Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh, Sukhjeet Singh	ENSDF	08-Mar-2022

Q(β^-)=−1408 *4*; S(n)=6478.7 *23*; S(p)=6845.5 *21*; Q(α)=5788.92 *15* 2021Wa16
S(2n)=11637 *5*, S(2p)=12124.1 *19* (2021Wa16).
In the past, ^{224}Ra was called ThX, and was first identified by Rutherford and Soddy, Phil. Mag. 4, 370 (1902), extracted from thorium with an estimated half-life of ≈4 d. Later studies of decay of ^{224}Ra: 1938Le07, 1962Ll02, 1962Wa28, 1971Jo14, 1977Ku15, 2004Sc04.
2014Bo26: mass determination with Penning-trap mass spectrometer ISOLTRAP facility at ISOLDE, CERN. Measured mass excess=18826 *28*.

Theoretical calculations: 132 references extracted from the NSR database are listed in document records.
Additional information 1.

^{224}Ra Levels

Cross Reference (XREF) Flags

A	^{224}Fr β^- decay (3.33 min)	E	^{226}Ra(p,t)
B	^{224}Ac ε decay (2.78 h)	F	^{226}Ra(α,α'2nγ)
C	^{228}Th α decay (1.9125 y)	G	^{226}Ra(^{58}Ni,^{60}Niγ)
D	Coulomb excitation	H	^{232}Th(^{136}Xe,Xγ)

E(level)†	J$^\pi$	T$_{1/2}$	XREF	Comments
0#	0$^+$	3.6316 d *23*	ABCDEFGH	%α=100; %^{14}C=4.0×10^{-9} *10* (1992Ar02) %^{14}C=4.0×10^{-9} *10* (1992Ar02), 6.5×10^{-9} *10* (1991Ho15,1991Ho24), 4.3×10^{-9} *12* (1985Pr01); fine structure looked for, but not observed (1991Ho15). Evaluated rms charge radius=5.705 fm *26* (2013An02). Measured change in rms radius: δ<r^2>(^{214}Ra,^{224}Ra)=+1.2680 fm^2 *2* (stat) *636* (syst) (2018Ly01, hyperfine structure by collinear laser resonance ionization spectroscopy at ISOLDE-CERN). Measured isotope shifts: $\delta\nu$(^{214}Ra,^{224}Ra)=−35652 MHz *4*; $\delta\nu$(^{226}Ra,^{224}Ra)=+6092 MHz *3* (2018Ly01, hyperfine structure by collinear laser resonance ionization spectroscopy at ISOLDE-CERN). δ<r^2>=+1.09 *11*, relative to ^{214}Ra (1988Ah02); other: 1989Ne03. T$_{1/2}$: weighted average of 3.6262 d *48* (2021Be13, National Physical Laboratory, U.K., from 238.6γ, 241.0γ and 583.2γ decay curves using HPGe detector); 3.6323 d *27* (2021Be13, NIST, from 238.6γ, 241.0γ and 583.2γ decay curves using HPGe detector); 3.6321 d *28* (2021Be13, NIST using an ionization chamber); and 3.6319 d *23* (2004Sc04, 4π ionization chamber at the Physikalisch-Technische Bundesanstalt-PTB). Other measurements: 3.66 d *4* (1971Jo14), 3.62 d *1* (1962Ll02), 3.64 d (1938Le07) are in agreement with the recommended value but much less precise.
84.372# *3*	2$^+$	0.748 ns *19*	ABCDEFGH	μ=+0.92 *22* (1973He13,2020StZV) J$^\pi$: E2 γ to 0$^+$. μ: from IPAC in ^{228}Th α decay (1973He13). B(E2)=3.96 *12* from Coul. ex. (2013Ga23,2012GaZV). Q$_2$=6.32 *10*, β_2=0.154 (2012GaZV,2013Ga23). T$_{1/2}$: from $\alpha\gamma$(t) in ^{228}Th α decay.
215.985@ *4*	1$^-$		ABCDE GH	J$^\pi$: E1 γ to 0$^+$.
250.782# *5*	4$^+$	0.181 ns *9*	ABCD FGH	J$^\pi$: $\alpha\gamma(\theta)$ from 0$^+$ parent (^{228}Th α decay, 1989Po19). T$_{1/2}$: from $\alpha\gamma$(t) in ^{228}Th α decay.
290.352@ *21*	3$^-$		ABCD FGH	J$^\pi$: E1 γ to 2$^+$; no γ to 0$^+$; HF=47 for α branch from 0$^+$; no β^- decay from 1$^-$

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Adopted Levels, Gammas (continued)

^{224}Ra Levels (continued)

