^{226}Ra(α,3nγ) 2002Ha30,1998Ma83

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Ictp-2014 Workshop Group	NDS 132, 257 (2016)	15-Jan-2016

2002Ha30: E(α)=33 MeV. Measured Eγ, Iγ, $\gamma\gamma$ using the Jurosphere array consisting of 15 Eurogam Phase I, seven TESSA-type and five NORDBALL-type HPGe detectors.

1998Ma83: E(α)=28 to 38 MeV. Measured Eγ, Iγ, $\gamma\gamma$ using five Compton-suppressed Ge detectors, Ece, Ice, ce-ce using two iron-free orange spectrometers and ce-γ coincidences using one orange spectrometer, one LEPS detector and four Compton-suppressed Ge detectors.

The level scheme is that proposed by 2002Ha30. It is in general agreement with that of 1998Ma83, however, 1998Ma83 was not able to establish a connection between levels observed in their experiment and those determined from radioactive decay studies.

^{227}Th Levels

E(level)[†]	J$^\pi$[‡]	Comments
0[#]	(1/2$^+$)	
9.23[#] *9*	(5/2$^+$)	
37.78 *10*	(3/2$^-$)	
73.4 *3*	(7/2$^-$)	
76.17[#] *10*	(9/2$^+$)	
77.56[@] *10*	(3/2$^+$)	
99.08 *24*	(3/2$^+$,5/2$^+$)	
149.85[&] *22*	(5/2$^-$)	
182.2[#] *3*	(13/2$^+$)	
204.16[@] *21*	(7/2$^+$)	
269.0[&] *3*	(9/2$^-$)	
344.2[#] *4*	(17/2$^+$)	
372.8[a] *6*	(15/2$^-$)	
382.9[@] *3*	(11/2$^+$)	
438.4[&] *3*	(13/2$^-$)	
553.6[a] *6*	(19/2$^-$)	
559.9[#] *5*	(21/2$^+$)	
607.6[@] *4*	(15/2$^+$)	
616.6[b] *4*		J$^\pi$: proposed as (13/2$^-$) by 2002Ha30.
662.1[&] *4*	(17/2$^-$)	
778.1[a] *6*	(23/2$^-$)	
823.6[#] *6*	(25/2$^+$)	
870.2[b] *5*		J$^\pi$: proposed as (17/2$^-$) by 2002Ha30.
873.3[@] *4*	(19/2$^+$)	
937.1[&] *5*	(21/2$^-$)	
1046.6[a] *6*	(27/2$^-$)	
1123.7[c] *7*		
1129.6[#] *6*	(29/2$^+$)	
1167.8[b] *5*		J$^\pi$: proposed as (21/2$^-$) by 2002Ha30.
1176.9[@] *5*	(23/2$^+$)	
1258.1[&] *5*	(25/2$^-$)	
1357.9[a] *7*	(31/2$^-$)	
1437.5[c] *7*		
1472.3[#] *7*	(33/2$^+$)	
1502.1[b] *6*		J$^\pi$: proposed as (25/2$^-$) by 2002Ha30.

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^{226}Ra(α,3nγ) 2002Ha30,1998Ma83 (continued)

^{227}Th Levels (continued)

E(level)[†]	J$^\pi$[‡]	Comments
1515.5[@] *6*	(27/2$^+$)	
1618.7[&] *7*	(29/2$^-$)	
1708.7[a] *8*	(35/2$^-$)	
1782.0[c] *7*		
1845.8[#] *8*	(37/2$^+$)	
1867.0[b] *6*		J$^\pi$: proposed as (29/2$^-$) by 2002Ha30.
1887.1[@] *8*	(31/2$^+$)	
2013.2[&] *9*	(33/2$^-$)	
2094.5[a] *8*	(39/2$^-$)	
2242.5[#] *10*	(41/2$^+$)	
2288.8?[@] *9*	(35/2$^+$)	
2436.7[&] *10*	(37/2$^-$)	
2655.1[#] *11*	(45/2$^+$)	

[†] From least-squares fit to Eγ, by evaluators.
[‡] From the Adopted Levels. These are in good agreement with the J^π assignments of 2002Ha30. Discrepancies, apart from the addition of parentheses by the evaluators, are noted in the comments.
[#] Band(A): K^π=1/2$^+$ band, α=+1/2.
[@] Band(B): K^π=1/2$^+$ band, α=−1/2.
[&] Band(C): K^π=1/2$^-$ band, α=+1/2.
[a] Band(D): K^π=1/2$^-$ band, α=−1/2.
[b] Band(E): Rotational band. Proposed as a K^π=3/2$^-$ band by 2002Ha30.
[c] Band(F): Rotational band.

