Adopted Levels, Gammas

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Y. A. Akovali	NDS 77,433 (1996)	1-Feb-1996

Q(β^-)=−641 *4*; S(n)=6396 *3*; S(p)=7440 *13*; Q(α)=4870.62 *25* 2012Wa38
Note: Current evaluation has used the following Q record −640 3 *6396* 3 *7479* 104870.63 *25* 1995Au04.
Energies and wave functions of K^π=0$^-$, 2$^+$, 2$^-$, 3$^-$ and second 0$^-$ octupole-vibrational states were calculated by 1975Iv03. See 1983Pi04 for calculations of K^π=0$^-$, 0$^+$ octupole-vibrational state energies; see 1970Ne08 for calculated energies of K^π=0$^-$,1$^-$,2$^-$ and 3$^-$ bands; and 1982Zi02 for calculated energies of K^π=0$^-$ band. The energies of the rotational states of the 0$^+$ and 0$^-$ bands were calculated by 1995Al06, 1995De13 and 1995Jo11 and compared with the experimental level energies.
For calculations of equilibrium deformation parameters see, for example, 1975Iv03, 1982Du16, 1982Le19, 1983Ro14 and 1984Na22.
For calculations of electric quadrupole and hexadecapole moments see, for example, 1975Iv03 and 1983Ro14.
Effects of the Coriolis and centrifugal forces for nuclei with stable octupole deformation were examined; B(E3; 0$^+$ to 3$^-$,K=0) value and effective moments of inertia for g.s. and K^π=0$^-$ bands were calculated as a function of octupole deformation by 1983Ro15. See also 1970Ne08 for calculated B(E3; 0$^+$ to 3$^-$) and 1977Ba45 for calculated B(E3; 0$^+$ to 3$^-$), B(E1; 0$^+$ to 1$^-$) values for K^π=0$^-$ band.
See 1995De13 for calculated branching ratios for E1, E2, E3 transitions and comparisons with the experimental values.
Partial $T_{1/2}$ for heavy ion emission were calculated by 1984Po08, 1985Po11 and 1995Si05. See 1995Na13 for discussions on multiclustering.

^{226}Ra Levels

Cross Reference (XREF) Flags

A	^{226}Fr β^- decay	E	^{226}Ra(d,d′)
B	^{226}Ac ε decay	F	^{230}Th(d,^{6}Li)
C	^{230}Th α decay	G	(HI,xnγ)
D	Coulomb excitation		

E(level)	J$^\pi$&	$T_{1/2}$	XREF	Comments
0.0†	0$^+$	1600 y *7*	ABCDEFG	%α=100; %^{14}C=3.2×10^{-9} *16* %^{14}C/%α=3.2×10^{-11} *16* (1985Ho21). Other measurement: %^{14}C/%α≤1×10^{-10} (1985Al28). $T_{1/2}$: weighted average of 1622 y *13* (1949Ko01), 1617 y *12* (1956Se10), 1577 y *9* (1959Go80), 1602 y *8* (1959Ma12), 1599 y *7* (1966Ra13). Earlier measurement: 1590 y (1931Cu01).
67.67† *1*	2$^+$	0.63 ns *2*	ABCDEFG	J$^\pi$: 67.67γ to 0$^+$ is E2. $T_{1/2}$: by (α)(ce 68γ)(t) in ^{230}Th α decay.
211.54† *2*	4$^+$	≈0.17 ns	A CDEFG	J$^\pi$: 143.87γ to 2$^+$ is E2; level is Coulomb excited. $T_{1/2}$: by (α)(143γ)(t) in ^{230}Th α decay.
253.73‡ *1*	1$^-$		ABCDEFG	J$^\pi$: the 253.73γ to 0$^+$ is E1.
321.54‡ *6*	3$^-$		A CDEFG	B(E3)↑=1.10 *11*
416.5† *3*	6$^+$		CDEFG	
446.3‡ *2*	5$^-$		A CDEFG	
626.7‡ *2*	7$^-$		D G	
650	(0$^+$)		D F	J$^\pi$: 1984Va13 report that a 0$^+$ state at 650 keV was identified by R. Zimmerman on the basis of a multiple-Coulomb excitation study. The level was weakly populated, if at all, in (d,^{6}Li).
669.4† *3*	8$^+$		D G	
824.6# *1*	0$^+$		A C F	J$^\pi$: L=0 in (d,^{6}Li); the α-hindrance factor in ^{230}Th α decay; γ transition to 1$^-$ state and the nonobservation of any γ to 3$^-$ state of K=0$^-$ band are consistent with the assignment.