E(level)†	J^π	$T_{1/2}$	XREF	Comments
				^{224}Fr; member of $K^\pi=0^-$ octupole band.
433.02@ *7*	$(5)^-$		A CD FGH	J^π: E1 γ to 4^+; no γ to levels with J<3; member of $K^\pi=0^-$ octupole band. γ-ray branching ratio is in disagreement in various experiments.
479.12# *10*	6^+	52.7 ps *42*	CDEFGH	J^π: γ to 4^+; member of g.s. band. $T_{1/2}$: from 2012GaZV.
640.69@ *18*	(7^-)		D FGH	J^π: (E2) γ to $(5)^-$; member of $K^\pi=0^-$ octupole band.
754.88# *20*	8^+	20.8 ps *+49−55*	D FGH	J^π: γ to (6^+); member of g.s. band. $T_{1/2}$: from 2012GaZV.
906.17@ *25*	(9^-)		D FGH	J^π: γ to (7^-); member of $K^\pi=0^-$ octupole band.
916.38 *6*	0^+		A C E	J^π: L(p,t)=0.
965.65 *6*	2^+		A D	J^π: γ rays to 0^+ and 2^+; populated in Coulomb excitation. Possible bandhead of $K^\pi=2^+$ γ-vibrational band.
992.70 *6*	(2^+)		A C	J^π: γ rays to 2^+ and 4^+; possible γ to 0^+; HF≈6.8 for α branch from 0^+.
1053.041 *23*	1^-		A	J^π: 1+E2 γ to 1^-; γ to 0^+.
1068.5# *3*	10^+		D FGH	J^π: γ to (8^+); member of g.s. band.
1090.087 *24*	$(2,3)^-$		A	J^π: M1(+E2) γ to $(3)^-$; γ rays to 1^- and 2^+.
1187.1 *4*	0^+,1,2		A	J^π: γ rays to 1^- and 2^+; log *ft*=8.2 from $1^{(-)}$.
1216.89 *19*	$(1^-,2)$		A	J^π: γ rays to 1^- and $(3)^-$; log *ft*=8.1 from $1^{(-)}$.
1220.7@ *4*	(11^-)		FGH	J^π: γ to (9^-); member of $K^\pi=0^-$ octupole band.
1223 *4*	0^+		E	J^π: L(p,t)=0.
1348.22 *9*	$2^+,3^+$		A	J^π: γ rays to 2^+ and 4^+; log *ft*=7.76 *11*, log $f^{1u}t$=8.5 from $1^{(-)}$.
1378.41 *3*	1^-		A	J^π: M1 γ to 1^-; γ rays to 0^+ and 2^+.
1379.04 *6*	$(1^+,2^+)$		A	J^π: M1 γ to (2^+); γ to 1^-; log *ft*=6.87 from $1^{(-)}$.
1389.93 *15*	$(0^+,1,2)$		A	J^π: γ rays to 1^- and 2^+; log *ft*=7.59 from $1^{(-)}$.
1413.7# *4*	(12^+)		FGH	J^π: possible member of g.s. band.
1425.152 *20*	$(0,1,2)^-$		A	J^π: M1 γ rays to 1^- and $(2,3)^-$.
1435.54 *3*	1^-		A	J^π: M1 γ to 1^-; γ to 0^+.
1437.11 *6*	2^+		A	J^π: γ rays to 0^+ and 4^+.
1553.67 *14*	$1,2^+$		A	J^π: γ to 0^+ g.s.
1573.6@ *6*	(13^-)		GH	J^π: possible member of $K^\pi=0^-$ octupole band.
1614.42 *17*	$(1^-,2)$		A	J^π: γ rays to $(3)^-$ and 1^-; log *ft*=7.80 from $1^{(-)}$.
1627 *3*			E	
1652.49 *4*	2^+		A	J^π: γ rays to 0^+ and 4^+.
1658.49 *9*	$1^{(-)},2^+$		A	J^π: γ rays to 0^+ and $(3)^-$.
1736.44 *16*	$1,2^+$		A	J^π: γ to 0^+ g.s.
1754.84 *9*	0^+,1,2‡		A	J^π: γ rays to 1^- and 2^+.
1761 *4*			E	E(level): possibly the same as the 1755 level.
1787.5# *6*	(14^+)		H	
1789.61 *6*	$1,2^+$		A	J^π: γ rays to 0^+ and 2^+.
1796.71 *9*	$(1^-,2)$‡		A	J^π: γ rays to 1^- and $(3)^-$.
1818.06 *19*	$(1^-,2)$‡		A	J^π: γ rays to 1^- and $(3)^-$.
1838.53 *10*	0,1,2‡		A	J^π: γ to 1^- level.
1896.3 *3*	$(1^-,2)$‡		A	J^π: γ rays to 1^- and $(3)^-$.
1949 *4*			E	
1964.7@ *8*	(15^-)		H	
1969.92 *10*	(0,1,2)‡		A	J^π: γ to 1^-.
2000.26 *17*	$(1^-,2)$‡		A	J^π: γ to 1^- and $(3)^-$.
2043.0 *3*	0,1,2‡		A	J^π: γ to 1^-.
2052.3 *4*	2^+‡		A	J^π: γ rays to 4^+ and 1^-.

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Adopted Levels, Gammas (continued)

^{224}Ra Levels (continued)

E(level)[†]	J^π	XREF	Comments
2077.3 *4*	$0^+,1,2$[‡]	A	J^π: γ rays to 1^- and 2^+.
2117.4 *4*	$1,2^+$	A	J^π: γ to 0^+ g.s.
2135.3 *5*	$0,1,2$[‡]	A	J^π: γ to 1^-.
2187.7[#] *8*	(16^+)	H	
2229.4 *4*	$(1^-,2)$[‡]	A	J^π: γ rays to 1^- and $(3)^-$.
2246.5 *3*	$1,2^+$	A	J^π: γ to 0^+ g.s.
2368.7 *4*	$1,2^+$	A	J^π: γ to 0^+ g.s.
2384.1[@] *9*	(17^-)	H	
2612.1[#] *10*	(18^+)	H	
2827.0[@] *11*	(19^-)	H	
3059.2[#] *11*	(20^+)	H	
3289.8[@] *12*	(21^-)	H	
3526.3[#] *12*	(22^+)	H	
3769.6[@] *13*	(23^-)	H	
4011.4[#] *13*	(24^+)	H	
4266.4[@] *14*	(25^-)	H	
4512.2[#] *14*	(26^+)	H	
4778.0?[@] *15*	(27^-)	H	
5030.4?[#] *15*	(28^+)	H	

† From least-squares fit to Eγ data for levels deduced from γ-ray data.
‡ log *ft*<7.8, log $f^{1u}t$<7.8 from 1^- ^{224}Fr rules out J=3.
# Band(A): $K^\pi=0^+$ g.s. band.
@ Band(B): $K^\pi=0^-$ band.

