2-	-36.047 (20)	30 $\pm$ 2 s		ϵ 99.94; α 0.06
		178	0	-36.252 (20)	12 $\pm$ 2 s		ϵ 100
		179	(5/2)-	-38.077 (11)	79 $\pm$ 1 s		ϵ 100
		180	(4,5)	-37.977 (22)	1.5 $\pm$ 0.1 m		ϵ 100
		181	5/2-	-39.47 (3)	4.90 $\pm$ 0.15 m		ϵ 100
		182	3+	-39.052 (21)	15 $\pm$ 1 m		ϵ 100
		183	5/2-	-40.2 (3)	57 $\pm$ 4 m		ϵ 100
		184	5-	-39.61 (3)	3.09 $\pm$ 0.03 h		ϵ 100
		185	5/2-	-40.34 (3)	14.4 $\pm$ 0.1 h		ϵ 100
		186	5+	-39.173 (17)	16.64 $\pm$ 0.03 h		ϵ 100; $\epsilon \approx 75.00$; $IT \approx 25.00$
		187	3/2+	-39.532 (6)	10.5 $\pm$ 0.3 h		ϵ 100
		187m	9/2-	-39.346 (6)	30.3 $\pm$ 0.6 ms		IT 100
		188	1-	-38.351 (10)	41.5 $\pm$ 0.5 h		ϵ 100
		188m	0	-37.428 (10)	4.2 $\pm$ 0.2 ms		ϵ ?; IT
		189	3/2+	-38.457 (13)	13.2 $\pm$ 0.1 d		ϵ 100
		189m	11/2-	-38.084 (13)	13.3 $\pm$ 0.3 ms		IT 100
		189m2	(25/2)+	-36.123 (13)	3.7 $\pm$ 0.2 ms		IT 100

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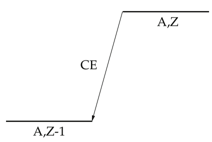

	EC decay
	$(A, Z) + e^- \rightarrow (A, Z-1) + \nu$
Atomic mass (Mass Excess Δ)	$M_A(A, Z) + m_e = M_A(A, Z-1) + Q + m_e$ $Q = \Delta(A, Z) - \Delta(A, Z-1)$

Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		163	7/2-	-34.91 (5)	2.67 $\pm$ 0.1 s		ϵ 86; α 14
		164	0+	-38.235 (10)	6.3 $\pm$ 0.2 s		ϵ 96.2; α 3.8
		165	(5/2-)	-38.861 (25)	5.1 $\pm$ 0.5 s		ϵ 100; $\alpha < 0.20$
		166	0+	-41.886 (10)	19.2 $\pm$ 0.6 s		ϵ 99.96; α 0.04
		167	(+)	-42.089 (19)	19.9 $\pm$ 0.5 s		ϵ 99.96; α 0.04
		168	0+	-44.897 (15)	50.9 $\pm$ 1.9 s		ϵ 100; α 0.0032
		169	(5/2-)	-44.918 (15)	74 $\pm$ 6 s		ϵ 100
		170	0+	-47.294 (15)	2.42 $\pm$ 0.04 m		ϵ 100
		171	(5/2-)	-47.09 (3)	2.38 $\pm$ 0.04 m		ϵ 100
		172	0+	-49.1 (3)	6.6 $\pm$ 0.9 m		ϵ 100
		173	5/2-	-48.73 (3)	7.6 $\pm$ 0.2 m		ϵ 100
		174	0+	-50.23 (3)	33.2 $\pm$ 2.1 m		ϵ 100
		175	(1/2-)	-49.63 (3)	35.2 $\pm$ 0.6 m		ϵ 100
		176	0+	-50.64 (3)	2.5 $\pm$ 0.1 h		ϵ 100
		177	1/2-	-49.7 (3)	132 $\pm$ 2 m		ϵ 100
		178	0+	-50.411 (15)	21.6 $\pm$ 0.3 d		ϵ 100
		179	7/2-	-49.296 (15)	37.05 $\pm$ 0.16 m		ϵ 100
		179m	1/2-	-49.074 (15)	6.40 $\pm$ 0.07 m		IT 99.71; ϵ 0.29
		180	0+	-49.6365 (24)	$\geq$ 6.6E+17 y	0.12% $\pm$ 0.01%	2ϵ 100
		181	9/2+	-48.253 (5)	121.2 $\pm$ 0.2 d		ϵ 100
		182	0+	-48.2475 (8)	**stable**	26.5% $\pm$ 0.16%	
		183	1/2-	-46.3671 (8)	$>$ 1.3E+19 y	14.31% $\pm$ 0.04%	α
		183m	11/2+	-46.0576 (8)	5.2 $\pm$ 0.3 s		IT 100
		184	0+	-45.7075 (9)	**stable**	30.64% $\pm$ 0.02%	
		185	3/2-	-43.3899 (9)	75.1 $\pm$ 0.3 d		β^- 100
		185m	11/2+	-43.1925 (9)	1.67 $\pm$ 0.03 m		IT 100
		186	0+	-42.5109 (15)	$>$ 2.3E+19 y	28.43% $\pm$ 0.19%	$2\beta^-$
		186m	(16+)	-38.9681 (15)	$>$ 3 ms		IT
		187	3/2-	-39.9061 (15)	24.000 $\pm$ 0.004 h		β^- 100
		188	0+	-38.67 (3)	69.78 $\pm$ 0.05 d		β^- 100
		189	(3/2-)	-35.48 (20)	10.7 $\pm$ 0.5 m		β^- 100
		190	0+	-34.3 (16)	30.0 $\pm$ 1.5 m		β^- 100
		190m	(10-)	-31.92 (16)	$\leq$ 3.1 ms		IT 100
75	**Re**	161m	11/2-	-20.75 (21)	14.7 $\pm$ 0.3 ms		α 93; p 7
		162	(2-)	-22.35 (20)	107 $\pm$ 13 ms		α 94; ϵ 6
		162m	(9+)	-22.18 (20)	77 $\pm$ 9 ms		α 91; ϵ 9
		163	1/2+	-26.008 (19)	390 $\pm$ 72 ms		ϵ 68; α 32
		163m	11/2-	-25.893 (19)	214 $\pm$ 5 ms		α 66; ϵ 34
		164	0	-27.52 (7)	0.85 +0.14-0.11 s		$\alpha \approx 58.00$; $\epsilon \approx 42.00$
		164m	0	-27.45 (7)	0.86 +0.15-0.11 s		IT ; $\alpha \approx 3.00$
		165	(1/2+)	-30.649 (25)	$\approx$ 1 s		α ; ϵ
		165m	(11/2-)	-30.601 (25)	2.1 $\pm$ 0.3 s		ϵ 87; α 13
		166	0	-31.89 (7)	2.25 $\pm$ 0.21 s		$\epsilon > 76.00$; $\alpha < 24.00$
		167	(9/2-)	-34.84 (5)	5.9 $\pm$ 0.3 s		$\alpha \approx 1.00$; $\epsilon \approx 99.00$; α 100
		168	(7+)	-35.79 (3)	4.4 $\pm$ 0.1 s		ϵ 100; $\alpha \approx$ 5.0E-3
		169	(9/2-)	-38.41 (11)	8.1 $\pm$ 0.5 s		ϵ 100; $\alpha < 0.01$; ϵ ; IT ; $\alpha \approx 0.20$
		170	(5+)	-38.92 (3)	9.2 $\pm$ 0.2 s		ϵ 100
		171	(9/2-)	-41.25 (3)	15.2 $\pm$ 0.4 s		ϵ 100
		172	(2)	-41.52 (5)	55 $\pm$ 5 s		ϵ 100; ϵ 100
		173	(5/2-)	-43.55 (3)	1.98 $\pm$ 0.26 m		ϵ 100
		174	(LE 4)	-43.67 (3)	2.40 $\pm$ 0.04 m		ϵ 100
		175	(5/2-)	-45.29 (3)	5.89 $\pm$ 0.05 m		ϵ 100

Continued on next page

Table 8.1 – *Continued from previous page*

Z	El	A	J^{π}	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		157	1/2+	-29.63 (21)	10.1 ± 0.4 ms		α 96.6; p 3.4
		157m	11/2-	-29.61 (21)	4.3 ± 0.1 ms		α 100
		157m2	(25/2-)	-28.04 (21)	1.7 ± 0.1 ms		α 100
		158	(2-)	-31.02 (20)	55 ± 15 ms		$\alpha \approx 91.00$; $\epsilon \approx 9.00$
		158m	(9+)	-30.88 (20)	36.7 ± 1.5 ms		α 95; ϵ 5
		159	1/2+	-34.445 (20)	0.83 ± 0.18 s		ϵ 66; α 34
		159m	11/2-	-34.381 (20)	0.56 ± 0.06 s		α 55; ϵ 45
		160	0	-35.87 (7)	1.55 ± 0.04 s		ϵ 66; α 34;
		162	0	-39.78 (5)	3.57 ± 0.12 s		ϵ 99.93; α 0.07
		163	0	-42.54 (4)	10.6 ± 1.8 s		$\epsilon \approx 99.80$; $\alpha \approx 0.20$
		164	(3+)	-43.28 (3)	14.2 ± 0.3 s		ϵ 100
		165	0	-45.854 (16)	31.0 ± 1.5 s		ϵ 100
		166	(2)+	-46.1 (3)	34.4 ± 0.5 s		ϵ 100
		167	(3/2+)	-48.35 (3)	80 ± 4 s		ϵ 100
		168	(2-,3+)	-48.39 (3)	2.0 ± 0.1 m		ϵ 100
		169	(5/2+)	-50.29 (3)	4.9 ± 0.4 m		ϵ 100
		170	(3+)	-50.14 (3)	6.76 ± 0.06 m		ϵ 100
		171	(5/2-)	-51.72 (3)	23.3 ± 0.3 m		ϵ 100
		172	(3+)	-51.33 (3)	36.8 ± 0.3 m		ϵ 100
		173	5/2-	-52.4 (3)	3.14 ± 0.13 h		ϵ 100
		174	3+	-51.74 (3)	1.14 ± 0.08 h		ϵ 100
		175	7/2+	-52.41 (3)	10.5 ± 0.2 h		ϵ 100
		176	(1)-	-51.37 (3)	8.09 ± 0.05 h		ϵ 100
		177	7/2+	-51.719 (4)	56.56 ± 0.06 h		ϵ 100
		178	(1+)	-50.503 (15)	9.31 ± 0.03 m		ϵ 100; ϵ 100
		178m	15-	-49.035 (15)	58 ± 4 ms		IT 100
		178m2	(21-)	-47.6 (15)	290 ± 12 ms		IT 100
		179	7/2+	-50.3617 (21)	1.82 ± 0.03 y		ϵ 100
		179m	(25/2+)	-49.0445 (21)	9.0 ± 0.2 ms		IT 100
		179m2	(37/2+)	-47.7222 (21)	54.1 ± 1.7 ms		IT 100
		180	1+	-48.9365 (23)	8.154 ± 0.006 h		ϵ 86; β^- 14
		180m	9-	-48.8594 (23)	> 1.2E+15 y	0.01201% ± 0.00032%	ϵ ?; β^- ?
		181	7/2+	-48.4419 (19)	**stable**	99.98799% ± 0.00032%	
		182	3-	-46.4335 (19)	114.74 ± 0.12 d		β^- 100
		182m	5+	-46.4172 (19)	283 ± 3 ms		IT 100
		182m2	10-	-45.9139 (19)	15.84 ± 0.1 m		IT 100
		183	7/2+	-45.2964 (19)	5.1 ± 0.1 d		β^- 100
		184	(5-)	-42.84 (3)	8.7 ± 0.1 h		β^- 100
		185	(7/2+)	-41.396 (14)	49.4 ± 1.5 m		β^- 100
		185m	(21/2)	-40.138 (14)	> 1 ms		
		186	(2-,3-)	-38.61 (6)	10.5 ± 0.3 m		β^- 100; β^- 100
		187	(7/2+)	-36.77 (20)	2.3 ± 0.6 m		β^- 100
		187m	(27/2-)	-34.98 (20)	22 ± 9 s		β^- ?; IT ?
		187m2	(41/2+)	-33.83 (20)	> 5 m		β^- ?; IT ?
		188	0	-33.66 (20)	19.6 ± 2 s		β^-
		190	0	-28.7 (4)	5.3 ± 0.7 s		β^- 100
		192	(1,2)	-23.1 (6)	2.2 ± 0.7 s		β^- 100
74	**W**	157	(7/2-)	-19.3 (5)	275 ± 40 ms		ϵ
		158	0+	-23.7 (5)	1.25 ± 0.21 ms		α 100
		159	0	-25.2 (4)	7.3 ± 2.7 ms		$\alpha \approx 99.90$; $\epsilon \approx 0.10$
		160	0+	-29.36 (21)	91 ± 5 ms		α 87
		161	0	-30.41 (20)	409 ± 18 ms		α 73; ϵ 27
		162	0+	-34.001 (18)	1.36 ± 0.07 s		ϵ 54.8; α 45.2

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Chapter 6

CSDA Range for protons

In the following figures range of protons in Carbon, Aluminum, Iron, Copper, Tin, Lead and Uranium. The range was computed using the *continuous slowing down approximation* (CSDA) which constitutes an upper bound of the real range.

The range for a different heavy charged particle i in the same materials can be approximated as:

$$R_i \simeq \frac{M_i}{z_i^2 M_p} R_{p^+}\Big|_{E_{p^+}=\frac{M_p}{M}E_i} \tag{6.1}$$

Sources:
NIST PSTAR Database (`http://physics.nist.gov/PhysRefData/Star/Text/PSTAR.html`)

Table 8.1 – *Continued from previous page*

Z	El	A	J^{π}	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		176	0+	-53.4885 (23)	**stable**	12.996% ± 0.083%	
		176m	8-	-52.4387 (23)	11.4 ± 0.3 s		IT 100
		177	(9/2+)	-50.9836 (23)	1.911 ± 0.003 h		β^- 100
		177m	(1/2-)	-50.6521 (23)	6.41 ± 0.02 s		IT 100
		178	0+	-49.693 (10)	74 ± 3 m		β^- 100
		179	(1/2-)	-46.4 (3)	8.0 ± 0.4 m		β^- 100
		180	0+	-44.4 (4)	2.4 ± 0.5 m		β^- 100
71	**Lu**	150	(2+)	-24.6 (5)	45 ± 3 ms		p 70.9; ϵ 29.1
		151	11/2-	-30.1 (4)	80.6 ± 2 ms		p 63.4; ϵ 36.6
		152	(4-,5-,6-)	-33.42 (20)	0.7 ± 0.1 s		ϵ 100; ϵp 15
		153	11/2-	-38.41 (21)	0.9 ± 0.2 s		$\alpha \approx 70.00$; $\epsilon \approx 30.00$
		155	11/2-	-42.55 (20)	68 ± 1 ms		α 90; ϵ 10
		155m	1/2+	-42.53 (20)	138 ± 8 ms		α 76; ϵ 24
		155m2	(25/2-)	-40.769 (20)	2.69 ± 0.03 ms		α 100
		156	(2)-	-43.75 (7)	494 ± 12 ms		$\alpha \approx 95.00$; $\epsilon \approx 5.00$; α 100
		157	(1/2+,3/2+)	-46.459 (15)	6.8 ± 1.8 s		$\alpha > 0.00$
		157m	(11/2-)	-46.433 (15)	4.79 ± 0.12 s		ϵ 94; α 6
		158	0	-47.213 (15)	10.6 ± 0.3 s		ϵ 99.09; α 0.91
		159	0	-49.71 (4)	12.1 ± 1 s		ϵ 100; α 0.1
		160	0	-50.27 (6)	36.1 ± 0.3 s		ϵ 100; $\alpha \leq$ 1.0E-4; $\epsilon \leq$ 100.00; α
		161	1/2+	-52.56 (3)	77 ± 2 s		ϵ 100
		161m	(9/2-)	-52.4 (3)	7.3 ± 0.4 ms		IT
		162	1-	-52.84 (8)	1.37 ± 0.02 m		$\epsilon \leq 100.00$; $\epsilon \leq 100.00$; $\epsilon \leq$ 100.00
		163	1/2(+)	-54.79 (3)	3.97 ± 0.13 m		ϵ 100
		164	1(-)	-54.64 (3)	3.14 ± 0.03 m		ϵ 100
		165	1/2+	-56.44 (3)	10.74 ± 0.1 m		ϵ 100
		166	6-	-56.02 (3)	2.65 ± 0.1 m		ϵ 100
		166m	3(-)	-55.99 (3)	1.41 ± 0.1 m		ϵ 58; IT 42
		166m2	0-	-55.98 (3)	2.12 ± 0.1 m		$\epsilon > 80.00$; $IT < 20.00$
		167	7/2+	-57.5 (3)	51.5 ± 1 m		ϵ 100; ϵ ; IT
		168	6(-)	-57.07 (5)	5.5 ± 0.1 m		ϵ 100
		168m	3+	-56.87 (5)	6.7 ± 0.4 m		$IT < 0.80$; $\epsilon > 99.60$
		169	7/2+	-58.083 (4)	34.06 ± 0.05 h		ϵ 100
		169m	1/2-	-58.054 (4)	160 ± 10 s		IT 100
		170	0+	-57.305 (17)	2.012 ± 0.02 d		ϵ 100
		170m	(4)-	-57.212 (17)	0.67 ± 0.1 s		IT 100
		171	7/2+	-57.829 (3)	8.24 ± 0.03 d		ϵ 100
		171m	1/2-	-57.757 (3)	79 ± 2 s		IT 100
		172	4-	-56.737 (3)	6.70 ± 0.03 d		ϵ 100
		172m	1-	-56.695 (3)	3.7 ± 0.5 m		IT 100
		173	7/2+	-56.8811 (22)	1.37 ± 0.01 y		ϵ 100
		174	(1)-	-55.5707 (22)	3.31 ± 0.05 y		ϵ 100
		174m	(6)-	-55.3999 (22)	142 ± 2 d		IT 99.38; ϵ 0.62
		175	7/2+	-55.1661 (19)	**stable**	97.401% ± 0.013%	
		176	7-	-53.3828 (19)	3.76E+10 ± 0.07E+10 y	2.599% ± 0.013%	β^- 100
		176m	1-	-53.26 (19)	3.664 ± 0.019 h		β^- 99.9; ϵ 0.09
		177	7/2+	-52.3843 (20)	6.647 ± 0.004 d		β^- 100
		177m	23/2-	-51.4141 (20)	160.44 ± 0.06 d		β^- 78.6; IT 21.4
		177m2	(39/2-)	-49.6443 (20)	6 +3-2 m		IT ?; β^- 100
		178	1(+)	-50.338 (3)	28.4 ± 0.2 m		β^- 100
		178m	(9-)	-50.214 (3)	23.1 ± 0.3 m		β^- 100
		179	7/2+	-49.059 (5)	4.59 ± 0.06 h		β^- 100

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Chapter 7

How to compute number densities

Definitions:

N_i: number density of the element (isotope or molecule) i. Units: molecules/cm^3, atoms/cm^3
ρ_i: density of i. Units: grams/cm^3
n_i: number of moles of the molecule or atom i. Unit: mol.
m_i: mass of i. Unit: grams.
M_i: atomic weight of i. Units: atomic mass unit (u) or grams/mol.

By definition, atomic weight is:

$$M_i \equiv \frac{m_i}{n_i}$$

then, the moles number of i is:

$$n_i = \frac{m_i}{M_i}$$

In one mole of matter there are $N_A = 6.0221 \cdot 10^{23}$ particles. Then, the atomic density of i is:

$$N_i = \frac{\rho_i N_A}{M_i} \tag{7.1}$$

For doing this we need to know the density of i and its average atomic weight. As we usually work with mixtures, compounds or solutions we will learn how to compute this.

The weight fraction of i is:

$$w_i \equiv \frac{m_i}{\sum_j m_j}$$

and the mole or atomic fraction:

$$y_i \equiv \frac{n_i}{\sum_j n_j}$$

In general, the isotopic abundance is commonly written as an atomic fraction, and the enrichment is written as mass weight fraction (wt%)

Using these definitions, we can now calculate the average atomic weight for mixtures or compounds.

$$\bar{M} = \frac{m_{\text{total}}}{n_{\text{total}}} = \frac{\sum_j n_j M_j}{n_{\text{total}}} = \frac{n_{\text{total}} \sum_j y_j M_j}{n_{\text{total}}} = \sum_j y_j M_j \tag{7.2}$$

or also:

$$\bar{M} = \frac{m_{\text{total}}}{n_{\text{total}}} = \frac{m_{\text{total}}}{\sum_j m_j/M_j} = \frac{m_{\text{total}}}{m_{\text{total}} \sum_j w_j/M_j} = \frac{1}{\sum_j w_j/M_j} \tag{7.3}$$

In the case we need to convert from weight fraction to atomic fraction or viceversa, we can do:

$$w_i = \frac{m_i}{m_{\text{total}}} = \frac{n_i M_i}{\sum_j n_j M_j} = \frac{n_{\text{total}} y_i M_i}{n_{\text{total}} \sum_j y_j M_j} = \frac{y_i M_i}{\sum_j y_j M_j} = \frac{y_i M_i}{\bar{M}} \tag{7.4}$$

$$y_i = \frac{n_i}{n_{\text{total}}} = \frac{m_i/M_i}{\sum_j m_j/M_j} = \frac{m_{\text{total}} w_i/M_i}{m_{\text{total}} \sum_j w_j/M_j} = \frac{w_i/M_i}{\sum_j w_j/M_j} = \frac{w_i \bar{M}}{M_i}$$

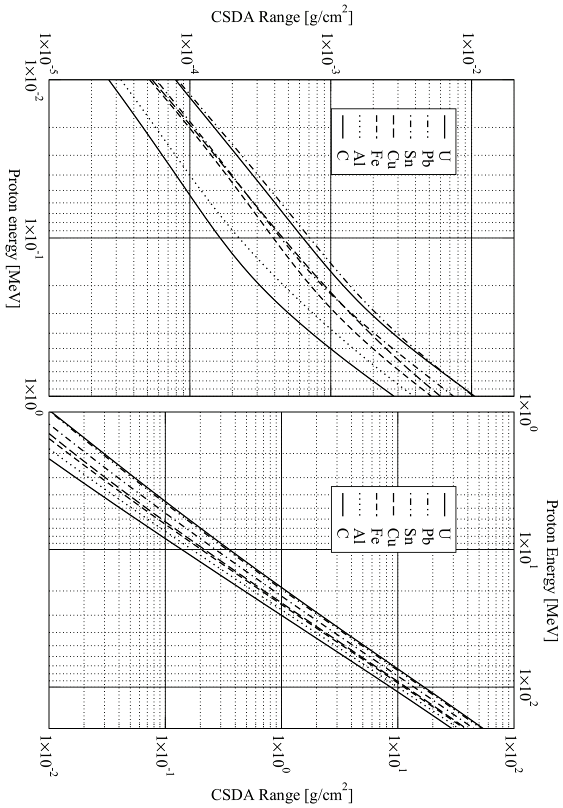

Figure 6.1: Mass attenuation (μ/ρ) and mass energy absorption coefficents (μ_{en}/ρ) for Nitrogen, $Z = 7$.

Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		179m	1/2+	-48.467 (5)	3.1 ± 0.9 ms		IT 100
		180	5+	-46.68 (7)	5.7 ± 0.1 m		β^- 100
		181	(7/2+)	-44.7 (3)	3.5 ± 0.3 m		β^- 100
		182	0	-41.88 (20)	2.0 ± 0.2 m		β^- 100
		183	(7/2+)	-39.5 (3)	58 ± 4 s		β^- 100
		184	(3+)	-36.4 (4)	19 ± 2 s		β^- 100
72	**Hf**	154	0+	-32.7 (5)	2 ± 1 s		ϵ 100; α ?
		155	0	-34.1 (4)	0.84 ± 0.03 s		ϵ 100
		156	0+	-37.85 (21)	23 ± 1 ms		α 100
		157	7/2-	-38.75 (20)	110 ± 6 ms		α 86; ϵ 14
		158	0+	-42.103 (17)	2.85 ± 0.07 s		ϵ 55.7; α 44.3
		159	7/2-	-42.853 (17)	5.6 ± 0.4 s		α 35; ϵ 65
		160	0+	-45.938 (9)	13.6 ± 0.2 s		ϵ 99.3; α 0.7
		161	0	-46.316 (23)	18.2 ± 0.5 s		$\epsilon > 99.87$; $\alpha < 0.13$
		162	0+	-49.167 (9)	39.4 ± 0.9 s		ϵ 99.99; α 0.008
		163	0	-49.29 (3)	40.0 ± 0.6 s		ϵ 100; $\alpha <$ 1.0E-4
		164	0+	-51.829 (19)	111 ± 8 s		ϵ 100
		165	(5/2-)	-51.64 (3)	76 ± 4 s		ϵ 100
		166	0+	-53.86 (3)	6.77 ± 0.3 m		ϵ 100
		167	(5/2)-	-53.47 (3)	2.05 ± 0.05 m		ϵ 100
		168	0+	-55.36 (3)	25.95 ± 0.2 m		ϵ 100
		169	5/2-	-54.72 (3)	3.24 ± 0.04 m		ϵ 100
		170	0+	-56.25 (3)	16.01 ± 0.13 h		ϵ 100
		171	7/2+	-55.43 (3)	12.1 ± 0.4 h		ϵ 100
		171m	1/2-	-55.41 (3)	29.5 ± 0.9 s		$IT \leq 100.00$; ϵ
		172	0+	-56.403 (24)	1.87 ± 0.03 y		ϵ 100
		173	1/2-	-55.41 (3)	23.6 ± 0.1 h		ϵ 100
		174	0+	-55.845 (3)	2.0E+15 ± 0.4E+15 y	0.16% ± 0.01%	α 100
		175	5/2(-)	-54.483 (3)	70 ± 2 d		ϵ 100
		176	0+	-54.5769 (21)	**stable**	5.26% ± 0.07%	
		177	7/2-	-52.885 (21)	**stable**	18.6% ± 0.09%	
		177m	23/2+	-51.5695 (21)	1.09 ± 0.05 s		IT 100
		177m2	37/2-	-50.145 (21)	51.4 ± 0.5 m		IT 100
		178	0+	-52.4396 (21)	**stable**	27.28% ± 0.07%	
		178m	8-	-51.2922 (21)	4.0 ± 0.2 s		IT 100
		178m2	16+	-49.9935 (21)	31 ± 1 y		IT 100
		179	9/2+	-50.4673 (21)	**stable**	13.62% ± 0.02%	
		179m	1/2-	-50.0923 (21)	18.67 ± 0.04 s		IT 100
		179m2	25/2-	-49.3616 (21)	25.05 ± 0.25 d		IT 100
		180	0+	-49.7838 (21)	**stable**	35.08% ± 0.16%	
		180m	8-	-48.6423 (21)	5.47 ± 0.04 h		IT 99.7; β^- 0.3
		181	1/2-	-47.4072 (21)	42.39 ± 0.06 d		β^- 100
		181m	(25/2-)	-45.6653 (21)	1.5 ± 0.5 ms		IT 100
		182	0+	-46.054 (6)	8.90E+6 ± 0.09E+6 y		β^- 100
		182m	(8-)	-44.881 (6)	61.5 ± 1.5 m		β^- 54; IT 46
		183	(3/2-)	-43.29 (3)	1.018 ± 0.002 h		β^- 100
		184	0+	-41.5 (4)	4.12 ± 0.05 h		β^- 100
		184m	(8-)	-40.23 (4)	48 ± 10 s		IT 100
		185	0	-38.36 (20)	3.5 ± 0.6 m		β^- 100
		186	0+	-36.4 (3)	2.6 ± 1.2 m		β^- 100
73	**Ta**	155	11/2-	-24 (5)	2.9 +1.5-1.1 ms		p 100
		156	(2-)	-25.8 (4)	144 ± 24 ms		p 100; ϵ
		156m	9+	-25.7 (4)	0.36 ± 0.04 s		ϵ 95.8; p 4.2

Continued on next page

Example:
UO_2 with 3% enrichment, and $\rho = 10\ \mathrm{g/cm^3}$.
We can calculate the isotopic masses of ^{235}U and ^{238}U using the mass delta from the Nuclear Wallet Card.

$$M_i = A + \Delta/931.5 \frac{\mathrm{Mev/c^2}}{\mathrm{g/mol}}$$

$$M_{235} = 235\ \mathrm{g/mol} + \frac{40.914\mathrm{Mev/c^2}}{931.5\frac{\mathrm{Mev/c^2}}{\mathrm{g/mol}}} = 235.0439\ \mathrm{g/mol}$$

$$M_{238} = 238\ \mathrm{g/mol} + \frac{47.304\mathrm{Mev/c^2}}{931.5\frac{\mathrm{Mev/c^2}}{\mathrm{g/mol}}} = 238.0508\ \mathrm{g/mol}$$

and the atomic weight for the oxygen is obtained from Nuclear Wallet Card, Appendix-I.

$$M_{\mathrm{O}} = 15.9994\ \mathrm{g/mol} \quad M_{235} = 235.0439\ \mathrm{g/mol} \quad M_{238} = 238.0508\ \mathrm{g/mol}$$

$$\bar{M}_{\mathrm{U}} = \frac{1}{\varepsilon/M_{235} + (1-\varepsilon)/M_{238}} = \frac{1}{0.03/235.0439\ \mathrm{g/mol} + 0.97/238.0508\ \mathrm{g/mol}} = 237.9595\ \mathrm{g/mol}$$

$$M_{\mathrm{UO_2}} = M_{\mathrm{U}} + 2M_{\mathrm{O}} = 237.9595\ \mathrm{g/mol} + 2 \cdot 15.999\ \mathrm{g/mol} = 269.9583\ \mathrm{g/mol}$$

Here, the small fraction of ^{234}U present -if any- was neglected. For low enriched uranium this is appropriate, but it might be important to take it into account if the enrichment is high.