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Adopted Levels, Gammas (continued)

^{226}Ra Levels (continued)

E(level)	J^{π}[&]	XREF	Comments
857.6[‡] *3*	9⁻	D G	
873.7[#] *1*	2⁺	A C F	J^{π}: the γ transitions to the 1⁻ and 3⁻ states of the K=0⁻ band; the α hindrance factor; L=2 in (d,^{6}Li).
959.9[†] *3*	10⁺	D G	
1048.8[@] *1*	1⁻	A F	J^{π}: the γ transitions to the 0⁺, 2⁺ states of g.s. band suggest 1 or 2⁺. L=1 in ^{230}Th(d,^{6}Li) determines π=−.
1070.5[@] *2*	(2⁻)	A	J^{π}: gammas to 2⁺ and 1⁻ levels and log *ft*=7.2 for the β branch from 1⁻ ^{226}Fr suggest J^{π}=0⁺,1,2. The J^{π}=2⁻ of K=1 band assignment was proposed by 1981Ku02 from spacing relative to the 1⁻ state at 1048.8 keV.
1077.2 *2*	1⁻,2	A	J^{π}: gammas to 2⁺, 1⁻, 3⁻ states and log *ft*=7.1 for the β decay from 1⁻ ^{226}Fr suggest J^{π}=2,1⁻.
1107 *3*	2⁺,3⁻	E	J^{π}: assigned by 1990Th02 from (d,d′) data, based on their observed deuteron-angular distributions, and on cross sections.
1122.4 *3*	(2⁺)	A E	J^{π}: γ to 4⁺ and log *ft*=8.6 for the β^- feeding from 1⁻ ^{226}Fr suggest J^{π}=2⁺ or 3⁺. From the (d,d′) data, 1990Th02 assigned 2⁺,3⁻. By assuming that the levels populated in the β^- decay and in the (d,d′) reaction are the same, J^{π}=(2⁺) is adopted.
1133.1[‡] *3*	11⁻	D G	
1140	[a]	F	
1156.2 *1*	2⁺	A E	J^{π}: gammas to 0⁺ and 4⁺.
1220		F	
1238.9 *5*	(2)	A	Gammas to 2⁺, 3⁻ states and β^- decay from 1⁻ ^{226}Fr are consistent with J^{π}=1⁻,2. The Alaga rule and absence of a γ to the g.s. imply J=2.
1280.5[†] *4*	12⁺	D G	
1330		F	
1390.0 *1*	2⁺	A E	J^{π}: gammas to 0⁺, 2⁺ states suggest J^{π}=1, 2⁺; the authors of 1990Th02 assign 2⁺ from their (d,d′) data.
1420	[a]	F	This level might be the same level observed in ^{226}Fr β^- decay at 1422.5.
1422.5 *10*	0,1,2	A	J^{π}: γ to 1⁻ and the log *ft* of 8.0 for the β^- decay from the 1⁻, ^{226}Fr suggest J^{π}=0, 1 or 2.
1437.8 *7*	1⁻,2	A	Gammas to 1⁻, 3⁻ states and the log *ft* of 8.2 from 1⁻ ^{226}Fr suggest J^{π}=1⁻ or 2.
1446[‡]	13⁻	D	
1540	[a]	F	
1587.3 *5*	1,2⁺	A	J^{π}: gammas to 0⁺, 1⁻ levels.
1621.3 *5*	1⁻,2⁺	A	J^{π}: gammas to 0⁺, 3⁻ states.
1625[†]	14⁺	D	
1723.4 *3*	2⁺	A E	J^{π}: from the gammas to 0⁺ and 1⁻ levels, J^{π} is 1 or 2⁺; the authors of 1990Th02 assign J^{π}=2⁺ from their (d,d′) data.
1738.5 *10*	1,2⁺	A	J^{π}: gammas to 0⁺ and 1⁻ levels.
1756.2 *10*	1,2⁺	A	J^{π}: gammas to 0⁺, 1⁻ levels.
1767.1 *10*	0,1,2	A	J^{π}: log *ft*=7.2 for the β^- decay from the 1⁻ ^{226}Fr parent.
1778.4 *10*	0,1,2	A	J^{π}: log *ft*=7.2 for the β^- decay from the 1⁻ parent.
1786.1 *10*	1⁻,2⁺	A	J^{π}: gammas to 0⁺, 3⁻ levels.
1793[‡]	15⁻	D	
1865.0 *10*	1,2⁺	A	J^{π}: gammas to 0⁺, 2⁺ levels.
1882.3 *7*	0,1,2	A	J^{π}: log *ft*=7.6 for the β branch from ^{226}Fr, 1⁻ parent;
1888.4 *15*	0,1,2	A	J^{π}: log *ft*=7.8 for the β^- decay from the 1⁻ parent.
1897.4 *10*	1⁻,2⁺	A	J^{π}: gammas to 0⁺, 3⁻ levels.
1907.8 *10*	1,2⁺	A	J^{π}: γ to 0⁺ g.s.
1945.6 *10*	1,2⁺	A	J^{π}: γ to 0⁺ g.s.
1951.0 *10*	1⁻,2⁺	A	J^{π}: gammas to 0⁺, 3⁻ levels.
1970.8 *5*	1⁻,2⁺	A	J^{π}: gammas to 0⁺, 3⁻ levels.
1982.7 *10*	0⁺,1	A	J^{π}: from log *ft*=7.3 for β^- decay from 1⁻ ^{226}Fr, J≤2; from γ to 2⁺ state J^{π} Ne 0⁻; γ to 1⁻ of octupole-vibrational band but not to the 3⁻ member of this band suggests J Ne 2.