$\gamma(^{224}Ra)$

E_i(level)	J^π_i	E_γ†	I_γ†	E_f	J^π_f	Mult.#	α@	Comments
84.372	2^+	84.373 *3*	100	0	0^+	E2‡	21.2	α(L)=15.57 *22*; α(M)=4.24 *6* α(N)=1.119 *16*; α(O)=0.238 *4*; α(P)=0.0343 *5*; α(Q)=0.0001015 *15* B(E2)(W.u.)=99 *3*
215.985	1^-	131.613 *4*	51.4 *6*	84.372	2^+	E1‡	0.247	α(K)=0.194 *3*; α(L)=0.0406 *6*; α(M)=0.00977 *14* α(N)=0.00254 *4*; α(O)=0.000559 *8*; α(P)=8.92×10^{-5} *13*; α(Q)=4.80×10^{-6} *7*
		215.983 *5*	100.0 *4*	0	0^+	E1‡	0.0752	α(K)=0.0600 *9*; α(L)=0.01148 *16*; α(M)=0.00274 *4* α(N)=0.000717 *10*; α(O)=0.0001593 *23*; α(P)=2.62×10^{-5} *4*; α(Q)=1.587×10^{-6} *23*
250.782	4^+	166.410 *4*	100	84.372	2^+	E2‡	1.164	B(E2)(W.u.)=140 *7* α(K)=0.225 *4*; α(L)=0.691 *10*; α(M)=0.187 *3* α(N)=0.0495 *7*; α(O)=0.01056 *15*; α(P)=0.001553 *22*; α(Q)=1.200×10^{-5} *17*
290.352	3^-	74.4 *1*	1.4 *4*	215.985	1^-	[E2]	38.5	α(L)=28.3 *5*; α(M)=7.70 *12* α(N)=2.03 *4*; α(O)=0.431 *7*; α(P)=0.0621 *10*; α(Q)=0.0001645 *25* I_γ: averaging by LWM.
		205.936 *27*	100.0 *10*	84.372	2^+	E1	0.0841	α(K)=0.0671 *10*; α(L)=0.01293 *19*; α(M)=0.00309 *5* α(N)=0.000807 *12*; α(O)=0.000179 *3*; α(P)=2.94×10^{-5} *5*; α(Q)=1.763×10^{-6} *25*
		290.5		0	0^+	[E3]	1.084	α(K)=0.196 *3*; α(L)=0.647 *9*; α(M)=0.180 *3* α(N)=0.0481 *7*; α(O)=0.01035 *15*; α(P)=0.001552 *22*; α(Q)=1.88×10^{-5} *3* E_γ: from Coulomb excitation.
433.02	$(5)^-$	142.66 *10*	56 *13*	290.352	3^-	[E2]	2.14	α(K)=0.279 *4*; α(L)=1.370 *20*; α(M)=0.372 *6* α(N)=0.0984 *15*; α(O)=0.0210 *3*; α(P)=0.00307 *5*; α(Q)=1.83×10^{-5} *3* I_γ: from Coulomb excitation based on extensive data for yield measurements. This value agrees with 54 *19* from (^{58}Ni,^{60}Niγ), but not with 26 *10* from α decay and 139 *39* from (^{136}Xe,Xγ). Weighted average of all four measurements is 43 *13* with reduced χ^2=3.4 as compared to critical χ^2=2.6.
		182.29 *10*	100 *12*	250.782	4^+	[E1]	0.1126	α(K)=0.0894 *13*; α(L)=0.01757 *25*; α(M)=0.00421 *6* α(N)=0.001098 *16*; α(O)=0.000243 *4*; α(P)=3.96×10^{-5} *6*; α(Q)=2.31×10^{-6} *4*
		348.5		84.372	2^+	[E3]	0.508	α(K)=0.1352 *19*; α(L)=0.273 *4*; α(M)=0.0753 *11* α(N)=0.0200 *3*; α(O)=0.00433 *6*; α(P)=0.000656 *10*; α(Q)=1.039×10^{-5} *15* E_γ: from Coulomb excitation.
479.12	6^+	228.3 *1*	100	250.782	4^+	[E2]	0.367	α(K)=0.1245 *18*; α(L)=0.179 *3*; α(M)=0.0480 *7* α(N)=0.01269 *18*; α(O)=0.00273 *4*; α(P)=0.000407 *6*; α(Q)=5.37×10^{-6} *8* B(E2)(W.u.)=157 *13*
640.69	(7^-)	160.5 *5*	13 *4*	479.12	6^+	[E1]	0.1530 *25*	α(K)=0.1209 *20*; α(L)=0.0243 *4*; α(M)=0.00583 *10* α(N)=0.001521 *25*; α(O)=0.000336 *6*; α(P)=5.43×10^{-5} *9*; α(Q)=3.07×10^{-6} *5* E_γ,I_γ: from (^{136}Xe,Xγ).
		207.8 *2*	100 *19*	433.02	$(5)^-$	[E2]	0.510	α(K)=0.1502 *22*; α(L)=0.265 *4*; α(M)=0.0714 *11* α(N)=0.0189 *3*; α(O)=0.00404 *6*; α(P)=0.000601 *9*; α(Q)=6.77×10^{-6} *10*
754.88	8^+	113.9 *5*	<11	640.69	(7^-)	[E1]	0.350 *7*	α(K)=0.272 *5*; α(L)=0.0594 *11*; α(M)=0.0143 *3* α(N)=0.00372 *7*; α(O)=0.000813 *15*; α(P)=0.0001285 *23*; α(Q)=6.64×10^{-6} *12*

From ENSDF

Adopted Levels, Gammas (continued)

$\gamma(^{224}Ra)$ (continued)