Now, the number density of molecules of UO_2 is:

$$N_{\mathrm{UO_2}} = \frac{10\ \mathrm{g/cm^3} \cdot 6.0221 \cdot 10^{23} 1/\mathrm{mol}}{269.9583\ \mathrm{g/mol}} = 2.2308 \cdot 10^{22}\ 1/\mathrm{cm^3}$$

For each molecule of UO_2 there is one atom of uranium and two of oxygen, then

$$N_{\mathrm{U}} = N_{\mathrm{UO_2}} = 2.2308 \cdot 10^{22}\ 1/\mathrm{cm^3}$$

$$N_{\mathrm{O}} = 2N_{\mathrm{UO_2}} = 4.4615 \cdot 10^{22}\ 1/\mathrm{cm^3}$$

Then, to calculate the amount of ^{235}U and ^{238}U we need the atomic fraction of ^{235}U:

$$y_{235} = \frac{\varepsilon \bar{M}_U}{M_{235}} = \frac{0.03 \cdot 237.9595\ \mathrm{g/mol}}{235.0439\ \mathrm{g/mol}} = 3.04\%$$

and using that:

$$N_{235} = y_{235} N_{\mathrm{U}} = 3.04\% \cdot 2.2308 \cdot 10^{22}\ 1/\mathrm{cm^3} = 6.7753 \cdot 10^{20} 1/\mathrm{cm^3}$$

$$N_{238} = (1 - y_{235}) N_{\mathrm{U}} = (1 - 3.04\%) \cdot 2.2308 \cdot 10^{22}\ 1/\mathrm{cm^3} = 2.1630 \cdot 10^{22}\ 1/\mathrm{cm^3}$$

Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		158	2-	-58.7 (3)	3.98 ± 0.06 m		ϵ 100; ϵ ?
		159	5/2+	-60.57 (3)	9.13 ± 0.16 m		ϵ 100
		160	1-	-60.3 (3)	9.4 ± 0.3 m		ϵ 100
		160m	5	-60.23 (3)	74.5 ± 1.5 s		IT 85; ϵ 15
		161	7/2+	-61.9 (3)	30.2 ± 0.8 m		ϵ 100
		162	1-	-61.47 (3)	21.70 ± 0.19 m		ϵ 100; IT 81; ϵ 19
		163	1/2+	-62.727 (6)	1.810 ± 0.005 h		ϵ 100
		164	1+	-61.904 (24)	2.0 ± 0.1 m		ϵ 100; $IT \approx$ 80.00; $\epsilon \approx$ 20.00
		165	1/2+	-62.929 (3)	30.06 ± 0.03 h		ϵ 100
		166	2+	-61.887 (12)	7.70 ± 0.03 h		ϵ 100
		166m	(6-)	-61.778 (12)	340 ± 25 ms		IT 100
		167	1/2+	-62.5429 (23)	9.25 ± 0.02 d		ϵ 100
		168	3+	-61.312 (3)	93.1 ± 0.2 d		ϵ 99.99; β^- 0.01
		169	1/2+	-61.2745 (21)	**stable**	100%	
		170	1-	-59.7952 (21)	128.6 ± 0.3 d		β^- 99.87; ϵ 0.13
		171	1/2+	-59.2103 (23)	1.92 ± 0.01 y		β^- 100
		172	2-	-57.374 (6)	63.6 ± 0.2 h		β^- 100
		173	(1/2+)	-56.253 (5)	8.24 ± 0.08 h		β^- 100
		174	(4)-	-53.86 (4)	5.4 ± 0.1 m		β^- 100
		174m	0+	-53.61 (4)	2.29 ± 0.01 s		IT 99; $\beta^- <$ 1.00
		175	(1/2+)	-52.31 (5)	15.2 ± 0.5 m		β^- 100
		176	(4+)	-49.37 (10)	1.9 ± 0.1 m		β^- 100
		177	(7/2-)	-47.5 (3)	90 ± 6 s		β^- 100
70	**Yb**	149	(1/2+,3/2+)	-33.2 (5)	0.7 ± 0.2 s		ϵp 100; ϵ 100
		151	(1/2+)	-41.5 (3)	1.6 ± 0.1 s		ϵ 100; $\epsilon p >$ 0.00; ϵ 100; $IT \approx$ 0.40; ϵp
		152	0+	-46.31 (21)	3.03 ± 0.06 s		ϵ 100; ϵp
		153	7/2-	-47.06 (20)	4.2 ± 0.2 s		ϵ 40; α 60
		154	0+	-49.932 (17)	0.409 ± 0.002 s		α 92.6; ϵ 7.4
		155	(7/2-)	-50.503 (17)	1.793 ± 0.019 s		α 89; ϵ 11
		156	0+	-53.265 (9)	26.1 ± 0.7 s		ϵ 90; α 10
		157	7/2-	-53.43 (10)	38.6 ± 1 s		ϵ 99.5; α 0.5
		158	0+	-56.009 (8)	1.49 ± 0.13 m		$\alpha \approx$ 2.1E-3; ϵ 100
		159	5/2(-)	-55.836 (18)	1.67 ± 0.09 m		ϵ 100
		160	0+	-58.163 (16)	4.8 ± 0.2 m		ϵ 100
		161	3/2-	-57.838 (15)	4.2 ± 0.2 m		ϵ 100
		162	0+	-59.825 (15)	18.87 ± 0.19 m		ϵ 100
		163	3/2-	-59.298 (15)	11.05 ± 0.35 m		ϵ 100
		164	0+	-61.016 (15)	75.8 ± 1.7 m		ϵ 100
		165	5/2-	-60.29 (3)	9.9 ± 0.3 m		ϵ 100
		166	0+	-61.594 (7)	56.7 ± 0.1 h		ϵ 100
		167	5/2-	-60.589 (5)	17.5 ± 0.2 m		ϵ 100
		168	0+	-61.5804 (21)	**stable**	0.123% ± 0.003%	
		169	7/2+	-60.3761 (21)	32.018 ± 0.005 d		ϵ 100
		169m	1/2-	-60.3519 (21)	46 ± 2 s		IT 100
		170	0+	-60.7636 (21)	**stable**	2.982% ± 0.039%	
		171	1/2-	-59.3068 (21)	**stable**	14.09% ± 0.14%	
		171m	7/2+	-59.2115 (21)	5.25 ± 0.24 ms		IT 100
		172	0+	-59.255 (21)	**stable**	21.68% ± 0.13%	
		173	5/2-	-57.551 (21)	**stable**	16.103% ± 0.063%	
		174	0+	-56.9443 (21)	**stable**	32.026% ± 0.08%	
		175	(7/2-)	-54.6954 (21)	4.185 ± 0.001 d		β^- 100
		175m	1/2-	-54.1805 (21)	68.2 ± 0.3 ms		IT 100

Continued on next page

Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		172	0	-51.48 (20)	25 ± 3 s		β^- 100
68	**Er**	145m	(11/2-)	-39.2 (4)	1.0 ± 0.3 s		ϵ 100; ϵp
		146	0+	-44.322 (7)	1.7 ± 0.6 s		ϵp 100; ϵ 100
		147	(1/2+)	-46.61 (4)	2.5 ± 0.2 s		ϵ 100; $\epsilon p > 0.00$; ϵ 100; $\epsilon p > 0.00$
		148	0+	-51.479 (10)	4.6 ± 0.2 s		ϵ 100
		149	(1/2+)	-53.74 (3)	4 ± 2 s		ϵ 100; ϵp 7
		149m	(11/2-)	-53 (3)	8.9 ± 0.2 s		ϵ 96.5; IT 3.5; ϵp 0.18
		150	0+	-57.831 (17)	18.5 ± 0.7 s		ϵ 100
		151	(7/2-)	-58.266 (16)	23.5 ± 2 s		ϵ 100
		151m	(27/2-)	-55.68 (16)	0.58 ± 0.02 s		IT 95.3; ϵ 4.7
		152	0+	-60.5 (9)	10.3 ± 0.1 s		α 90; ϵ 10
		153	(7/2-)	-60.476 (9)	37.1 ± 0.2 s		α 53; ϵ 47
		154	0+	-62.606 (5)	3.73 ± 0.09 m		ϵ 99.53; α 0.47
		155	7/2-	-62.209 (6)	5.3 ± 0.3 m		α 0.02; ϵ 99.98
		156	0+	-64.213 (24)	19.5 ± 1 m		ϵ 100; α 1.7e-05
		157	3/2-	-63.41 (3)	18.65 ± 0.1 m		ϵ 100
		157m	(9/2+)	-63.26 (3)	76 ± 6 ms		IT 100
		158	0+	-65.3 (3)	2.29 ± 0.06 h		ϵ 100
		159	3/2-	-64.56 (4)	36 ± 1 m		ϵ 100
		160	0+	-66.058 (25)	28.58 ± 0.09 h		ϵ 100
		161	3/2-	-65.199 (9)	3.21 ± 0.03 h		ϵ 100
		162	0+	-66.3329 (19)	**stable**	$0.139\% \pm 0.005\%$	
		163	5/2-	-65.166 (5)	75.0 ± 0.4 m		ϵ 100
		164	0+	-65.941 (3)	**stable**	$1.601\% \pm 0.003\%$	
		165	5/2-	-64.52 (3)	10.36 ± 0.04 h		ϵ 100
		166	0+	-64.9245 (21)	**stable**	$33.503\% \pm 0.036\%$	
		167	7/2+	-63.2897 (21)	**stable**	$22.869\% \pm 0.009\%$	
		167m	1/2-	-63.0819 (21)	2.269 ± 0.006 s		IT 100
		168	0+	-62.9897 (21)	**stable**	$26.978\% \pm 0.018\%$	
		169	1/2-	-60.9216 (21)	9.392 ± 0.018 d		β^- 100
		170	0+	-60.108 (24)	**stable**	$14.91\% \pm 0.036\%$	
		171	5/2-	-57.7183 (24)	7.516 ± 0.002 h		β^- 100
		172	0+	-56.483 (4)	49.3 ± 0.3 h		β^- 100
		173	(7/2-)	-53.65 (20)	1.4 ± 0.1 m		β^- 100
		174	0+	-51.9 (3)	3.2 ± 0.2 m		β^- 100
		175	(9/2+)	-48.7 (4)	1.2 ± 0.3 m		β^- 100
69	**Tm**	146	(5-)	-31.2 (4)	80 ± 10 ms		p ; ϵ
		146m	(8+)	-31.1 (4)	200 ± 10 ms		p ; ϵ
		147	11/2-	-35.974 (7)	0.58 ± 0.03 s		ϵ 85; p 15
		148	(10+)	-38.765 (10)	0.7 ± 0.2 s		ϵ 100
		149	(11/2-)	-43.9 (3)	0.9 ± 0.2 s		ϵ 100; ϵp 0.2
		150	(6-)	-46.49 (20)	2.20 ± 0.06 s		ϵ 100
		150m	(10+)	-45.82 (20)	5.2 ± 0.3 ms		IT 100
		151	(11/2-)	-50.778 (20)	4.17 ± 0.11 s		ϵ 100; ϵ 100
		152	(2)-	-51.77 (7)	8.0 ± 1 s		ϵ 100; ϵ 100
		153	(11/2-)	-53.991 (14)	1.48 ± 0.01 s		α 91; ϵ 9
		153m	(1/2+)	-53.948 (14)	2.5 ± 0.2 s		α 92; ϵ 8
		154	(2-)	-54.427 (14)	8.1 ± 0.3 s		α 54; ϵ 46; α 58; ϵ 42; IT
		155	11/2-	-56.626 (10)	21.6 ± 0.2 s		ϵ 99.11; α 0.89
		155m	1/2+	-56.585 (10)	45 ± 3 s		$\epsilon > 98.00$; $\alpha < 2.00$
		156	2-	-56.84 (15)	83.8 ± 1.8 s		ϵ 99.94; α 0.06
		157	1/2+	-58.71 (3)	3.63 ± 0.09 m		ϵ 100

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Another way to solve it:
Because the enrichment is a weight fraction, we could convert everything to mass fraction. The atomic fraction of uranium and oxygen in the uranium dioxide are:

$$y_{\mathrm{U}} = \frac{1}{1+2} = \frac{1}{3}$$
$$y_{\mathrm{O}} = \frac{2}{1+2} = \frac{2}{3}$$

and, using (7.4):

$$w_{\mathrm{U}} = \frac{y_{\mathrm{U}} \cdot \bar{M}_{\mathrm{U}}}{y_{\mathrm{U}} \cdot \bar{M}_{\mathrm{U}} + y_{\mathrm{O}} \cdot \bar{M}_{\mathrm{O}}} = \frac{1/3 \cdot 237.9595\ \mathrm{g/mol}}{1/3 \cdot 237.9595\ \mathrm{g/mol} + 2/3 \cdot 15.9994\ \mathrm{g/mol}} = 88.147\%$$

Then, the weight fraction of ^{235}U respect to the total amount is:

$$w_{235} = \varepsilon \cdot w_{\mathrm{U}} = 2.644\%$$

for ^{238}U:

$$w_{238} = (1-\varepsilon) \cdot w_{\mathrm{U}} = 85.502\%$$

and for oxygen:

$$w_{\mathrm{O}} = 1 - w_{\mathrm{U}} = 11.853\%$$

finally we just do:

$$N_{235} = \frac{w_{235}\rho N_A}{M_{235}} = 6.7753 \cdot 10^{20}\ 1/\mathrm{cm}^3$$
$$N_{238} = \frac{w_{238}\rho N_A}{M_{238}} = 2.1630 \cdot 10^{22}\ 1/\mathrm{cm}^3$$
$$N_{\mathrm{O}} = \frac{w_{\mathrm{O}}\rho N_A}{M_{\mathrm{O}}} = 4.4615 \cdot 10^{22}\ 1/\mathrm{cm}^3$$

Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		155	3/2+	-71.247 (12)	5.32 ± 0.06 d		ϵ 100
		156	3-	-70.09 (4)	5.35 ± 0.1 d		ϵ 100
		156m	(7-)	-70.04 (4)	24.4 ± 1 h		IT 100
		156m2	(0+)	-70.002 (4)	5.3 ± 0.2 h		$IT < 100.00$; $\epsilon > 0.00$
		157	3/2+	-70.7629 (17)	71 ± 7 y		ϵ 100
		158	3-	-69.4697 (19)	180 ± 11 y		ϵ 83.4; β^- 16.6
		158m	0-	-69.3594 (19)	10.70 ± 0.17 s		$\epsilon < 0.01$; IT 100; $\beta^- < 0.60$
		159	3/2+	-69.5315 (18)	**stable**	100%	
		160	3-	-67.8354 (18)	72.3 ± 0.2 d		β^- 100
		161	3/2+	-67.4607 (19)	6.89 ± 0.02 d		β^- 100
		162	1-	-65.67 (4)	7.60 ± 0.15 m		β^- 100
		163	3/2+	-64.594 (4)	19.5 ± 0.3 m		β^- 100
		164	(5+)	-62.08 (10)	3.0 ± 0.1 m		β^- 100
		165	(3/2+)	-60.66 (20)	2.11 ± 0.1 m		β^- 100
		166	(2-)	-57.88 (7)	25.1 ± 2.1 s		β^- 100
		167	(3/2+)	-55.9 (4)	19.4 ± 2.7 s		β^- 100
		168	(4-)	-52.6 (5)	8.2 ± 1.3 s		β^- 100
66	**Dy**	139	(7/2+)	-37.6 (5)	0.6 ± 0.2 s		ϵ ; ϵp
		141	(9/2-)	-45.2 (3)	0.9 ± 0.2 s		ϵ 100; ϵp
		142	0+	-49.9 (7)	2.3 ± 0.3 s		ϵp 0.06; ϵ 100
		143	(1/2+)	-52.169 (13)	5.6 ± 1 s		ϵ 100; ϵp
		143m	(11/2-)	-51.858 (13)	3.0 ± 0.3 s		ϵ 100; ϵp
		144	0+	-56.57 (7)	9.1 ± 0.4 s		ϵ 100; ϵp
		145	(1/2+)	-58.243 (7)	6 ± 2 s		ϵ 100; $\epsilon p \approx 50.00$
		145m	(11/2-)	-58.124 (7)	14.1 ± 0.7 s		$\epsilon p \approx 50.00$; ϵ 100
		146	0+	-62.555 (7)	29 ± 3 s		ϵ 100
		146m	(10+)	-59.619 (7)	150 ± 20 ms		IT 100
		147	(1/2+)	-64.195 (8)	67 ± 7 s		ϵ 100; ϵp 0.05
		147m	(11/2-)	-63.444 (8)	55.2 ± 0.5 s		ϵ 68.9; IT 31.1
		148	0+	-67.86 (9)	3.3 ± 0.2 m		ϵ 100
		149	(7/2-)	-67.703 (9)	4.20 ± 0.14 m		ϵ 100
		149m	(27/2-)	-65.042 (9)	0.490 ± 0.015 s		IT 99.3; ϵ 0.7
		150	0+	-69.311 (5)	7.17 ± 0.05 m		ϵ 64; α 36
		151	7/2(-)	-68.752 (4)	17.9 ± 0.3 m		ϵ 94.4; α 5.6
		152	0+	-70.118 (5)	2.38 ± 0.02 h		ϵ 99.9; α 0.1
		153	7/2(-)	-69.143 (4)	6.4 ± 0.1 h		ϵ 99.99; α 0.0094
		154	0+	-70.393 (8)	$3.0\mathrm{E}{+}6 \pm 1.5\mathrm{E}{+}6$ y		α 100
		155	3/2-	-69.152 (12)	9.9 ± 0.2 h		ϵ 100
		156	0+	-70.522 (6)	**stable**	$0.056\% \pm 0.003\%$	
		157	3/2-	-69.42 (6)	8.14 ± 0.04 h		ϵ 100
		157m	11/2-	-69.221 (6)	21.6 ± 1.6 ms		IT 100
		158	0+	-70.405 (3)	**stable**	$0.095\% \pm 0.003\%$	
		159	3/2-	-69.1661 (21)	144.4 ± 0.2 d		ϵ 100
		160	0+	-69.6711 (19)	**stable**	$2.329\% \pm 0.018\%$	
		161	5/2+	-68.0541 (19)	**stable**	$18.889\% \pm 0.042\%$	
		162	0+	-68.1798 (19)	**stable**	$25.475\% \pm 0.036\%$	
		163	5/2-	-66.3795 (19)	**stable**	$24.896\% \pm 0.042\%$	
		164	0+	-65.9663 (19)	**stable**	$28.26\% \pm 0.054\%$	
		165	7/2+	-63.6109 (19)	2.334 ± 0.001 h		β^- 100
		165m	1/2-	-63.5027 (19)	1.257 ± 0.006 m		IT 97.76; β^- 2.24
		166	0+	-62.5831 (20)	81.6 ± 0.1 h		β^- 100
		167	(1/2-)	-59.93 (6)	6.20 ± 0.08 m		β^- 100

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Chapter 8

Ground and isomeric states properties

The properties of ground and isomeric states for all nuclides included in NuDat 2.6 are listed in the following table. For each state the following data is given:

- Atomic number (Z), chemical symbol and mass number (A).
- Spin and parity $(J\pi)$.
- Mass excess: $\Delta = M - A$, where M is the mass a neutral atom. Mass excess is given in MeV; to convert to atomic mass units, the relationship $1\ \mathrm{u} = 931.494\ \mathrm{MeV/c^2}$ can be used.
- Half life $(T_{1/2})$ or level width (Γ)
- Abundance (isotope atom fraction) of natural occurring nuclides.
- Decay modes, followed by emission probability in %:

  $\beta-$: $\beta-$ decay.
  ϵ: electron capture, $\beta+$ decay, or $EC + \beta+$.
  IT: isomeric transition (γ emission or conversion electron).
  $n, p, \alpha, \ldots$: $n, p, \alpha, \ldots$ emission.
  SF: spontaneous fission.
  $\beta - p, \beta - \alpha, \beta - n, \ldots$: delayed $p, \alpha, n, \ldots$ emission following $\beta-$ decay.
  $\epsilon - p, \epsilon - \alpha, \epsilon - n, \ldots$: delayed $p, \alpha, n, \ldots$ emission following $\beta+$ or EC decay.
  $^{12}C, ^{24}Ne, \ldots$: $^{12}C, ^{24}Ne, \ldots$ nuclei emission.

Source:
IAEA NuDat 2.6 `http://www-nds.iaea.org/nudat2/`.

Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		168	0+	-58.56 (14)	8.7 ± 0.3 m		β^- 100
		169	(5/2)-	-55.6 (3)	39 ± 8 s		β^- 100
67	**Ho**	140	(6-,0-,8+)	-29.2 (5)	6 ± 3 ms		p 100
		141	7/2-	-34.3 (5)	4.1 ± 0.3 ms		p 100
		142	(7-,8+)	-37.2 (5)	0.4 ± 0.1 s		ϵ 100; $\epsilon p > 0.00$
		144	(5-)	-44.609 (8)	0.7 ± 0.1 s		ϵ 100; ϵp
		145	(11/2-)	-49.12 (7)	2.4 ± 0.1 s		ϵ 100
		146	(10+)	-51.238 (7)	3.6 ± 0.3 s		ϵ 100
		147	(11/2-)	-55.757 (5)	5.8 ± 0.4 s		ϵ 100
		148	(1+)	-57.99 (8)	2.2 ± 1.1 s		ϵ 100; ϵ 100; ϵp 0.08
		148m	(10+)	-57.3 (8)	2.35 ± 0.04 ms		IT 100
		149	(11/2-)	-61.664 (14)	21.1 ± 0.2 s		ϵ 100
		149m	(1/2+)	-61.616 (14)	56 ± 3 s		ϵ 100
		150	2-	-61.946 (14)	72 ± 4 s		ϵ 100
		150m	(9)+	-61.446 (14)	24.1 ± 0.5 s		ϵ 100;
		151	(11/2-)	-63.623 (8)	35.2 ± 0.1 s		ϵ 78; α 22
		151m	(1/2+)	-63.582 (8)	47.2 ± 1.3 s		α 80; ϵ 20
		152	2-	-63.608 (13)	161.8 ± 0.3 s		ϵ 88; α 12
		152m	9+	-63.448 (13)	50.0 ± 0.4 s		ϵ 89.2; α 10.8
		153	11/2-	-65.013 (5)	2.01 ± 0.03 m		ϵ 99.95; α 0.05
		153m	1/2+	-64.944 (5)	9.3 ± 0.5 m		ϵ 99.82; α 0.18
		154	2-	-64.639 (8)	11.76 ± 0.19 m		α 0.02; ϵ 99.98; ϵ 100; $\alpha <$ 1.0E-3
		155	5/2+	-66.04 (18)	48 ± 1 m		ϵ 100
		156	4-	-65.47 (6)	56 ± 1 m		ϵ 100
		156m	1-	-65.42 (6)	9.5 ± 1.5 s		IT 100; ϵ 75; IT 25
		157	7/2-	-66.832 (23)	12.6 ± 0.2 m		ϵ 100
		158	5+	-66.18 (3)	11.3 ± 0.4 m		ϵ 100
		158m	2-	-66.12 (3)	28 ± 2 m		$IT > 81.00$; $\epsilon < 19.00$
		158m2	(9+)	-66 (3)	21.3 ± 2.3 m		$\epsilon \geq 93.00$; $IT \leq 7.00$
		159	7/2-	-67.328 (3)	33.05 ± 0.11 m		ϵ 100
		159m	1/2+	-67.123 (3)	8.30 ± 0.08 s		IT 100
		160	5+	-66.381 (15)	25.6 ± 0.3 m		ϵ 100
		160m	2-	-66.321 (15)	5.02 ± 0.05 h		IT 73; ϵ 27
		160m2	(9+)	-66.211 (15)	3 ± 0 s		IT 100
		161	7/2-	-67.196 (3)	2.48 ± 0.05 h		ϵ 100
		161m	1/2+	-66.985 (3)	6.76 ± 0.07 s		IT 100
		162	1+	-66.04 (4)	15.0 ± 1 m		ϵ 100
		162m	6-	-65.934 (4)	67.0 ± 0.7 m		IT 62; ϵ 38
		163	7/2-	-66.3769 (19)	4570 ± 25 y		ϵ 100
		163m	1/2+	-66.079 (19)	1.09 ± 0.03 s		IT 100
		164	1+	-64.9801 (23)	29 ± 1 m		ϵ 60; β^- 40
		164m	6-	-64.8403 (23)	37.5 +1.5-0.5 m		IT 100
		165	7/2-	-64.8977 (20)	**stable**	100%	
		166	0-	-63.07 (20)	26.824 ± 0.012 h		β^- 100
		166m	7-	-63.064 (20)	$1.20E3 \pm 0.18E3$ y		β^- 100
		167	7/2-	-62.28 (6)	3.003 ± 0.018 h		β^- 100
		168	3+	-60.06 (3)	2.99 ± 0.07 m		β^- 100
		168m	(6+)	()	132 ± 4 s		$IT \geq 99.50$; $\beta^- \leq 0.50$
		169	7/2-	-58.796 (20)	4.72 ± 0.1 m		β^- 100
		170	(6+)	-56.24 (5)	2.76 ± 0.05 m		β^- 100
		170m	(1+)	-56.12 (5)	43 ± 2 s		β^- 100
		171	(7/2-)	-54.5 (6)	53 ± 2 s		β^- 100

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Table 8.1: Ground and isomeric states properties (Adapted from IAEA NuDat 2.6).

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
0	**n**	1	1/2+	8.0713 (5)	10.183 ± 0.017 m		β^- 100%
1	**H**	1	1/2+	7.2889 (10)	**stable**	$99.9885\% \pm 0.007\%$	
		2	1+	13.1357 (15)	**stable**	$0.0115\% \pm 0.007\%$	
		3	1/2+	14.9498 (22)	12.32 ± 0.02 y		β^- 100%
2	**He**	3	1/2+	14.9312 (23)	**stable**	$0.000134\% \pm$ 3e-06%	
		4	0+	2.4249 (6)	**stable**	$99.999866\% \pm$ 3e-06%	
		6	0+	17.5928 (4)	801 ± 10 ms		β^- 100%
		8	0+	31.6096 (18)	119.1 ± 1.2 ms		β^- 100%; $\beta^- n$ 16%
3	**Li**	6	1+	14.0868 (15)	**stable**	$7.59\% \pm 0.04\%$	
		7	3/2-	14.907 (4)	**stable**	$92.41\% \pm 0.04\%$	
		8	2+	20.9457 (5)	839.9 ± 0.9 ms		β^- 100%; $\beta^- \alpha$ 100%
		9	3/2-	24.9549 (9)	178.3 ± 0.4 ms		β^- 100%; $\beta^- n$ 50.8%
		11	3/2-	40.7284 (11)	8.75 ± 0.14 ms		$\beta^- \alpha, n$ 0.027%; β^- 100%; $\beta^- n$ 83%; $\beta^- 2n$ 4.1%
4	**Be**	7	3/2-	15.7689 (7)	53.24 ± 0.04 d		ϵ 100
		9	3/2-	11.3484 (8)	**stable**	100%	
		10	0+	12.6074 (8)	$1.387E+6 \pm 0.012E+6$ y		β^- 100
		11	1/2+	20.1771 (24)	13.81 ± 0.08 s		β^- 100; $\beta^- \alpha$ 3.1
		12	0+	25.077 (4)	21.49 ± 0.03 ms		β^- 100; $\beta^- n \leq 1.00$
		14	0+	39.95 (13)	4.35 ± 0.17 ms		β^- 100; $\beta^- n$ 81; $\beta^- 2n$ 5
5	**B**	8	2+	22.9215 (10)	770 ± 3 ms		ϵ 100; $\epsilon\alpha$ 100
		10	3+	12.0507 (4)	**stable**	$19.9\% \pm 0.7\%$	
		11	3/2-	8.6679 (4)	**stable**	$80.1\% \pm 0.7\%$	
		12	1+	13.3688 (14)	20.20 ± 0.02 ms		β^- 100; $\beta^- 3\alpha$ 1.58
		13	3/2-	16.5621 (11)	17.33 ± 0.17 ms		β^- 100
		14	2-	23.664 (21)	12.5 ± 0.5 ms		β^- 100
		15	0	28.964 (22)	9.93 ± 0.07 ms		β^- 100; $\beta^- n$ 93.6; $\beta^- 2n$ 0.4
		17	(3/2-)	43.77 (17)	5.08 ± 0.05 ms		β^- 100; $\beta^- n$ 63; $\beta^- 2n$ 11; $\beta^- 3n$ 3.5; $\beta^- 4n$ 0.4
		19	(3/2-)	58.8 (4)	2.92 ± 0.13 ms		β^- 100; $\beta^- n$ 72; $\beta^- 2n$ 16
6	**C**	9	(3/2-)	28.9094 (21)	126.5 ± 0.9 ms		ϵ 100; ϵp 61.6; $\epsilon\alpha$ 38.4
		10	0+	15.6986 (4)	19.308 ± 0.004 s		ϵ 100
		11	3/2-	10.6503 (10)	20.334 ± 0.024 m		ϵ 100
		12	0+	0 ()	**stable**	$98.93\% \pm 0.08\%$	
		13	1/2-	3.125 (21)	**stable**	$1.07\% \pm 0.08\%$	
		14	0+	3.0198 (4)	5700 ± 30 y		β^- 100
		15	1/2+	9.8731 (8)	2.449 ± 0.005 s		β^- 100
		16	0+	13.694 (4)	0.747 ± 0.008 s		β^- 100; $\beta^- n$ 99
		17	3/2+	21.032 (17)	193 ± 13 ms		β^- 100; $\beta^- n$ 32
		18	0+	24.92 (3)	92 ± 2 ms		$\beta^- n$ 31.5; β^- 100
		19	1/2+	32.41 (10)	49 ± 4 ms		β^- ; $\beta^- n$ 61
		20	0+	37.56 (24)	14 +6-5 ms		β^- 100; $\beta^- n$ 72
		22	0+	52.1 (5)	6.1 +1.4-1.2 ms		β^- 100; $\beta^- n$ 61; $\beta^- 2n <$ 37.00
7	**N**	12	1+	17.338 (10)	11.000 ± 0.016 ms		ϵ 100
		13	1/2-	5.3454 (3)	9.965 ± 0.004 m		ϵ 100
		14	1+	2.8634 (19)	**stable**	$99.636\% \pm 0.02\%$	
		15	1/2-	0.1014 (6)	**stable**	$0.364\% \pm 0.02\%$	
		16	2-	5.684 (3)	7.13 ± 0.02 s		β^- 100; $\beta^- \alpha$ 0.0012
		17	1/2-	7.87 (15)	4.173 ± 0.004 s		β^- 100; $\beta^- n$ 95.1
		18	1-	13.113 (19)	620 ± 8 ms		$\beta^- \alpha$ 12.2; $\beta^- n$ 7; β^- 100

