^{226}Ra(α,6nγ) 1993Ac02

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

History

1993Ac02 (also 1986Sc18): Eα=55 MeV from Bonn cyclotron facility, target=300 μg/cm^2 sandwiched between 40 μg/cm2 carbon and beryllium; measured Eγ, Iγ, ce, γ(ce)-coin, $\alpha\gamma$(ce)-coin, (ce)(ce)(t) using Ge detectors and double orange spectrometer. Deduced levels, J^π, multipolarity, level half-life, B(E1)/B(E2) ratios, intrinsic electric dipole to quadrupole moments.

1993Ac02 state that a large number of additional γ rays at higher higher energies were observed but were not assigned to rotational bands. The authors further cite Ph.D. theses by M. Marten-Tolle and B. Ackermann, University of Bonn (1992) for details of data. The evaluators of the current evaluation obtained copies of both the theses through McMaster University library, but could not find any more details than given in the paper by 1993Ac02.

^{224}Th Levels

Ratios of magnitude of electric dipole moment D_0 to electric quadrupole moment Q_0 deduced by 1993Ac02 from experimental B(E1)/B(E2) ratios are listed under comments as D_0/Q_0.

The level scheme is that proposed by 1993Ac02 based on coincidence relations and energy sums.

E(level)†	J^π‡	$T_{1/2}$	Comments
0.0#	0^+		
98.1# *3*	2^+	0.590 ns *40*	$T_{1/2}$: from (186 ce(L2))(98 ce(L2))(t) (1986Sc18).
251.0?@ *3*	1^-		
284.1# *5*	4^+		
305.3@ *5*	3^-		
464.5@ *5*	5^-		
534.7# *5*	6^+		$D_0/Q_0=7.3\times10^{-4}$ fm^{-1} *11*.
699.5@ *5*	7^-		
833.9# *6*	8^+		$D_0/Q_0=6.7\times10^{-4}$ fm^{-1} *7*.
997.7@ *6*	9^-		
1173.8# *6*	10^+		$D_0/Q_0=7.3\times10^{-4}$ fm^{-1} *4*.
1347.3@ *6*	11^-		$D_0/Q_0=8.8\times10^{-4}$ fm^{-1} *6*.
1549.8# *6*	12^+		$D_0/Q_0=8.4\times10^{-4}$ fm^{-1} *4*.
1738.7@ *6*	13^-		$D_0/Q_0=8.0\times10^{-4}$ fm^{-1} *4*.
1958.9# *7*	14^+		$D_0/Q_0=9.3\times10^{-4}$ fm^{-1} *5*.
2164.7@ *7*	15^-		$D_0/Q_0=8.9\times10^{-4}$ fm^{-1} *6*.
2398.0# *7*	16^+		
2620.2?@ *7*	17^-		$D_0/Q_0=10.0\times10^{-4}$ fm^{-1} *13*.
2864?#	18^+		

† From least squares fit to Eγ data.
‡ As proposed by 1993Ac02, based on multipolarity assignments, band structure and systematics.
# Band(A): $K^\pi=0^+$ g.s. band.
@ Band(B): $K^\pi=0^-$ band.

^{226}Ra(α,6nγ) 1993Ac02 (continued)

γ(^{224}Th)