E_i(level)	J_i^π	E_γ†	I_γ†	E_f	J_f^π	Mult.#	δ#	α@	Comments
									B(E1)(W.u.)=0.0003 *3* E_γ: uncertainty assigned by evaluators.
754.88	8^+	275.8 *2*	100 *5*	479.12	6^+	[E2]		0.197	α(K)=0.0844 *12*; α(L)=0.0833 *12*; α(M)=0.0222 *4* α(N)=0.00587 *9*; α(O)=0.001265 *18*; α(P)=0.000191 *3*; α(Q)=3.42×10^{-6} *5* B(E2)(W.u.)=1.7×10^{2} *5*
906.17	(9^-)	151.2 *5*	<15	754.88	8^+	[E1]		0.177 *3*	α(K)=0.1394 *23*; α(L)=0.0284 *5*; α(M)=0.00681 *12* α(N)=0.00177 *3*; α(O)=0.000391 *7*; α(P)=6.30×10^{-5} *11*; α(Q)=3.51×10^{-6} *6*
		265.5 *2*	100 *8*	640.69	(7^-)	[E2]		0.223	α(K)=0.0914 *13*; α(L)=0.0968 *14*; α(M)=0.0259 *4* α(N)=0.00683 *10*; α(O)=0.001472 *21*; α(P)=0.000222 *4*; α(Q)=3.74×10^{-6} *6*
916.38	0^+	700.5‡ *5*	≈21‡	215.985	1^-				
		832.01 *8*	100‡ *17*	84.372	2^+				
965.65	2^+	881.32 *7*	100 *6*	84.372	2^+				
		965.56 *10*	63 *7*	0	0^+				
992.70	(2^+)	741.9 *2*	88 *19*	250.782	4^+				
		908.10 *10*	100 *8*	84.372	2^+				
		992.9& *10*	≈88	0	0^+				
1053.041	1^-	762.63 *4*	23.4 *12*	290.352	3^-	(E2)		0.01536	α(K)=0.01137 *16*; α(L)=0.00300 *5*; α(M)=0.000745 *11* α(N)=0.000197 *3*; α(O)=4.38×10^{-5} *7*; α(P)=7.23×10^{-6} *11*; α(Q)=3.96×10^{-7} *6*
		837.03 *7*	100 *5*	215.985	1^-	M1+E2	1.6 *+18−4*	0.0219 *66*	α(K)=0.0172 *55*; α(L)=0.0035 *9*; α(M)=0.00086 *20* α(N)=0.00023 *6*; α(O)=5.1×10^{-5} *12*; α(P)=8.7×10^{-6} *22*; α(Q)=6.0×10^{-7} *20*
		968.62 *13*	3.4 *4*	84.372	2^+				
		1053.01 *8*	2.2 *3*	0	0^+				
1068.5	10^+	313.6 *2*	100	754.88	8^+	[E2]		0.1332	α(K)=0.0646 *9*; α(L)=0.0507 *8*; α(M)=0.01343 *19* α(N)=0.00355 *5*; α(O)=0.000768 *11*; α(P)=0.0001172 *17*; α(Q)=2.55×10^{-6} *4* E_γ: NRM average of three values. Weighted average gives 313.3 *4* with reduced χ^2=9.2.
1090.087	$(2,3)^-$	799.705 *37*	100 *6*	290.352	3^-	M1(+E2)		0.033 *19*	α(K)=0.026 *16*; α(L)=0.0050 *24*; α(M)=0.00121 *56* α(N)=3.2×10^{-4} *15*; α(O)=7.2×10^{-5} *34*; α(P)=1.25×10^{-5} *61*; α(Q)=9.1×10^{-7} *55* α: for δ(E2/M1)=1. α: overlaps M1 and E2.
		874.10 *7*	39 *3*	215.985	1^-				
		1005.5 *5*	5.5 *7*	84.372	2^+				
1187.1	0^+,1,2	970.9 *5*	86 *9*	215.985	1^-				
		1103.0 *5*	100 *27*	84.372	2^+				
1216.89	$(1^-,2)$	926.5 *2*	100 *24*	290.352	3^-				

$^{224}_{88}Ra_{136}$-5

$\gamma(^{224}Ra)$ (continued)

E_i(level)	J^π_i	E_γ†	I_γ†	E_f	J^π_f	Mult.#	δ#	α@	Comments
1216.89	$(1^-,2)$	1001.1 *5*	71 *9*	215.985	1^-				
1220.7	(11^-)	314.5 *2*	100	906.17	(9^-)				
1348.22	$2^+,3^+$	1097.6 *2*	100 *27*	250.782	4^+				
		1263.80 *10*	81 *11*	84.372	2^+				
1378.41	1^-	325.348 *19*	34.9 *17*	1053.041	1^-	M1(+E2)	<0.3	0.549 *20*	α(K)=0.441 *18*; α(L)=0.0821 *20*; α(M)=0.0196 *5* α(N)=0.00518 *12*; α(O)=0.00118 *3*; α(P)=0.000205 *6*; α(Q)=1.58×10^{-5} *7*
		461.98 *8*	11.2 *6*	916.38	0^+				
		1294.21 *6*	28.2 *31*	84.372	2^+				
		1378.45 *10*	100 *6*	0	0^+				
1379.04	$(1^+,2^+)$	386.4 *10*	27.9 *23*	992.70	(2^+)				
		413.40 *5*	94 *6*	965.65	2^+	M1(+E2)	<0.5	0.272 *24*	α(K)=0.218 *21*; α(L)=0.041 *3*; α(M)=0.0098 *6* α(N)=0.00259 *15*; α(O)=0.00059 *4*; α(P)=0.000102 *7*; α(Q)=7.8×10^{-6} *8*
		1163.04 *10*	100 *7*	215.985	1^-				
1389.93	$(0^+,1,2)$	1173.89 *23*	100 *15*	215.985	1^-				
		1305.6 *2*	48 *7*	84.372	2^+				
1413.7	(12^+)	345.2 *2*	100	1068.5	10^+				
1425.152	$(0,1,2)^-$	335.056 *19*	22.9 *9*	1090.087	$(2,3)^-$	M1(+E2)	<0.5	0.48 *5*	α(K)=0.39 *4*; α(L)=0.073 *4*; α(M)=0.0176 *9* α(N)=0.00465 *22*; α(O)=0.00106 *6*; α(P)=0.000183 *11*; α(Q)=1.39×10^{-5} *14*
		372.08 *4*	14.4 *7*	1053.041	1^-	M1(+E2)	<1.1	0.308 *86*	α(K)=0.243 *75*; α(L)=0.049 *9*; α(M)=0.0120 *19* α(N)=0.0032 *5*; α(O)=0.00072 *12*; α(P)=0.000123 *23*; α(Q)=8.7×10^{-6} *27*
		1209.2 *2*	1.50 *15*	215.985	1^-				
		1340.800 *25*	100 *7*	84.372	2^+				
1435.54	1^-	382.511 *25*	45.9 *22*	1053.041	1^-	M1(+E2)	<0.7	0.32 *5*	α(K)=0.25 *5*; α(L)=0.049 *5*; α(M)=0.0118 *11* α(N)=0.0031 *3*; α(O)=0.00070 *7*; α(P)=0.000122 *13*; α(Q)=9.1×10^{-6} *15*
		442.78 *8*	24 *3*	992.70	(2^+)				
		519.5 *2*	7.9 *6*	916.38	0^+				
		1219.42 *10*	20.8 *24*	215.985	1^-				
		1350.9 *2*	38 *11*	84.372	2^+				
		1435.60 *10*	100 *10*	0	0^+				
1437.11	2^+	1186.35 *10*	34 *4*	250.782	4^+				
		1352.60 *10*	86 *12*	84.372	2^+				
		1437.20 *10*	100 *10*	0	0^+				
1553.67	$1,2^+$	1338.0 *5*	≈100	215.985	1^-				
		1469.4 *2*	100 *12*	84.372	2^+				
		1553.5 *2*	48 *6*	0	0^+				
1573.6	(13^-)	356.7 *5*	100	1220.7	(11^-)	[E2]		0.0920	α(K)=0.0496 *7*; α(L)=0.0315 *5*; α(M)=0.00827 *13* α(N)=0.00218 *4*; α(O)=0.000475 *7*; α(P)=7.33×10^{-5} *11*;