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		143	(1/2)+	-68.23 (20)	39 ± 2 s		ϵ 100
		143m	(11/2-)	-68.08 (20)	110.0 ± 1.4 s		ϵ 100
		144	0+	-71.76 (3)	4.47 ± 0.06 m		ϵ 100
		145	1/2+	-72.927 (19)	23.0 ± 0.4 m		ϵ 100
		145m	11/2-	-72.178 (19)	85 ± 3 s		IT 94.3; ϵ 5.7
		146	0+	-76.087 (4)	48.27 ± 0.1 d		ϵ 100
		147	7/2-	-75.357 (3)	38.06 ± 0.12 h		ϵ 100
		148	0+	-76.2696 (25)	70.9 ± 1 y		α 100
		149	7/2-	-75.127 (4)	9.28 ± 0.1 d		α 0.00043; ϵ 100
		150	0+	-75.763 (6)	$1.79E+6 \pm 0.08E+6$ y		α 100
		151	7/2-	-74.188 (3)	123.9 ± 1 d		ϵ 100; $\alpha \approx$ 8.0E-7
		152	0+	-74.7065 (17)	$1.08E14 \pm 0.08E14$ y	$0.2\% \pm 0.01\%$	α 100
		153	3/2-	-72.8821 (17)	240.4 ± 1 d		ϵ 100
		154	0+	-73.7055 (17)	**stable**	$2.18\% \pm 0.03\%$	
		155	3/2-	-72.0694 (17)	**stable**	$14.8\% \pm 0.12\%$	
		155m	11/2-	-71.9484 (17)	31.97 ± 0.27 ms		IT 100
		156	0+	-72.5345 (17)	**stable**	$20.47\% \pm 0.09\%$	
		157	3/2-	-70.823 (17)	**stable**	$15.65\% \pm 0.02\%$	
		158	0+	-70.6891 (17)	**stable**	$24.84\% \pm 0.07\%$	
		159	3/2-	-68.5609 (17)	18.479 ± 0.004 h		β^- 100
		160	0+	-67.9409 (18)	$> 3.1E+19$ y	$21.86\% \pm 0.19\%$	$2\beta^-$
		161	5/2-	-65.505 (20)	3.66 ± 0.05 m		β^- 100
		162	0+	-64.28 (4)	8.4 ± 0.2 m		β^- 100
		163	(5/2-,7/2+)	-61.47 (7)	68 ± 3 s		β^- 100
		164	0+	-59.9 (4)	45 ± 3 s		β^- 100
		165	0	-56.6 (5)	10.3 ± 1.6 s		β^- 100
		166	0+	-54.5 (6)	4.8 ± 1 s		β^- 100
65	**Tb**	139	0	-48 (3)	1.6 ± 0.2 s		ϵ ; ϵp ?
		140	(7+)	-50.5 (8)	2.0 ± 0.5 s		ϵp 0.26; ϵ 100
		141	(5/2-)	-54.54 (11)	3.5 ± 0.2 s		ϵ 100; ϵ 100
		142	1+	-56.6 (7)	597 ± 17 ms		ϵ 100; ϵp 0.0022
		142m	5-	-56.3 (7)	303 ± 17 ms		IT 100
		143	(11/2-)	-60.42 (5)	12 ± 1 s		ϵ 100; ϵ
		144	1+	-62.37 (3)	≈ 1 s		ϵ 100
		144m	(6-)	-61.97 (3)	4.25 ± 0.15 s		IT 66; ϵ 34
		146	1+	-67.76 (4)	8 ± 4 s		ϵ 100; ϵ 100
		146m	(10+)	-66.98 (4)	1.18 ± 0.02 ms		IT 100
		147	(1/2+)	-70.743 (8)	1.64 ± 0.03 h		ϵ 100
		147m	(11/2-)	-70.692 (8)	1.83 ± 0.06 m		ϵ 100
		148	2-	-70.54 (13)	60 ± 1 m		ϵ 100
		148m	(9)+	-70.45 (13)	2.20 ± 0.05 m		ϵ 100
		149	1/2+	-71.489 (4)	4.118 ± 0.025 h		α 16.7; ϵ 83.3
		149m	11/2-	-71.453 (4)	4.16 ± 0.04 m		ϵ 99.98; α 0.02
		150	(2-)	-71.105 (7)	3.48 ± 0.16 h		ϵ 100; $\alpha < 0.05$
		150m	9+	-70.631 (7)	5.8 ± 0.2 m		ϵ
		151	1/2(+)	-71.623 (4)	17.609 ± 0.014 h		ϵ 99.99; α 0.0095
		151m	(11/2-)	-71.523 (4)	25 ± 3 s		IT 93.4; ϵ 6.6
		152	2-	-70.72 (4)	17.5 ± 0.1 h		$\alpha <$ 7.0E-7; ϵ 100
		152m	8+	-70.21 (4)	4.2 ± 0.1 m		IT 78.8; ϵ 21.2
		153	5/2+	-71.313 (4)	2.34 ± 0.01 d		ϵ 100
		154	0	-70.15 (5)	21.5 ± 0.4 h		ϵ 100; $\beta^- < 0.10$; ϵ 98.2; IT 1.8; ϵ 78.2; IT 21.8; $\beta^- < 0.10$

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Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		157	(3/2-)	-66.73 (5)	8.03 ± 0.07 m		β^- 100
		158	0+	-65.2 (8)	5.30 ± 0.03 m		β^- 100
		159	5/2-	-62.25 (7)	11.37 ± 0.15 s		β^- 100
		160	0+	-60.42 (20)	9.6 ± 0.3 s		β^- 100
		161	0	-56.75 (14)	4.8 ± 0.4 s		β^- 100
		162	0+	-54.8 (5)	2.4 ± 0.5 s		β^- 100
63	**Eu**	131	3/2+	-38.7 (4)	17.8 ± 1.9 ms		p 89; ϵ 11
		134	0	-49.72 (20)	0.5 ± 0.2 s		ϵ 100; $\epsilon p > 0.00$
		135	0	-54.1 (3)	1.5 ± 0.2 s		ϵ 100; ϵp
		136	(7+)	-56.1 (20)	3.3 ± 0.3 s		ϵ 100; ϵp 0.09; ϵ 100; ϵp 0.09
		137	(11/2-)	-60.02 (20)	11 ± 2 s		ϵ 100
		138	(6-)	-61.75 (3)	12.1 ± 0.6 s		ϵ 100
		139	(11/2)-	-65.398 (13)	17.9 ± 0.6 s		ϵ 100
		140	1+	-66.99 (5)	1.51 ± 0.02 s		ϵ 100; IT 100; $\epsilon < 1.00$
		141	5/2+	-69.926 (13)	40.7 ± 0.7 s		ϵ 100
		141m	11/2-	-69.829 (13)	2.7 ± 0.3 s		IT 87; ϵ 13
		142	1+	-71.31 (3)	2.34 ± 0.12 s		ϵ 100; ϵ 100
		143	5/2+	-74.242 (11)	2.59 ± 0.02 m		ϵ 100
		144	1+	-75.619 (11)	10.2 ± 0.1 s		ϵ 100
		145	5/2+	-77.992 (4)	5.93 ± 0.04 d		ϵ 100
		146	4-	-77.117 (6)	4.61 ± 0.03 d		ϵ 100
		147	5/2+	-77.544 (3)	24.1 ± 0.6 d		ϵ 100; α 0.0022
		148	5-	-76.299 (10)	54.5 ± 0.5 d		ϵ 100; α 9.4e-07
		149	5/2+	-76.44 (4)	93.1 ± 0.4 d		ϵ 100
		150	5-	-74.791 (6)	36.9 ± 0.9 y		ϵ 100
		150m	0-	-74.75 (6)	12.8 ± 0.1 h		ϵ 11; $IT \leq$ 5.0E-8; β^- 89
		151	5/2+	-74.6517 (18)	$\geq$ 1.7E+18 y	47.81% ± 0.03%	α
		152	3-	-72.8871 (18)	13.528 ± 0.014 y		ϵ 72.1; β^- 27.9
		152m	0-	-72.8415 (18)	9.3116 ± 0.0013 h		β^- 72; ϵ 28
		152m2	8-	-72.7392 (18)	96 ± 1 m		IT 100
		153	5/2+	-73.3661 (18)	**stable**	52.19% ± 0.06%	
		154	3-	-71.737 (18)	8.601 ± 0.01 y		ϵ 0.02; β^- 99.98
		154m	8-	-71.5916 (18)	46.3 ± 0.4 m		IT 100
		155	5/2+	-71.8169 (18)	4.753 ± 0.014 y		β^- 100
		156	0+	-70.085 (6)	15.19 ± 0.08 d		β^- 100
		157	5/2+	-69.46 (5)	15.18 ± 0.03 h		β^- 100
		158	(1-)	-67.2 (8)	45.9 ± 0.2 m		β^- 100
		159	5/2+	-66.046 (7)	18.1 ± 0.1 m		β^- 100
		160	1	-63.25 (6)	38 ± 4 s		β^- 100
		161	0	-61.8 (6)	26 ± 3 s		β^- 100
		162	0	-58.69 (6)	10.6 ± 1 s		β^- 100
		163	0	-56.8 (10)	7.7 ± 0.4 s		β^- 100
		164	0	-53.4 (4)	4.2 ± 0.2 s		β^- 100
		165	0	-50.8 (5)	2.3 ± 0.2 s		β^- 100
64	**Gd**	135	(5/2+)	-44 (5)	1.1 ± 0.2 s		ϵ 100; ϵp 18
		137	(7/2)	-51.2 (4)	2.2 ± 0.2 s		ϵ 100; ϵp
		138	0+	-55.66 (20)	4.7 ± 0.9 s		ϵ 100
		139	(9/2-)	-57.63 (20)	5.8 ± 0.9 s		$\epsilon p > 0.00$; $\epsilon > 0.00$; $\epsilon p > 0.00$; $\epsilon > 0.00$
		140	0+	-61.78 (3)	15.8 ± 0.4 s		ϵ 100
		141	1/2+	-63.224 (20)	14 ± 4 s		ϵ 100; ϵp 0.03
		141m	11/2-	-62.846 (20)	24.5 ± 0.5 s		ϵ 89; IT 11
		142	0+	-66.96 (3)	70.2 ± 0.6 s		ϵ 100

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		19	0	15.857 (16)	336 ± 3 ms		β^- 100; $\beta^- n$ 41.8
		20	2-	21.77 (6)	136 ± 3 ms		β^- 100; $\beta^- n$ 42.9
		21	(1/2-)	25.25 (10)	83 ± 8 ms		β^- 100; $\beta^- n$ 90.5
		22	(0-,1-)	32.04 (19)	20 ± 2 ms		β^- 100; $\beta^- n$ 33; $\beta^- 2n$ 12
		23	0	38.4 (3)	14.5 ± 1.4 ms		β^- 100; $\beta^- n$; $\beta^- 2n$
8	**O**	13	(3/2-)	23.115 (10)	8.58 ± 0.05 ms		ϵ 100; ϵp 100
		14	0+	8.0074 (11)	70.620 ± 0.015 s		ϵ 100
		15	1/2-	2.8556 (5)	122.24 ± 0.16 s		ϵ 100
		16	0+	-4.737 (16)	**stable**	99.757% ± 0.016%	
		17	5/2+	-0.8087 (6)	**stable**	0.038% ± 0.001%	
		18	0+	-0.7828 (7)	**stable**	0.205% ± 0.014%	
		19	5/2+	3.334 (3)	26.88 ± 0.05 s		β^- 100
		20	0+	3.7961 (9)	13.51 ± 0.05 s		β^- 100
		21	(5/2+)	8.062 (12)	3.42 ± 0.1 s		β^- 100
		22	0+	9.28 (6)	2.25 ± 0.09 s		β^- 100; $\beta^- n < 22.00$
		23	1/2+	14.62 (9)	97 ± 8 ms		β^- 100; $\beta^- n$ 7
		24	0+	18.5 (11)	65 ± 5 ms		$\beta^- n$ 58; β^- 100
9	**F**	17	5/2+	1.9517 (25)	64.49 ± 0.16 s		ϵ 100
		18	1+	0.8731 (5)	109.77 ± 0.05 m		ϵ 100
		19	1/2+	-1.4874 (9)	**stable**	100%	
		20	2+	-0.0174 (3)	11.07 ± 0.06 s		β^- 100
		21	5/2+	-0.0476 (18)	4.158 ± 0.02 s		β^- 100
		22	(4+)	2.793 (12)	4.23 ± 0.04 s		β^- 100; $\beta^- n < 11.00$
		23	5/2+	3.31 (10)	2.23 ± 0.14 s		β^- 100
		24	(1,2,3)+	7.56 (7)	390 ± 70 ms		β^- 100; $\beta^- n < 5.90$
		25	5/2+	11.36 (8)	80 ± 9 ms		β^- 100; $\beta^- n$ 23.1
		26	(1+)	18.67 (8)	9.7 ± 0.7 ms		$\beta^- n$ 11; β^- 100
		27	(5/2+)	24.63 (19)	5.0 ± 0.2 ms		β^- 100; $\beta^- n$ 77
		29	(5/2+)	40 (6)	2.5 ± 0.3 ms		β^- 100; $\beta^- n$ 100
10	**Ne**	17	1/2-	16.5004 (4)	109.2 ± 0.6 ms		ϵp 100; $\epsilon\alpha$; ϵ 100
		18	0+	5.3176 (4)	1.6670 ± 0.0017 s		ϵ 100
		19	1/2+	1.752 (16)	17.22 ± 0.02 s		ϵ 100
		20	0+	-7.0419 (16)	**stable**	90.48% ± 0.03%	
		21	3/2+	-5.7317 (4)	**stable**	0.27% ± 0.01%	
		22	0+	-8.0247 (18)	**stable**	9.25% ± 0.03%	
		23	5/2+	-5.154 (10)	37.24 ± 0.12 s		β^- 100
		24	0+	-5.9516 (5)	3.38 ± 0.02 m		β^- 100
		25	1/2+	-2.06 (4)	602 ± 8 ms		β^- 100
		26	0+	0.479 (18)	197 ± 1 ms		$\beta^- n$ 0.13; β^- 100
		27	(3/2+)	7.04 (7)	31.5 ± 1.3 ms		β^- 100; $\beta^- n$ 2
		28	0+	11.29 (10)	18.9 ± 0.4 ms		β^- 100; $\beta^- n$ 12; β^- 3.6
		29	(3/2+)	18.4 (10)	14.8 ± 0.3 ms		β^- 100; $\beta^- n$ 28; $\beta^- 2n$ 4
		30	0+	23 (3)	7.3 ± 0.3 ms		$\beta^- n$ 13; β^- 8.9; β^- 100
		31	0	30.8 (16)	3.4 ± 0.8 ms		β^- 100; $\beta^- n$
		32	0+	37 (5)	3.5 ± 0.9 ms		β^- 100; $\beta^- n$
11	**Na**	20	2+	6.8502 (10)	447.9 ± 2.3 ms		ϵ 100; $\epsilon\alpha$ 20.05
		21	3/2+	-2.1846 (3)	22.49 ± 0.04 s		ϵ 100
		22	3+	-5.1815 (17)	2.6027 ± 0.001 y		ϵ 100
		23	3/2+	-9.5298 (18)	**stable**	100%	
		24	4+	-8.4179 (4)	14.997 ± 0.012 h		β^- 100
		24m	1+	-7.9457 (4)	20.18 ± 0.1 ms		IT 99.95; $\beta^- \approx 0.05$
		25	5/2+	-9.3578 (12)	59.1 ± 0.6 s		β^- 100
		26	3+	-6.861 (4)	$1.07128 \pm$ 2.5E-4 s		β^- 100

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		128	0+	-60.07 (20)	5 ± 0 s		ϵ 100; ϵp
		129	(5/2+)	-62.23 (20)	4.9 ± 0.2 s		$\epsilon > 0.00$; $\epsilon p > 0.00$
		130	0+	-66.6 (3)	21 ± 3 s		ϵ 100
		131	(5/2+)	-67.77 (3)	25.4 ± 0.9 s		ϵ 100; $\epsilon p > 0.00$
		132	0+	-71.426 (24)	94 ± 8 s		ϵ 100
		133	(7/2+)	-72.33 (5)	70 ± 10 s		ϵ 100
		133m	(1/2+)	-72.2 (5)	≈ 70 s		ϵ ; IT
		134	0+	-75.646 (12)	8.5 ± 1.5 m		ϵ 100
		135	9/2(-)	-76.214 (19)	12.4 ± 0.6 m		ϵ 100
		135m	(1/2+)	-76.149 (19)	5.5 ± 0.5 m		$\epsilon > 99.97$; $IT < 0.03$
		136	0+	-79.199 (12)	50.65 ± 0.33 m		ϵ 100
		137	1/2+	-79.584 (12)	38.5 ± 1.5 m		ϵ 100
		137m	11/2-	-79.065 (12)	1.60 ± 0.15 s		IT 100
		138	0+	-82.018 (12)	5.04 ± 0.09 h		ϵ 100
		139	3/2+	-82.01 (3)	29.7 ± 0.5 m		ϵ 100
		139m	11/2-	-81.78 (3)	5.50 ± 0.2 h		ϵ 88.2; IT 11.8
		140	0+	-84.25 (3)	3.37 ± 0.02 d		ϵ 100
		141	3/2+	-84.193 (4)	2.49 ± 0.03 h		ϵ 100
		141m	11/2-	-83.436 (4)	62.0 ± 0.8 s		IT 100; $\epsilon < 0.05$
		142	0+	-85.9493 (18)	**stable**	27.152% ± 0.04%	
		143	7/2-	-84.0015 (18)	**stable**	12.174% ± 0.026%	
		144	0+	-83.7473 (18)	2.29E+15 ± 0.16E+15 y	23.798% ± 0.019%	α 100
		145	7/2-	-81.4312 (18)	**stable**	8.293% ± 0.012%	
		146	0+	-80.9252 (18)	**stable**	17.189% ± 0.032%	
		147	5/2-	-78.146 (18)	10.98 ± 0.01 d		β^- 100
		148	0+	-77.4068 (24)	**stable**	5.756% ± 0.021%	
		149	5/2-	-74.3743 (24)	1.728 ± 0.001 h		β^- 100
		150	0+	-73.683 (3)	0.79E19 ± 0.07E19 y	5.638% ± 0.028%	
		151	3/2+	-70.946 (3)	12.44 ± 0.07 m		β^- 100
		152	0+	-70.152 (25)	11.4 ± 0.2 m		β^- 100
		153	(3/2)-	-67.34 (3)	31.6 ± 1 s		β^- 100
		154	0+	-65.68 (11)	25.9 ± 0.2 s		β^- 100
		155	0	-62.47 (15)	8.9 ± 0.2 s		β^- 100
		156	0+	-60.52 (20)	5.06 ± 0.13 s		β^- 100
61	**Pm**	128	0	-47.6 (5)	1.0 ± 0.3 s		ϵ 100; α ; ϵp
		129	(5/2-)	-52.5 (4)	2.4 ± 0.9 s		ϵ 100
		130	(4,5,6)	-55.2 (3)	2.6 ± 0.2 s		ϵ 100; ϵp
		131	(11/2-)	-59.59 (20)	6.3 ± 0.8 s		ϵ 100
		132	(3+)	-61.64 (20)	6.2 ± 0.6 s		ϵ 100; $\epsilon p \approx$ 5.0E-5
		133	(3/2+)	-65.41 (5)	13.5 ± 2.1 s		ϵ 100
		133m	(11/2-)	-65.28 (5)	< 8.8 s		IT ; ϵ
		134	(2+)	-66.74 (6)	≈ 5 s		ϵ 100; ϵ 100
		135	(3/2+,5/2+)	-69.98 (6)	49 ± 3 s		ϵ 100
		135m	(11/2-)	-69.91 (6)	45 ± 4 s		ϵ 100
		136	(5-)	-71.2 (8)	107 ± 6 s		ϵ 100; ϵ 100
		137	11/2-	-74.073 (13)	2.4 ± 0.1 m		ϵ 100
		138	0	-74.94 (3)	10 ± 2 s		ϵ 100
		138m	0	-74.92 (3)	3.24 ± 0.05 m		ϵ
		139	(5/2)+	-77.5 (14)	4.15 ± 0.05 m		ϵ 100
		139m	(11/2)-	-77.312 (14)	180 ± 20 ms		IT 99.94; ϵ 0.06
		140	1+	-78.21 (4)	9.2 ± 0.2 s		ϵ 100; ϵ 100
		141	5/2+	-80.523 (14)	20.90 ± 0.05 m		ϵ 100
		142	1+	-81.16 (3)	40.5 ± 0.5 s		ϵ 100

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		26	0+	-7.1409 (11)	2.229 ± 0.003 s		ϵ 100
		27	5/2+	-12.3843 (14)	4.15 ± 0.04 s		ϵ 100
		28	0+	-21.4927 (4)	**stable**	92.223% ± 0.019%	
		29	1/2+	-21.895 (5)	**stable**	4.685% ± 0.008%	
		30	0+	-24.4329 (22)	**stable**	3.092% ± 0.011%	
		31	3/2+	-22.949 (4)	157.3 ± 0.3 m		β^- 100
		32	0+	-24.0776 (3)	153 ± 19 y		β^- 100
		33	3/2+	-20.5143 (7)	6.11 ± 0.21 s		β^- 100
		34	0+	-19.957 (14)	2.77 ± 0.2 s		β^- 100
		35	0	-14.36 (4)	0.78 ± 0.12 s		β^- 100; $\beta^- n < 5.00$
		36	0+	-12.42 (6)	0.45 ± 0.06 s		β^- 100; $\beta^- n < 10.00$
		37	(7/2-)	-6.59 (8)	90 ± 60 ms		β^- 100; $\beta^- n$ 17
		39	0	2.32 (9)	47.5 ± 2 ms		β^- ; $\beta^- n$
		40	0+	5.43 (23)	33.0 ± 1 ms		β^- ; $\beta^- n$
		41	0	12.1 (4)	20.0 ± 2.5 ms		β^- ; $\beta^- n$?
		42	0+	16.6 (5)	12.5 ± 3.5 ms		β^- 100; $\beta^- n$
15	**P**	26	(3+)	10.97 (20)	43.7 ± 0.6 ms		ϵ 100; ϵp
		27	1/2+	-0.72 (3)	260 ± 80 ms		ϵp 0.07; ϵ 100
		28	3+	-7.149 (11)	270.3 ± 0.5 ms		ϵ 100; ϵp 0.0013; $\epsilon\alpha$ 0.00086
		29	1/2+	-16.9526 (6)	4.142 ± 0.015 s		ϵ 100
		30	1+	-20.2006 (3)	2.498 ± 0.004 m		ϵ 100
		31	1/2+	-24.4405 (7)	**stable**	100%	
		32	1+	-24.3048 (4)	14.262 ± 0.014 d		β^- 100
		33	1/2+	-26.3373 (11)	25.35 ± 0.11 d		β^- 100
		34	1+	-24.5486 (8)	12.43 ± 0.08 s		β^- 100
		35	1/2+	-24.8578 (19)	47.3 ± 0.7 s		β^- 100
		36	4-	-20.251 (13)	5.6 ± 0.3 s		β^- 100
		37	0	-19 (4)	2.31 ± 0.13 s		β^- 100
		38	(0-:4-)	-14.64 (7)	0.64 ± 0.14 s		β^- 100; $\beta^- n$ 12
		39	(1/2+)	-12.8 (8)	0.28 ± 0.04 s		β^- 100; $\beta^- n$ 26
		40	(2-,3-)	-8.07 (11)	125 ± 25 ms		β^- 100; $\beta^- n$ 15.8
		41	(1/2+)	-4.98 (8)	100 ± 5 ms		β^- 100; $\beta^- n$ 30
		42	0	1.01 (21)	48.5 ± 1.5 ms		β^- 100; $\beta^- n$ 50
		43	(1/2+)	4.7 (4)	36.5 ± 1.5 ms		β^- 100; $\beta^- n$ 100
		44	0	10.4 (8)	18.5 ± 2.5 ms		β^- ; $\beta^- n$
16	**S**	27	(5/2+)	17 (4)	15.5 ± 1.5 ms		ϵp 2.3; $\epsilon 2p$ 1.1; ϵ 100
		28	0+	4.07 (16)	125 ± 10 ms		ϵ 100; ϵp 20.7
		29	5/2+	-3.16 (5)	187 ± 4 ms		ϵ 100; ϵp 47
		30	0+	-14.062 (3)	1.178 ± 0.005 s		ϵ 100
		31	1/2+	-19.043 (10)	2.572 ± 0.013 s		ϵ 100
		32	0+	-26.0155 (13)	**stable**	94.99% ± 0.26%	
		33	3/2+	-26.5858 (14)	**stable**	0.75% ± 0.02%	
		34	0+	-29.9316 (6)	**stable**	4.25% ± 0.24%	
		35	3/2+	-28.8461 (4)	87.37 ± 0.04 d		β^- 100
		36	0+	-30.6641 (19)	**stable**	0.01% ± 0.01%	
		37	7/2-	-26.8964 (20)	5.05 ± 0.02 m		β^- 100
		38	0+	-26.861 (7)	170.3 ± 0.7 m		β^- 100
		39	(7/2)-	-23.16 (5)	11.5 ± 0.5 s		β^- 100
		40	0+	-22.93 (11)	8.8 ± 2.2 s		β^- 100
		41	(7/2-)	-19.09 (6)	1.99 ± 0.05 s		β^- 100; $\beta^- n$
		42	0+	-17.68 (12)	1.03 ± 0.03 s		β^- 100
		43	0	-12.07 (10)	0.28 ± 0.03 s		$\beta^- n$ 40; β^- 100

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		27	5/2+	-5.518 (4)	301 ± 6 ms		$\beta^- n$ 0.13; β^- 100
		28	1+	-0.988 (10)	30.5 ± 0.4 ms		β^- 100; $\beta^- n$ 0.58
		29	3/2+	2.67 (12)	44.9 ± 1.2 ms		β^- 100; $\beta^- n$ 21.5
		30	2+	8.374 (23)	48 ± 2 ms		β^- 100; $\beta^- n$ 30; $\beta^- 2n$ 1.15; $\beta^- \alpha$ 5.5e-05
		31	3/2(+)	12.54 (10)	17.0 ± 0.4 ms		$\beta^- n$ 37; $\beta^- 2n$ 0.87; $\beta^- 3n < 0.05$; β^- 100
		32	(3-,4-)	18.81 (12)	13.2 ± 0.4 ms		β^- 100; $\beta^- n$ 24; $\beta^- 2n$ 8
		33	(3/2+)	24 (6)	8.0 ± 0.4 ms		β^- 100; $\beta^- n$ 47; $\beta^- 2n$ 13
		34	0	31.3 (5)	5.5 ± 1 ms		$\beta^- n \approx 15.00$; β^- 100; $\beta^- 2n \approx 50.00$
		35	0	37.8 (6)	1.5 ± 0.5 ms		β^- 100; $\beta^- n$
12	**Mg**	20	0+	17.56 (3)	90.8 ± 2.4 ms		ϵ 100; $\epsilon p \approx 27.00$
		21	5/2+	10.913 (16)	122 ± 3 ms		$\epsilon\alpha < 0.50$; ϵ 100; ϵp 32.6
		22	0+	-0.3999 (3)	3.8755 ± 0.0012 s		ϵ 100
		23	3/2+	-5.4732 (7)	11.317 ± 0.011 s		ϵ 100
		24	0+	-13.9335 (13)	**stable**	78.99% ± 0.04%	
		25	5/2+	-13.1927 (5)	**stable**	10% ± 0.01%	
		26	0+	-16.2145 (3)	**stable**	11.01% ± 0.03%	
		27	1/2+	-14.5866 (5)	9.458 ± 0.012 m		β^- 100
		28	0+	-15.0186 (20)	20.915 ± 0.009 h		β^- 100
		29	3/2+	-10.603 (11)	1.30 ± 0.12 s		β^- 100
		30	0+	-8.892 (13)	335 ± 17 ms		β^- 100
		31	1/2(+)	-3.19 (17)	232 ± 15 ms		β^- 100; $\beta^- n$ 1.7
		32	0+	-0.912 (18)	86 ± 5 ms		β^- 100; $\beta^- n$ 5.5
		33	3/2-	4.947 (22)	90.5 ± 1.6 ms		β^- 100; $\beta^- n$ 14
		34	0+	8.56 (9)	20 ± 10 ms		β^- 100; $\beta^- n$
		35	(7/2-)	15.64 (18)	70 ± 40 ms		β^- 100; $\beta^- n$ 52
		36	0+	20.4 (5)	3.9 ± 1.3 ms		$\beta^- n$; β^- 100
13	**Al**	22	4+	18.2 (4)	91.1 ± 0.5 ms		$\epsilon 2p$ 1.1; $\epsilon\alpha$ 0.04; ϵ 100; ϵp 54.5
		23	5/2+	6.748 (3)	446 ± 6 ms		ϵ 100; ϵp 1.22
		24	4+	-0.0489 (10)	2.053 ± 0.004 s		ϵ 100; ϵp 0.0016; $\epsilon\alpha$ 0.04
		24m	1+	0.3768 (10)	130 ± 3 ms		IT 82.5; ϵ 17.5; $\epsilon\alpha$ 0.03
		25	5/2+	-8.9161 (5)	7.183 ± 0.012 s		ϵ 100
		26	5+	-12.2101 (6)	7.17E+5 ± 0.24E+5 y		ϵ 100
		26m	0+	-11.9818 (6)	6.3464 ± 7.0E-4 s		ϵ 100
		27	5/2+	-17.1967 (10)	**stable**	100%	
		28	3+	-16.8504 (12)	2.2414 ± 0.0012 m		β^- 100
		29	5/2+	-18.2153 (12)	6.56 ± 0.06 m		β^- 100
		30	3+	-15.872 (14)	3.62 ± 0.06 s		β^- 100
		31	(3/2,5/2)+	-14.955 (20)	644 ± 25 ms		β^- 100
		32	1+	-11.06 (9)	33.0 ± 0.2 ms		β^- 100; $\beta^- n$ 0.7
		33	(5/2)+	-8.44 (7)	41.7 ± 0.2 ms		$\beta^- n$ 8.5; β^- 100
		34	0	-3.05 (6)	42 ± 6 ms		β^- 100; $\beta^- n$ 27
		35	0	-0.22 (7)	37.2 ± 0.8 ms		β^- 100; $\beta^- n$ 38
		36	0	5.95 (10)	90 ± 40 ms		β^- 100; $\beta^- n < 31.00$
		37	0	9.81 (12)	10.7 ± 1.3 ms		β^- 100
		38	0	16.21 (25)	7.6 ± 0.6 ms		β^- ; $\beta^- n$
		39	0	21 (6)	7.6 ± 1.6 ms		$\beta^- n$; β^-
14	**Si**	22	0+	33 (4)	29 ± 2 ms		ϵ 100; ϵp 32
		23	(5/2)+	23.1 (4)	42.3 ± 0.4 ms		ϵ 100; ϵp 71; $\epsilon 2p$ 3.6
		24	0+	10.755 (19)	140.5 ± 1.5 ms		ϵ 100; ϵp 45
		25	5/2+	3.827 (10)	220 ± 3 ms		ϵ 100; ϵp 35

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		142m	(8)-	-80.27 (3)	2.0 ± 0.2 ms		IT 100
		143	5/2+	-82.96 (3)	265 ± 7 d		ϵ 100
		144	5-	-81.416 (3)	363 ± 14 d		ϵ 100
		145	5/2+	-81.267 (3)	17.7 ± 0.4 y		ϵ 100; α 2.8e-07
		146	3-	-79.454 (4)	5.53 ± 0.05 y		ϵ 66; β^- 34
		147	7/2+	-79.0416 (18)	2.6234 ± 2.0E-4 y		β^- 100
		148	1-	-76.865 (6)	5.368 ± 0.002 d		β^- 100
		148m	5-,6-	-76.727 (6)	41.29 ± 0.11 d		β^- 95.8; IT 4.2
		149	7/2+	-76.063 (3)	53.08 ± 0.05 h		β^- 100
		150	(1-)	-73.596 (20)	2.68 ± 0.02 h		β^- 100
		151	5/2+	-73.389 (5)	28.40 ± 0.04 h		β^- 100
		152	1+	-71.26 (3)	4.12 ± 0.08 m		β^- 100
		152m	(8)	-71.11 (3)	13.8 ± 0.2 m		β^- 100; $IT \geq 0.00$; β^- 100
		153	5/2-	-70.678 (11)	5.25 ± 0.02 m		β^- 100
		154	(3,4)	-68.49 (4)	2.68 ± 0.07 m		β^- 100; β^- 100
		155	5/2-	-66.97 (3)	41.5 ± 0.2 s		β^- 100
		156	4-	-64.21 (3)	26.70 ± 0.1 s		β^- 100
		157	(5/2-)	-62.37 (11)	10.56 ± 0.1 s		β^- 100
		158	0	-59.12 (11)	4.8 ± 0.5 s		β^- 100
		159	0	-56.82 (15)	1.5 ± 0.2 s		β^- 100
62	**Sm**	129	(1/2+,3/2+)	-41.3 (7)	0.55 ± 0.1 s		ϵ 100; $\epsilon p > 0.00$
		131	0	-49.6 (3)	1.2 ± 0.2 s		ϵ 100; $\epsilon p > 0.00$
		132	0+	-54.7 (3)	4.0 ± 0.3 s		ϵ 100; ϵp
		133	(5/2+)	-56.83 (20)	2.89 ± 0.16 s		ϵ 100; $\epsilon p > 0.00$; ϵ ; IT ; ϵp
		134	0+	-61.22 (20)	9.5 ± 0.8 s		ϵ 100
		135	(3/2+,5/2+)	-62.86 (15)	10.3 ± 0.5 s		ϵp 0.02; ϵ 100
		136	0+	-66.811 (12)	47 ± 2 s		ϵ 100
		137	(9/2-)	-68.03 (4)	45 ± 1 s		ϵ 100
		138	0+	-71.498 (12)	3.1 ± 0.2 m		ϵ 100
		139	1/2+	-72.38 (11)	2.57 ± 0.1 m		ϵ 100
		139m	11/2-	-71.923 (11)	10.7 ± 0.6 s		IT 93.7; ϵ 6.3
		140	0+	-75.456 (12)	14.82 ± 0.12 m		ϵ 100
		141	1/2+	-75.934 (9)	10.2 ± 0.2 m		ϵ 100
		141m	11/2-	-75.758 (9)	22.6 ± 0.2 m		ϵ 99.69; IT 0.31
		142	0+	-78.987 (4)	72.49 ± 0.05 m		ϵ 100
		143	3/2+	-79.517 (3)	8.75 ± 0.06 m		ϵ 100
		143m	11/2-	-78.763 (3)	66 ± 2 s		IT 99.76; ϵ 0.24
		143m2	23/2(-)	-76.723 (3)	30 ± 3 ms		IT 100
		144	0+	-81.9657 (25)	**stable**	3.07% ± 0.07%	
		145	7/2-	-80.6515 (25)	340 ± 3 d		ϵ 100
		146	0+	-80.996 (3)	10.3E+7 ± 0.5E+7 y		α 100
		147	7/2-	-79.2657 (18)	1.060E11 ± 0.011E11 y	14.99% ± 0.18%	α 100
		148	0+	-79.3358 (18)	7E+15 ± 3E+15 y	11.24% ± 0.1%	α 100
		149	7/2-	-77.135 (18)	**stable**	13.82% ± 0.07%	
		150	0+	-77.0504 (17)	**stable**	7.38% ± 0.01%	
		151	5/2-	-74.5755 (17)	90 ± 8 y		β^- 100
		152	0+	-74.7622 (17)	**stable**	26.75% ± 0.16%	
		153	3/2+	-72.5593 (17)	46.284 ± 0.004 h		β^- 100
		153m	11/2-	-72.4609 (17)	10.6 ± 0.3 ms		IT 100
		154	0+	-72.4549 (19)	**stable**	22.75% ± 0.29%	
		155	3/2-	-70.1905 (19)	22.3 ± 0.2 m		β^- 100
		156	0+	-69.363 (9)	9.4 ± 0.2 h		β^- 100