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Adopted Levels, Gammas (continued)

^{226}Ra Levels (continued)

E(level)	J^{π} &	XREF	Comments
1993 †	16^+	D	
2006.7 *15*	0,1,2	A	log *ft*=7.3 for the β^- decay from 1^- ^{226}Fr parent.
2015.2 *15*	0,1,2	A	log *ft*=7.5 for the β branch from 1^- ^{226}Fr parent.
2056.8 *5*	1,2^+	A	J^{π}: γ to 0^+ g.s.
2086.1 *10*	1,2^+	A	J^{π}: γ to 0^+ g.s.
2170 ‡	17^-	D	
2182.3 *15*	0,1,2	A	log *ft*=7.5 for the β branch from 1^- ^{226}Fr parent.
2189.4 *10*	2^+	A E	J^{π}: (d,d′) data and γ to 0^+ g.s..
2269.7 *10*	1,2^+	A	J^{π}: γ to 0^+ g.s.
2382 †	18^+	D	

† Band(A): K=0 g.s. band.
‡ Band(B): K=0 octupole vibrational band.
# Band(C): K=0 band.
@ Band(D): K=1 band.
& The J^{π} assignments for all levels of the g.s. band and the K=0 octupole-vibrational band are from the Coulomb excitation, γ-decay pattern, and the (HI,xnγ) data. The arguments for the 2^+ and the 1^- states of these two bands are given explicitly. Assignments made from (d,d′) data are based on deuteron angular distributions and on measured cross sections.
[a] From J^{π}=L^{-1}, deduced in (d,^{6}Li).

γ(^{226}Ra)

E_i(level)	J^{π}_i	E_{γ} †	I_{γ} ‡	E_f	J^{π}_f	Mult. #	α @	Comments
67.67	2^+	67.67 *1*	100	0.0	0^+	E2	61.9	B(E2)(W.u.)=123 *5*
211.54	4^+	143.87 *1*	100	67.67	2^+	E2	2.11	B(E2)(W.u.)≈212
253.73	1^-	186.05 *1*	73 *4*	67.67	2^+	E1	0.108	
		253.73 *1*	100 *7*	0.0	0^+	E1	0.0520	
321.54	3^-	67.81 *20*		253.73	1^-			
		110.00 *5*	10 *3*	211.54	4^+			
		253.9 *1*	100 *11*	67.67	2^+			
416.5	6^+	204.9 *3*	100	211.54	4^+			
446.3	5^-	124.8 *2*	3.3 *11*	321.54	3^-			
		234.8 *2*	100	211.54	4^+			
626.7	7^-	180.4 *2*	8.5 *10*	446.3	5^-			
		210.3 *2*	100	416.5	6^+			
650	(0^+)	396		253.73	1^-			E_{γ}: from Coulomb excitation.
669.4	8^+	252.8 *2*	100	416.5	6^+			
824.6	0^+	570.9 *1*	100	253.73	1^-			
857.6	9^-	188.2 *2*	100	669.4	8^+			
		231.0 *2*	54 *5*	626.7	7^-			
873.7	2^+	552.2 *1*	91 *7*	321.54	3^-			
		620.0 *1*	100 *10*	253.73	1^-			
959.9	10^+	290.6 *2*	100	669.4	8^+			
1048.8	1^-	795.1 *1*	32 *3*	253.73	1^-			
		980.6 *5*	100 *10*	67.67	2^+			
		1048.1 *5*	79 *9*	0.0	0^+			
1070.5	(2^-)	816.9 *2*	14.7 *14*	253.73	1^-			
		1002.2 *5*	100 *10*	67.67	2^+			
1077.2	1^-,2	755.8 *2*	9.5 *10*	321.54	3^-			
		823.5 *3*	7.8 *8*	253.73	1^-			
		1009.0 *5*	100 *10*	67.67	2^+			