γ(^{224}Ra) (continued)

E_i(level)	J^π_i	E_γ†	I_γ†	E_f	J^π_f	Mult.#	α@	Comments
								α(Q)=1.91×10^{-6} *3* E_γ: 348.5 *2* in (^{58}Ni,^{60}Niγ) is discrepant.
1614.42	(1$^-$,2)	1323.9 *3*	42 *7*	290.352	3$^-$			
		1398.5 *2*	100 *13*	215.985	1$^-$			
1652.49	2$^+$	659.64 *10*	11.5 *21*	992.70	(2$^+$)			
		1401.6 *2*	7.0 *10*	250.782	4$^+$			
		1568.18 *6*	55 *7*	84.372	2$^+$			
		1652.47 *5*	100 *12*	0	0$^+$			
1658.49	1$^{(-)}$,2$^+$	1368.1 *2*	68 *16*	290.352	3$^-$			
		1442.3 *2*	40 *5*	215.985	1$^-$			
		1658.54 *10*	100 *20*	0	0$^+$			
1736.44	1,2$^+$	1520.6 *2*	22 *3*	215.985	1$^-$			
		1736.19 *25*	100 *17*	0	0$^+$			
1754.84	0$^+$,1,2	702.0 *2*	51 *16*	1053.041	1$^-$			
		1538.4 *2*	22 *3*	215.985	1$^-$			
		1670.53 *10*	100 *16*	84.372	2$^+$			
1787.5	(14$^+$)	373.8 *5*	100	1413.7	(12$^+$)	[E2]	0.0809	α(K)=0.0450 *7*; α(L)=0.0266 *4*; α(M)=0.00697 *11* α(N)=0.00184 *3*; α(O)=0.000401 *6*; α(P)=6.21×10^{-5} *10*; α(Q)=1.721×10^{-6} *25*
1789.61	1,2$^+$	1573.73 *8*	100 *12*	215.985	1$^-$			
		1705.12 *10*	49 *8*	84.372	2$^+$			
		1789.4 *2*	76 *12*	0	0$^+$			
1796.71	(1$^-$,2)	1506.4 *2*	43 *6*	290.352	3$^-$			
		1580.8 *2*	39 *6*	215.985	1$^-$			
		1712.30 *10*	100 *17*	84.372	2$^+$			
1818.06	(1$^-$,2)	1527.7 *2*	89 *17*	290.352	3$^-$			
		1602.1 *5*	100 *17*	215.985	1$^-$			
1838.53	0,1,2	1622.54 *10*	100	215.985	1$^-$			
1896.3	(1$^-$,2)	1607.1 *5*	100 *17*	290.352	3$^-$			
		1679.5 *5*	61 *17*	215.985	1$^-$			
		1811.6 *5*	72 *17*	84.372	2$^+$			
1964.7	(15$^-$)	391.1 *5*	100	1573.6	(13$^-$)	[E2]	0.0717	α(K)=0.0411 *6*; α(L)=0.0227 *4*; α(M)=0.00593 *9* α(N)=0.001565 *23*; α(O)=0.000341 *5*; α(P)=5.30×10^{-5} *8*; α(Q)=1.559×10^{-6} *23*
1969.92	(0,1,2)	1753.93 *10*	100	215.985	1$^-$			
2000.26	(1$^-$,2)	947.2 *2*	100 *12*	1053.041	1$^-$			
		1784.3 *3*	70 *12*	215.985	1$^-$			
2043.0	0,1,2	1827.05 *27*	100	215.985	1$^-$			
2052.3	2$^+$	1801.3 *5*	100 *19*	250.782	4$^+$			
		1836.5 *5*	63 *19*	215.985	1$^-$			
2077.3	0$^+$,1,2	1862.0 *5*	47 *9*	215.985	1$^-$			
		1992.4 *4*	100 *17*	84.372	2$^+$			
2117.4	1,2$^+$	2033.2 *5*	65 *12*	84.372	2$^+$			
		2117.3 *5*	100 *14*	0	0$^+$			
2135.3	0,1,2	1919.3 *5*	100	215.985	1$^-$			

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Adopted Levels, Gammas (continued)

$\gamma(^{224}Ra)$ (continued)