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		44	0+	-9.1 (14)	100 ± 1 ms		β^- 100; $\beta^- n$ 18
		45	0	-4 (7)	68 ± 2 ms		β^- 100; $\beta^- n$ 54
		46	0+	0 (AP)	50 ± 8 ms		β^- 100
17	**Cl**	31	0	-7.07 (5)	150 ± 25 ms		ϵ 100; ϵp 0.7
		32	1+	-13.3351 (9)	298 ± 1 ms		ϵ 100; $\epsilon\alpha$ 0.05; ϵp 0.03
		33	3/2+	-21.0032 (4)	2.511 ± 0.004 s		ϵ 100
		34	0+	-24.44 (7)	1.5264 ± 0.0014 s		ϵ 100
		34m	3+	-24.2936 (7)	32.00 ± 0.04 m		ϵ 55.4; IT 44.6
		35	3/2+	-29.0135 (4)	**stable**	75.76% ± 0.1%	
		36	2+	-29.5219 (4)	3.01E+5 ± 0.02E+5 y		β^- 98.1; ϵ 1.9
		37	3/2+	-31.7615 (5)	**stable**	24.24% ± 0.1%	
		38	2-	-29.7981 (10)	37.24 ± 0.05 m		β^- 100
		38m	5-	-29.1267 (10)	715 ± 3 ms		IT 100
		39	3/2+	-29.8002 (17)	56.2 ± 0.6 m		β^- 100
		40	2-	-27.56 (3)	1.35 ± 0.02 m		β^- 100
		41	(1/2+)	-27.31 (7)	38.4 ± 0.8 s		β^- 100
		42	0	-24.91 (14)	6.8 ± 0.3 s		β^- 100
		43	(1/2+)	-24.41 (21)	3.13 ± 0.09 s		β^- 100
		44	(2-)	-20.61 (14)	0.56 ± 0.11 s		β^- 100; $\beta^- n < 8.00$
		45	(1/2+)	-18.36 (10)	413 ± 25 ms		β^- 100; $\beta^- n$ 24
		46	0	-13.81 (16)	232 ± 2 ms		β^- 100; $\beta^- n$ 60
		47	0	-10.1 (8)	101 ± 6 ms		β^- 100; $\beta^- n > 0.00$
18	**Ar**	31	5/2(+)	11.29 (21)	14.4 ± 0.6 ms		ϵ 100; ϵp 62; $\epsilon 2p$ 8.5
		32	0+	-2.2003 (18)	100.5 ± 0.3 ms		ϵ 100; ϵp 35.6
		33	1/2+	-9.3843 (4)	173.0 ± 2 ms		ϵ 100; ϵp 38.7
		34	0+	-18.3773 (3)	844.5 ± 3.4 ms		ϵ 100
		35	3/2+	-23.0473 (7)	1.7756 ± 0.001 s		ϵ 100
		36	0+	-30.2315 (3)	**stable**	0.3336% ± 0.0021%	
		37	3/2+	-30.9476 (21)	35.04 ± 0.04 d		ϵ 100
		38	0+	-34.7147 (25)	**stable**	0.0629% ± 0.0007%	
		39	7/2-	-33.242 (5)	269 ± 3 y		β^- 100
		40	0+	-35.0398 (22)	**stable**	99.6035% ± 0.0025%	
		41	7/2-	-33.0675 (3)	109.61 ± 0.04 m		β^- 100
		42	0+	-34.423 (6)	32.9 ± 1.1 y		β^- 100
		43	(5/2-)	-32.01 (5)	5.37 ± 0.06 m		β^- 100
		44	0+	-32.6732 (16)	11.87 ± 0.05 m		β^- 100
		45	5/2-,7/2-	-29.7707 (5)	21.48 ± 0.15 s		β^- 100
		46	0+	-29.73 (4)	8.4 ± 0.6 s		β^- 100
		47	(3/2)-	-25.21 (9)	1.23 ± 0.03 s		β^- 100; $\beta^- n < 0.20$
		48	0+	-22.6 (7)	475 ± 40 ms		β^- 100
		49	0	-16.8 (8)	170 ± 50 ms		β^- 100; $\beta^- n$ 65
		50	0+	-12.8 (9)	85 ± 30 ms		β^- 100; $\beta^- n$ 35
19	**K**	35	3/2+	-11.1729 (5)	178 ± 8 ms		ϵ 100; ϵp 0.37
		36	2+	-17.4173 (3)	342 ± 2 ms		ϵ 100; ϵp 0.05; $\epsilon\alpha$ 0.0034
		37	3/2+	-24.8001 (9)	1.226 ± 0.007 s		ϵ 100
		38	3+	-28.8006 (25)	7.636 ± 0.018 m		ϵ 100
		38m	0+	-28.6702 (25)	924.3 ± 0.3 ms		ϵ 99.97; IT 0.03
		39	3/2+	-33.8071 (5)	**stable**	93.2581% ± 0.0044%	
		40	4-	-33.5354 (6)	1.248E+9 ± 0.003E+9 y	0.0117% ± 0.0001%	β^- 89.28; ϵ 10.72
		41	3/2+	-35.5595 (4)	**stable**	6.7302% ± 0.0044%	
		42	2-	-35.022 (11)	12.321 ± 0.025 h		β^- 100
		43	3/2+	-36.5753 (4)	22.3 ± 0.1 h		β^- 100
		44	2-	-35.7814 (4)	22.13 ± 0.19 m		β^- 100

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		142	0+	-84.532 (3)	> 5E+16 y	11.114% ± 0.051%	$2\beta^-$
		143	3/2-	-81.605 (3)	33.039 ± 0.006 h		β^- 100
		144	0+	-80.431 (3)	284.91 ± 0.05 d		β^- 100
		145	(5/2-)	-77.09 (4)	3.01 ± 0.06 m		β^- 100
		146	0+	-75.641 (18)	13.52 ± 0.13 m		β^- 100
		147	(5/2-)	-72.014 (9)	56.4 ± 1 s		β^- 100
		148	0+	-70.398 (11)	56 ± 1 s		β^- 100
		149	(3/2-)	-66.67 (10)	5.3 ± 0.2 s		β^- 100
		150	0+	-64.849 (12)	4.0 ± 0.6 s		β^- 100
		151	(5/2+)	-61.225 (18)	1.76 ± 0.06 s		β^- 100; β^-
		152	0+	-59.31 (20)	1.4 ± 0.2 s		β^- 100
59	**Pr**	121	(3/2)	-41.4 (7)	10 +6-3 ms		p 100
		122	0	-44.7 (5)	≈ 0.5 s		ϵ ?
		123	0	-50.1 (6)	≈ 0.8 s		ϵ ?
		124	0	-53 (6)	1.2 ± 0.2 s		$\epsilon p > 0.00$; ϵ 100
		125	0	-57.7 (4)	3.3 ± 0.7 s		ϵ 100; ϵp
		126	>3	-60.14 (20)	3.14 ± 0.22 s		ϵ 100; ϵp
		127	0	-64.32 (20)	4.2 ± 0.3 s		ϵ 100
		128	4,5,6	-66.33 (3)	2.84 ± 0.09 s		ϵ 100
		129	(11/2-)	-69.77 (3)	30 ± 4 s		$\epsilon > 0.00$
		130	(7,8)	-71.18 (6)	40 ± 4 s		ϵ 100; ϵ 100; ϵ 100
		131	(3/2+)	-74.3 (5)	1.51 ± 0.02 m		ϵ 100
		131m	(11/2-)	-74.15 (5)	5.73 ± 0.2 s		IT 96.4; ϵ 3.6
		132	(2)+	-75.21 (6)	1.6 ± 0.3 m		ϵ 100
		133	(3/2+)	-77.937 (12)	6.5 ± 0.3 m		ϵ 100
		133m	(11/2-)	-77.745 (12)	1.1 ± 0.2 s		IT 100
		134	(6-)	-78.51 (4)	≈ 11 m		ϵ 100; ϵ 100
		135	3/2(+)	-80.936 (12)	24 ± 1 m		ϵ 100
		136	2+	-81.329 (12)	13.1 ± 0.1 m		ϵ 100
		137	5/2+	-83.179 (11)	1.28 ± 0.03 h		ϵ 100
		138	1+	-83.127 (14)	1.45 ± 0.05 m		ϵ 100
		138m	7-	-82.763 (14)	2.12 ± 0.04 h		ϵ 100
		139	5/2+	-84.821 (8)	4.41 ± 0.04 h		ϵ 100
		140	1+	-84.691 (6)	3.39 ± 0.01 m		ϵ 100
		141	5/2+	-86.0158 (22)	**stable**	100%	
		142	2-	-83.7877 (22)	19.12 ± 0.04 h		β^- 99.98; ϵ 0.02
		142m	5-	-83.784 (22)	14.6 ± 0.5 m		IT 100
		143	7/2+	-83.0674 (23)	13.57 ± 0.02 d		β^- 100
		144	0-	-80.75 (3)	17.28 ± 0.05 m		β^- 100
		144m	3-	-80.691 (3)	7.2 ± 0.3 m		IT 99.93; β^- 0.07
		145	7/2+	-79.626 (7)	5.984 ± 0.01 h		β^- 100
		146	(2)-	-76.69 (4)	24.15 ± 0.18 m		β^- 100
		147	(5/2+)	-75.444 (16)	13.4 ± 0.3 m		β^- 100
		148	1-	-72.535 (15)	2.29 ± 0.02 m		β^- 100
		148m	(4)	-72.445 (15)	2.01 ± 0.07 m		β^- 100
		149	(5/2+)	-71.039 (10)	2.26 ± 0.07 m		β^- 100
		150	(1)-	-68.299 (9)	6.19 ± 0.16 s		β^- 100
		151	(3/2-)	-66.78 (12)	18.90 ± 0.07 s		β^- 100
		152	(4+)	-63.758 (19)	3.57 ± 0.18 s		β^- 100
		153	0	-61.581 (14)	4.28 ± 0.11 s		β^- 100
		154	(3+)	-58.19 (15)	2.3 ± 0.1 s		β^- 100
60	**Nd**	125	(5/2)	-47.4 (4)	0.65 ± 0.15 s		ϵ 100; $\epsilon p > 0.00$
		127	0	-55.3 (4)	1.8 ± 0.4 s		ϵ 100; ϵp

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Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		129	3/2+	-81.326 (21)	11.6 ± 0.2 m		ϵ 100
		129m	11/2-	-81.154 (21)	0.56 ± 0.05 s		IT 100
		130	3(+)	-81.63 (3)	8.7 ± 0.1 m		ϵ 100
		131	3/2+	-83.77 (3)	59 ± 2 m		ϵ 100
		132	2-	-83.72 (4)	4.8 ± 0.2 h		ϵ 100
		132m	6-	-83.54 (4)	24.3 ± 0.5 m		IT 76; ϵ 24
		133	5/2+	-85.49 (3)	3.912 ± 0.008 h		ϵ 100
		134	1+	-85.219 (20)	6.45 ± 0.16 m		ϵ 100
		135	5/2+	-86.651 (10)	19.5 ± 0.2 h		ϵ 100
		136	1+	-86.04 (5)	9.87 ± 0.03 m		ϵ 100
		136m	(8+)	-85.81 (5)	114 ± 3 ms		IT 100
		137	7/2+	-87.106 (12)	6E+4 ± 2E+4 y		ϵ 100
		138	5+	-86.521 (3)	1.02E+11 ± 0.01E+11 y	0.08881% ± 0.00071%	ϵ 65.6; β^- 34.4
		139	7/2+	-87.2282 (23)	**stable**	99.9119% ± 0.0071%	
		140	3-	-84.3179 (23)	1.67855 ± 1.2E-4 d		β^- 100
		141	(7/2+)	-82.934 (4)	3.92 ± 0.03 h		β^- 100
		142	2-	-80.022 (7)	91.1 ± 0.5 m		β^- 100
		143	(7/2)+	-78.171 (7)	14.2 ± 0.1 m		β^- 100
		144	(3-)	-74.833 (18)	40.8 ± 0.4 s		β^- 100
		145	(5/2+)	-72.832 (12)	24.8 ± 2 s		β^- 100
		146	2-	-69.05 (3)	6.27 ± 0.1 s		β^- 100; β^- 100
		147	(3/2+)	-66.678 (11)	4.06 ± 0.04 s		β^- 100; $\beta^- n$ 0.04
		148	(2-)	-62.709 (19)	1.26 ± 0.08 s		β^- 100; $\beta^- n$ 0.15
		149	(3/2-)	-60.22 (20)	1.05 ± 0.03 s		β^- 100; $\beta^- n$ 1.43
		150	(3+)	-56.55 (20)	0.86 ± 0.05 s		β^- 100; $\beta^- n$ 2.7
58	**Ce**	121	(5/2)	-52.5 (5)	1.1 ± 0.1 s		ϵ 100; $\epsilon p \approx 1.00$
		123	(5/2)	-60.1 (3)	3.8 ± 0.2 s		ϵ 100; $\epsilon p > 0.00$
		124	0+	-64.6 (3)	6 ± 2 s		ϵ 100
		125	(7/2-)	-66.66 (20)	9.7 ± 0.3 s		ϵ 100; ϵp
		126	0+	-70.82 (3)	51.0 ± 0.3 s		ϵ 100
		127	(1/2+)	-71.98 (6)	34 ± 2 s		ϵ 100
		127m	(5/2+)	-71.97 (6)	28.6 ± 0.7 s		ϵ 100
		128	0+	-75.53 (3)	3.93 ± 0.02 m		ϵ 100
		129	5/2+	-76.29 (3)	3.5 ± 0.5 m		$\epsilon > 0.00$
		130	0+	-79.42 (3)	22.9 ± 0.5 m		ϵ 100
		131	7/2+	-79.71 (3)	10.3 ± 0.3 m		ϵ 100
		131m	(1/2+)	-79.64 (3)	5.4 ± 0.4 m		ϵ 100; IT
		132	0+	-82.471 (20)	3.51 ± 0.11 h		ϵ 100
		132m	(8-)	-80.13 (20)	9.4 ± 0.3 ms		IT 100
		133	1/2+	-82.423 (16)	97 ± 4 m		ϵ 100
		133m	9/2-	-82.386 (16)	5.1 ± 0.3 h		ϵ ; IT
		134	0+	-84.836 (20)	3.16 ± 0.04 d		ϵ 100
		135	1/2(+)	-84.625 (11)	17.7 ± 0.3 h		ϵ 100
		135m	(11/2-)	-84.179 (11)	20 ± 1 s		IT 100
		136	0+	-86.474 (12)	> 0.7E+14 y	0.185% ± 0.002%	2ϵ
		137	3/2+	-85.884 (12)	9.0 ± 0.3 h		ϵ 100
		137m	11/2-	-85.629 (12)	34.4 ± 0.3 h		IT 99.21; ϵ 0.79
		138	0+	-87.564 (10)	≥ 0.9E+14 y	0.251% ± 0.002%	2ϵ 100
		138m	7-	-85.435 (10)	8.65 ± 0.2 ms		IT 100
		139	3/2+	-86.95 (7)	137.641 ± 0.02 d		ϵ 100
		139m	11/2-	-86.196 (7)	54.8 ± 1 s		IT 100
		140	0+	-88.0786 (22)	**stable**	88.45% ± 0.051%	
		141	7/2-	-85.4354 (22)	32.508 ± 0.013 d		β^- 100

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		45	3/2+	-36.6156 (5)	17.81 ± 0.61 m		β^- 100
		46	(2-)	-35.4139 (7)	105 ± 10 s		β^- 100
		47	1/2+	-35.709 (3)	17.50 ± 0.24 s		β^- 100
		48	(2-)	-32.2852 (23)	6.8 ± 0.2 s		β^- 100; $\beta^- n$ 1.14
		49	(1/2+,3/2+)	-29.612 (3)	1.26 ± 0.05 s		β^- 100; $\beta^- n$ 86
		50	(0-,1-,2-)	-25.736 (10)	472 ± 4 ms		β^- 100; $\beta^- n$ 29
		51	(1/2+,3/2+)	-21.6 (6)	365 ± 5 ms		$\beta^- n$ 47; β^- 100
		52	(2-)	-16 (7)	118 ± 6 ms		β^- 100; $\beta^- n \approx 73.00$
		53	(3/2+)	-11.1 (7)	30 ± 5 ms		β^- 100; $\beta^- n \approx 75.00$; $\beta^- 2n < 10$
		54	0	-4.3 (9)	10 ± 5 ms		β^- 100; $\beta^- n > 0.00$
20	**Ca**	35	0	4.79 (20)	25.7 ± 0.2 ms		ϵ 100; ϵp 95.9; $\epsilon 2p$ 4.1
		36	0+	-6.45 (4)	102 ± 2 ms		ϵ 100; ϵp 54.3
		37	3/2+	-13.1357 (8)	181.1 ± 1 ms		ϵ 100; ϵp 82.1
		38	0+	-22.0584 (3)	440 ± 12 ms		ϵ 100
		39	3/2+	-27.2827 (6)	859.6 ± 1.4 ms		ϵ 100
		40	0+	-34.8463 (21)	> 3.0E+21 y	96.94% ± 0.16%	2ϵ
		41	7/2-	-35.1379 (14)	1.02E+5 ± 0.07E+5 y		ϵ 100
		42	0+	-38.5472 (15)	**stable**	0.647% ± 0.023%	
		43	7/2-	-38.4089 (23)	**stable**	0.135% ± 0.01%	
		44	0+	-41.4688 (3)	**stable**	2.09% ± 0.11%	
		45	7/2-	-40.8123 (4)	162.61 ± 0.09 d		β^- 100
		46	0+	-43.1399 (22)	> 0.28E+16 y	0.004% ± 0.003%	$2\beta^-$
		47	7/2-	-42.345 (22)	4.536 ± 0.003 d		β^- 100
		48	0+	-44.2234 (22)	> 5.8E22 y	0.187% ± 0.021%	$2\beta^-$ 75
		49	3/2-	-41.2986 (22)	8.718 ± 0.006 m		β^- 100
		50	0+	-39.588 (3)	13.9 ± 0.6 s		β^- 100
		51	(3/2-)	-35.87 (9)	10.0 ± 0.8 s		β^- 100; $\beta^- n$
		52	0+	-32.5 (7)	4.6 ± 0.3 s		β^- 100; $\beta^- n \leq 2.00$
		53	(3/2-,5/2-)	-27.5 (5)	90 ± 15 ms		β^- 100; $\beta^- n > 30.00$
		54	0+	-23 (7)	86 ± 7 ms		β^- 100
		55	(5/2-)	-17 (8)	22 ± 2 ms		β^- 100; $\beta^- n$
		56	0+	-12.4 (9)	11 ± 2 ms		β^- ; $\beta^- n$?
21	**Sc**	40	4-	-20.523 (3)	182.3 ± 0.7 ms		ϵ 100; ϵp 0.44; $\epsilon\alpha$ 0.02
		41	7/2-	-28.6424 (8)	596.3 ± 1.7 ms		ϵ 100
		42	0+	-32.1211 (17)	681.3 ± 0.7 ms		ϵ 100
		42m	(7)+	-31.5048 (17)	61.7 ± 0.4 s		ϵ 100
		43	7/2-	-36.1881 (19)	3.891 ± 0.012 h		ϵ 100
		44	2+	-37.8163 (18)	3.97 ± 0.04 h		ϵ 100
		44m	6+	-37.5453 (18)	58.61 ± 0.1 h		IT 98.8; ϵ 1.2
		45	7/2-	-41.0703 (6)	**stable**	100%	
		45m	3/2+	-41.0579 (6)	318 ± 7 ms		IT 100
		46	4+	-41.7596 (6)	83.79 ± 0.04 d		β^- 100
		46m	1-	-41.6171 (6)	18.75 ± 0.04 s		IT 100
		47	7/2-	-44.3367 (19)	3.3492 ± 6.0E-4 d		β^- 100
		48	6+	-44.503 (5)	43.67 ± 0.09 h		β^- 100
		49	7/2-	-46.56 (3)	57.18 ± 0.13 m		β^- 100
		50	5+	-44.546 (15)	102.5 ± 0.5 s		β^- 100
		50m	2+,3+	-44.289 (15)	0.35 ± 0.04 s		$IT > 97.50$; $\beta^- < 2.50$
		51	(7/2)-	-43.227 (20)	12.4 ± 0.1 s		β^- 100
		52	3(+)	-40.36 (19)	8.2 ± 0.2 s		β^- 100
		53	(7/2-)	-37.5 (3)	2.4 ± 0.6 s		β^- 100; $\beta^- n$?

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		118	2	-68.409 (13)	14 ± 2 s		ϵ 100; $\epsilon p < 0.04$; $\epsilon\alpha <$ 2.4E-3; $\epsilon\alpha <$ 2.4E-3; ϵ 100; $\epsilon p < 0.04$
		119	9/2+	-72.305 (14)	43.0 ± 0.2 s		ϵ 100; ϵ 100
		120	2(+)	-73.889 (10)	61.3 ± 1.1 s		ϵ 100; $\epsilon\alpha$ 2e-05; ϵp 7e-06; ϵ 100
		121	3/2(+)	-77.1 (14)	155 ± 4 s		ϵ 100
		121m	9/2(+)	-77.032 (14)	122 ± 3 s		ϵ 83; IT 17
		122	1+	-78.14 (3)	21.18 ± 0.19 s		ϵ 100
		122m	(5)-	-78.01 (3)	0.36 ± 0.02 s		IT 100
		122m2	8(-)	-78 (3)	3.70 ± 0.11 m		ϵ 100
		123	1/2+	-81.044 (12)	5.88 ± 0.03 m		ϵ 100
		123m	(11/2)-	-80.887 (12)	1.64 ± 0.12 s		IT 100
		124	1+	-81.731 (8)	30.9 ± 0.4 s		ϵ 100
		124m	(7)+	-81.269 (8)	6.3 ± 0.2 s		IT 100
		125	1/2(+)	-84.088 (8)	46.7 ± 0.1 m		ϵ 100
		126	1+	-84.345 (12)	1.64 ± 0.02 m		ϵ 100
		127	1/2+	-86.24 (6)	6.25 ± 0.1 h		ϵ 100
		128	1+	-85.931 (5)	3.66 ± 0.02 m		ϵ 100
		129	1/2+	-87.499 (5)	32.06 ± 0.06 h		ϵ 100
		130	1+	-86.9 (8)	29.21 ± 0.04 m		ϵ 98.4; β^- 1.6
		130m	5-	-86.736 (8)	3.46 ± 0.06 m		IT 99.84; ϵ 0.16
		131	5/2+	-88.059 (5)	9.689 ± 0.016 d		ϵ 100
		132	2+	-87.1557 (19)	6.480 ± 0.006 d		ϵ 98.13; β^- 1.87
		133	7/2+	-88.0709 (8)	**stable**	100%	
		134	4+	-86.8911 (16)	2.0652 ± 4.0E-4 y		ϵ 0.0003; β^- 100
		134m	8-	-86.7524 (16)	2.912 ± 0.002 h		IT 100
		135	7/2+	-87.5818 (10)	2.3E+6 ± 0.3E+6 y		β^- 100
		135m	19/2-	-85.9489 (10)	53 ± 2 m		IT 100
		136	5+	-86.339 (19)	13.04 ± 0.03 d		β^- 100
		136m	8-	-85.8211 (19)	17.5 ± 0.2 s		β^- ; $IT > 0.00$
		137	7/2+	-86.5459 (4)	30.08 ± 0.09 y		β^- 100
		138	3-	-82.887 (9)	33.41 ± 0.18 m		β^- 100
		138m	6-	-82.807 (9)	2.91 ± 0.08 m		β^- 19; IT 81
		139	7/2+	-80.701 (3)	9.27 ± 0.05 m		β^- 100
		140	1-	-77.05 (8)	63.7 ± 0.3 s		β^- 100
		141	7/2+	-74.48 (10)	24.84 ± 0.16 s		β^- 100; $\beta^- n$ 0.04
		142	0-	-70.525 (11)	1.684 ± 0.014 s		β^- 100; $\beta^- n$ 0.09
		143	3/2+	-67.675 (22)	1.791 ± 0.007 s		β^- 100; $\beta^- n$ 1.64
		144	1(-)	-63.27 (3)	0.994 ± 0.006 s		β^- 100; $\beta^- n$ 3.03; β^-
		145	3/2+	-60.056 (11)	0.587 ± 0.005 s		β^- 100; $\beta^- n$ 14.7
		146	1-	-55.57 (4)	0.321 ± 0.002 s		β^- 100; $\beta^- n$ 14.2
		147	(3/2+)	-52.02 (5)	0.230 ± 0.001 s		β^- 100; $\beta^- n$ 28.5
		148	0	-47.3 (6)	146 ± 6 ms		β^- 100; $\beta^- n$ 25.1
		149	0	-43.84 (20)	> 50 ms		β^- ; $\beta^- n$
		150	0	-39 (3)	> 50 ms		β^- ; $\beta^- n$
		151	0	-35.1 (4)	> 50 ms		β^- ; $\beta^- n$
56	**Ba**	114	0+	-45.96 (11)	0.43 +0.3-0.15 s		ϵ 99.1; ϵp 20; α 0.9; $^{12}C <$ 0.0034
		115	(5/2+)	-49 (6)	0.45 ± 0.05 s		ϵ 100; $\epsilon p > 15.00$
		116	0+	-54.6 (4)	1.3 ± 0.2 s		ϵ 100; ϵp 3
		117	(3/2)	-57.5 (3)	1.75 ± 0.07 s		ϵ 100; $\epsilon\alpha > 0.00$; $\epsilon p > 0.00$
		118	0+	-62.37 (20)	5.5 ± 0.2 s		ϵ 100; ϵp
		119	(5/2+)	-64.59 (20)	5.4 ± 0.3 s		ϵ 100; $\epsilon p < 25.00$

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Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		43	(3/2+)	-1.94 (20)	20.6 ± 0.9 ms		ϵ 100; ϵp 81; $\epsilon 2p$ 7.1; $\epsilon 3p$ 0.08
		44	0+	-13.14 (20)	42.8 ± 0.6 ms		ϵp 14; ϵ 100
		45	(7/2-)	-19.4 (20)	60.9 ± 0.4 ms		ϵ 100; ϵp 34.4
		46	0+	-29.473 (20)	0.26 ± 0.06 s		ϵ 100
		47	3/2-	-34.558 (14)	500 ± 15 ms		ϵ 100
		48	0+	-42.822 (7)	21.56 ± 0.03 h		ϵ 100
		49	5/2-	-45.3329 (24)	42.3 ± 0.1 m		ϵ 100
		50	0+	-50.2619 (9)	> 1.3E+18 y	4.345% ± 0.013%	2ϵ
		51	7/2-	-51.4512 (9)	27.7025 ± 0.0024 d		ϵ 100
		52	0+	-55.418 (6)	**stable**	83.789% ± 0.018%	
		53	3/2-	-55.2858 (6)	**stable**	9.501% ± 0.017%	
		54	0+	-56.9336 (6)	**stable**	2.365% ± 0.007%	
		55	3/2-	-55.1086 (6)	3.497 ± 0.003 m		β^- 100
		56	0+	-55.2812 (19)	5.94 ± 0.1 m		β^- 100
		57	(3/2)-	-52.5241 (19)	21.1 ± 1 s		β^- 100
		58	0+	-51.83 (20)	7.0 ± 0.3 s		β^- 100
		59	(1/2-)	-47.89 (24)	1.05 ± 0.09 s		β^- 100
		60	0+	-46.5 (21)	0.49 ± 0.01 s		β^- 100
		61	(5/2-)	-42.2 (3)	243 ± 11 ms		β^- 100; $\beta^- n$
		62	0+	-40.4 (3)	206 ± 12 ms		β^- 100; $\beta^- n$
		63	1/2-	-35.6 (3)	129 ± 2 ms		β^- 100; $\beta^- n$
		64	0+	-33.3 (3)	42 ± 2 ms		β^- 100
		65	(1/2-)	-27.8 (3)	28 ± 3 ms		β^- 100
		66	0+	-24.3 (5)	23 ± 4 ms		β^- 100
25	**Mn**	46	(4+)	-11.96 (11)	36.2 ± 0.4 ms		ϵ 100; ϵp 57
		47	(5/2-)	-22.26 (16)	88.0 ± 1.3 ms		ϵ 100; $\epsilon p < 1.70$
		48	4+	-29.32 (11)	158.1 ± 2.2 ms		ϵ 100; ϵp 0.28; $\epsilon\alpha <$ 6.0E-4
		49	5/2-	-37.615 (24)	382 ± 7 ms		ϵ 100
		50	0+	-42.6274 (9)	283.19 ± 0.1 ms		ϵ 100
		50m	5+	-42.4021 (9)	1.75 ± 0.03 m		ϵ 100
		51	5/2-	-48.2437 (9)	46.2 ± 0.1 m		ϵ 100
		52	6+	-50.7068 (19)	5.591 ± 0.003 d		ϵ 100
		52m	2+	-50.3291 (19)	21.1 ± 0.2 m		ϵ 98.25; IT 1.75
		53	7/2-	-54.689 (6)	3.74E+6 ± 0.04E+6 y		ϵ 100
		54	3+	-55.5565 (12)	312.12 ± 0.06 d		ϵ 100; $\beta^- <$ 2.9E-4
		55	5/2-	-57.7117 (4)	**stable**	100%	
		56	3+	-56.9108 (5)	2.5789 ± 1.0E-4 h		β^- 100
		57	5/2-	-57.4861 (15)	85.4 ± 1.8 s		β^- 100
		58	1+	-55.827 (3)	3.0 ± 0.1 s		β^- 100
		58m	4+	-55.756 (3)	65.4 ± 0.5 s		$\beta^- \approx 90.00$; $IT \approx 10.00$
		59	(5/2)-	-55.5252 (23)	4.59 ± 0.05 s		β^- 100
		60	1+	-52.9678 (23)	0.28 ± 0.02 s		β^- 100
		60m	4+	-52.6959 (23)	1.77 ± 0.02 s		β^- 88.5; IT 11.5
		61	(5/2)-	-51.742 (23)	0.67 ± 0.04 s		β^- 100
		62	(3+)	-48.181 (3)	671 ± 5 ms		β^- 100; $\beta^- n$; $\beta^- n$; β^- 100
		63	5/2-	-46.887 (4)	0.275 ± 0.004 s		β^- 100; $\beta^- n$
		64	(1+)	-42.989 (4)	90 ± 4 ms		β^- 100; $\beta^- n$ 33
		65	(5/2-)	-40.967 (4)	84 ± 8 ms		β^- 100
		66	0	-36.75 (11)	65 ± 2 ms		β^- 100
		67	(5/2+)	-32.8 (4)	51 ± 4 ms		β^- 100; $\beta^- n > 10.0$
		68	(>3)	-28 (5)	28 ± 3 ms		$\beta^- n$; β^- 100
		69	5/2-	-24.4 (6)	18 ± 4 ms		β^- 100