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Adopted Levels, Gammas (continued)

$\gamma(^{226}Ra)$ (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[‡]	E_f	J^π_f
1122.4	(2^+)	910.9 *2*	100	211.54	4^+
1133.1	11^-	173.2 *2*	70 *7*	959.9	10^+
		275.5 *2*	100	857.6	9^-
1156.2	2^+	834.7 *1*	56 *4*	321.54	3^-
		902.6 *3*	16.0 *12*	253.73	1^-
		944.6 *3*	100 *10*	211.54	4^+
		1087.9 *5*	42 *4*	67.67	2^+
		1155.8 *5*	60 *6*	0.0	0^+
1238.9	(2)	917.3 *5*	50 *10*	321.54	3^-
		1171.7 *10*	100 *15*	67.67	2^+
1280.5	12^+	320.6 *2*		959.9	10^+
1390.0	2^+	516.30 *5*	10.4 *8*	873.7	2^+
		565.4 *1*	8.2 *8*	824.6	0^+
		1322.5 *5*	100 *9*	67.67	2^+
		1390.7 *10*	57 *6*	0.0	0^+
1422.5	0,1,2	1168.8 *10*	100	253.73	1^-
1437.8	1^-,2	1117.0 *10*	100 *25*	321.54	3^-
		1183.5 *8*	86 *9*	253.73	1^-
1446	13^-	166		1280.5	12^+
		313		1133.1	11^-
1587.3	$1,2^+$	1333.6 *5*	100 *19*	253.73	1^-
		1587.0 *15*	15 *4*	0.0	0^+
1621.3	$1^-,2^+$	1299.6 *5*	100 *14*	321.54	3^-
		1368.3 *10*	53 *14*	253.73	1^-
		1554.4 *15*	25 *6*	67.67	2^+
		1620.9 *15*	29 *4*	0.0	0^+
1625	14^+	179		1446	13^-
		345		1280.5	12^+
1723.4	2^+	646.2 *3*	13 *3*	1077.2	1^-,2
		1471.1 *10*	100 *16*	253.73	1^-
		1655.0 *10*	53 *7*	67.67	2^+
		1722.1 *15*	26 *4*	0.0	0^+
1738.5	$1,2^+$	1486.2 *15*	18 *3*	253.73	1^-
		1670.4 *10*	52 *7*	67.67	2^+
		1738.3 *10*	100 *10*	0.0	0^+
1756.2	$1,2^+$	1503.2 *10*	29 *4*	253.73	1^-
		1755.4 *10*	100 *15*	0.0	0^+
1767.1	0,1,2	1513.4 *10*		253.73	1^-
1778.4	0,1,2	1524.7 *10*		253.73	1^-
1786.1	$1^-,2^+$	1465.2 *15*	64 *14*	321.54	3^-
		1532.4 *10*	100 *19*	253.73	1^-
		1785.2 *15*	17 *4*	0.0	0^+
1793	15^-	168		1625	14^+
		347		1446	13^-
1865.0	$1,2^+$	991.4 *8*	23 *4*	873.7	2^+
1865.0	$1,2^+$	1610.7 *10*	100 *11*	253.73	1^-
		1797.2 *15*	26 *4*	67.67	2^+
		1865.5 *10*	58 *6*	0.0	0^+
1882.3	0,1,2	444.50 *5*		1437.8	1^-,2
1888.4	0,1,2	1634.7 *15*		253.73	1^-
1897.4	$1^-,2^+$	1576.0 *10*	100 *29*	321.54	3^-
		1685.2 *15*	57 *12*	211.54	4^+
		1897.8 *15*	72 *15*	0.0	0^+
1907.8	$1,2^+$	1083.6 *8*	63 *12*	824.6	0^+
		1839.6 *10*	100 *10*	67.67	2^+
		1907.4 *15*	44 *9*	0.0	0^+
1945.6	$1,2^+$	1692.6 *10*	100 *12*	253.73	1^-
		1944.0 *15*	14 *4*	0.0	0^+
1951.0	$1^-,2^+$	1628.2 *15*	24 *4*	321.54	3^-
		1697.3 *10*	82 *12*	253.73	1^-
		1883.9 *10*	100 *12*	67.67	2^+
		1951.1 *15*	31 *1*	0.0	0^+
1970.8	$1^-,2^+$	848.3 *5*	13.4 *20*	1122.4	(2^+)
		1648.9 *15*	16.1 *22*	321.54	3^-
		1716.8 *10*	78 *8*	253.73	1^-
		1903.4 *10*	100 *10*	67.67	2^+
		1971.1 *10*	32 *5*	0.0	0^+
1982.7	0^+,1	1109.7 *10*	36 *8*	873.7	2^+
		1728.4 *10*	100 *10*	253.73	1^-
		1914.8 *15*	38 *6*	67.67	2^+
1993	16^+	200[&]		1793	15^-
		368		1625	14^+
2006.7	0,1,2	1753.0 *15*		253.73	1^-
2015.2	0,1,2	1761.5 *15*		253.73	1^-
2056.8	$1,2^+$	1231.9 *5*	100 *10*	824.6	0^+
		1990.3 *10*	96 *10*	67.67	2^+
		2056.9 *15*	43 *7*	0.0	0^+
2086.1	$1,2^+$	2017.6 *10*	100 *17*	67.67	2^+
		2087.8 *15*	18 *5*	0.0	0^+
2170	17^-	177		1993	16^+
		377		1793	15^-
2182.3	0,1,2	1928.6 *15*		253.73	1^-
2189.4	2^+	1365.0 *10*	75 *30*	824.6	0^+
		2120.9 *10*	100 *14*	67.67	2^+
		2190.9 *15*	31 *5*	0.0	0^+
2269.7	$1,2^+$	2014.4 *15*	60 *12*	253.73	1^-
		2202.2 *10*	100 *11*	67.67	2^+
		2272.0 *20*	27 *9*	0.0	0^+
2382	18^+	389		1993	16^+