E_i(level)	J^π_i	E_γ†	I_γ†	E_f	J^π_f	Mult.#	α@	Comments
2187.7	(16$^+$)	400.2 *5*	100	1787.5	(14$^+$)	[E2]	0.0674	α(K)=0.0392 *6*; α(L)=0.0209 *3*; α(M)=0.00546 *8* α(N)=0.001442 *22*; α(O)=0.000314 *5*; α(P)=4.90×10^{-5} *8*; α(Q)=1.483×10^{-6} *22*
2229.4	(1$^-$,2)	1938.3 *10*	73 *18*	290.352	3$^-$			
		2013.4 *5*	91 *18*	215.985	1$^-$			
		2145.2 *5*	100 *18*	84.372	2$^+$			
2246.5	1,2$^+$	2030.5 *5*	100 *16*	215.985	1$^-$			
		2162.0 *5*	93 *15*	84.372	2$^+$			
		2246.6 *5*	14 *3*	0	0$^+$			
2368.7	1,2$^+$	2152.5 *5*	100 *16*	215.985	1$^-$			
		2368.8 *5*	53 *11*	0	0$^+$			
2384.1	(17$^-$)	419.4 *5*	100	1964.7	(15$^-$)	[E2]	0.0597	α(K)=0.0357 *5*; α(L)=0.0178 *3*; α(M)=0.00464 *7* α(N)=0.001224 *18*; α(O)=0.000267 *4*; α(P)=4.19×10^{-5} *6*; α(Q)=1.340×10^{-6} *19*
2612.1	(18$^+$)	424.4 *5*	100	2187.7	(16$^+$)	[E2]	0.0579	α(K)=0.0349 *5*; α(L)=0.01712 *25*; α(M)=0.00445 *7* α(N)=0.001175 *18*; α(O)=0.000257 *4*; α(P)=4.02×10^{-5} *6*; α(Q)=1.306×10^{-6} *19*
2827.0	(19$^-$)	442.9 *5*	100	2384.1	(17$^-$)	[E2]	0.0520	α(K)=0.0320 *5*; α(L)=0.01484 *22*; α(M)=0.00385 *6* α(N)=0.001015 *15*; α(O)=0.000222 *4*; α(P)=3.50×10^{-5} *5*; α(Q)=1.193×10^{-6} *17*
3059.2	(20$^+$)	447.1 *5*	100	2612.1	(18$^+$)	[E2]	0.0508	α(K)=0.0314 *5*; α(L)=0.01438 *21*; α(M)=0.00372 *6* α(N)=0.000983 *15*; α(O)=0.000215 *4*; α(P)=3.39×10^{-5} *5*; α(Q)=1.169×10^{-6} *17*
3289.8	(21$^-$)	462.8 *5*	100	2827.0	(19$^-$)	[E2]	0.0466	α(K)=0.0293 *5*; α(L)=0.01284 *19*; α(M)=0.00332 *5* α(N)=0.000876 *13*; α(O)=0.000192 *3*; α(P)=3.03×10^{-5} *5*; α(Q)=1.087×10^{-6} *16*
3526.3	(22$^+$)	467.1 *5*	100	3059.2	(20$^+$)	[E2]	0.0456	α(K)=0.0288 *4*; α(L)=0.01246 *18*; α(M)=0.00322 *5* α(N)=0.000849 *13*; α(O)=0.000186 *3*; α(P)=2.94×10^{-5} *5*; α(Q)=1.066×10^{-6} *16*
3769.6	(23$^-$)	479.8 *5*	100	3289.8	(21$^-$)	[E2]	0.0427	α(K)=0.0273 *4*; α(L)=0.01143 *17*; α(M)=0.00294 *5* α(N)=0.000777 *12*; α(O)=0.0001705 *25*; α(P)=2.70×10^{-5} *4*; α(Q)=1.007×10^{-6} *15*
4011.4	(24$^+$)	485.1 *5*	100	3526.3	(22$^+$)	[E2]	0.0416	α(K)=0.0268 *4*; α(L)=0.01104 *16*; α(M)=0.00284 *4* α(N)=0.000750 *11*; α(O)=0.0001645 *24*; α(P)=2.61×10^{-5} *4*; α(Q)=9.84×10^{-7} *14*
4266.4	(25$^-$)	496.8 *5*	100	3769.6	(23$^-$)	[E2]	0.0393	α(K)=0.0255 *4*; α(L)=0.01023 *15*; α(M)=0.00263 *4* α(N)=0.000694 *10*; α(O)=0.0001524 *22*; α(P)=2.42×10^{-5} *4*; α(Q)=9.37×10^{-7} *14*
4512.2	(26$^+$)	500.8 *5*	100	4011.4	(24$^+$)	[E2]	0.0385	α(K)=0.0251 *4*; α(L)=0.00998 *15*; α(M)=0.00256 *4* α(N)=0.000676 *10*; α(O)=0.0001485 *22*; α(P)=2.36×10^{-5} *4*; α(Q)=9.21×10^{-7} *13*
4778.0?	(27$^-$)	511.6& *5*		4266.4	(25$^-$)			
5030.4?	(28$^+$)	518.2& *5*		4512.2	(26$^+$)			

† From weighted averages of available data.

‡ From ^{228}Th α decay.

From ce data in ^{224}Fr β^- decay, unless otherwise noted.

@ Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

& Placement of transition in the level scheme is uncertain.

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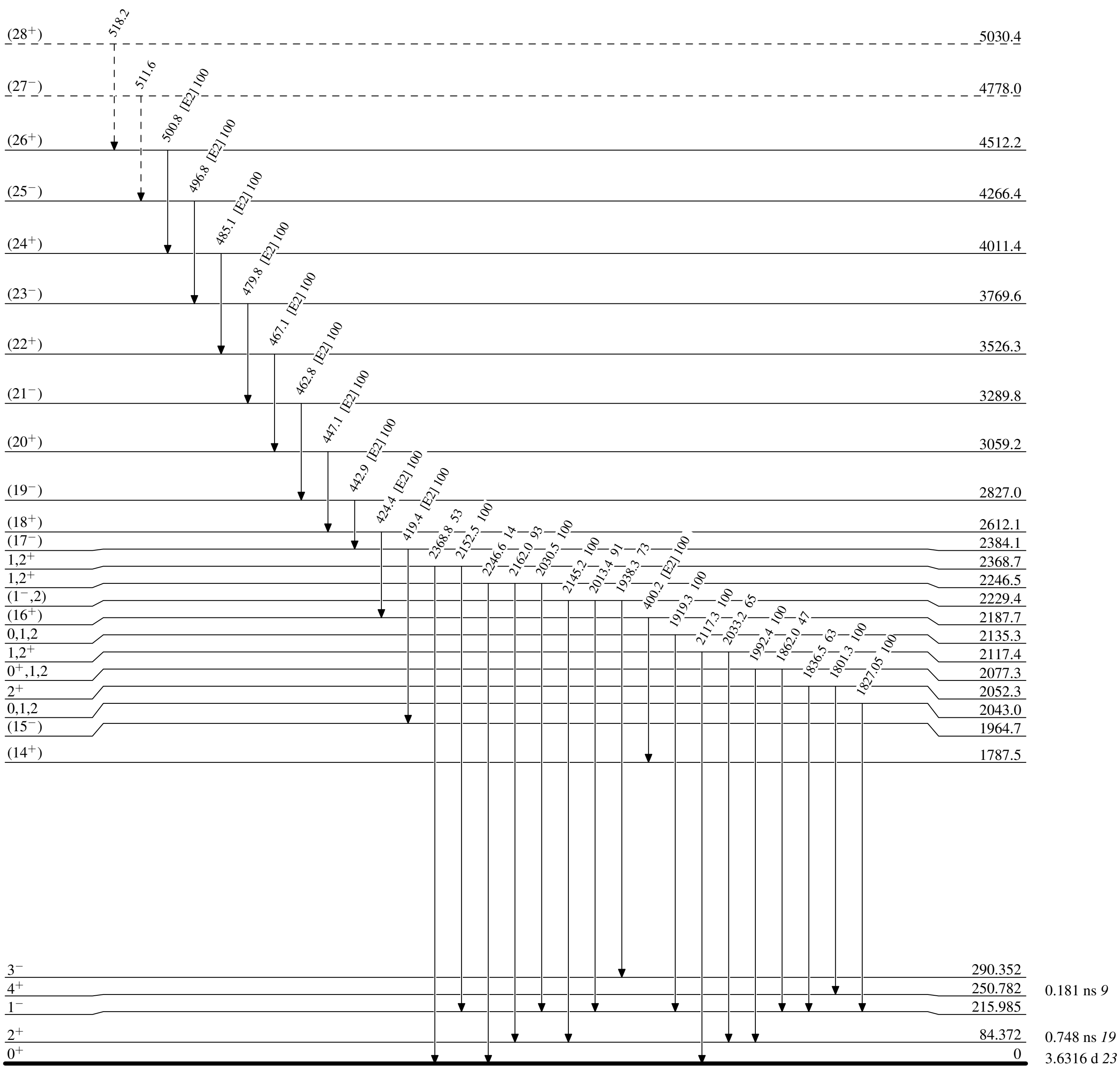
Adopted Levels, Gammas