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		54	(3)+	-33.7 (5)	526 ± 15 ms		β^- 100
		55	(7/2)-	-29.6 (7)	96 ± 2 ms		β^- 100; $\beta^- n$ 17
		56	(1+)	-24.5 (7)	26 ± 6 ms		β^- 100; $\beta^- n$?; β^- 100; $\beta^- n > 14.00$
		57	(7/2-)	-20.1 (7)	22 ± 2 ms		β^- 100; $\beta^- n$
		58	0	-14.4 (8)	12 ± 5 ms		β^- 100; $\beta^- n$
22	Ti	39	(3/2+)	2.2 (3)	31 +6-4 ms		ϵ 100; ϵp 100
		40	0+	-8.85 (16)	52.4 ± 0.3 ms		ϵ ; ϵp 97.5
		41	3/2+	-15.1 (4)	80.4 ± 0.9 ms		ϵ 100; ϵp 100
		42	0+	-25.1046 (3)	199 ± 6 ms		ϵ 100
		43	7/2-	-29.321 (7)	509 ± 5 ms		ϵ 100
		44	0+	-37.5485 (7)	60.0 ± 1.1 y		ϵ 100
		45	7/2-	-39.0083 (8)	184.8 ± 0.5 m		ϵ 100
		46	0+	-44.127 (3)	**stable**	8.25% ± 0.03%	
		47	5/2-	-44.9364 (4)	**stable**	7.44% ± 0.02%	
		48	0+	-48.4917 (4)	**stable**	73.72% ± 0.03%	
		49	7/2-	-48.5628 (4)	**stable**	5.41% ± 0.02%	
		50	0+	-51.4307 (4)	**stable**	5.18% ± 0.02%	
		51	3/2-	-49.7318 (6)	5.76 ± 0.01 m		β^- 100
		52	0+	-49.469 (7)	1.7 ± 0.1 m		β^- 100
		53	(3/2)-	-46.83 (10)	32.7 ± 0.9 s		β^- 100
		54	0+	-45.59 (12)	1.5 ± 0.4 s		β^- 100
		55	(1/2)-	-41.67 (15)	1.3 ± 0.1 s		β^- 100
		56	0+	-38.94 (20)	0.200 ± 0.005 s		$\beta^- n$; β^- 100
		57	(5/2-)	-33.5 (5)	98 ± 5 ms		β^- 100; $\beta^- n$
		58	0+	-30.7 (5)	57 ± 10 ms		β^- 100; $\beta^- n$
		59	(5/2-)	-25 (5)	27.5 ± 2.5 ms		β^- 100
		60	0+	-21.5 (6)	22.4 ± 2.5 ms		β^-
		61	(1/2-)	-15.5 (7)	15 ± 4 ms		β^- 100; $\beta^- n$
23	V	43	0	-18.02 (23)	79.3 ± 2.4 ms		ϵ 100
		44	(2+)	-24.12 (12)	111 ± 7 ms		ϵ 100; $\epsilon\alpha$; ϵ 100
		45	7/2-	-31.88 (17)	547 ± 6 ms		ϵ 100
		46	0+	-37.0744 (3)	422.50 ± 0.11 ms		ϵ 100
		46m	3+	-36.2729 (3)	1.02 ± 0.07 ms		IT 100
		47	3/2-	-42.0056 (3)	32.6 ± 0.3 m		ϵ 100
		48	4+	-44.4764 (11)	15.9735 ± 0.0025 d		ϵ 100
		49	7/2-	-47.9609 (9)	330 ± 15 d		ϵ 100
		50	6+	-49.224 (9)	> 2.1E+17 y	0.25% ± 0.002%	$\epsilon > 92.90$; $\beta^- < 7.10$
		51	7/2-	-52.2039 (9)	**stable**	99.75% ± 0.002%	
		52	3+	-51.4438 (9)	3.743 ± 0.005 m		β^- 100
		53	7/2-	-51.85 (3)	1.543 ± 0.014 m		β^- 100
		54	3+	-49.892 (15)	49.8 ± 0.5 s		β^- 100
		55	(7/2-)	-49.15 (10)	6.54 ± 0.15 s		β^- 100
		56	1+	-46.08 (20)	0.216 ± 0.004 s		β^- 100; $\beta^- n$
		57	(7/2-)	-44.19 (23)	0.32 ± 0.03 s		β^- 100; $\beta^- n$
		58	(1+)	-40.21 (25)	191 ± 10 ms		β^- 100; $\beta^- n$
		59	(5/2-)	-37.1 (3)	97 ± 2 ms		β^- 100; $\beta^- n < 3.00$
		60	0	-32.6 (5)	68 ± 5 ms		β^- ; $\beta^- n$; β^- 100; $\beta^- n$; β^- 100
		61	(3/2-)	-29.5 (3)	52.6 ± 4.2 ms		β^- 100; $\beta^- n \geq 6.00$
		62	0	-24.6 (4)	33.5 ± 2 ms		β^- 100; $\beta^- n$
		63	7/2-	-21.1 (5)	19.2 ± 2.4 ms		β^- 100; $\beta^- n \approx 35.00$
		64	0	-15.6 (5)	19 ± 8 ms		β^- 100
24	Cr	42	0+	6.5 (3)	13.3 ± 1 ms		ϵ 100; ϵp 94.4

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Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		120	0+	-68.9 (3)	24 ± 2 s		ϵ 100
		121	5/2(+)	-70.74 (14)	29.7 ± 1.5 s		ϵ 100
		122	0+	-74.61 (3)	1.95 ± 0.15 m		ϵ 100
		123	5/2(+)	-75.655 (12)	2.7 ± 0.4 m		ϵ 100
		124	0+	-79.09 (12)	11.0 ± 0.5 m		ϵ 100
		125	1/2(+)	-79.668 (11)	3.3 ± 0.3 m		ϵ 100
		126	0+	-82.67 (12)	100 ± 2 m		ϵ 100
		127	1/2+	-82.815 (11)	12.7 ± 0.4 m		ϵ 100
		127m	7/2-	-82.735 (11)	1.9 ± 0.2 s		IT 100
		128	0+	-85.379 (5)	2.43 ± 0.05 d		ϵ 100
		129	1/2+	-85.064 (11)	2.23 ± 0.11 h		ϵ 100
		129m	7/2+	-85.056 (11)	2.16 ± 0.02 h		$\epsilon \leq 100.00$; IT
		130	0+	-87.262 (3)	**stable**	0.106% ± 0.001%	2ϵ
		130m	8-	-84.787 (3)	9.4 ± 0.4 ms		IT 100
		131	1/2+	-86.684 (3)	11.50 ± 0.06 d		ϵ 100
		131m	9/2-	-86.496 (3)	14.6 ± 0.2 m		IT 100
		132	0+	-88.4349 (11)	> 3.0E+21 y	0.101% ± 0.001%	2ϵ
		133	1/2+	-87.5535 (10)	10.551 ± 0.011 y		ϵ 100
		133m	11/2-	-87.2652 (10)	38.93 ± 0.1 h		IT 99.99; ϵ 0.01
		134	0+	-88.9501 (3)	**stable**	2.417% ± 0.018%	
		135	3/2+	-87.8508 (3)	**stable**	6.592% ± 0.012%	
		135m	11/2-	-87.5826 (3)	28.7 ± 0.2 h		IT 100
		136	0+	-88.8872 (3)	**stable**	7.854% ± 0.024%	
		136m	7-	-86.8567 (3)	0.3084 ± 0.0019 s		IT 100
		137	3/2+	-87.7215 (3)	**stable**	11.232% ± 0.024%	
		137m	11/2-	-87.0598 (3)	2.552 ± 0.001 m		IT 100
		138	0+	-88.2619 (3)	**stable**	71.698% ± 0.042%	
		139	7/2-	-84.914 (3)	83.06 ± 0.28 m		β^- 100
		140	0+	-83.27 (8)	12.7527 ± 0.0023 d		β^- 100
		141	3/2-	-79.733 (5)	18.27 ± 0.07 m		β^- 100
		142	0+	-77.845 (6)	10.6 ± 0.2 m		β^- 100
		143	5/2-	-73.937 (7)	14.5 ± 0.3 s		β^- 100
		144	0+	-71.767 (7)	11.5 ± 0.2 s		β^- 100
		145	5/2-	-67.516 (8)	4.31 ± 0.16 s		β^- 100
		146	0+	-64.941 (20)	2.22 ± 0.07 s		β^- 100
		147	(3/2-)	-60.264 (20)	0.894 ± 0.01 s		β^- 100; $\beta^- n$ 0.06
		148	0+	-57.59 (6)	0.612 ± 0.017 s		β^- 100; $\beta^- n$ 0.4
		149	0	-53.17 (20)	0.344 ± 0.007 s		β^- 100; $\beta^- n$ 0.43
		150	0+	-50.3 (4)	0.3 ± 0 s		β^- 100; $\beta^- n$
57	La	117	(3/2+,3/2-)	-46.5 (4)	23.5 ± 2.6 ms		p 93.9; ϵ 6.1
		117m	(9/2+)	-46.3 (4)	10 ± 5 ms		ϵ 2.6; p 97.4
		120	0	-57.7 (5)	2.8 ± 0.2 s		ϵ 100; $\epsilon p > 0.00$
		121	0	-62.4 (5)	5.3 ± 0.2 s		ϵ 100
		122	0	-64.5 (3)	8.6 ± 0.5 s		ϵ 100; ϵp
		123	0	-68.71 (20)	17 ± 3 s		ϵ 100
		124	(8-)	-70.26 (6)	29.21 ± 0.17 s		ϵ 100; ϵ 100
		125	(3/2+)	-73.76 (3)	64.8 ± 1.2 s		ϵ 100
		125m	0	-73.65 (3)	0.39 ± 0.04 s		
		126	(5+)	-74.97 (9)	54 ± 2 s		$\epsilon > 0.00$; ϵ ; IT
		127	(11/2-)	-77.9 (3)	5.1 ± 0.1 m		ϵ 100
		127m	(3/2+)	-77.88 (3)	3.7 ± 0.4 m		ϵ 100; IT
		128	(5+)	-78.63 (5)	5.18 ± 0.14 m		ϵ 100; ϵ 100

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
26	Fe	45	(3/2+)	13.79 (20)	1.89 +0.49-0.21 ms		$\epsilon 3p$ 3.3; $2p$ 70; $\epsilon \leq 30.00$; ϵp 19; $\epsilon 2p$ 7.8
		46	0+	0.8 (4)	13.0 ± 2 ms		ϵ 100; ϵp 78.7
		47	(7/2-)	-6.6 (3)	21.9 ± 0.2 ms		ϵ 100; ϵp 88.4; $\epsilon 2p$
		48	0+	-18.16 (7)	45.3 ± 0.6 ms		ϵ 100; ϵp 15.9
		49	(7/2-)	-24.82 (15)	64.7 ± 0.3 ms		ϵ 100; ϵp 56.7
		50	0+	-34.49 (6)	155 ± 11 ms		ϵ 100; ϵp ?
		51	5/2-	-40.221 (15)	305 ± 5 ms		ϵ 100
		52	0+	-48.333 (7)	8.275 ± 0.008 h		ϵ 100
		52m	12+	-41.375 (7)	45.9 ± 0.6 s		ϵ 100; $IT < 4.0E-3$
		53	7/2-	-50.9467 (17)	8.51 ± 0.02 m		ϵ 100
		53m	19/2-	-47.9063 (17)	2.54 ± 0.02 m		IT 100
		54	0+	-56.2538 (5)	**stable**	5.845% ± 0.035%	
		55	3/2-	-57.4806 (5)	2.744 ± 0.009 y		ϵ 100
		56	0+	-60.6063 (5)	**stable**	91.754% ± 0.036%	
		57	1/2-	-60.1811 (5)	**stable**	2.119% ± 0.01%	
		58	0+	-62.1544 (5)	**stable**	0.282% ± 0.004%	
		59	3/2-	-60.6641 (5)	44.495 ± 0.009 d		β^- 100
		60	0+	-61.413 (3)	2.62E+6 ± 0.04E+6 y		β^- 100
		61	3/2-,5/2-	-58.92 (3)	5.98 ± 0.06 m		β^- 100
		62	0+	-58.878 (3)	68 ± 2 s		β^- 100
		63	(5/2-)	-55.636 (4)	6.1 ± 0.6 s		β^- 100
		64	0+	-54.969 (5)	2.0 ± 0.2 s		β^- 100
		65	(1/2-)	-51.221 (7)	0.81 ± 0.05 s		β^- 100
		65m	(9/2+)	-50.819 (7)	1.12 ± 0.15 s		β^- 100
		66	0+	-50.068 (4)	440 ± 60 ms		β^- 100
		67	(1/2-)	-45.7 (4)	0.40 ± 0.04 s		β^- 100
		68	0+	-43.1 (7)	180 ± 19 ms		β^- 100
		69	1/2-	-38.4 (5)	110 ± 6 ms		β^- 100
		70	0+	-36.3 (6)	71 ± 10 ms		β^- 100
		71	0	-31 (8)	28 ± 5 ms		β^- 100; $\beta^- n$
27	Co	50	(6+)	-17.19 (17)	38.8 ± 0.2 ms		ϵ 100; ϵp 70.5; $\epsilon 2p$
		52	(6+)	-33.92 (7)	115 ± 23 ms		ϵ 100
		53	(7/2-)	-42.6585 (18)	240 ± 9 ms		ϵ 100
		53m	(19/2-)	-39.4615 (18)	247 ± 12 ms		$\epsilon \approx 98.50$; $p \approx 1.50$
		54	0+	-48.0092 (5)	193.28 ± 0.07 ms		ϵ 100
		54m	7+	-47.8122 (5)	1.48 ± 0.02 m		ϵ 100
		55	7/2-	-54.0292 (5)	17.53 ± 0.03 h		ϵ 100
		56	4+	-56.0397 (6)	77.236 ± 0.026 d		ϵ 100
		57	7/2-	-59.3449 (6)	271.74 ± 0.06 d		ϵ 100
		58	2+	-59.8465 (12)	70.86 ± 0.06 d		ϵ 100
		58m	5+	-59.8215 (12)	9.10 ± 0.09 h		IT 100
		59	7/2-	-62.229 (5)	**stable**	100%	
		60	5+	-61.6496 (5)	1925.28 ± 0.14 d		β^- 100
		60m	2+	-61.591 (5)	10.467 ± 0.006 m		IT 99.76; β^- 0.24
		61	7/2-	-62.8975 (9)	1.650 ± 0.005 h		β^- 100
		62	2+	-61.431 (20)	1.50 ± 0.04 m		β^- 100
		62m	5+	-61.409 (20)	13.91 ± 0.05 m		$\beta^- > 99.00$; $IT < 1.00$
		63	7/2-	-61.839 (20)	27.4 ± 0.5 s		β^- 100
		64	1+	-59.792 (20)	0.30 ± 0.03 s		β^- 100
		65	(7/2)-	-59.1851 (21)	1.16 ± 0.03 s		β^- 100
		66	(3+)	-56.408 (14)	0.20 ± 0.02 s		β^- 100
		67	(7/2-)	-55.322 (6)	0.425 ± 0.02 s		β^- 100

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		111	(7/2+)	-54.39 (9)	0.81 ± 0.2 s		ϵ 90; α 10
		112	0+	-60.028 (8)	2.7 ± 0.8 s		ϵ 99.16; α 0.84
		113	(5/2+)	-62.204 (7)	2.74 ± 0.08 s		ϵ ; ϵp 7; $\alpha \approx 0.01$; $\epsilon\alpha \approx$ 7.0E-3
		114	0+	-67.086 (11)	10.0 ± 0.4 s		ϵ 100
		115	(5/2+)	-68.657 (12)	18 ± 4 s		ϵp 0.34; α 0.0003; ϵ 100
		116	0+	-73.047 (13)	59 ± 2 s		ϵ 100
		117	5/2(+)	-74.185 (10)	61 ± 2 s		ϵ 100; ϵp 0.0029
		118	0+	-78.079 (10)	3.8 ± 0.9 m		ϵ 100
		119	(5/2+)	-78.794 (10)	5.8 ± 0.3 m		ϵ 100
		120	0+	-82.172 (12)	40 ± 1 m		ϵ 100
		121	5/2(+)	-82.473 (11)	40.1 ± 2 m		ϵ 100
		122	0+	-85.355 (11)	20.1 ± 0.1 h		ϵ 100
		123	(1/2)+	-85.249 (10)	2.08 ± 0.02 h		ϵ 100
		124	0+	-87.6612 (18)	≥ 1.6E+14 y	0.0952% ± 0.0003%	2ϵ
		125	1/2(+)	-87.1932 (18)	16.9 ± 0.2 h		ϵ 100
		125m	9/2(-)	-86.9406 (18)	57 ± 1 s		IT 100
		126	0+	-89.146 (4)	**stable**	0.089% ± 0.0002%	
		127	1/2+	-88.322 (4)	36.346 ± 0.003 d		ϵ 100
		127m	9/2-	-88.025 (4)	69.2 ± 0.9 s		IT 100
		128	0+	-89.8602 (11)	**stable**	1.9102% ± 0.0008%	
		129	1/2+	-88.696 (6)	**stable**	26.4006% ± 0.0082%	
		129m	11/2-	-88.4599 (6)	8.88 ± 0.02 d		IT 100
		130	0+	-89.8804 (9)	**stable**	4.071% ± 0.0013%	
		131	3/2+	-88.4136 (22)	**stable**	21.232% ± 0.03%	
		131m	11/2-	-88.2497 (22)	11.84 ± 0.04 d		IT 100
		132	0+	-89.2789 (5)	**stable**	26.9086% ± 0.0033%	
		132m	(10+)	-86.5267 (5)	8.39 ± 0.11 ms		IT 100
		133	3/2+	-87.6435 (24)	5.2475 ± 5.0E-4 d		β^- 100
		133m	11/2-	-87.4103 (24)	2.198 ± 0.013 d		IT 100
		134	0+	-88.1245 (8)	> 5.8E+22 y	10.4357% ± 0.0021%	$2\beta^-$
		134m	7-	-86.1589 (8)	290 ± 17 ms		IT 100
		135	3/2+	-86.418 (5)	9.14 ± 0.02 h		β^- 100
		135m	11/2-	-85.891 (5)	15.29 ± 0.05 m		$IT > 99.40$; $\beta^- < 0.60$
		136	0+	-86.4291 (10)	> 2.4E+21 y	8.8573% ± 0.0044%	$2\beta^-$
		137	7/2-	-82.3833 (11)	3.818 ± 0.013 m		β^- 100
		138	0+	-79.975 (3)	14.08 ± 0.08 m		β^- 100
		139	3/2-	-75.6445 (21)	39.68 ± 0.14 s		β^- 100
		140	0+	-72.9864 (23)	13.60 ± 0.1 s		β^- 100
		141	5/2(-)	-68.197 (3)	1.73 ± 0.01 s		β^- 100; $\beta^- n$ 0.04
		142	0+	-65.23 (3)	1.23 ± 0.02 s		β^- 100; $\beta^- n$ 0.21
		143	5/2-	-60.203 (5)	0.511 ± 0.006 s		β^- 100; $\beta^- n$ 1
		144	0+	-56.872 (5)	0.388 ± 0.007 s		β^- 100; $\beta^- n$ 3
		145	0	-51.493 (11)	188 ± 4 ms		β^- 100; $\beta^- n$ 5
		146	0+	-47.955 (24)	146 ± 6 ms		β^- 100; $\beta^- n$ 6.9
		147	(3/2-)	-42.5 (4)	0.10 +0.1-0.05 s		β^- ; $\beta^- n < 8.00$
55	Cs	114	(1+)	-54.68 (7)	0.57 ± 0.02 s		ϵ 99.98; ϵp 8.7; $\epsilon\alpha$ 0.19; α 0.02
		115	0	-59.7 (3)	1.4 ± 0.8 s		ϵ 100; $\epsilon p \approx 0.07$
		116	(1+)	-62.07 (10)	0.70 ± 0.04 s		$\epsilon\alpha$ 0.05; ϵ 100; ϵp 2.8
		116m	4+,5,6	-61.97 (10)	3.85 ± 0.13 s		ϵ 100; ϵp 0.51; $\epsilon\alpha$ 0.008
		117	(9/2+)	-66.49 (6)	8.4 ± 0.6 s		ϵ 100; ϵ

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$\mathbf{T_{1/2}, \Gamma}$	Abundance	Decay Mode
		132	0+	-85.18 (7)	3.204 ± 0.013 d		β^- 100
		133	(3/2+)	-82.944 (24)	12.5 ± 0.3 m		β^- 100
		133m	(11/2-)	-82.61 (24)	55.4 ± 0.4 m		β^- 83.5; IT 16.5
		134	0+	-82.559 (11)	41.8 ± 0.8 m		β^- 100
		135	(7/2-)	-77.903 (15)	19.0 ± 0.2 s		β^- 100
		136	0+	-74.479 (25)	17.63 ± 0.08 s		β^- 100; $\beta^- n$ 1.31
		137	(7/2-)	-69.29 (12)	2.49 ± 0.05 s		β^- 100; $\beta^- n$ 2.99
		138	0+	-65.76 (12)	1.4 ± 0.4 s		β^- 100; $\beta^- n$ 6.3
53	**I**	108	(1)	-52.65 (21)	36 ± 6 ms		α 91; ϵ 9; $p < 1.00$
		110	0	-60.46 (5)	0.65 ± 0.02 s		ϵ 83; α 17; ϵp 11; $\epsilon\alpha$ 1.1
		111	(5/2+)	-64.954 (5)	2.5 ± 0.2 s		$\alpha \approx 0.10$; ϵ 99.9
		112	0	-67.063 (10)	3.42 ± 0.11 s		ϵ 100; $\alpha \approx$ 1.2E-3
		113	5/2+	-71.119 (8)	6.6 ± 0.2 s		ϵ 100; α 3.3e-07
		114	1+	-72.8 (3)	2.1 ± 0.2 s		ϵ 100; ϵp
		114m	(7)	-72.5 (3)	6.2 ± 0.5 s		ϵ 91; IT 9
		115	(5/2+)	-76.34 (3)	1.3 ± 0.2 m		ϵ 100
		116	1+	-77.49 (10)	2.91 ± 0.15 s		ϵ 100
		117	(5/2)+	-80.43 (3)	2.22 ± 0.04 m		ϵ 100
		118	2-	-80.971 (20)	13.7 ± 0.5 m		ϵ 100
		118m	(7-)	-80.867 (20)	8.5 ± 0.5 m		$\epsilon < 100.00$; IT
		119	5/2+	-83.77 (3)	19.1 ± 0.4 m		ϵ 100
		120	2-	-83.755 (15)	81.6 ± 0.2 m		ϵ 100
		120m	(7-)	-83.435 (15)	53 ± 4 m		ϵ 100
		121	5/2+	-86.253 (5)	2.12 ± 0.01 h		ϵ 100
		122	1+	-86.082 (5)	3.63 ± 0.06 m		ϵ 100
		123	5/2+	-87.945 (4)	13.2235 ± 0.0019 h		ϵ 100
		124	2-	-87.367 (24)	4.1760 ± 3.0E-4 d		ϵ 100
		125	5/2+	-88.8385 (16)	59.407 ± 0.01 d		ϵ 100
		126	2-	-87.912 (4)	12.93 ± 0.05 d		ϵ 52.7; β^- 47.3
		127	5/2+	-88.985 (4)	**stable**	100%	
		128	1+	-87.739 (4)	24.99 ± 0.02 m		β^- 93.1; ϵ 6.9
		129	7/2+	-88.507 (3)	1.57E+7 ± 0.04E+7 y		β^- 100
		130	5+	-86.936 (3)	12.36 ± 0.01 h		β^- 100
		130m	2+	-86.896 (3)	8.84 ± 0.06 m		IT 84; β^- 16
		131	7/2+	-87.4427 (6)	8.0252 ± 6.0E-4 d		β^- 100
		132	4+	-85.698 (6)	2.295 ± 0.013 h		β^- 100
		132m	(8-)	-85.578 (6)	1.387 ± 0.015 h		IT 86; β^- 14
		133	7/2+	-85.886 (5)	20.83 ± 0.08 h		β^- 100
		133m	(19/2-)	-84.252 (5)	9 ± 2 s		IT 100
		134	(4)+	-84.072 (8)	52.5 ± 0.2 m		β^- 100
		134m	(8)-	-83.756 (8)	3.52 ± 0.04 m		IT 97.7; β^- 2.3
		135	7/2+	-83.791 (7)	6.58 ± 0.03 h		β^- 100
		136	(1-)	-79.572 (19)	83.4 ± 1 s		β^- 100
		136m	(6-)	-78.932 (19)	46.9 ± 1 s		β^- 100
		137	(7/2+)	-76.51 (3)	24.5 ± 0.2 s		β^- 100; $\beta^- n$ 7.14
		138	(2-)	-71.9 (10)	6.23 ± 0.03 s		β^- 100; $\beta^- n$ 5.56
		139	(7/2+)	-68.53 (12)	2.280 ± 0.011 s		β^- 100; $\beta^- n$ 10
		140	(4-)	-63.6 (12)	0.86 ± 0.04 s		β^- 100; $\beta^- n$ 9.3
		141	0	-60.3 (13)	0.43 ± 0.02 s		β^- 100; $\beta^- n$ 21.2
		142	0	-55 (4)	222 ± 12 ms		β^- 100; $\beta^- n$?
		143	0	-51.1 (4)	130 ± 45 ms		β^- ?
54	**Xe**	109	(7/2+)	-45.9 (3)	13 ± 2 ms		α 100
		110	0+	-51.92 (10)	93 ± 3 ms		ϵp ; α 64; ϵ

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Z	El	A	J^π	Δ[MeV]	$\mathbf{T_{1/2}, \Gamma}$	Abundance	Decay Mode
		68	(7-)	-51.91 (13)	0.199 ± 0.021 s		β^- 100; β^- 100
		69	7/2-	-50 (3)	229 ± 24 ms		β^- 100
		70	(6-)	-45.6 (8)	108 ± 7 ms		β^- 100; β^- 100
		71	(7/2-)	-43.9 (8)	80 ± 3 ms		β^- 100; $\beta^- n \leq 6.00$
		72	(6-,7-)	-39.7 (6)	59.9 ± 1.7 ms		$\beta^- n \geq 6.00$; β^- 100
		73	0	-37.2 (7)	41 ± 4 ms		β^-
		74	0+	-32.7 (8)	25 ± 5 ms		β^- ; $\beta^- n \approx 18.00$
28	**Ni**	48	0+	18 (5)	2.1 +1.4-0.6 ms		$2p \approx 70.00$; ϵ
		49	0	8.7 (4)	7.5 ± 1 ms		ϵp 83; ϵ 100
		50	0+	-3.6 (3)	18.5 ± 1.2 ms		ϵ 100; ϵp 86.7; $\epsilon 2p$
		51	(7/2-)	-11.5 (3)	23.8 ± 0.2 ms		ϵ ; ϵp 87.2
		52	0+	-22.89 (20)	40.8 ± 0.2 ms		ϵ 100; ϵp 31.4
		53	(7/2-)	-29.7 (3)	55.2 ± 0.7 ms		ϵ 100; ϵp 23.4
		54	0+	-39.22 (5)	104 ± 7 ms		ϵ 100
		55	7/2-	-45.3351 (8)	204.7 ± 3.7 ms		ϵ 100
		56	0+	-53.9068 (5)	6.075 ± 0.01 d		ϵ 100
		57	3/2-	-56.0831 (7)	35.60 ± 0.06 h		ϵ 100
		58	0+	-60.2281 (5)	**stable**	68.077% ± 0.009%	
		59	3/2-	-61.156 (5)	7.6E+4 ± 0.5E+4 y		ϵ 100
		60	0+	-64.4725 (5)	**stable**	26.223% ± 0.008%	
		61	3/2-	-64.2212 (5)	**stable**	1.1399% ± 0.0013%	
		62	0+	-66.7458 (5)	**stable**	3.6346% ± 0.004%	
		63	1/2-	-65.5122 (5)	101.2 ± 1.5 y		β^- 100
		64	0+	-67.0984 (5)	**stable**	0.9255% ± 0.0019%	
		65	5/2-	-65.1252 (6)	2.5175 ± 5.0E-4 h		β^- 100
		66	0+	-66.0062 (14)	54.6 ± 0.3 h		β^- 100
		67	(1/2)-	-63.743 (3)	21 ± 1 s		β^- 100
		68	0+	-63.464 (3)	29 ± 2 s		β^- 100
		69	9/2+	-59.979 (4)	11.2 ± 0.9 s		β^- 100
		69m	1/2-	-59.658 (4)	3.5 ± 0.9 s		β^- 100
		70	0+	-59.2136 (22)	6.0 ± 0.3 s		β^- 100
		71	(9/2+)	-55.4059 (23)	2.56 ± 0.03 s		β^- 100
		71m	(1/2-)	-54.9069 (23)	2.3 ± 0.3 s		β^- 100
		72	0+	-54.2258 (23)	1.57 ± 0.05 s		β^- 100
		73	(9/2+)	-50.1079 (25)	0.84 ± 0.03 s		β^- 100
		74	0+	-48.7 (4)	0.68 ± 0.18 s		β^- 100; $\beta^- n$
		75	(7/2+)	-44.1 (4)	344 ± 25 ms		β^- 100; $\beta^- n$ 10
		76	0+	-41.6 (5)	0.238 +0.015-0.018 s		β^- 100; $\beta^- n$
		77	0	-36.7 (5)	128 +36-32 ms		β^- 100; $\beta^- n$ 30
		78	0+	-34.1 (8)	0.11 +0.1-0.06 s		$\beta^- n$; β^- 100
29	**Cu**	55	(3/2-)	-31.6 (3)	27 ± 8 ms		ϵ 100; ϵp 15
		56	(4+)	-38.2 (4)	93 ± 3 ms		ϵp 0.4; ϵ 100
		57	3/2-	-47.3082 (6)	196.3 ± 0.7 ms		ϵ 100
		58	1+	-51.6671 (7)	3.204 ± 0.007 s		ϵ 100
		59	3/2-	-56.3577 (6)	81.5 ± 0.5 s		ϵ 100
		60	2+	-58.3445 (16)	23.7 ± 0.4 m		ϵ 100
		61	3/2-	-61.9837 (10)	3.333 ± 0.005 h		ϵ 100
		62	1+	-62.7869 (7)	9.673 ± 0.008 m		ϵ 100
		63	3/2-	-65.5792 (5)	**stable**	69.15% ± 0.15%	
		64	1+	-65.424 (5)	12.701 ± 0.002 h		ϵ 61.5; β^- 38.5
		65	3/2-	-67.2633 (7)	**stable**	30.85% ± 0.15%	
		66	1+	-66.2579 (7)	5.120 ± 0.014 m		β^- 100
		67	3/2-	-67.3187 (12)	61.83 ± 0.12 h		β^- 100