E_i(level)	J^π_i	E_γ[†]	I_γ[#]	E_f	J^π_f	Mult.[‡]	α[&]	Comments
98.1	2+	98.1 *3*		0.0	0+	E2	12.33 *25*	α(L)=9.01 *19*; α(M)=2.48 *5* α(N)=0.664 *14*; α(O)=0.148 *3*; α(P)=0.0245 *5*; α(Q)=0.0001059 *19*
251.0?	1−	152.9[a] *3*		98.1	2+			
284.1	4+	186.0 *3*		98.1	2+	E2	0.863	α(K)=0.179 *3*; α(L)=0.501 *8*; α(M)=0.1367 *22* α(N)=0.0366 *6*; α(O)=0.00821 *13*; α(P)=0.001383 *22*; α(Q)=1.482×10^{-5} *22*
305.3	3−	207.2 *3*		98.1	2+			
464.5	5−	180.4 *3*		284.1	4+			
534.7	6+	70.2 *3*	85 *25*	464.5	5−	[E1]	0.299 *6*	α(L)=0.226 *4*; α(M)=0.0552 *10* α(N)=0.0145 *3*; α(O)=0.00325 *6*; α(P)=0.000556 *10*; α(Q)=2.84×10^{-5} *5* Iγ(70)/Iγ(251)=0.85 *25* (1993Ac02).
		250.6 *3*	100	284.1	4+	(E2)	0.299	α(K)=0.1039 *15*; α(L)=0.1435 *22*; α(M)=0.0388 *6* α(N)=0.01040 *16*; α(O)=0.00234 *4*; α(P)=0.000399 *6*; α(Q)=6.96×10^{-6} *10*
699.5	7−	164.8 *3*		534.7	6+			
		235.0 *3*		464.5	5−			
833.9	8+	134.4 *3*	100	699.5	7−	[E1]	0.243	α(K)=0.189 *3*; α(L)=0.0410 *7*; α(M)=0.00992 *15* α(N)=0.00261 *4*; α(O)=0.000598 *9*; α(P)=0.0001075 *17*; α(Q)=6.79×10^{-6} *10*
		299.2 *3*	50 *10*	534.7	6+	[E2]	0.1700	α(K)=0.0733 *11*; α(L)=0.0712 *11*; α(M)=0.0191 *3* α(N)=0.00512 *8*; α(O)=0.001156 *17*; α(P)=0.000199 *3*; α(Q)=4.58×10^{-6} *7* Iγ(134)/Iγ(299)=2.0 *4* (1993Ac02).
997.7	9−	163.8 *3*		833.9	8+			
		298.2 *3*		699.5	7−			
1173.8	10+	176.1 *3*	100	997.7	9−	[E1]	0.1276	α(K)=0.1004 *15*; α(L)=0.0205 *3*; α(M)=0.00495 *8* α(N)=0.001306 *20*; α(O)=0.000301 *5*; α(P)=5.49×10^{-5} *8*; α(Q)=3.73×10^{-6} *6*
		339.9 *3*	36 *4*	833.9	8+	[E2]	0.1166	α(K)=0.0569 *8*; α(L)=0.0440 *7*; α(M)=0.01172 *17* α(N)=0.00314 *5*; α(O)=0.000711 *11*; α(P)=0.0001234 *18*; α(Q)=3.42×10^{-6} *5* Iγ(176)/Iγ(340)=2.8 *3* (1993Ac02). E_γ: from 1986Sc18. Eγ=399.9 in figure 13 of 1993Ac02 is a misprint .
1347.3	11−	173.4 *3*	100	1173.8	10+	[E1]	0.1323	α(K)=0.1041 *16*; α(L)=0.0213 *4*; α(M)=0.00515 *8* α(N)=0.001359 *20*; α(O)=0.000313 *5*; α(P)=5.70×10^{-5} *9*; α(Q)=3.86×10^{-6} *6*
		349.6 *3*	30 *4*	997.7	9−	[E2]	0.1076	α(K)=0.0539 *8*; α(L)=0.0396 *6*; α(M)=0.01055 *16* α(N)=0.00282 *4*; α(O)=0.000640 *10*; α(P)=0.0001114 *16*; α(Q)=3.21×10^{-6} *5* Iγ(173)/Iγ(350)=3.3 *4* (1993Ac02).
1549.8	12+	202.5 *3*	100	1347.3	11−	[E1]	0.0916	α(K)=0.0725 *11*; α(L)=0.01446 *21*; α(M)=0.00348 *5* α(N)=0.000920 *14*; α(O)=0.000212 *3*; α(P)=3.90×10^{-5} *6*; α(Q)=2.74×10^{-6} *4*
		376.0 *3*	29 *3*	1173.8	10+	[E2]	0.0880	α(K)=0.0467 *7*; α(L)=0.0305 *5*; α(M)=0.00807 *12* α(N)=0.00216 *3*; α(O)=0.000491 *7*; α(P)=8.58×10^{-5} *13*; α(Q)=2.73×10^{-6} *4* Iγ(202)/Iγ(376)=3.4 *3* (1993Ac02).
1738.7	13−	188.9 *3*	100	1549.8	12+	[E1]	0.1080	α(K)=0.0853 *13*; α(L)=0.0172 *3*; α(M)=0.00414 *6* α(N)=0.001094 *16*; α(O)=0.000252 *4*; α(P)=4.62×10^{-5} *7*; α(Q)=3.20×10^{-6} *5*
		391.4 *3*	50 *5*	1347.3	11−	[E2]	0.0790	α(K)=0.0432 *6*; α(L)=0.0264 *4*; α(M)=0.00698 *10*

Continued on next page (footnotes at end of table)

^{226}Ra(α,6nγ) 1993Ac02 (continued)