Legend

Level Scheme

Intensities: Relative photon branching from each level

- - - - - -► γ Decay (Uncertain)



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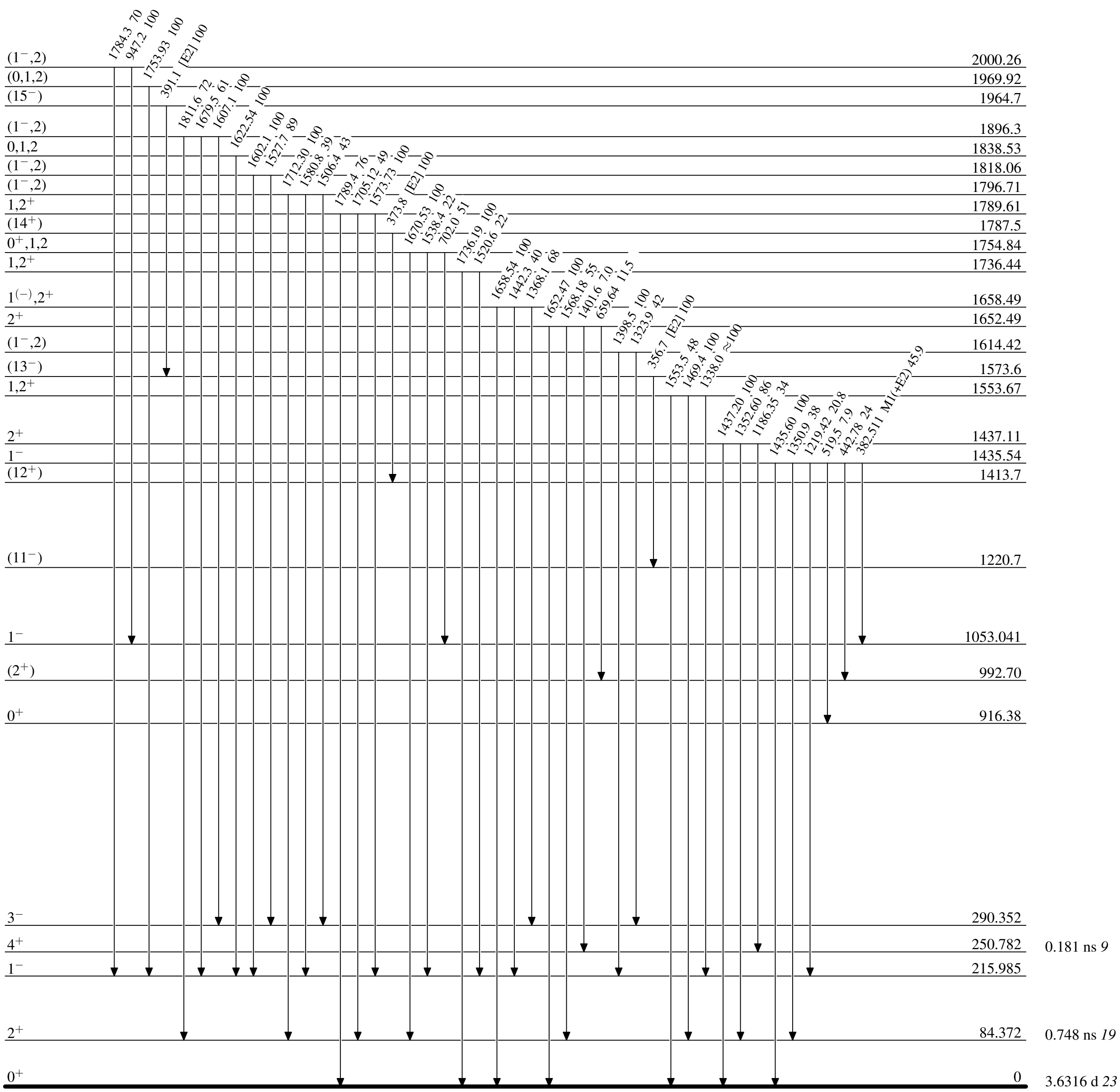
Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level