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$\mathbf{T_{1/2}, \Gamma}$	Abundance	Decay Mode
		121m	11/2-	-89.1908 (22)	43.9 ± 0.5 y		IT 77.6; β^- 22.4
		122	0+	-89.943 (3)	**stable**	4.63% ± 0.03%	
		123	11/2-	-87.818 (3)	129.2 ± 0.4 d		β^- 100
		123m	3/2+	-87.793 (3)	40.06 ± 0.01 m		β^- 100
		124	0+	-88.237 (14)	> 1.2E+21 y	5.79% ± 0.05%	$2\beta^-$
		125	11/2-	-85.8988 (15)	9.64 ± 0.03 d		β^- 100
		125m	3/2+	-85.8713 (15)	9.52 ± 0.05 m		β^- 100
		126	0+	-86.021 (11)	2.30E+5 ± 0.14E+5 y		β^- 100
		127	(11/2-)	-83.47 (10)	2.10 ± 0.04 h		β^- 100
		127m	(3/2+)	-83.465 (10)	4.13 ± 0.03 m		β^- 100
		128	0+	-83.34 (3)	59.07 ± 0.14 m		β^- 100
		128m	(7-)	-81.24 (3)	6.5 ± 0.5 s		IT 100
		129	(3/2+)	-80.59 (3)	2.23 ± 0.04 m		β^- 100
		129m	(11/2-)	-80.56 (3)	6.9 ± 0.1 m		β^- 100; IT < 2.0E-3
		130	0+	-80.137 (9)	3.72 ± 0.07 m		β^- 100
		130m	(7-)	-78.19 (9)	1.7 ± 0.1 m		β^- 100
		131	(3/2+)	-77.272 (9)	56.0 ± 0.5 s		β^- 100; β^- 100; IT
		132	0+	-76.548 (6)	39.7 ± 0.8 s		β^- 100
		133	7/2-	-70.847 (23)	1.46 ± 0.03 s		β^- 100; $\beta^- n$ 0.03
		134	0+	-66.32 (15)	1.050 ± 0.011 s		β^- 100; $\beta^- n$ 17
		135	(7/2-)	-60.6 (4)	530 ± 20 ms		β^- 100; $\beta^- n$ 21
		136	0+	-56.3 (5)	0.25 ± 0.03 s		β^- 100; $\beta^- n$ 30
		137	0	-50.3 (6)	190 ± 60 ms		β^- 100; $\beta^- n$ 58
51	**Sb**	104	0	-59.17 (22)	0.44 +0.15-0.11 s		$p < 1.00$; ϵ 100; $\epsilon p < 7.00$
		105	(5/2+)	-63.853 (16)	1.22 ± 0.11 s		ϵ 99; p 1
		106	(2+)	-66.473 (7)	0.6 ± 0.2 s		ϵ
		107	(5/2+)	-70.653 (4)	4.0 ± 0.2 s		ϵ 100
		108	(4+)	-72.445 (5)	7.4 ± 0.3 s		ϵ 100
		109	(5/2+)	-76.251 (5)	17.0 ± 0.7 s		ϵ 100
		110	(3+,4+)	-77.45 (6)	23.0 ± 0.4 s		ϵ 100
		111	(5/2+)	-80.837 (9)	75 ± 1 s		ϵ 100
		112	3+	-81.601 (18)	51.4 ± 1 s		ϵ 100
		113	5/2+	-84.417 (17)	6.67 ± 0.07 m		ϵ 100
		114	3+	-84.496 (22)	3.49 ± 0.03 m		ϵ 100
		115	5/2+	-87.003 (16)	32.1 ± 0.3 m		ϵ 100
		116	3+	-86.822 (5)	15.8 ± 0.8 m		ϵ 100
		116m	8-	-86.439 (5)	60.3 ± 0.6 m		ϵ 100
		117	5/2+	-88.642 (9)	2.80 ± 0.01 h		ϵ 100
		118	1+	-87.996 (3)	3.6 ± 0.1 m		ϵ 100
		118m	8-	-87.746 (3)	5.00 ± 0.02 h		ϵ 100
		119	5/2+	-89.474 (8)	38.19 ± 0.22 h		ϵ 100
		119m	(27/2+)	-86.632 (8)	0.85 ± 0.09 s		IT 100
		120	1+	-88.417 (7)	15.89 ± 0.04 m		ϵ 100; ϵ 100
		121	5/2+	-89.6 (3)	**stable**	57.21% ± 0.05%	
		122	2-	-88.335 (3)	2.7238 ± 2.0E-4 d		β^- 97.59; ϵ 2.41
		122m	(8)-	-88.171 (3)	4.191 ± 0.003 m		IT 100
		123	7/2+	-89.2261 (22)	**stable**	42.79% ± 0.05%	
		124	3-	-87.6223 (22)	60.20 ± 0.03 d		β^- 100
		124m	5+	-87.6114 (22)	93 ± 5 s		IT 75; β^- 25
		124m2	(8)-	-87.5855 (22)	20.2 ± 0.2 m		IT 100
		125	7/2+	-88.258 (3)	2.75856 ± 2.5E-4 y		β^- 100
		126	(8-)	-86.4 (3)	12.35 ± 0.06 d		β^- 100
		126m	(5+)	-86.38 (3)	19.15 ± 0.08 m		β^- 86; IT 14

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$\mathbf{T_{1/2}, \Gamma}$	Abundance	Decay Mode
		62	0+	-51.9864 (7)	116.121 ± 0.021 ms		ϵ 100; ϵp
		63	3/2-	-56.547 (13)	32.4 ± 0.5 s		ϵ 100
		64	0+	-58.8334 (15)	2.627 ± 0.012 m		ϵ 100
		65	3/2-	-62.6572 (8)	15.2 ± 0.2 m		ϵ 100
		66	0+	-63.724 (3)	9.49 ± 0.03 h		ϵ 100
		67	3/2-	-66.8788 (12)	3.2617 ± 5.0E-4 d		ϵ 100
		68	1+	-67.0857 (15)	67.71 ± 0.09 m		ϵ 100
		69	3/2-	-69.3277 (12)	**stable**	60.108% ± 0.009%	
		70	1+	-68.91 (12)	21.14 ± 0.03 m		β^- 99.59; ϵ 0.41
		71	3/2-	-70.139 (8)	**stable**	39.892% ± 0.009%	
		72	3-	-68.5882 (8)	14.10 ± 0.02 h		β^- 100
		73	3/2-	-69.6993 (17)	4.86 ± 0.03 h		β^- 100
		74	(3-)	-68.049 (4)	8.12 ± 0.12 m		β^- 100
		74m	(0)	-67.989 (4)	9.5 ± 1 s		IT 75; $\beta^- < 50.00$
		75	3/2-	-68.4645 (24)	126 ± 2 s		β^- 100
		76	2+	-66.2966 (20)	32.6 ± 0.6 s		β^- 100
		77	3/2-	-65.9923 (24)	13.2 ± 0.2 s		β^- 100
		78	2+	-63.7059 (19)	5.09 ± 0.05 s		β^- 100
		79	3/2-	-62.5476 (19)	2.847 ± 0.003 s		β^- 100; $\beta^- n$ 0.09
		80	3	-59.224 (3)	1.676 ± 0.014 s		β^- 100; $\beta^- n$ 0.86
		81	5/2-	-57.628 (3)	1.217 ± 0.005 s		β^- 100; $\beta^- n$ 11.9
		82	(1,2,3)	-52.9307 (24)	0.599 ± 0.002 s		β^- 100; $\beta^- n$ 19.8
		83	0	-49.257 (3)	308.1 ± 1 ms		β^- 100; $\beta^- n$ 62.8
		84	(0-)	-44.3 (4)	0.085 ± 0.01 s		β^- 100; $\beta^- n$ 74; β^- 100; $\beta^- n$?
		85	(1/2-,3/2-)	-40.2 (5)	< 100 ms		β^- ; $\beta^- n > 35.0$
32	**Ge**	61	(3/2-)	-33.7 (3)	44 ± 6 ms		ϵ 100; $\epsilon p > 58.00$
		62	0+	-42.24 (14)	129 ± 35 ms		ϵ 100; ϵp
		63	3/2-	-46.92 (4)	150 ± 9 ms		ϵ 100
		64	0+	-54.315 (4)	63.7 ± 2.5 s		ϵ 100
		65	3/2-	-56.481 (3)	30.9 ± 0.5 s		ϵ 100; ϵp 0.01
		66	0+	-61.6069 (24)	2.26 ± 0.05 h		ϵ 100
		67	1/2-	-62.658 (5)	18.9 ± 0.3 m		ϵ 100
		68	0+	-66.9787 (19)	270.95 ± 0.16 d		ϵ 100
		69	5/2-	-67.1005 (13)	39.05 ± 0.1 h		ϵ 100
		70	0+	-70.5618 (8)	**stable**	20.57% ± 0.27%	
		71	1/2-	-69.9064 (8)	11.43 ± 0.03 d		ϵ 100
		71m	9/2+	-69.708 (8)	20.41 ± 0.18 ms		IT 100
		72	0+	-72.5856 (5)	**stable**	27.45% ± 0.32%	
		73	9/2+	-71.2972 (5)	**stable**	7.75% ± 0.12%	
		73m	1/2-	-71.2305 (5)	0.499 ± 0.011 s		IT 100
		74	0+	-73.4221 (5)	**stable**	36.5% ± 0.2%	
		75	1/2-	-71.8561 (5)	82.78 ± 0.04 m		β^- 100
		75m	7/2+	-71.7164 (5)	47.7 ± 0.5 s		IT 99.97; β^- 0.03
		76	0+	-73.2128 (9)	**stable**	7.73% ± 0.12%	
		77	7/2+	-71.2138 (4)	11.30 ± 0.01 h		β^- 100
		77m	1/2-	-71.0541 (4)	52.9 ± 0.6 s		IT 19; β^- 81
		78	0+	-71.862 (4)	88.0 ± 1 m		β^- 100
		79	(1/2)-	-69.53 (4)	18.98 ± 0.03 s		β^- 100
		79m	(7/2+)	-69.34 (4)	39.0 ± 1 s		β^- 96; IT 4
		80	0+	-69.5353 (21)	29.5 ± 0.4 s		β^- 100
		81	(9/2+)	-66.2916 (21)	7.6 ± 0.6 s		β^- 100

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}$, Γ	Abundance	Decay Mode
		68	1+	-65.567 (16)	30.9 ± 0.6 s		β^- 100
		68m	(6-)	-64.8454 (16)	3.75 ± 0.05 m		*IT* 84; β^- 16
		69	3/2-	-65.7362 (14)	2.85 ± 0.15 m		β^- 100
		70	(6-)	-62.9763 (11)	44.5 ± 0.2 s		β^- 100
		70m	(3-)	-62.8752 (11)	33 ± 2 s		β^- 52; *IT* 48
		70m2	1+	-62.7337 (11)	6.6 ± 0.2 s		*IT* 6.8; β^- 93.2
		71	3/2(-)	-62.7111 (15)	19.4 ± 1.6 s		β^- 100
		72	(2)	-59.783 (14)	6.63 ± 0.03 s		β^- 100
		73	(3/2-)	-58.9872 (20)	4.2 ± 0.3 s		β^- 100
		74	(1+,3+)	-56.006 (6)	1.594 ± 0.01 s		β^- 100
		75	(5/2-)	-54.471 (24)	1.222 ± 0.008 s		β^- 100; β^-n 3.5
		76	(3,4)	-50.976 (7)	637 ± 7 ms		β^- 100; β^-n 7.2; β^- 100
		77	(5/2-)	-48.3 (5)	468.1 ± 2 ms		β^-n 30.3; β^- 100
		78	(4-,5-,6-)	-44.5 (5)	335 ± 11 ms		β^- 100; β^-n > 65.00
		79	0	-41.9 (4)	188 ± 25 ms		β^- 100; β^-n 55
		80	0	-36.4 (6)	0.17 +0.11-0.05 s		β^-
30	Zn	54	0+	-6 (4)	1.59 +0.6-0.35 ms		$2p$ 92
		55	(5/2-)	-14.4 (4)	19.8 ± 1.3 ms		ϵ 100; ϵp 91
		56	0+	-25.2 (4)	30.0 ± 1.7 ms		ϵ 100; ϵp 86
		57	(7/2-)	-32.55 (21)	38 ± 4 ms		ϵ 100; ϵp ≥ 65.00
		58	0+	-42.3 (5)	86 ± 8 ms		ϵ 100; ϵp < 3.00
		59	3/2-	-47.2149 (8)	182.0 ± 1.8 ms		ϵ 100; ϵp 0.1
		60	0+	-54.1737 (6)	2.38 ± 0.05 m		ϵ 100
		61	3/2-	-56.343 (16)	89.1 ± 0.2 s		ϵ 100
		61m	1/2-	-56.255 (16)	< 430 ms		*IT*
		61m2	3/2-	-55.925 (16)	0.14 ± 0.07 s		*IT*
		61m3	5/2-	-55.587 (16)	< 0.13 s		*IT*
		62	0+	-61.1674 (7)	9.186 ± 0.013 h		ϵ 100
		63	3/2-	-62.213 (16)	38.47 ± 0.05 m		ϵ 100
		64	0+	-66.0036 (7)	≥ 7.0E20 y	49.17% ± 0.75%	2ϵ
		65	5/2-	-65.9116 (7)	243.93 ± 0.09 d		ϵ 100
		66	0+	-68.899 (9)	**stable**	27.73% ± 0.98%	
		67	5/2-	-67.88 (9)	**stable**	4.04% ± 0.16%	
		68	0+	-70.0068 (9)	**stable**	18.45% ± 0.63%	
		69	1/2-	-68.4175 (9)	56.4 ± 0.9 m		β^- 100
		69m	9/2+	-67.9789 (9)	13.76 ± 0.02 h		*IT* 99.97; β^- 0.03
		70	0+	-69.5646 (20)	≥ 2.3E+17 y	0.61% ± 0.1%	$2\beta^-$
		71	1/2-	-67.329 (3)	2.45 ± 0.1 m		β^- 100
		71m	9/2+	-67.171 (3)	3.96 ± 0.05 h		β^- 100; *IT* ≤ 0.05
		72	0+	-68.1454 (21)	46.5 ± 0.1 h		β^- 100
		73	(1/2)-	-65.5934 (19)	23.5 ± 1 s		β^- 100; β^- ; *IT*
		73m	(5/2+)	-65.3979 (19)	13.0 ± 0.2 ms		*IT* 100
		74	0+	-65.757 (3)	95.6 ± 1.2 s		β^- 100
		75	(7/2+)	-62.5589 (20)	10.2 ± 0.2 s		β^- 100
		76	0+	-62.303 (15)	5.7 ± 0.3 s		β^- 100
		77	(7/2+)	-58.7891 (20)	2.08 ± 0.05 s		β^- 100
		77m	(1/2-)	-58.0167 (20)	1.05 ± 0.1 s		*IT* > 50.00; β^- < 50.00
		78	0+	-57.4832 (19)	1.47 ± 0.15 s		β^- 100
		79	(9/2+)	-53.4322 (22)	0.995 ± 0.019 s		β^- 100; β^-n 1.3
		80	0+	-51.649 (3)	0.54 ± 0.02 s		β^- 100; β^-n 1
		81	(5/2+)	-46.2 (5)	304 ± 13 ms		β^- 100; β^-n 7.5
31	Ga	60	(2+)	-39.78 (20)	70 ± 13 ms		$\epsilon\alpha$ < 0.02; ϵ 98.4; ϵp 1.6
		61	3/2-	-47.09 (5)	167 ± 3 ms		ϵ 100; ϵp < 0.25

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Z	El	A	J^π	Δ[MeV]	$T_{1/2}$, Γ	Abundance	Decay Mode
		126m2	(3-)	-86.36 (3)	≈ 11 s		*IT* 100
		127	7/2+	-86.701 (5)	3.85 ± 0.05 d		β^- 100
		128	8-	-84.61 (3)	9.01 ± 0.04 h		β^- 100; β^- 96.4; *IT* 3.6
		129	7/2+	-84.629 (21)	4.40 ± 0.01 h		β^- 100
		129m	(19/2-)	-82.778 (21)	17.7 ± 0.1 m		β^- 85; *IT* 15
		130	(8-)	-82.29 (16)	39.5 ± 0.8 m		β^- 100
		130m	(4,5)+	-82.285 (16)	6.3 ± 0.2 m		β^- 100
		131	(7/2+)	-81.976 (11)	23.03 ± 0.04 m		β^- 100
		132	(4)+	-79.669 (10)	2.79 ± 0.07 m		β^- 100; β^- 100
		133	(7/2+)	-78.94 (3)	2.34 ± 0.05 m		β^- 100
		134	(0-)	-74.17 (4)	0.78 ± 0.06 s		β^- 100
		134m	(7-)	-73.89 (4)	10.07 ± 0.05 s		β^- 100; β^-n 0.09
		135	(7/2+)	-69.79 (5)	1.679 ± 0.015 s		β^-n 22; β^- 100
		136	1-	-64.5 (3)	0.923 ± 0.014 s		β^- 100; β^-n 16.3
		137	(7/2+)	-60.4 (4)	492 ± 25 ms		β^- 100; β^-n 49
		138	0	-54.8 (3)	350 ± 15 ms		β^- 100; β^-n 72
		139	0	-50.3 (5)	93 +14-3 ms		β^- 100; β^-n 90
52	Te	107	0	-60.54 (7)	3.1 ± 0.1 ms		α 70; ϵ 30
		108	0+	-65.784 (6)	2.1 ± 0.1 s		ϵ 51; α 49; ϵp 2.4
		109	(5/2+)	-67.715 (4)	4.6 ± 0.3 s		$\epsilon\alpha$ < 5.0E-3; ϵ 96.1; ϵp 9.4; α 3.9
		110	0+	-72.23 (7)	18.6 ± 0.8 s		ϵ 100; α ≈ 3.0E-3
		111	(5/2)+	-73.587 (6)	19.3 ± 0.4 s		ϵ 100; ϵp
		112	0+	-77.567 (8)	2.0 ± 0.2 m		ϵ 100
		113	(7/2+)	-78.35 (3)	1.7 ± 0.2 m		ϵ 100
		114	0+	-81.89 (3)	15.2 ± 0.7 m		ϵ 100
		115	7/2+	-82.06 (3)	5.8 ± 0.2 m		ϵ 100
		115m	(1/2)+	-82.04 (3)	6.7 ± 0.4 m		*IT* ; ϵ ≤ 100.00
		116	0+	-85.27 (3)	2.49 ± 0.04 h		ϵ 100
		117	1/2+	-85.097 (13)	62 ± 2 m		ϵ 100
		117m	(11/2-)	-84.801 (13)	103 ± 3 ms		*IT* 100
		118	0+	-87.684 (19)	6.00 ± 0.02 d		ϵ 100
		119	1/2+	-87.181 (8)	16.05 ± 0.05 h		ϵ 100
		119m	11/2-	-86.92 (8)	4.70 ± 0.04 d		ϵ 100; *IT* < 8.0E-3
		120	0+	-89.37 (3)	**stable**	0.09% ± 0.01%	
		121	1/2+	-88.55 (3)	19.17 ± 0.04 d		ϵ 100
		121m	11/2-	-88.25 (3)	164.2 ± 0.8 d		ϵ 11.4; *IT* 88.6
		122	0+	-90.3158 (16)	**stable**	2.55% ± 0.12%	
		123	1/2+	-89.1735 (16)	> 9.2E+16 y	0.89% ± 0.03%	ϵ 100
		123m	11/2-	-88.926 (16)	119.2 ± 0.1 d		*IT* 100
		124	0+	-90.5266 (16)	**stable**	4.74% ± 0.14%	
		125	1/2+	-89.0243 (16)	**stable**	7.07% ± 0.15%	
		125m	11/2-	-88.8795 (16)	57.40 ± 0.15 d		*IT* 100
		126	0+	-90.0666 (16)	**stable**	18.84% ± 0.25%	
		127	3/2+	-88.283 (16)	9.35 ± 0.07 h		β^- 100
		127m	11/2-	-88.1947 (16)	106.1 ± 0.7 d		*IT* 97.6; β^- 2.4
		128	0+	-88.9937 (9)	2.41E+24 ± 0.39E+24 y	31.74% ± 0.08%	$2\beta^-$ 100
		129	3/2+	-87.0048 (9)	69.6 ± 0.3 m		β^- 100
		129m	11/2-	-86.8993 (9)	33.6 ± 0.1 d		*IT* 63; β^- 37
		130	0+	-87.3529 (11)	≥ 3.0E+24 y	34.08% ± 0.62%	$2\beta^-$ 100
		131	3/2+	-85.211 (6)	25.0 ± 0.1 m		β^- 100
		131m	11/2-	-85.0287 (6)	33.25 ± 0.25 h		β^- 74.1; *IT* 25.9
		131m2	(23/2+)	-83.271 (6)	93 ± 12 ms		*IT* 100

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Z	El	A	J^π	Δ[MeV]	$T_{1/2}$, Γ	Abundance	Decay Mode
		81m	(1/2+)	-65.6125 (21)	7.6 ± 0.6 s		β^- 100
		82	0+	-65.415 (22)	4.56 ± 0.26 s		β^- 100
		83	(5/2)+	-60.9764 (24)	1.85 ± 0.06 s		β^- 100
		84	0+	-58.148 (3)	0.954 ± 0.014 s		β^-n 10.2; β^- 100
		85	(1/2+,5/2+)	-53.123 (4)	0.56 ± 0.05 s		β^- 100; β^-n 14
		87	(5/2+)	-44.2 (5)	≈ 0.14 s		β^- 100; β^-n
33	As	64	0	-39.4 (3)	18 +43-7 ms		ϵ 100
		65	0	-46.94 (8)	128 ± 16 ms		ϵ 100
		66	(0+)	-52.03 (3)	95.77 ± 0.23 ms		ϵ 100
		67	(5/2-)	-56.5859 (14)	42.5 ± 1.2 s		ϵ 100
		68	3+	-58.8945 (18)	151.6 ± 0.8 s		ϵ 100
		69	5/2-	-63.09 (3)	15.2 ± 0.2 m		ϵ 100
		70	4+	-64.34 (5)	52.6 ± 0.3 m		ϵ 100
		71	5/2-	-67.893 (4)	65.30 ± 0.07 h		ϵ 100
		72	2-	-68.229 (4)	26.0 ± 0.1 h		ϵ 100
		73	3/2-	-70.952 (4)	80.30 ± 0.06 d		ϵ 100
		74	2-	-70.8597 (17)	17.77 ± 0.02 d		ϵ 66; β^- 34
		75	3/2-	-73.0337 (9)	**stable**	100%	
		75m	9/2+	-72.7298 (9)	17.62 ± 0.23 ms		*IT* 100
		76	2-	-72.2908 (9)	1.0942 ± 7.0E-4 d		β^- 100
		77	3/2-	-73.9164 (17)	38.83 ± 0.05 h		β^- 100
		78	2-	-72.817 (10)	90.7 ± 0.2 m		β^- 100
		79	3/2-	-73.636 (5)	9.01 ± 0.15 m		β^- 100
		80	1+	-72.171 (16)	15.2 ± 0.2 s		β^- 100
		81	3/2-	-72.533 (3)	33.3 ± 0.8 s		β^- 100
		82	(2-)	-70.103 (4)	19.1 ± 0.5 s		β^- 100
		82m	(5-)	-69.956 (4)	13.6 ± 0.4 s		β^- 100
		83	(5/2-,3/2-)	-69.669 (3)	13.4 ± 0.3 s		β^- 100
		84	(3-)	-65.853 (3)	4.2 ± 0.5 s		β^- 100; β^-n 0.18
		85	(3/2-)	-63.189 (3)	2.021 ± 0.01 s		β^- 100; β^-n 59.4
		86	0	-58.962 (3)	0.945 ± 0.008 s		β^- 100; β^-n 26
		87	(3/2-)	-55.618 (3)	0.56 ± 0.08 s		β^- 100; β^-n 15.4
34	Se	65	(3/2-)	-32.9 (6)	33 ± 4 ms		ϵ 100; ϵp 100
		67	0	-46.58 (7)	136 ± 12 ms		ϵ 100; ϵp 0.5
		68	0+	-54.1894 (5)	35.5 ± 0.7 s		ϵ 100
		69	(1/2-,3/2-)	-56.3 (3)	27.4 ± 0.2 s		ϵ 100; ϵp 0.05
		70	0+	-61.9298 (16)	41.1 ± 0.3 m		ϵ 100
		71	(5/2-)	-63.146 (3)	4.74 ± 0.05 m		ϵ 100
		72	0+	-67.8681 (20)	8.40 ± 0.08 d		ϵ 100
		73	9/2+	-68.227 (7)	7.15 ± 0.08 h		ϵ 100
		73m	3/2-	-68.201 (7)	39.8 ± 1.3 m		*IT* 72.6; ϵ 27.4
		74	0+	-72.2127 (3)	**stable**	0.89% ± 0.04%	
		75	5/2+	-72.169 (3)	119.79 ± 0.04 d		ϵ 100
		76	0+	-75.2518 (7)	**stable**	9.37% ± 0.29%	
		77	1/2-	-74.5993 (10)	**stable**	7.63% ± 0.16%	
		77m	7/2+	-74.4374 (10)	17.4 ± 0.8 s		*IT* 100
		78	0+	-77.0258 (20)	**stable**	23.77% ± 0.28%	
		79	7/2+	-75.9173 (24)	2.95E+5 ± 0.38E+5 y		β^- 100
		79m	1/2-	-75.8215 (24)	3.92 ± 0.01 m		*IT* 99.94; β^- 0.06
		80	0+	-77.7598 (15)	**stable**	49.61% ± 0.41%	$2\beta^-$
		81	1/2-	-76.3894 (15)	18.45 ± 0.12 m		β^- 100

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Z	El	A	J^π	Δ[MeV]	$T_{1/2}$, Γ	Abundance	Decay Mode
		123m	(1/2)-	-83.1 (23)	47.4 ± 0.4 s		β^- 100
		124	(1)+	-80.87 (3)	3.12 ± 0.09 s		β^- 100
		124m	(8-)	-80.82 (3)	3.7 ± 0.2 s		β^- 100
		125	9/2+	-80.48 (3)	2.36 ± 0.04 s		β^- 100
		125m	1/2(-)	-80.12 (3)	12.2 ± 0.2 s		β^- 100
		126	3(+)	-77.81 (4)	1.53 ± 0.01 s		β^- 100
		126m	(8-)	-77.71 (4)	1.64 ± 0.05 s		β^- 100
		127	(9/2+)	-76.892 (22)	1.09 ± 0.01 s		β^- 100; β^-n ≤ 0.03
		127m	(1/2-)	-76.43 (22)	3.67 ± 0.04 s		β^- 100; β^-n 0.69
		127m2	(21/2-)	-75.029 (22)	1.04 ± 0.1 s		β^- 100
		128	(3)+	-74.36 (5)	0.84 ± 0.06 s		β^- 100; β^-n < 0.05
		128m	(8-)	-74.02 (5)	0.72 ± 0.1 s		β^- 100; β^-n < 0.05
		129	(9/2+)	-72.81 (4)	0.61 ± 0.01 s		β^- 100; β^-n 0.25
		129m	(1/2-)	-72.44 (4)	1.23 ± 0.03 s		*IT* < 0.30; β^- > 99.70; β^-n 2.5
		129m2	(23/2-)	-71.18 (4)	0.67 ± 0.1 s		β^- 100
		130	1(-)	-69.89 (4)	0.29 ± 0.02 s		β^- 100; β^-n 0.93
		130m	(10-)	-69.84 (4)	0.54 ± 0.01 s		β^- 100; β^-n 1.65
		130m2	(5+)	-69.49 (4)	0.54 ± 0.01 s		β^- 100; β^-n 1.65
		131	(9/2+)	-68.05 (20)	0.28 ± 0.03 s		β^- 100; β^-n ≤ 2.00
		131m	(1/2-)	-67.748 (20)	0.35 ± 0.05 s		β^-n ≤ 2.00; *IT* ≤ 0.02; β^- ≥ 99.98
		131m2	(21/2+)	-64.286 (20)	0.32 ± 0.06 s		β^- > 99.00; *IT* < 1.00; β^-n ≈ 0.03
		132	(7-)	-62.41 (6)	0.207 ± 0.006 s		β^- 100; β^-n 6.3
		133	(9/2+)	-57.8 (3)	165 ± 3 ms		β^- 100; β^-n 85
		133m	(1/2-)	-57.4 (3)	180 ± 15 ms		*IT* ; β^-n ; β^-
		134	(4- to 7-)	-52 (4)	140 ± 4 ms		β^- 100; β^-n 65
		135	0	-47.2 (5)	92 ± 10 ms		β^- 100; β^-n
50	Sn	100	0+	-56.9 (6)	0.86 +0.37-0.2 s		ϵ 100; ϵp < 17.00
		101	(5/2+)	-59.9 (3)	1.7 ± 0.3 s		ϵp 26; ϵ 100
		102	0+	-64.93 (10)	3.8 ± 0.2 s		ϵ 100
		103	(5/2+)	-66.97 (7)	7.0 ± 0.2 s		ϵ 100; ϵp 1.2
		104	0+	-71.625 (6)	20.8 ± 0.5 s		ϵ 100
		105	(5/2+)	-73.338 (4)	32.7 ± 0.5 s		ϵ 100; ϵp 0.01
		106	0+	-77.354 (5)	115 ± 5 s		ϵ 100
		107	(5/2+)	-78.512 (5)	2.90 ± 0.05 m		ϵ 100
		108	0+	-82.071 (5)	10.30 ± 0.08 m		ϵ 100
		109	5/2+	-82.633 (8)	18.0 ± 0.2 m		ϵ 100
		110	0+	-85.844 (14)	4.11 ± 0.1 h		ϵ 100
		111	7/2+	-85.941 (6)	35.3 ± 0.6 m		ϵ 100
		112	0+	-88.6579 (17)	< 1.3E+21 y	0.97% ± 0.01%	2ϵ
		113	1/2+	-88.3303 (22)	115.09 ± 0.03 d		ϵ 100
		113m	7/2+	-88.2528 (22)	21.4 ± 0.4 m		*IT* 91.1; ϵ 8.9
		114	0+	-90.5594 (15)	**stable**	0.66% ± 0.01%	
		115	1/2+	-90.0338 (15)	**stable**	0.34% ± 0.01%	
		116	0+	-91.5259 (10)	**stable**	14.54% ± 0.09%	
		117	1/2+	-90.3977 (5)	**stable**	7.68% ± 0.07%	
		117m	11/2-	-90.0831 (5)	13.76 ± 0.04 d		*IT* 100
		118	0+	-91.6528 (5)	**stable**	24.22% ± 0.09%	
		119	1/2+	-90.065 (7)	**stable**	8.59% ± 0.04%	
		119m	11/2-	-89.9755 (7)	293.1 ± 0.7 d		*IT* 100
		120	0+	-91.0982 (22)	**stable**	32.58% ± 0.09%	
		121	3/2+	-89.1971 (22)	27.03 ± 0.04 h		β^- 100