γ(^{224}Th) (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[#]	E_f	J^π_f	Mult.[‡]	α[&]	Comments
								α(N)=0.00187 *3*; α(O)=0.000425 *6*; α(P)=7.45×10^{-5} *11*; α(Q)=2.50×10^{-6} *4* Iγ(189)/Iγ(391)=2.01 *20* (1993Ac02).
1958.9	14$^+$	220.2 *3*	100	1738.7	13$^-$	[E1]	0.0753	α(K)=0.0598 *9*; α(L)=0.01175 *17*; α(M)=0.00283 *4* α(N)=0.000747 *11*; α(O)=0.0001728 *25*; α(P)=3.18×10^{-5} *5*; α(Q)=2.29×10^{-6} *4*
		409.0 *3*	29 *3*	1549.8	12$^+$	[E2]	0.0703	α(K)=0.0396 *6*; α(L)=0.0227 *4*; α(M)=0.00598 *9* α(N)=0.001599 *23*; α(O)=0.000364 *6*; α(P)=6.40×10^{-5} *10*; α(Q)=2.27×10^{-6} *4* Iγ(220)/Iγ(409)=3.5 *4* (1993Ac02).
2164.7	15$^-$	205.8 *3*	100	1958.9	14$^+$	[E1]	0.0882	α(K)=0.0699 *10*; α(L)=0.01389 *20*; α(M)=0.00334 *5* α(N)=0.000883 *13*; α(O)=0.000204 *3*; α(P)=3.75×10^{-5} *6*; α(Q)=2.65×10^{-6} *4*
		426.1 *3*	45 *6*	1738.7	13$^-$	[E2]	0.0633	α(K)=0.0366 *6*; α(L)=0.0197 *3*; α(M)=0.00518 *8* α(N)=0.001386 *20*; α(O)=0.000316 *5*; α(P)=5.57×10^{-5} *8*; α(Q)=2.08×10^{-6} *3* Iγ(206)/Iγ(426)=2.2 *3* (1993Ac02).
2398.0	16$^+$	233.3 *3*		2164.7	15$^-$			
		439.1 *3*		1958.9	14$^+$			
2620.2?	17$^-$	222.3[@a]	100	2398.0	16$^+$	[E1]	0.0737	α(K)=0.0585 *9*; α(L)=0.01148 *16*; α(M)=0.00276 *4* α(N)=0.000730 *11*; α(O)=0.0001688 *24*; α(P)=3.11×10^{-5} *5*; α(Q)=2.24×10^{-6} *4*
		455.4[a] *3*	42 *11*	2164.7	15$^-$	[E2]	0.0535	α(K)=0.0322 *5*; α(L)=0.01579 *23*; α(M)=0.00413 *6* α(N)=0.001104 *16*; α(O)=0.000252 *4*; α(P)=4.47×10^{-5} *7*; α(Q)=1.81×10^{-6} *3* Iγ(222)/Iγ(455)=2.4 *6* (1993Ac02).
2864?	18$^+$	466[a] *1*		2398.0	16$^+$			

† 1993Ac02 state that the uncertainty varies from 0.1 keV for transitions between the lower levels to 0.3 keV for transitions between the upper levels. The evaluators assigned an uncertainty of ±0.3 keV to all transitions.

‡ From Adopted Gammas. 1986Sc18 state that the multipolarities of the stronger γ rays were determined from Iγ and I(ce), but do not provide experimental information.

Relative branching ratios deduced from measured Iγ(E1:J to J-1)/Iγ(E2: J to J-2).

@ Deduced from level energies; γ not shown in level scheme figure 13, but is present in spectral figure 3 and in table 2 of 1993Ac02.

& 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.

^{a} Placement of transition in the level scheme is uncertain.