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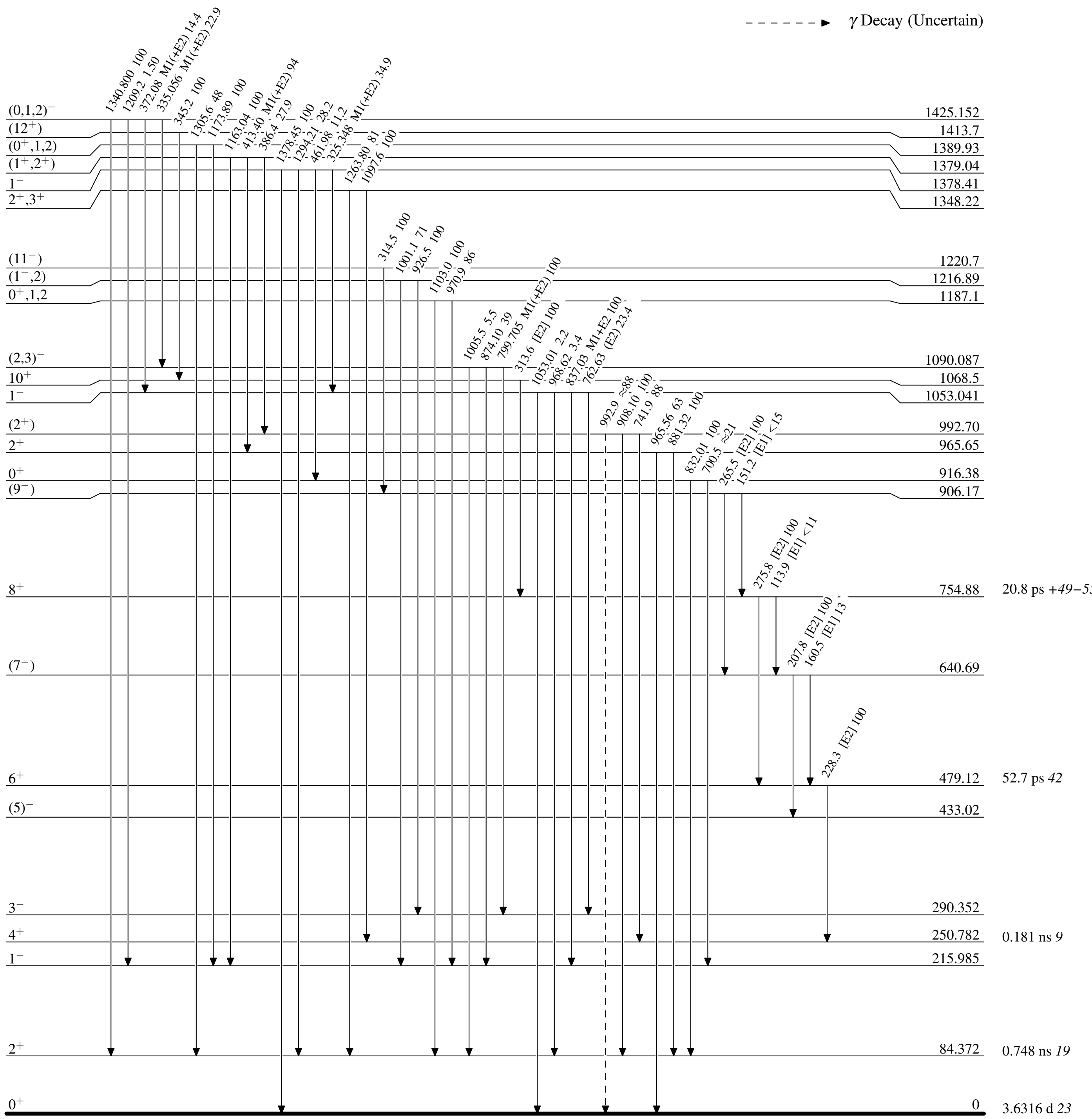
Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level



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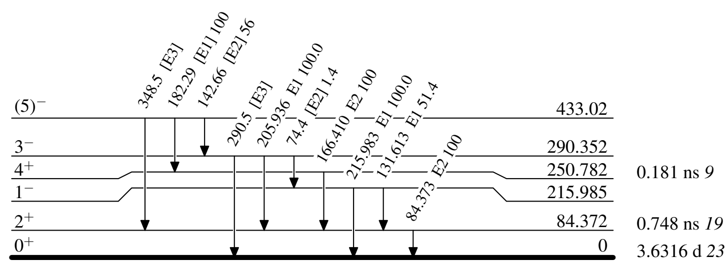
Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level



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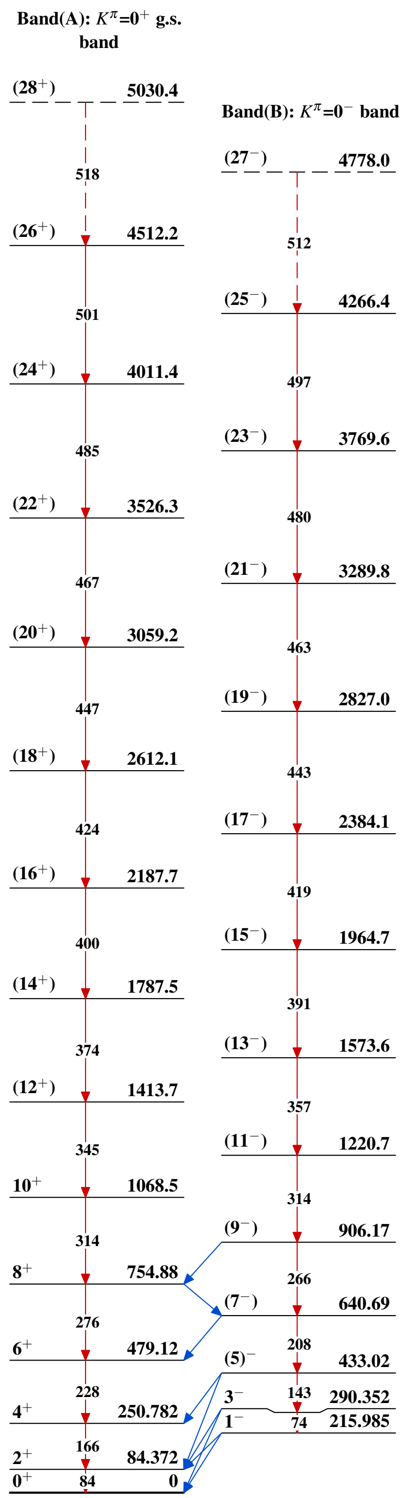
Adopted Levels, Gammas



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