† From ^{226}Fr β^- decay, ^{230}Th α decay and (HI,xnγ), except where noted.

‡ Relative photon intensity deexciting each level, adopted from ^{226}Fr β^- decay, ^{230}Th α decay and (HI,xnγ) data.

\# From ce work in ^{230}Th α decay and ^{226}Ac ε decay.

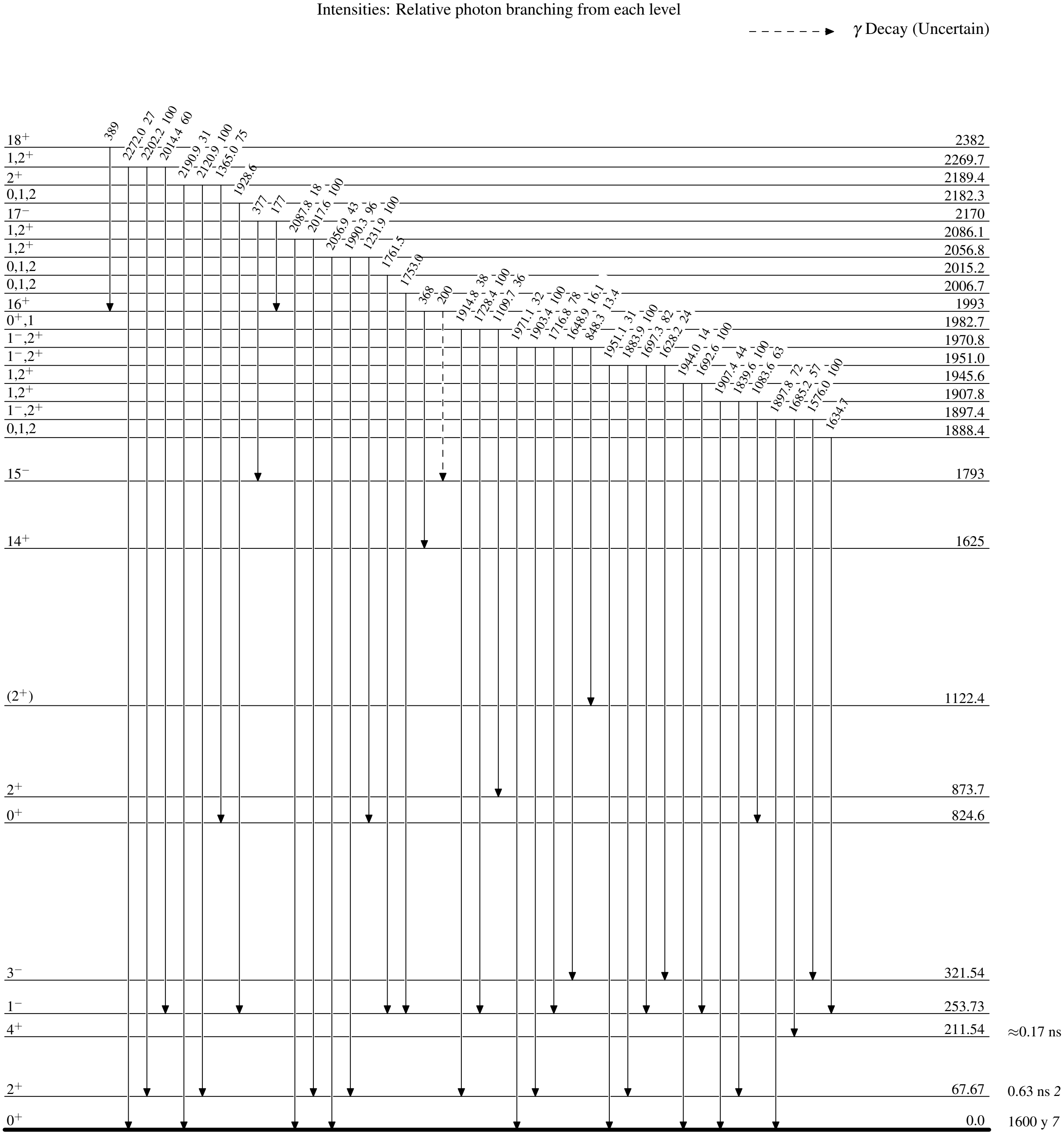
@ Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