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Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		131	(7/2-)	-55.38 (20)	68 ± 3 ms		β^- 100; $\beta^- n$ 3.5
		132	0+	-50.9 (3)	97 ± 10 ms		β^- 100; $\beta^- n$ 60
		133	(7/2-)	()	57 ± 10 ms		β^- 100; $\beta^- n$; $\beta^- 2n$
49	**In**	98	0	-53.9 (20)	32 +32-11 ms		ϵ ; ϵ
		99	0	-61.38 (20)	3.0 ± 0.8 s		ϵ
		100	(6+,7+)	-64.34 (18)	5.9 ± 0.2 s		ϵ 100; ϵp 1.6
		101	(9/2+)	-68.6 (3)	15.1 ± 0.3 s		ϵ ; ϵp
		102	(6+)	-70.695 (5)	23.3 ± 0.1 s		ϵ 100; ϵp 0.0093
		103	(9/2)+	-74.629 (9)	65 ± 7 s		ϵ 100
		103m	(1/2-)	-73.998 (9)	34 ± 2 s		IT 33; ϵ 67
		104	(6+)	-76.183 (6)	1.80 ± 0.03 m		ϵ 100
		104m	(3+)	-76.089 (6)	15.7 ± 0.5 s		IT 80; ϵ 20
		105	9/2+	-79.64 (10)	5.07 ± 0.07 m		ϵ 100
		105m	(1/2-)	-78.966 (10)	48 ± 6 s		IT 100
		106	7+	-80.604 (11)	6.2 ± 0.1 m		ϵ 100
		106m	(2)+	-80.575 (11)	5.2 ± 0.1 m		ϵ 100
		107	9/2+	-83.564 (10)	32.4 ± 0.3 m		ϵ 100
		107m	1/2-	-82.886 (10)	50.4 ± 0.6 s		IT 100
		108	7+	-84.116 (9)	58.0 ± 1.2 m		ϵ 100
		108m	2+	-84.086 (9)	39.6 ± 0.7 m		ϵ 100
		109	9/2+	-86.488 (4)	4.167 ± 0.018 h		ϵ 100
		109m	1/2-	-85.838 (4)	1.34 ± 0.07 m		IT 100
		109m2	(19/2+)	-84.387 (4)	0.209 ± 0.006 s		IT 100
		110	7+	-86.472 (12)	4.9 ± 0.1 h		ϵ 100
		110m	2+	-86.41 (12)	69.1 ± 0.5 m		ϵ 100
		111	9/2+	-88.393 (4)	2.8047 ± 4.0E-4 d		ϵ 100
		111m	1/2-	-87.856 (4)	7.7 ± 0.2 m		IT 100
		112	1+	-87.993 (5)	14.97 ± 0.1 m		ϵ 56; β^- 44
		112m	4+	-87.836 (5)	20.56 ± 0.06 m		IT 100
		113	9/2+	-89.3683 (15)	**stable**	4.29% ± 0.05%	
		113m	1/2-	-88.9766 (15)	99.476 ± 0.023 m		IT 100
		114	1+	-88.5708 (15)	71.9 ± 0.1 s		β^- 99.5; ϵ 0.5
		114m	5+	-88.3805 (15)	49.51 ± 0.01 d		IT 96.75; ϵ 3.25
		115	9/2+	-89.5363 (12)	4.41E+14 ± 0.25E+14 y	95.71% ± 0.05%	β^- 100
		115m	1/2-	-89.2001 (12)	4.486 ± 0.004 h		IT 95; β^- 5
		116	1+	-88.2497 (22)	14.10 ± 0.03 s		ϵ 0.02; β^- 99.98
		116m	5+	-88.1224 (22)	54.29 ± 0.17 m		β^- 100
		116m2	8-	-87.96 (22)	2.18 ± 0.04 s		IT 100
		117	9/2+	-88.943 (5)	43.2 ± 0.3 m		β^- 100
		117m	1/2-	-88.628 (5)	116.2 ± 0.3 m		β^- 52.9; IT 47.1
		118	1+	-87.228 (8)	5.0 ± 0.5 s		β^- 100
		118m	5+	-87.168 (8)	4.45 ± 0.05 m		β^- 100
		118m2	8-	-87.028 (8)	8.5 ± 0.3 s		IT 98.6; β^- 1.4
		119	9/2+	-87.699 (8)	2.4 ± 0.1 m		β^- 100
		119m	1/2-	-87.388 (8)	18.0 ± 0.3 m		β^- 95.6; IT 4.4
		120	1+	-85.73 (4)	3.08 ± 0.08 s		β^- 100; β^- 100
		120m	(5)+	-85.66 (4)	46.2 ± 0.8 s		β^- 100
		121	9/2+	-85.84 (3)	23.1 ± 0.6 s		β^- 100
		121m	1/2-	-85.52 (3)	3.88 ± 0.1 m		β^- 98.8; IT 1.2
		122	1+	-83.57 (5)	1.5 ± 0.3 s		β^- 100
		122m	5+	-83.53 (5)	10.3 ± 0.6 s		β^- 100
		122m2	(8-)	-83.28 (5)	10.8 ± 0.4 s		β^- 100
		123	(9/2)+	-83.428 (23)	6.17 ± 0.05 s		β^- 100

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Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		81m	7/2+	-76.2864 (15)	57.28 ± 0.02 m		IT 99.95; β^- 0.05
		82	0+	-77.594 (15)	**stable**	8.73% ± 0.22%	
		83	9/2+	-75.341 (3)	22.3 ± 0.3 m		β^- 100
		83m	1/2-	-75.112 (3)	70.1 ± 0.4 s		β^- 100
		84	0+	-75.9476 (20)	3.26 ± 0.1 m		β^- 100
		85	(5/2+)	-72.414 (3)	32.9 ± 0.3 s		β^- 100
		86	0+	-70.503 (3)	14.3 ± 0.3 s		β^- 100
		87	(5/2+)	-66.4261 (22)	5.50 ± 0.12 s		β^- 100; $\beta^- n$ 0.2
		88	0+	-63.884 (3)	1.53 ± 0.06 s		β^- 100; $\beta^- n$ 0.67
		89	(5/2+)	-58.992 (4)	0.41 ± 0.04 s		β^- 100; $\beta^- n$ 7.8
		91	0	-50.3 (5)	0.27 ± 0.05 s		β^- 100; $\beta^- n$ 21
35	**Br**	70	0+	-51.426 (15)	79.1 ± 0.8 ms		ϵ 100
		70m	9+	-49.133 (15)	2.2 ± 0.2 s		ϵ 100
		71	(5/2)-	-56.502 (5)	21.4 ± 0.6 s		ϵ 100
		72	1+	-59.067 (7)	78.6 ± 2.4 s		ϵ 100
		72m	(3-)	-58.966 (7)	10.6 ± 0.3 s		IT 100; ϵ
		73	1/2-	-63.648 (7)	3.4 ± 0.2 m		ϵ 100
		74	(0-)	-65.285 (6)	25.4 ± 0.3 m		ϵ 100
		74m	4(+)	-65.271 (6)	46 ± 2 m		ϵ 100
		75	3/2-	-69.107 (4)	96.7 ± 1.3 m		ϵ 100
		76	1-	-70.289 (9)	16.2 ± 0.2 h		ϵ 100
		76m	(4)+	-70.186 (9)	1.31 ± 0.02 s		$IT > 99.40$; $\epsilon < 0.60$
		77	3/2-	-73.235 (3)	57.036 ± 0.006 h		ϵ 100
		77m	9/2+	-73.129 (3)	4.28 ± 0.1 m		IT 100
		78	1+	-73.452 (4)	6.45 ± 0.04 m		$\epsilon \geq 99.99$; $\beta^- \leq 0.01$
		79	3/2-	-76.0684 (15)	**stable**	50.69% ± 0.07%	
		79m	9/2+	-75.8608 (15)	5.1 ± 0.4 s		IT 100
		80	1+	-75.8894 (15)	17.68 ± 0.02 m		β^- 91.7; ϵ 8.3
		80m	5-	-75.8035 (15)	4.4205 ± 8.0E-4 h		IT 100
		81	3/2-	-77.9755 (13)	**stable**	49.31% ± 0.07%	
		82	5-	-77.4972 (13)	35.282 ± 0.007 h		β^- 100
		82m	2-	-77.4513 (13)	6.13 ± 0.05 m		IT 97.6; β^- 2.4
		83	3/2-	-79.006 (5)	2.40 ± 0.02 h		β^- 100
		84	2-	-77.79 (3)	31.76 ± 0.08 m		β^- 100
		84m	(6)-	-77.47 (3)	6.0 ± 0.2 m		β^- 100
		85	3/2-	-78.575 (3)	2.90 ± 0.06 m		β^- 100
		86	(1-)	-75.632 (3)	55.1 ± 0.4 s		β^- 100
		87	3/2-	-73.892 (3)	55.65 ± 0.13 s		$\beta^- n$ 2.6; β^- 100
		88	(2-)	-70.716 (3)	16.29 ± 0.06 s		β^- 100; $\beta^- n$ 6.58
		89	(3/2-,5/2-)	-68.274 (3)	4.40 ± 0.03 s		β^- 100; $\beta^- n$ 13.8
		90	0	-64 (3)	1.91 ± 0.01 s		β^- 100; $\beta^- n$ 25.2
		91	0	-61.107 (4)	0.541 ± 0.005 s		β^- 100; $\beta^- n$ 20
		92	(2-)	-56.233 (7)	0.343 ± 0.015 s		$\beta^- n$ 33.1; β^- 100
		93	(5/2-)	-52.85 (20)	102 ± 10 ms		β^- 100; $\beta^- n$ 68
		94	0	-47.6 (4)	70 ± 20 ms		β^- 100; $\beta^- n$ 68
36	**Kr**	69	0	-32.4 (4)	32 ± 10 ms		ϵ 100
		70	0+	-41.6 (4)	52 ± 17 ms		ϵ 100; $\epsilon p \leq 1.30$
		71	(5/2-)	-46.33 (13)	100 ± 3 ms		ϵ 100; ϵp 2.1
		72	0+	-53.94 (8)	17.1 ± 0.2 s		ϵ 100; $\epsilon p <$ 1.0E-6
		73	3/2-	-56.552 (7)	27.3 ± 1 s		ϵ 100; ϵp 0.25
		74	0+	-62.3315 (20)	11.50 ± 0.11 m		ϵ 100
		75	5/2+	-64.324 (8)	4.29 ± 0.17 m		ϵ 100

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Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		122	0+	-64.7 (4)	175 ± 16 ms		$\beta^- \geq 97.50$; $\beta^- n \leq 2.50$
		123	0	-60.6 (6)	174 +38-34 ms		β^-
		124	0+	-58.8 (5)	38 +38-19 ms		β^- 100
47	**Ag**	94	(0+)	-52.4 (6)	26 +26-9 ms		ϵ 100; ϵp ; ϵ 100; ϵp 20
		94m	(21+)	-45.7 (6)	0.40 ± 0.04 s		ϵ 95.4; ϵp 27; p 4.1; $2p$ 0.5
		95	(9/2+)	-59.6 (4)	1.75 ± 0.12 s		ϵp ; ϵ 100
		95m	(1/2-)	-59.3 (4)	< 500 ms		IT 100
		96	(8)+	-64.62 (6)	4.40 ± 0.06 s		ϵ 100; ϵp 8.5; ϵ 100; ϵp 18
		97	(9/2+)	-70.83 (11)	25.5 ± 0.3 s		ϵ 100
		98	(6+)	-73.05 (4)	47.5 ± 0.3 s		ϵ 100; ϵp 0.0011
		99	(9/2)+	-76.712 (6)	124 ± 3 s		ϵ 100
		99m	(1/2-)	-76.206 (6)	10.5 ± 0.5 s		IT 100
		100	(5)+	-78.138 (5)	2.01 ± 0.09 m		ϵ 100
		100m	(2)+	-78.122 (5)	2.24 ± 0.13 m		ϵ ; IT
		101	9/2+	-81.334 (5)	11.1 ± 0.3 m		ϵ 100
		101m	(1/2)-	-81.06 (5)	3.10 ± 0.1 s		IT 100
		102	5(+)	-82.247 (8)	12.9 ± 0.3 m		ϵ 100
		102m	2+	-82.237 (8)	7.7 ± 0.5 m		ϵ 51; IT 49
		103	7/2+	-84.8 (4)	65.7 ± 0.7 m		ϵ 100
		103m	1/2-	-84.666 (4)	5.7 ± 0.3 s		IT 100
		104	5+	-85.114 (5)	69.2 ± 1 m		ϵ 100
		104m	2+	-85.108 (5)	33.5 ± 2 m		ϵ 99.93; $IT < 0.07$
		105	1/2-	-87.071 (5)	41.29 ± 0.07 d		ϵ 100
		105m	7/2+	-87.045 (5)	7.23 ± 0.16 m		IT 99.66; ϵ 0.34
		106	1+	-86.94 (4)	23.96 ± 0.04 m		ϵ 99.5; $\beta^- < 1.00$
		106m	6+	-86.851 (4)	8.28 ± 0.02 d		ϵ 100
		107	1/2-	-88.405 (3)	**stable**	51.839% ± 0.008%	
		107m	7/2+	-88.312 (3)	44.3 ± 0.2 s		IT 100
		108	1+	-87.606 (3)	2.382 ± 0.011 m		β^- 97.15; ϵ 2.85
		108m	6+	-87.496 (3)	438 ± 9 y		ϵ 91.3; IT 8.7
		109	1/2-	-88.7195 (20)	**stable**	48.161% ± 0.008%	
		109m	7/2+	-88.6315 (20)	39.6 ± 0.2 s		IT 100
		110	1+	-87.4574 (20)	24.6 ± 0.2 s		β^- 99.7; ϵ 0.3
		110m	6+	-87.3398 (20)	249.76 ± 0.04 d		β^- 98.64; IT 1.36
		111	1/2-	-88.2179 (22)	7.45 ± 0.01 d		β^- 100
		111m	7/2+	-88.1581 (22)	64.8 ± 0.8 s		IT 99.3; β^- 0.7
		112	2(-)	-86.5837 (24)	3.130 ± 0.009 h		β^- 100
		113	1/2-	-87.03 (17)	5.37 ± 0.05 h		β^- 100
		113m	7/2+	-86.986 (17)	68.7 ± 1.6 s		IT 64; β^- 36
		114	1+	-84.931 (5)	4.6 ± 0.1 s		β^- 100
		115	1/2-	-84.983 (18)	20.0 ± 0.5 m		β^- 100
		115m	7/2+	-84.942 (18)	18.0 ± 0.7 s		β^- 79; IT 21
		116	(0-)	-82.543 (3)	237 ± 5 s		β^- 100
		116m	(3+)	-82.495 (3)	20 ± 1 s		β^- 93; IT 7
		116m2	(6-)	-82.413 (3)	9.3 ± 0.3 s		β^- 92; IT 8
		117	(1/2-)	-82.182 (14)	72.8 +2-0.7 s		β^- 100
		117m	(7/2+)	-82.153 (14)	5.34 ± 0.05 s		β^- 94; IT 6
		118	1(-)	-79.554 (3)	3.76 ± 0.15 s		β^- 100
		118m	4(+)	-79.426 (3)	2.0 ± 0.2 s		β^- 59; IT 41
		119	(1/2-)	-78.646 (15)	6.0 ± 0.5 s		β^- 100; β^- 100
		120	3(+)	-75.651 (4)	1.23 ± 0.04 s		β^- 100; $\beta^- n <$ 3.0E-3
		120m	6(-)	-75.448 (4)	0.40 ± 0.03 s		$\beta^- \approx 63.00$; $IT \approx 37.00$
		121	(7/2+)	-74.403 (12)	0.78 ± 0.02 s		β^- 100; $\beta^- n$ 0.08

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Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		92	0-	-74.773 (6)	4.492 ± 0.02 s		β^- 100; $\beta^- n$ 0.01
		93	5/2-	-72.62 (8)	5.84 ± 0.02 s		β^- 100; $\beta^- n$ 1.39
		94	3(-)	-68.562 (3)	2.702 ± 0.005 s		β^- 100; $\beta^- n$ 10.5
		95	5/2-	-65.894 (20)	377.7 ± 0.8 ms		β^- 100; $\beta^- n$ 8.7
		96	2(-)	-61.354 (3)	203 ± 3 ms		β^- 100; $\beta^- n$ 13.3
		97	3/2+	-58.518 (5)	169.1 ± 0.6 ms		β^- 100; $\beta^- n$ 25.5
		98	(0,1)	-54.03 (5)	102 ± 4 ms		β^- 100; $\beta^- n$ 13.8; $\beta^- 2n$ 0.05
		98m	(3,4)	-53.76 (5)	96 ± 3 ms		β^- 100
		99	(5/2+)	-51.22 (11)	54 ± 4 ms		β^- 100; $\beta^- n$ 15.8
		100	(3+,4-)	-46.55 (20)	51 ± 8 ms		β^- 100; $\beta^- n$ 6; $\beta^- 2n$ 0.16
		101	(3/2+)	-42.97 (22)	32 ± 5 ms		β^- 100; $\beta^- n$ 28
		102	0	-37.9 (3)	37 ± 3 ms		β^- 100; $\beta^- n$ 18
38	**Sr**	73	0	-31.9 (4)	> 25 ms		ϵ 100; $\epsilon p > 0.00$
		75	(3/2-)	-46.62 (22)	88 ± 3 ms		ϵ 100; ϵp 5.2
		76	0+	-54.25 (3)	7.89 ± 0.07 s		ϵ 100; ϵp 3.4e-05
		77	5/2+	-57.803 (8)	9.0 ± 0.2 s		ϵ 100; $\epsilon p < 0.25$
		78	0+	-63.174 (7)	160 ± 8 s		ϵ 100
		79	3/2(-)	-65.477 (8)	2.25 ± 0.1 m		ϵ 100
		80	0+	-70.311 (3)	106.3 ± 1.5 m		ϵ 100
		81	1/2-	-71.528 (3)	22.3 ± 0.4 m		ϵ 100
		82	0+	-76.01 (6)	25.34 ± 0.02 d		ϵ 100
		83	7/2+	-76.798 (7)	32.41 ± 0.03 h		ϵ 100
		83m	1/2-	-76.538 (7)	4.95 ± 0.12 s		IT 100
		84	0+	-80.6493 (13)	**stable**	0.56% ± 0.01%	
		85	9/2+	-81.103 (3)	64.850 ± 0.007 d		ϵ 100
		85m	1/2-	-80.864 (3)	67.63 ± 0.04 m		IT 86.6; ϵ 13.4
		86	0+	-84.5232 (11)	**stable**	9.86% ± 0.01%	
		87	9/2+	-84.88 (11)	**stable**	7% ± 0.01%	
		87m	1/2-	-84.4915 (11)	2.815 ± 0.012 h		IT 99.7; ϵ 0.3
		88	0+	-87.9213 (11)	**stable**	82.58% ± 0.01%	
		89	5/2+	-86.2087 (11)	50.53 ± 0.07 d		β^- 100
		90	0+	-85.949 (3)	28.90 ± 0.03 y		β^- 100
		91	5/2+	-83.653 (6)	9.63 ± 0.05 h		β^- 100
		92	0+	-82.867 (3)	2.66 ± 0.04 h		β^- 100
		93	5/2+	-80.086 (8)	7.43 ± 0.03 m		β^- 100
		94	0+	-78.843 (7)	75.3 ± 0.2 s		β^- 100
		95	1/2+	-75.124 (6)	23.90 ± 0.14 s		β^- 100
		96	0+	-72.933 (9)	1.07 ± 0.01 s		β^- 100
		97	1/2+	-68.592 (10)	429 ± 5 ms		β^- 100; $\beta^- n \leq 0.05$
		98	0+	-66.437 (10)	0.653 ± 0.002 s		β^- 100; $\beta^- n$ 0.25
		99	3/2+	-62.529 (7)	0.269 ± 0.001 s		β^- 100; $\beta^- n$ 0.1
		100	0+	-59.833 (10)	202 ± 3 ms		β^- 100; $\beta^- n$ 0.78
		101	(5/2-)	-55.57 (8)	118 ± 3 ms		β^- 100; $\beta^- n$ 2.37
		102	0+	-52.4 (21)	69 ± 6 ms		β^- 100; $\beta^- n$ 5.5
		103	0	-47.53 (20)	68 +48-20 ms		β^-
		104	0+	-43.9 (4)	43 +9-7 ms		β^-
		105	0	-38.6 (5)	40 +36-13 ms		β^-
39	**Y**	77	(5/2+)	-46.78 (6)	57 +22-12 ms		ϵ 100; ϵp ; p
		78	(0+)	-52.5 (4)	53 ± 8 ms		ϵ 100; ϵp ; ϵp ; ϵ 100
		79	(5/2+)	-58.4 (5)	14.8 ± 0.6 s		ϵ 100; ϵp
		80	(4-)	-61.148 (6)	30.1 ± 0.5 s		ϵ 100; ϵp
		80m	(1-)	-60.92 (6)	4.8 ± 0.3 s		IT 81; ϵ 19

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}$, Γ	Abundance	Decay Mode
		76	0+	-69.014 (4)	14.8 ± 0.1 h		ϵ 100
		77	5/2+	-70.1694 (20)	74.4 ± 0.6 m		ϵ 100
		78	0+	-74.1795 (7)	≥ 1.5E+21 y	0.355% ± 0.003%	2ϵ
		79	1/2-	-74.443 (4)	35.04 ± 0.1 h		ϵ 100
		79m	7/2+	-74.313 (4)	50 ± 3 s		IT 100
		80	0+	-77.8925 (8)	**stable**	2.286% ± 0.01%	
		81	7/2+	-77.6947 (14)	2.29E+5 ± 0.11E+5 y		ϵ 100
		81m	1/2-	-77.5041 (14)	13.10 ± 0.03 s		ϵ 0.0025; IT 100
		82	0+	-80.5902 (9)	**stable**	11.593% ± 0.031%	
		83	9/2+	-79.99 (3)	**stable**	11.5% ± 0.019%	
		83m	1/2-	-79.9484 (3)	1.85 ± 0.03 h		IT 100
		84	0+	-82.4393 (4)	**stable**	56.987% ± 0.015%	
		85	9/2+	-81.4803 (20)	10.752 ± 0.025 y		β^- 100
		85m	1/2-	-81.1753 (20)	4.480 ± 0.008 h		β^- 78.6; IT 21.4
		86	0+	-83.2656 (4)	**stable**	17.279% ± 0.041%	
		87	5/2+	-80.7095 (25)	76.3 ± 0.5 m		β^- 100
		88	0+	-79.691 (3)	2.84 ± 0.03 h		β^- 100
		89	3/2(+)	-76.5357 (21)	3.15 ± 0.04 m		β^- 100
		90	0+	-74.9592 (19)	32.32 ± 0.09 s		β^- 100
		91	5/2(+)	-70.9739 (22)	8.57 ± 0.04 s		β^- 100
		92	0+	-68.769 (3)	1.840 ± 0.008 s		β^- 100; $\beta^- n$ 0.03
		93	1/2+	-64.136 (3)	1.286 ± 0.01 s		β^- 100; $\beta^- n$ 1.95
		94	0+	-61.348 (12)	212 ± 5 ms		β^- 100; $\beta^- n$ 1.11
		95	1/2(+)	-56.159 (19)	0.114 ± 0.003 s		β^- 100; $\beta^- n$ 2.87
		96	0+	-53.08 (20)	80 ± 6 ms		β^- 100; $\beta^- n$ 3.7
		97	(3/2+)	-47.42 (13)	63 ± 4 ms		β^- 100; $\beta^- n$ 6.7
		98	0+	-44.5 (5)	46 ± 8 ms		β^- 100; $\beta^- n$ 7
		99	0	-38.8 (5)	13 +34-6 ms		β^- 100; $\beta^- n$ 11
		100	0+	-35.2 (5)	7 +11-3 ms		β^- 100; $\beta^- n$
37	**Rb**	74	(0+)	-51.917 (4)	64.9 ± 0.5 ms		ϵ 100
		75	(3/2-)	-57.2186 (16)	19.0 ± 1.2 s		ϵ 100
		76	1(-)	-60.478 (12)	36.5 ± 0.6 s		ϵ 100; $\epsilon\alpha$ 3.8e-07
		77	3/2-	-64.8304 (13)	3.77 ± 0.04 m		ϵ 100
		78	0(+)	-66.936 (7)	17.66 ± 0.03 m		ϵ 100
		78m	4(-)	-66.825 (7)	5.74 ± 0.03 m		ϵ 91; IT 9
		79	5/2+	-70.8029 (21)	22.9 ± 0.5 m		ϵ 100
		80	1+	-72.1754 (19)	33.4 ± 0.7 s		ϵ 100
		81	3/2-	-75.456 (5)	4.572 ± 0.004 h		ϵ 100
		81m	9/2+	-75.37 (5)	30.5 ± 0.3 m		IT 97.6; ϵ 2.4
		82	1+	-76.188 (3)	1.2575 ± 2.0E-4 m		ϵ 100
		82m	5-	-76.119 (3)	6.472 ± 0.006 h		IT < 0.33; ϵ 100
		83	5/2-	-79.0706 (23)	86.2 ± 0.1 d		ϵ 100
		84	2-	-79.756 (3)	32.82 ± 0.07 d		ϵ 96.1; β^- 3.9
		84m	6-	-79.293 (3)	20.26 ± 0.04 m		IT 100
		85	5/2-	-82.1673 (5)	**stable**	72.17% ± 0.02%	
		86	2-	-82.747 (20)	18.642 ± 0.018 d		β^- 99.99; ϵ 0.0052
		86m	6-	-82.1909 (20)	1.017 ± 0.003 m		IT 100; β^- < 0.30
		87	3/2-	-84.5977 (6)	4.81E+10 ± 0.09E+10 y	27.83% ± 0.02%	β^- 100
		88	2-	-82.6089 (16)	17.773 ± 0.011 m		β^- 100
		89	3/2-	-81.712 (5)	15.15 ± 0.12 m		β^- 100
		90	0-	-79.365 (7)	158 ± 5 s		β^- 100
		90m	3-	-79.258 (7)	258 ± 4 s		β^- 97.4; IT 2.6
		91	3/2(-)	-77.746 (8)	58.4 ± 0.4 s		β^- 100

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}$, Γ	Abundance	Decay Mode
		122	(3+)	-71.11 (4)	0.529 ± 0.013 s		β^- 99.8; $\beta^- n$ 0.2; β^- ; IT ; $\beta^- n$
		122m	(9-)	-71.03 (4)	0.20 ± 0.05 s		β^- ; $\beta^- n$
		123	(7/2+)	-69.55 (3)	0.300 ± 0.005 s		β^- 100; $\beta^- n$ 0.55
		124	—>2	-66.2 (3)	0.172 ± 0.005 s		β^- 100; $\beta^- n$ 1.3
		125	(9/2+)	-64.43 (20)	166 ± 7 ms		β^- 100; $\beta^- n$
		126	0	-60.85 (20)	107 ± 12 ms		β^- 100; $\beta^- n$
		127	0	-58.8 (3)	109 ± 25 ms		β^- 100
		128	0	-54.9 (3)	58 ± 5 ms		β^- 100; $\beta^- n$
		129	(9/2+)	-52.6 (4)	46 +5-9 ms		β^- 100; $\beta^- n$; β^- ; $\beta^- n$
		130	0	-46.3 (3)	≈ 50 ms		β^- ; $\beta^- n$
48	**Cd**	96	0+	-55.6 (4)	1.03 +0.24-0.21 s		ϵ 100
		97	(9/2+)	-60.5 (3)	1.10 ± 0.07 s		ϵ 100; ϵp 12; ϵ 100; ϵp 25
		98	0+	-67.62 (5)	9.2 ± 0.3 s		ϵ 100; ϵp < 0.03
		99	(5/2+)	-69.9311 (16)	16 ± 3 s		$\epsilon\alpha$ < 1.0E-4; ϵp 0.17; ϵ 100
		100	0+	-74.1946 (17)	49.1 ± 0.5 s		ϵ 100
		101	(5/2+)	-75.8361 (14)	1.36 ± 0.05 m		ϵ 100
		102	0+	-79.6597 (17)	5.5 ± 0.5 m		ϵ 100
		103	(5/2)+	-80.6521 (18)	7.3 ± 0.1 m		ϵ 100
		104	0+	-83.9683 (17)	57.7 ± 1 m		ϵ 100
		105	5/2+	-84.3339 (13)	55.5 ± 0.4 m		ϵ 100
		106	0+	-87.1304 (17)	> 3.6E+20 y	1.25% ± 0.06%	2ϵ
		107	5/2+	-86.99 (17)	6.50 ± 0.02 h		ϵ 100
		108	0+	-89.2524 (21)	> 1.9E+18 y	0.89% ± 0.03%	2ϵ
		109	5/2+	-88.5043 (16)	461.4 ± 1.2 d		ϵ 100
		110	0+	-90.3503 (17)	**stable**	12.49% ± 0.18%	
		111	1/2+	-89.2547 (17)	**stable**	12.8% ± 0.12%	
		111m	11/2-	-88.8585 (17)	48.50 ± 0.09 m		IT 100
		112	0+	-90.5777 (17)	**stable**	24.13% ± 0.21%	
		113	1/2+	-89.0464 (16)	8.00E15 ± 0.26E15 y	12.22% ± 0.12%	β^- 100
		113m	11/2-	-88.7829 (16)	14.1 ± 0.5 y		β^- 99.86; IT 0.14
		114	0+	-90.018 (16)	> 2.1E18 y	28.73% ± 0.42%	$2\beta^-$
		115	1/2+	-88.0876 (17)	53.46 ± 0.05 h		β^- 100
		115m	(11/2)-	-87.9066 (17)	44.56 ± 0.24 d		β^- 100
		116	0+	-88.7164 (17)	3.3E+19 ± 0.4E+19 y	7.49% ± 0.18%	$2\beta^-$
		117	1/2+	-86.4223 (20)	2.49 ± 0.04 h		β^- 100
		117m	(11/2)-	-86.2859 (20)	3.36 ± 0.05 h		β^- 100
		118	0+	-86.706 (20)	50.3 ± 0.2 m		β^- 100
		119	3/2+	-83.98 (4)	2.69 ± 0.02 m		β^- 100
		119m	(11/2-)	-83.83 (4)	2.20 ± 0.02 m		β^- 100
		120	0+	-83.957 (4)	50.80 ± 0.21 s		β^- 100
		121	(3/2+)	-81.06 (8)	13.5 ± 0.3 s		β^- 100
		121m	(11/2-)	-80.84 (8)	8.3 ± 0.8 s		β^- 100
		122	0+	-80.616 (4)	5.24 ± 0.03 s		β^- 100
		123	(3/2+)	-77.32 (4)	2.10 ± 0.02 s		β^- 100
		123m	(11/2-)	-77 (4)	1.82 ± 0.03 s		β^- ≤ 100.00; IT
		124	0+	-76.697 (9)	1.25 ± 0.02 s		β^- 100
		125	(3/2+)	-73.35 (6)	0.68 ± 0.04 s		β^- 100; β^- 100
		126	0+	-72.256 (4)	0.515 ± 0.017 s		β^- 100
		127	(3/2+)	-68.44 (6)	0.37 ± 0.07 s		β^- 100
		128	0+	-67.25 (17)	0.28 ± 0.04 s		β^- 100
		129	(3/2+)	-63.31 (20)	0.27 ± 0.04 s		
		130	0+	-61.54 (16)	162 ± 7 ms		$\beta^- n$ 3.5; β^- 100