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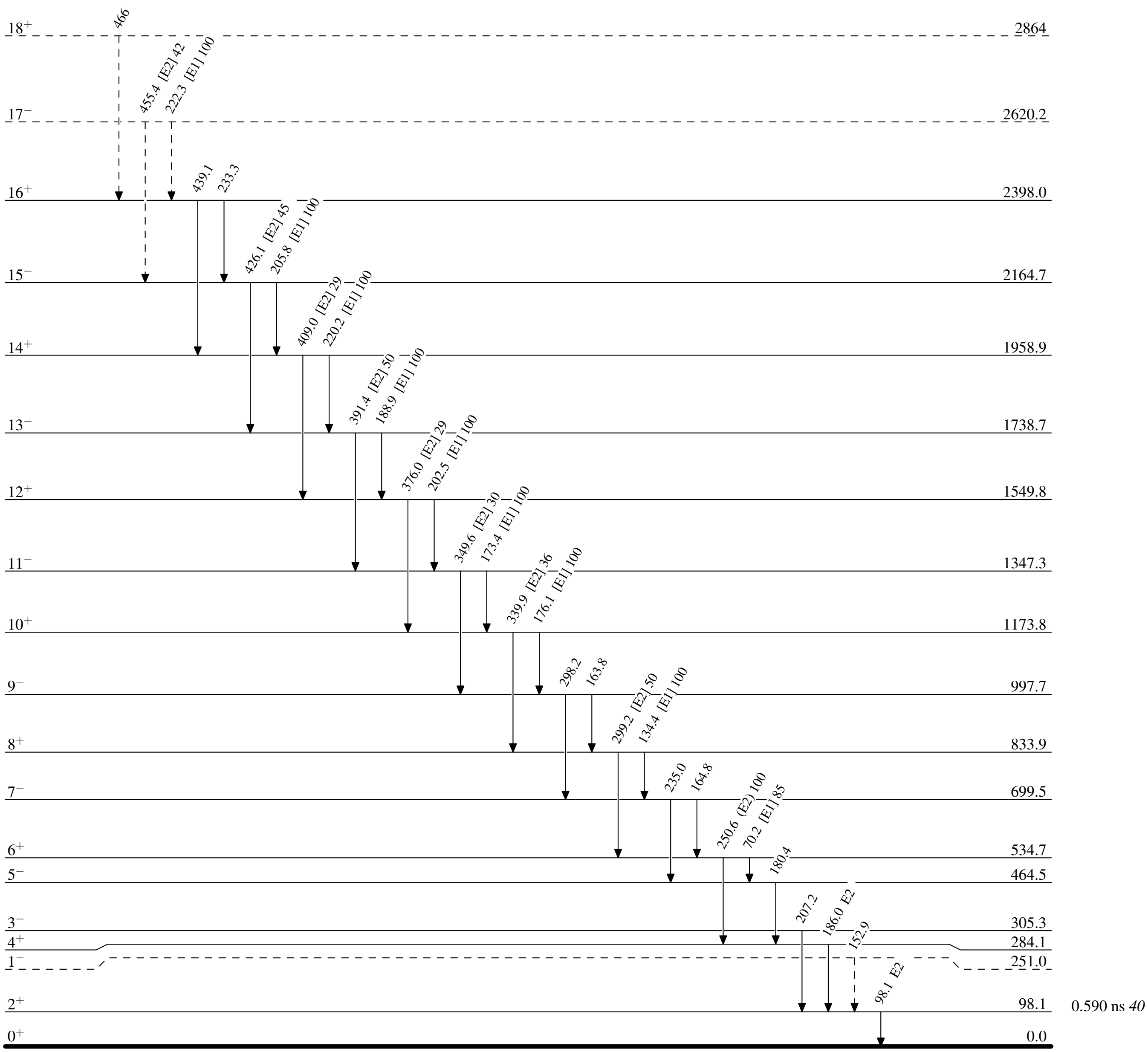
Legend

Level Scheme

Intensities: Relative photon branching from each level

γ Decay (Uncertain)



$^{224}_{90}Th_{134}$

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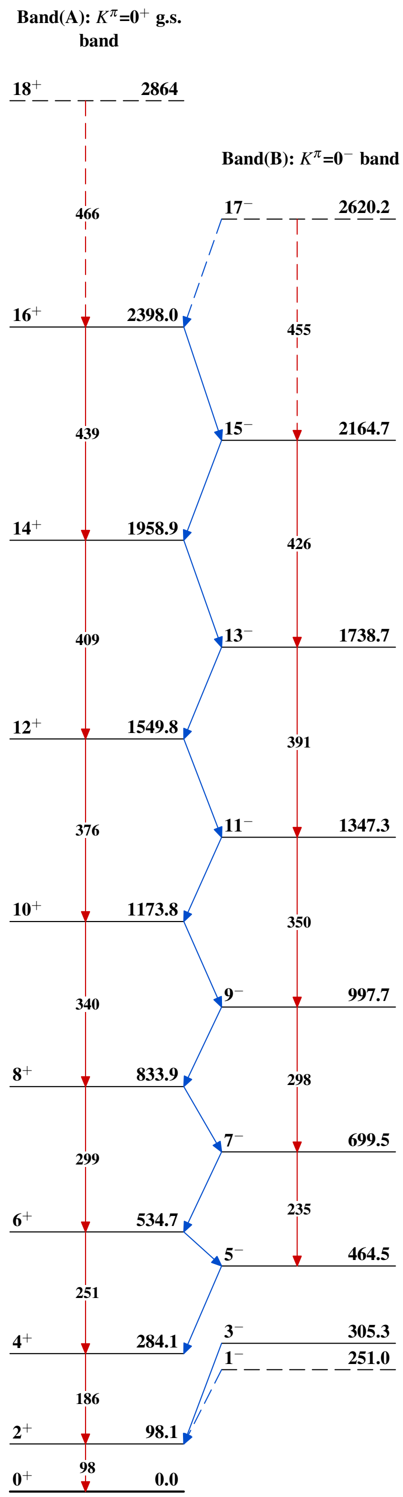

$^{224}_{90}Th_{134}$