& Placement of transition in the level scheme is uncertain.

Adopted Levels, Gammas

Level Scheme

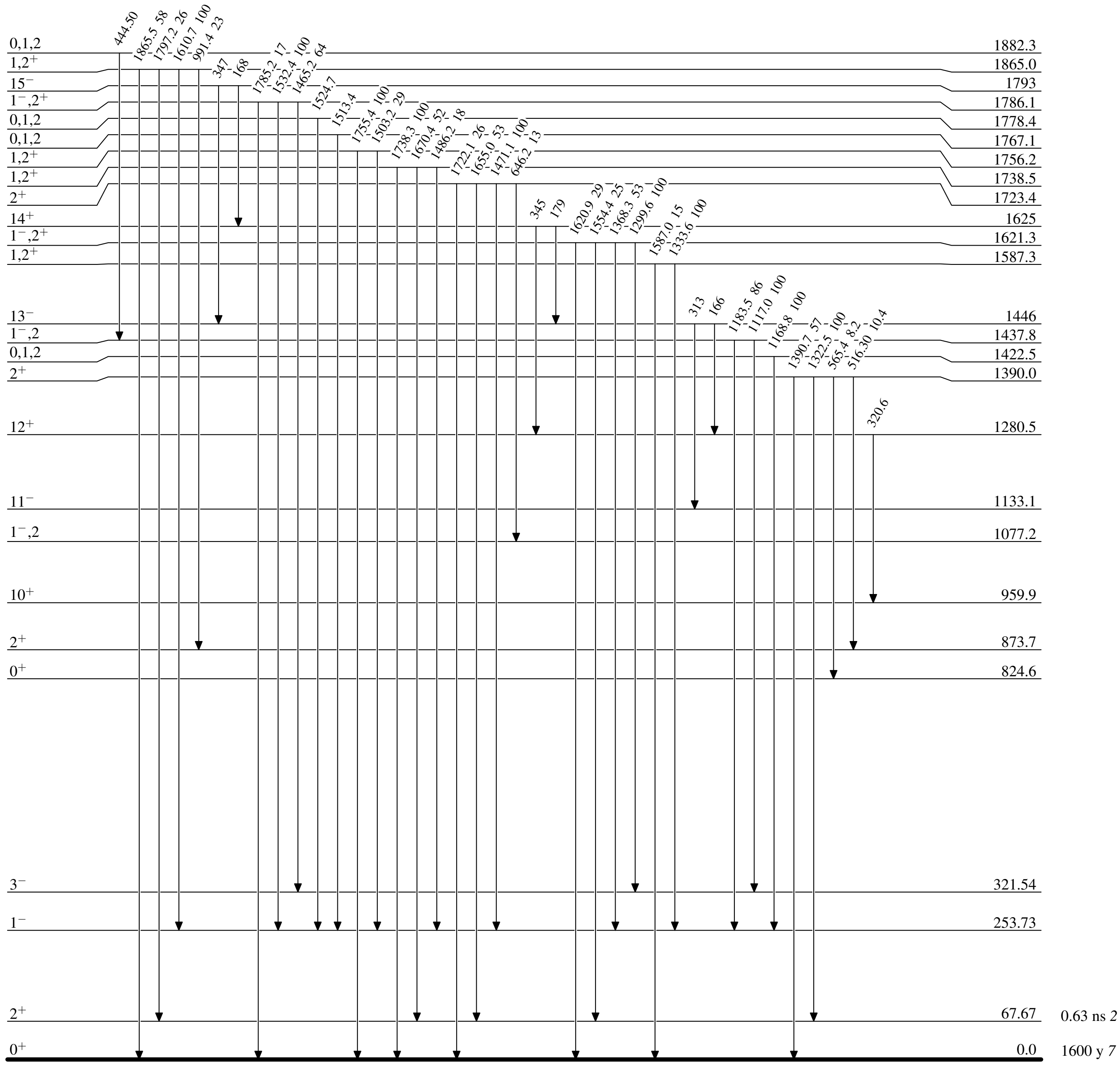
Intensities: Relative photon branching from each level