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}$, Γ	Abundance	Decay Mode
		81	(5/2+)	-65.713 (6)	70.4 ± 1 s		ϵ 100
		82	1+	-68.064 (6)	8.30 ± 0.2 s		ϵ 100
		83	9/2+	-72.206 (19)	7.08 ± 0.06 m		ϵ 100
		83m	3/2-	-72.144 (19)	2.85 ± 0.02 m		IT 40; ϵ 60
		84	(6+)	-73.894 (4)	39.5 ± 0.8 m		ϵ 100
		84m	1+	-73.827 (4)	4.6 ± 0.2 s		ϵ 100
		85	(1/2)-	-77.842 (19)	2.68 ± 0.05 h		ϵ 100
		85m	9/2+	-77.822 (19)	4.86 ± 0.2 h		ϵ 100; IT < 2.0E-3
		86	4-	-79.283 (14)	14.74 ± 0.02 h		ϵ 100
		86m	(8+)	-79.065 (14)	48 ± 1 m		IT 99.31; ϵ 0.69
		87	1/2-	-83.0183 (16)	79.8 ± 0.3 h		ϵ 100
		87m	9/2+	-82.6375 (16)	13.37 ± 0.03 h		ϵ 1.57; IT 98.43
		88	4-	-84.2987 (19)	106.626 ± 0.021 d		ϵ 100
		89	1/2-	-87.7096 (25)	**stable**	100%	
		89m	9/2+	-86.8006 (25)	15.663 ± 0.005 s		IT 100
		90	2-	-86.4953 (25)	64.053 ± 0.02 h		β^- 100
		90m	7+	-85.8136 (25)	3.19 ± 0.06 h		IT 100; β^- 0.0018
		91	1/2-	-86.353 (3)	58.51 ± 0.06 d		β^- 100
		91m	9/2+	-85.797 (3)	49.71 ± 0.04 m		IT 100; β^- < 1.50
		92	2-	-84.818 (9)	3.54 ± 0.01 h		β^- 100
		93	1/2-	-84.228 (11)	10.18 ± 0.08 h		β^- 100
		93m	(9/2)+	-83.47 (11)	0.82 ± 0.04 s		IT 100
		94	2-	-82.353 (7)	18.7 ± 0.1 m		β^- 100
		95	1/2-	-81.213 (7)	10.3 ± 0.1 m		β^- 100
		96	0-	-78.345 (7)	5.34 ± 0.05 s		β^- 100
		96m	8+	-77.205 (7)	9.6 ± 0.2 s		β^- 100
		97	(1/2-)	-76.13 (7)	3.75 ± 0.03 s		β^- 100; $\beta^- n$ 0.06
		97m	(9/2)+	-75.463 (7)	1.17 ± 0.03 s		$\beta^- n$ < 0.08; β^- > 99.30; IT < 0.70
		97m2	(27/2-)	-72.608 (7)	142 ± 8 ms		IT 98.4; β^- 1.6
		98	(0)-	-72.304 (8)	0.548 ± 0.002 s		β^- 100; $\beta^- n$ 0.33
		98m	(4,5)	-71.894 (8)	2.0 ± 0.2 s		β^- > 80.00; IT < 20.00; $\beta^- n$ 3.4
		99	(5/2+)	-70.659 (7)	1.484 ± 0.007 s		β^- 100; $\beta^- n$ 1.7
		100	1-,2-	-67.336 (11)	735 ± 7 ms		$\beta^- n$ 0.92; β^- 100
		100m	(3,4,5)	-67.191 (11)	0.94 ± 0.03 s		β^- 100
		101	(5/2+)	-65.07 (8)	0.45 ± 0.02 s		β^- 100; $\beta^- n$ 1.94
		102	HighJ	-61.21 (20)	0.36 ± 0.04 s		β^- 100; $\beta^- n$ 4.9; β^- 100; $\beta^- n$ 4.9
		103	(5/2+)	-58.5 (10)	0.23 ± 0.02 s		β^- 100; $\beta^- n$ 8
		104	0	-54.1 (4)	197 ± 4 ms		β^- 100; $\beta^- n$
		105	0	-50.8 (5)	85 +5-4 ms		β^- ; $\beta^- n$ < 82.00
		106	0	-46.1 (5)	62 +25-14 ms		β^-
		107	(5/2+)	-42.4 (5)	41 +15-9 ms		β^- 100
		108	0	-37.3 (6)	25 +66-10 ms		β^- ; $\beta^- n$
40	**Zr**	79	0	-47.1 (4)	56 ± 30 ms		ϵ ; ϵp
		80	0+	-55.5 (15)	4.6 ± 0.6 s		ϵ 100; ϵp
		81	(3/2-)	-58.4 (16)	5.5 ± 0.4 s		ϵ 100; ϵp 0.12
		82	0+	-63.94 (20)	32 ± 5 s		ϵ 100
		83	(1/2-)	-65.912 (7)	41.6 ± 2.4 s		ϵ 100; ϵp
		84	0+	-71.422 (6)	25.8 ± 0.5 m		ϵ 100
		85	(7/2+)	-73.175 (7)	7.86 ± 0.04 m		ϵ 100
		85m	(1/2-)	-72.883 (7)	10.9 ± 0.3 s		IT ≤ 92.00; ϵ > 8.00
		86	0+	-77.969 (4)	16.5 ± 0.1 h		ϵ 100

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}$, Γ	Abundance	Decay Mode
		107	7/2+	-86.861 (12)	21.7 ± 0.4 m		β^- 100
		108	1+	-85.031 (14)	16.8 ± 0.5 s		β^- 100; β^- 100; IT
		109	7/2+	-85.011 (6)	80 ± 2 s		β^- 100
		110	(GE4)	-82.844 (19)	28.5 ± 1.5 s		β^- 100; β^- 100
		111	(7/2+)	-82.304 (7)	11 ± 1 s		β^- 100
		112	1+	-79.73 (4)	3.45 ± 0.37 s		β^- 100; β^- 100
		113	(7/2+)	-78.767 (7)	2.80 ± 0.12 s		β^- 100
		114	1+	-75.71 (7)	1.85 ± 0.05 s		β^- 100
		114m	(7-)	-75.51 (7)	1.86 ± 0.06 s		β^- 100
		115	(7/2+)	-74.23 (8)	0.99 ± 0.05 s		β^- 100
		116	1+	-70.74 (7)	0.68 ± 0.06 s		β^- 100
		116m	(6-)	-70.59 (7)	0.57 ± 0.05 s		β^- 100
		117	(7/2+)	-68.897 (9)	0.44 ± 0.04 s		β^- 100
		118	0	-64.887 (24)	266 +22-21 ms		β^- 100; $\beta^- n$ 3.1
		119	(7/2+)	-62.85 (20)	171 ± 18 ms		β^- 100; $\beta^- n$ 6.4
		120	0	-58.81 (20)	136 +14-13 ms		β^- 100; $\beta^- n$ < 5.40
		121	0	-56.4 (3)	151 +67-58 ms		β^- 100; $\beta^- n$
46	**Pd**	92	0+	-55.1 (5)	0.7 +0.4-0.2 s		ϵ 100
		93	(9/2+)	-59.1 (4)	1.00 ± 0.09 s		ϵ 100; ϵp
		94	0+	-66.102 (5)	9.6 ± 0.2 s		ϵ 100
		95	(9/2+)	-69.966 (5)	5 ± 3 s		ϵ 100
		95m	(21/2+)	-68.091 (5)	13.3 ± 0.3 s		ϵ 89; IT 11; ϵp 0.93
		96	0+	-76.183 (4)	122 ± 2 s		ϵ 100
		97	(5/2+)	-77.806 (5)	3.10 ± 0.09 m		ϵ 100
		98	0+	-81.32 (5)	17.7 ± 0.3 m		ϵ 100
		99	(5/2)+	-82.184 (5)	21.4 ± 0.2 m		ϵ 100
		100	0+	-85.226 (18)	3.63 ± 0.09 d		ϵ 100
		101	5/2+	-85.432 (5)	8.47 ± 0.06 h		ϵ 100
		102	0+	-87.929 (3)	**stable**	1.02% ± 0.01%	
		103	5/2+	-87.483 (3)	16.991 ± 0.019 d		ϵ 100
		104	0+	-89.393 (3)	**stable**	11.14% ± 0.08%	
		105	5/2+	-88.416 (3)	**stable**	22.33% ± 0.08%	
		106	0+	-89.906 (3)	**stable**	27.33% ± 0.03%	
		107	5/2+	-88.371 (3)	6.5E+6 ± 0.3E+6 y		β^- 100
		107m	11/2-	-88.156 (3)	21.3 ± 0.5 s		IT 100
		108	0+	-89.521 (3)	**stable**	26.46% ± 0.09%	
		109	5/2+	-87.603 (3)	13.7012 ± 0.0024 h		β^- 100
		109m	11/2-	-87.414 (3)	4.696 ± 0.003 m		IT 100
		110	0+	-88.348 (7)	**stable**	11.72% ± 0.09%	
		111	5/2+	-86.003 (7)	23.4 ± 0.2 m		β^- 100
		111m	11/2-	-85.831 (7)	5.5 ± 0.1 h		IT 73; β^- 27
		112	0+	-86.323 (7)	21.03 ± 0.05 h		β^- 100
		113	(5/2+)	-83.591 (7)	93 ± 5 s		β^- 100
		113m	(9/2-)	-83.51 (7)	0.3 ± 0.1 s		IT 100
		114	0+	-83.491 (7)	2.42 ± 0.06 m		β^- 100
		115	(5/2+)	-80.426 (14)	25 ± 2 s		β^- 100
		115m	(11/2-)	-80.337 (14)	50 ± 3 s		β^- 92; IT 8
		116	0+	-79.831 (7)	11.8 ± 0.4 s		β^- 100
		117	(5/2+)	-76.424 (7)	4.3 ± 0.3 s		β^- 100
		118	0+	-75.391 (8)	1.9 ± 0.1 s		β^- 100
		119	0	-71.408 (8)	0.92 ± 0.01 s		β^- 100
		120	0+	-70.31 (9)	0.5 ± 0.1 s		β^- 100
		121	(3/2+)	-66.3 (5)	285 ± 24 ms		β^- 100; $\beta^- n$ ≤ 0.80

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		96	0+	-86.0804 (15)	**stable**	5.54% ± 0.14%	
		97	5/2+	-86.12 (3)	2.83 ± 0.23 d		ϵ 100
		98	0+	-88.225 (6)	**stable**	1.87% ± 0.03%	
		99	5/2+	-87.6202 (20)	**stable**	12.76% ± 0.14%	
		100	0+	-89.2222 (20)	**stable**	12.6% ± 0.07%	
		101	5/2+	-87.9529 (20)	**stable**	17.06% ± 0.02%	
		102	0+	-89.1012 (20)	**stable**	31.55% ± 0.14%	
		103	3/2+	-87.262 (20)	39.247 ± 0.013 d		β^- 100
		104	0+	-88.092 (3)	**stable**	18.62% ± 0.27%	
		105	3/2+	-85.931 (3)	4.44 ± 0.02 h		β^- 100
		106	0+	-86.321 (6)	371.8 ± 1.8 d		β^- 100
		107	(5/2)+	-83.859 (9)	3.75 ± 0.05 m		β^- 100
		108	0+	-83.658 (9)	4.55 ± 0.05 m		β^- 100
		109	(5/2+)	-80.735 (9)	34.5 ± 1 s		β^- 100
		110	0+	-80.069 (9)	11.6 ± 0.6 s		β^- 100
		111	5/2+	-76.782 (10)	2.12 ± 0.07 s		β^- 100
		112	0+	-75.627 (10)	1.75 ± 0.07 s		β^- 100
		113	(1/2+)	-71.87 (4)	0.80 ± 0.05 s		β^- 100; β^- 100
		114	0+	-70.215 (12)	0.52 ± 0.05 s		β^- 100
		115	(3/2+)	-66.19 (9)	318 ± 19 ms		β^- ; β^- 100; β^-n ; β^- 100; β^-n ; β^- 100; β^-n
		116	0+	-64.16 (20)	204 +32-29 ms		β^-
		117	0	-59.56 (20)	142 +18-17 ms		β^- 100
		118	0+	-57.3 (3)	123 +48-35 ms		β^- 100; β^-n
45	**Rh**	90	0	-52 (4)	12 +9-4 ms		ϵ ?; ϵ ?
		91	(9/2+)	-58.8 (4)	1.47 ± 0.22 s		ϵ ; ϵ
		92	(6+)	-62.999 (4)	4.66 ± 0.25 s		ϵ 100; ϵ 100
		93	(9/2+)	-69.017 (3)	12.2 ± 0.7 s		ϵ 100
		94	(4+)	-72.907 (4)	66 ± 6 s		ϵp 1.8; ϵ 100
		94m	(8+)	-72.607 (4)	25.8 ± 0.2 s		ϵ 100
		95	9/2+	-78.342 (4)	5.02 ± 0.1 m		ϵ 100
		95m	(1/2)-	-77.799 (4)	1.96 ± 0.04 m		IT 88; ϵ 12
		96	GE 6+	-79.688 (10)	9.90 ± 0.1 m		ϵ 100
		96m	3+	-79.636 (10)	1.51 ± 0.02 m		IT 60; ϵ 40
		97	9/2+	-82.6 (4)	30.7 ± 0.6 m		ϵ 100
		97m	1/2-	-82.34 (4)	46.2 ± 1.6 m		ϵ 94.4; IT 5.6
		98	(2)+	-83.175 (12)	8.72 ± 0.12 m		ϵ 100; IT 89; ϵ 11
		99	1/2-	-85.577 (7)	16.1 ± 0.2 d		ϵ 100
		99m	9/2+	-85.512 (7)	4.7 ± 0.1 h		$\epsilon > 99.84$; $IT < 0.16$
		100	1-	-85.587 (18)	20.8 ± 0.1 h		ϵ 100
		100m	(5+)	-85.479 (18)	4.6 ± 0.2 m		$IT \approx 98.30$; $\epsilon \approx 1.70$
		101	1/2-	-87.412 (6)	3.3 ± 0.3 y		ϵ 100
		101m	9/2+	-87.254 (6)	4.34 ± 0.01 d		ϵ 92.8; IT 7.2
		102	(1-,2-)	-86.778 (5)	207.3 ± 1.7 d		ϵ 78; β^- 22
		102m	6(+)	-86.638 (5)	3.742 ± 0.01 y		ϵ 99.77; IT 0.23
		103	1/2-	-88.026 (3)	**stable**	100%	
		103m	7/2+	-87.986 (3)	56.114 ± 0.009 m		IT 100
		104	1+	-86.953 (3)	42.3 ± 0.4 s		β^- 99.55; ϵ 0.45
		104m	5+	-86.824 (3)	4.34 ± 0.03 m		β^- 0.13; IT 99.87
		105	7/2+	-87.849 (4)	35.36 ± 0.06 h		β^- 100
		105m	1/2-	-87.719 (4)	42.9 ± 0.3 s		IT 100
		106	1+	-86.36 (6)	30.07 ± 0.35 s		β^- 100
		106m	(6)+	-86.223 (6)	131 ± 2 m		β^- 100

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		87	(9/2)+	-79.348 (4)	1.68 ± 0.01 h		ϵ 100
		87m	(1/2)-	-79.012 (4)	14.0 ± 0.2 s		IT 100
		88	0+	-83.629 (6)	83.4 ± 0.3 d		ϵ 100
		89	9/2+	-84.877 (4)	78.41 ± 0.12 h		ϵ 100
		89m	1/2-	-84.289 (4)	4.161 ± 0.017 m		IT 93.77; ϵ 6.23
		90	0+	-88.7742 (22)	**stable**	51.45% ± 0.4%	
		90m	5-	-86.4552 (22)	809.2 ± 2 ms		IT 100
		91	5/2+	-87.8973 (22)	**stable**	11.22% ± 0.05%	
		92	0+	-88.4607 (22)	**stable**	17.15% ± 0.08%	
		93	5/2+	-87.1238 (22)	1.61E+6 ± 0.05E+6 y		β^- 100
		94	0+	-87.2725 (23)	**stable**	17.38% ± 0.28%	
		95	5/2+	-85.6633 (22)	64.032 ± 0.006 d		β^- 100
		96	0+	-85.4477 (25)	2.35E+19 ± 0.21E+19 y	2.8% ± 0.09%	$2\beta^-$
		97	1/2+	-82.9515 (25)	16.749 ± 0.008 h		β^- 100
		98	0+	-81.296 (9)	30.7 ± 0.4 s		β^- 100
		99	(1/2+)	-77.626 (11)	2.1 ± 0.1 s		β^- 100
		100	0+	-76.384 (8)	7.1 ± 0.4 s		β^- 100
		101	(3/2+)	-73.173 (9)	2.3 ± 0.1 s		β^- 100
		102	0+	-71.595 (9)	2.9 ± 0.2 s		β^- 100
		103	(5/2-)	-67.825 (10)	1.32 ± 0.11 s		β^- 100; $\beta^-n \leq 1.00$
		104	0+	-65.733 (10)	0.87 ± 0.06 s		β^- 100; $\beta^-n \leq 1.00$
		105	0	-61.474 (12)	0.66 ± 0.07 s		β^- 100; $\beta^-n \leq 2.00$
		106	0+	-59 (3)	191 ± 19 ms		β^- 100; $\beta^-n \leq 7.00$
		107	0	-54.3 (3)	138 ± 4 ms		β^- 100; $\beta^-n \leq 23.00$
		108	0+	-51.4 (4)	73 ± 4 ms		β^- 100; β^-n
		109	0	-46.2 (5)	63 +38-17 ms		β^- ; β^-n
		110	0+	-42.9 (6)	37 +17-9 ms		β^-
41	**Nb**	82	(0+)	-52.2 (3)	50 ± 5 ms		ϵ 100; ϵp
		83	(5/2+)	-58.4 (3)	3.8 ± 0.2 s		ϵ 100
		84	(1+,2+,3+)	-61 (3)	9.8 ± 0.9 s		ϵ 100; ϵp
		85	(9/2+)	-66.28 (4)	20.5 ± 1.2 s		ϵ 100; IT ; ϵ ; ϵ ; IT
		86	(6+)	-69.134 (6)	88 ± 1 s		ϵ 100
		87	(1/2-)	-73.875 (7)	3.75 ± 0.09 m		ϵ 100
		87m	(9/2+)	-73.871 (7)	2.6 ± 0.1 m		ϵ
		88	(8+)	-76.18 (5)	14.55 ± 0.06 m		ϵ 100; ϵ 100
		89	(9/2+)	-80.65 (3)	2.03 ± 0.07 h		ϵ 100
		89m	(1/2)-	-80.62 (3)	66 ± 2 m		ϵ 100
		90	8+	-82.663 (5)	14.60 ± 0.05 h		ϵ 100
		90m	4-	-82.538 (5)	18.81 ± 0.06 s		IT 100
		91	9/2+	-86.639 (4)	6.8E+2 ± 1.3E+2 y		ϵ 100
		91m	1/2-	-86.535 (4)	60.86 ± 0.22 d		IT 96.6; ϵ 3.4
		92	(7)+	-86.455 (3)	3.47E+7 ± 0.24E+7 y		ϵ 100; $\beta^- < 0.05$
		92m	(2)+	-86.319 (3)	10.15 ± 0.02 d		ϵ 100
		93	9/2+	-87.2142 (23)	**stable**	100%	
		93m	1/2-	-87.1834 (23)	16.12 ± 0.12 y		IT 100
		94	6+	-86.3704 (23)	2.03E+4 ± 0.16E+4 y		β^- 100
		94m	3+	-86.3295 (23)	6.263 ± 0.004 m		IT 99.5; β^- 0.5
		95	9/2+	-86.7863 (16)	34.991 ± 0.006 d		β^- 100
		95m	1/2-	-86.5506 (16)	3.61 ± 0.03 d		IT 94.4; β^- 5.6
		96	6+	-85.608 (4)	23.35 ± 0.05 h		β^- 100
		97	9/2+	-85.6103 (23)	72.1 ± 0.7 m		β^- 100
		97m	1/2-	-84.8669 (23)	58.7 ± 1.8 s		IT 100
		98	1+	-83.533 (6)	2.86 ± 0.06 s		β^- 100

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		98m	(5+)	-83.449 (6)	51.3 ± 0.4 m		β^- 99.9; $IT < 0.20$
		99	9/2+	-82.33 (12)	15.0 ± 0.2 s		β^- 100
		99m	1/2-	-81.965 (12)	2.5 ± 0.2 m		$\beta^- > 96.20$; $IT < 3.80$
		100	1+	-79.806 (8)	1.5 ± 0.2 s		β^- 100
		100m	(5+)	-79.492 (8)	2.99 ± 0.11 s		β^- 100
		101	(5/2+)	-78.886 (4)	7.1 ± 0.3 s		β^- 100
		102	(4+)	-76.314 (4)	4.3 ± 0.4 s		β^- 100; β^- 100
		103	(5/2+)	-75.023 (4)	1.5 ± 0.2 s		β^- 100
		104	(1+)	-71.828 (4)	4.9 ± 0.3 s		β^- 100; $\beta^- n$ 0.06
		104m	0	-71.613 (4)	0.94 ± 0.04 s		β^- 100; $\beta^- n$ 0.05
		105	(5/2+)	-69.91 (4)	2.95 ± 0.06 s		β^- 100; $\beta^- n$ 1.7
		106	0	-66.198 (5)	0.93 ± 0.04 s		β^- 100; $\beta^- n$ 4.5
		107	0	-63.718 (8)	300 ± 9 ms		β^- 100; $\beta^- n$ 8
		108	(2+)	-59.56 (10)	220 ± 18 ms		β^- 100; $\beta^- n$ 8
		109	(5/2)	-56.8 (3)	106 ± 9 ms		β^- 100; $\beta^- n < 15.00$
		110	0	-52.3 (3)	86 ± 6 ms		β^- 100; $\beta^- n$ 40
		111	(5/2+)	-49 (4)	51 +6-5 ms		β^-
		112	(2+)	-44.4 (5)	33 +9-6 ms		β^-
42	**Mo**	83	0	-46.7 (4)	6 +30-3 ms		ϵ 100
		84	0+	-54.5 (4)	2.3 ± 0.3 s		ϵ 100; ϵp
		85	(1/2-)	-57.51 (16)	3.2 ± 0.2 s		ϵ ; $\epsilon p \approx 0.14$
		86	0+	-64.11 (4)	19.1 ± 0.3 s		ϵ 100
		87	7/2+	-66.883 (4)	14.02 ± 0.26 s		ϵ 100; ϵp 15
		88	0+	-72.686 (4)	8.0 ± 0.2 m		ϵ 100
		89	(9/2+)	-75.015 (4)	2.11 ± 0.1 m		ϵ 100
		89m	(1/2-)	-74.627 (4)	190 ± 15 ms		IT 100
		90	0+	-80.174 (6)	5.56 ± 0.09 h		ϵ 100
		91	9/2+	-82.208 (11)	15.49 ± 0.01 m		ϵ 100
		91m	1/2-	-81.555 (11)	64.6 ± 0.6 s		ϵ 50; IT 50
		92	0+	-86.809 (4)	**stable**	14.53% ± 0.3%	
		93	5/2+	-86.808 (4)	4.0E+3 ± 0.8E+3 y		ϵ 100
		93m	21/2+	-84.383 (4)	6.85 ± 0.07 h		IT 99.88; ϵ 0.12
		94	0+	-88.4141 (15)	**stable**	9.15% ± 0.09%	
		95	5/2+	-87.7119 (15)	**stable**	15.84% ± 0.11%	
		96	0+	-88.7949 (15)	**stable**	16.67% ± 0.15%	
		97	5/2+	-87.5448 (15)	**stable**	9.6% ± 0.14%	
		98	0+	-88.1161 (15)	**stable**	24.39% ± 0.37%	
		99	1/2+	-85.9702 (15)	65.976 ± 0.024 h		β^- 100
		100	0+	-86.1878 (20)	7.3E+18 ± 0.4E+18 y	9.82% ± 0.31%	$2\beta^-$ 100
		101	1/2+	-83.5147 (20)	14.61 ± 0.03 m		β^- 100
		102	0+	-83.573 (9)	11.3 ± 0.2 m		β^- 100
		103	(3/2+)	-80.97 (10)	67.5 ± 1.5 s		β^- 100
		104	0+	-80.359 (9)	60 ± 2 s		β^- 100
		105	(5/2-)	-77.346 (9)	35.6 ± 1.6 s		β^- 100
		106	0+	-76.144 (9)	8.73 ± 0.12 s		β^- 100
		107	(5/2+)	-72.561 (10)	3.5 ± 0.5 s		β^- 100
		108	0+	-70.766 (10)	1.09 ± 0.02 s		β^- 100; $\beta^- n < 0.50$
		109	(7/2-)	-66.676 (11)	660 ± 45 ms		β^- 100; $\beta^- n$ 1.3
		110	0+	-64.552 (24)	0.27 ± 0.01 s		β^- 100; $\beta^- n$ 2
		111	0	-60.06 (20)	220 +41-36 ms		β^- ; $\beta^- n \leq 12$
		112	0+	-57.6 (3)	120 +13-11 ms		β^-
		113	0	-52.9 (3)	78 +6-5 ms		β^-
		114	0+	-50 (4)	60 +13-9 ms		β^-

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Table 8.1 – *Continued from previous page*

Z	El	A	J^π	Δ[MeV]	$T_{1/2}, \Gamma$	Abundance	Decay Mode
		115	0	-44.7 (4)	51 +79-19 ms		β^- ; $\beta^- n$
43	**Tc**	85	0	-46 (4)	≈ 0.5 s		p ?
		86	(0+)	-51.3 (3)	54 ± 7 ms		ϵ 100; ϵp
		87	(9/2+)	-57.69 (4)	2.2 ± 0.2 s		ϵ 100
		88	(3+)	-61.679 (4)	5.8 ± 0.2 s		ϵ 100; ϵ 100
		89	(9/2+)	-67.395 (4)	12.8 ± 0.9 s		ϵ 100
		89m	(1/2-)	-67.332 (4)	12.9 ± 0.8 s		ϵ 100; $IT < 0.01$
		90	1+	-70.724 (3)	8.7 ± 0.2 s		ϵ 100
		90m	(6+)	-70.224 (3)	49.2 ± 0.4 s		ϵ 100
		91	(9/2)+	-75.987 (3)	3.14 ± 0.02 m		ϵ 100
		91m	(1/2)-	-75.848 (3)	3.3 ± 0.1 m		ϵ 100; $IT < 1.00$
		92	(8)+	-78.925 (4)	4.25 ± 0.15 m		ϵ 100
		93	9/2+	-83.607 (4)	2.75 ± 0.05 h		ϵ 100
		93m	1/2-	-83.215 (4)	43.5 ± 1 m		IT 77.4; ϵ 22.6
		94	7+	-84.158 (4)	293 ± 1 m		ϵ 100
		94m	(2)+	-84.082 (4)	52.0 ± 1 m		ϵ 100; $IT < 0.10$
		95	9/2+	-86.021 (5)	20.0 ± 0.1 h		ϵ 100
		95m	1/2-	-85.982 (5)	61 ± 2 d		ϵ 96.12; IT 3.88
		96	7+	-85.822 (5)	4.28 ± 0.07 d		ϵ 100
		96m	4+	-85.787 (5)	51.5 ± 1 m		IT 98; ϵ 2
		97	9/2+	-87.224 (4)	4.21E+6 ± 0.16E+6 y		ϵ 100
		97m	1/2-	-87.128 (4)	91.0 ± 0.6 d		IT 96.06; ϵ 3.94
		98	(6)+	-86.432 (4)	4.2E+6 ± 0.3E+6 y		β^- 100
		99	9/2+	-87.3271 (17)	2.111E+5 ± 0.012E+5 y		β^- 100
		99m	1/2-	-87.1844 (17)	6.0067 ± 5.0E-4 h		IT 100; β^- 0.0037
		100	1+	-86.0202 (20)	15.46 ± 0.19 s		β^- 100; ϵ 0.0026
		101	9/2+	-86.339 (24)	14.02 ± 0.01 m		β^- 100
		102	1+	-84.569 (9)	5.28 ± 0.15 s		β^- 100; β^- 98; IT 2
		103	5/2+	-84.6 (10)	54.2 ± 0.8 s		β^- 100
		104	(3+)	-82.509 (25)	18.3 ± 0.3 m		β^- 100
		105	(3/2-)	-82.29 (4)	7.6 ± 0.1 m		β^- 100
		106	(2+)	-79.774 (13)	35.6 ± 0.6 s		β^- 100
		107	(3/2-)	-78.746 (9)	21.2 ± 0.2 s		β^- 100
		108	(2)+	-75.919 (9)	5.17 ± 0.07 s		β^- 100
		109	(5/2+)	-74.279 (10)	0.86 ± 0.04 s		β^- 100; $\beta^- n$ 0.08
		110	(2+)	-71.031 (10)	0.92 ± 0.03 s		β^- 100; $\beta^- n$ 0.04
		111	(5/2+)	-69.021 (11)	350 ± 21 ms		β^- 100; $\beta^- n$ 0.85
		112	0	-65.253 (6)	0.29 ± 0.02 s		β^- 100; $\beta^- n$ 4
		113	>5/2	-62.88 (10)	160 +50-40 ms		β^- ; $\beta^- n$ 2.1
		114	>3	-58.85 (20)	100 ± 20 ms		β^- 100; $\beta^- n$?; β^- 100; $\beta^- n$?
		115	0	-56.1 (3)	83 +20-13 ms		β^- ; $\beta^- n$
		116	0	-51.5 (3)	56 +15-10 ms		β^-
		117	(5/2+)	-48.4 (4)	85 +95-30 ms		β^-
44	**Ru**	88	0+	-54.4 (3)	1.2 +0.3-0.2 s		ϵ 100
		89	(9/2+)	-58.1 (3)	1.5 ± 0.2 s		ϵ 100; $\epsilon p < 0.15$
		90	0+	-64.883 (4)	11.7 ± 0.9 s		ϵ 100
		91	(9/2+)	-68.239 (3)	7.9 ± 0.4 s		ϵ 100; IT ; $\epsilon > 0.00$; $\epsilon p > 0.00$
		92	0+	-74.301 (3)	3.65 ± 0.05 m		ϵ 100
		93	(9/2)+	-77.214 (4)	59.7 ± 0.6 s		ϵ 100
		93m	(1/2)-	-76.479 (4)	10.8 ± 0.3 s		ϵ 78; IT 22; ϵp 0.03
		94	0+	-82.579 (4)	51.8 ± 0.6 m		ϵ 100
		95	5/2+	-83.458 (10)	1.643 ± 0.013 h		ϵ 100

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