Adopted Levels, Gammas

Level Scheme (continued)

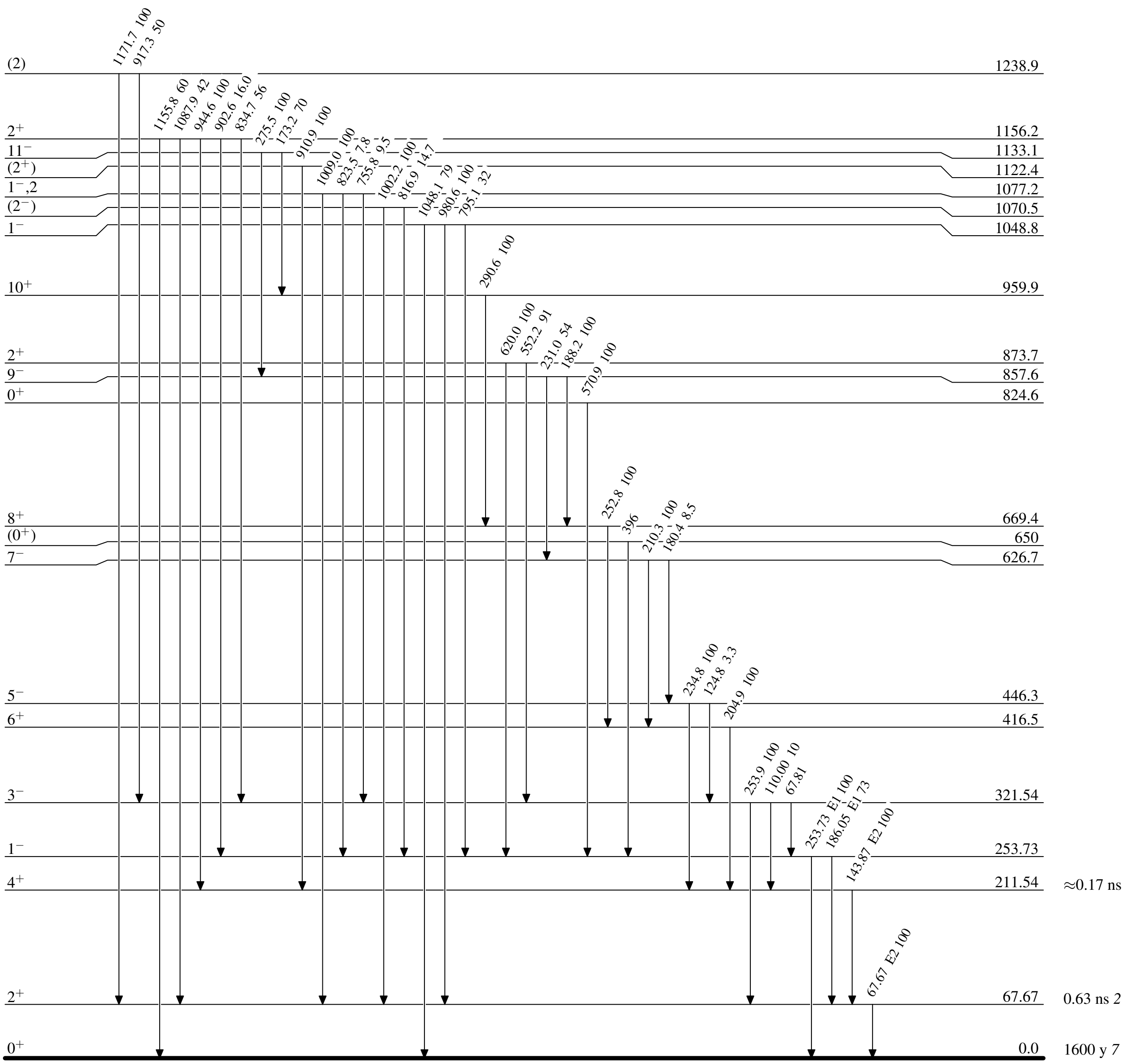
Intensities: Relative photon branching from each level



Adopted Levels, Gammas

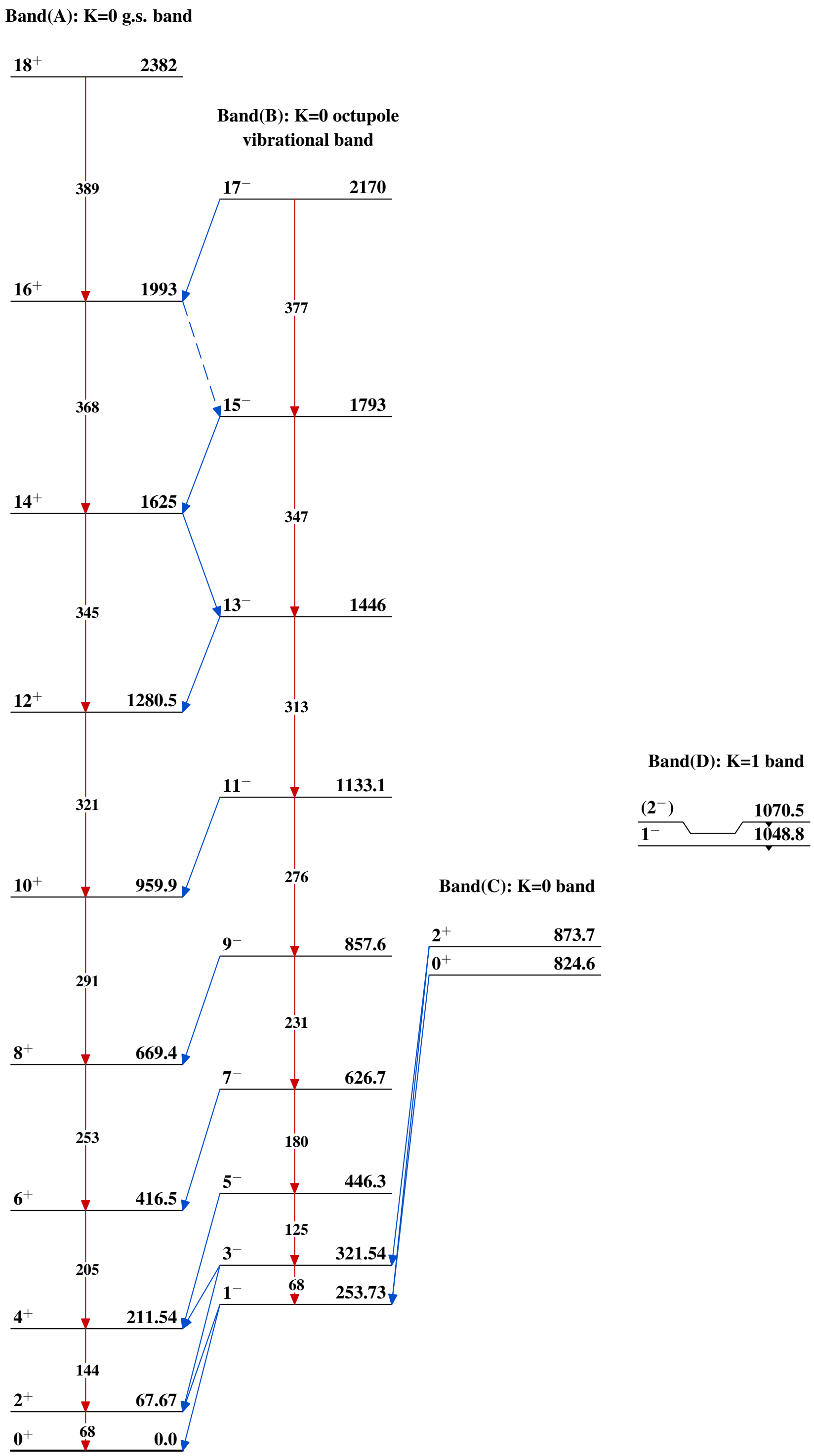
Level Scheme (continued)

Intensities: Relative photon branching from each level



$^{226}_{88}Ra_{138}$

Adopted Levels, Gammas



$^{226}_{88}Ra_{138}$