γ(^{227}Th)

E$_\gamma$[†]	I$_\gamma$[#]	E$_i$(level)	J$_i^\pi$	E$_f$	J$_f^\pi$	Mult.	Comments
(9.3[‡] *1*)		9.23	(5/2$^+$)	0	(1/2$^+$)		
28.57[‡] *5*		37.78	(3/2$^-$)	9.23	(5/2$^+$)		
35.7[b]		73.4	(7/2$^-$)	37.78	(3/2$^-$)		
37.0[‡] *3*		37.78	(3/2$^-$)	0	(1/2$^+$)		
54.3 *3*		204.16	(7/2$^+$)	149.85	(5/2$^-$)		9/2$^+$ to 7/2$^-$ transition shown in table IV of 2002Ha30 is a misprint. It should be 7/2$^+$ to 5/2$^-$.
54.5 *5*		662.1	(17/2$^-$)	607.6	(15/2$^+$)		17/2$^+$ to 15/2$^-$ transition shown in table IV of 2002Ha30 is a misprint. It should be 17/2$^-$ to 15/2$^+$.
55.6 *5*		438.4	(13/2$^-$)	382.9	(11/2$^+$)		13/2$^+$ to 11/2$^-$ transition shown in table IV of 2002Ha30 is a misprint. It should be 13/2$^-$ to 11/2$^+$.
64.4 *5*	7.2 *14*	73.4	(7/2$^-$)	9.23	(5/2$^+$)		
64.8 *3*	10.8 *16*	269.0	(9/2$^-$)	204.16	(7/2$^+$)		9/2$^+$ to 7/2$^-$ transition shown in table IV of 2002Ha30 is a misprint. It should be 9/2$^-$ to 7/2$^+$.
66.94[‡] *3*		76.17	(9/2$^+$)	9.23	(5/2$^+$)	E2[&]	
68.33[‡] *2*		77.56	(3/2$^+$)	9.23	(5/2$^+$)		Mult.: proposed as (E2) by 1998Ma83 based on strong L-subshell conversion electrons.
72.2 *3*	18.8 *27*	149.85	(5/2$^-$)	77.56	(3/2$^+$)		5/2$^+$ to 3/2$^-$ transition shown in table IV of 2002Ha30 is a misprint. It should be 5/2$^-$ to 3/2$^+$.
76.5 *3*		149.85	(5/2$^-$)	73.4	(7/2$^-$)	(E2)[&]	

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^{226}Ra(α,3nγ) 2002Ha30,1998Ma83 (continued)

$\gamma(^{227}Th)$ (continued)

E_γ[†]	I_γ[#]	E_i(level)	J_i^π	E_f	J_f^π	Mult.	Comments
99.2 *3*		99.08	(3/2$^+$,5/2$^+$)	0	(1/2$^+$)		E_γ: from figure 7 of 2002Ha30.
105.2 *3*		204.16	(7/2$^+$)	99.08	(3/2$^+$,5/2$^+$)		
106.0 *3*		182.2	(13/2$^+$)	76.17	(9/2$^+$)	E2[&]	
113.9 *3*	22.5 *34*	382.9	(11/2$^+$)	269.0	(9/2$^-$)	E1[a]	
119.1 *3*	15.7 *24*	269.0	(9/2$^-$)	149.85	(5/2$^-$)	E2[&]	
126.5 *3*	6.2 *12*	204.16	(7/2$^+$)	77.56	(3/2$^+$)		
162.0 *3*	24.6 *37*	344.2	(17/2$^+$)	182.2	(13/2$^+$)	E2[&]	
169.2[@] *3*	25.4[@] *64*	607.6	(15/2$^+$)	438.4	(13/2$^-$)	E1[a]	
169.4[@] *3*	35.3[@] *53*	438.4	(13/2$^-$)	269.0	(9/2$^-$)	E2[&]	
178.7 *3*	12.7 *19*	382.9	(11/2$^+$)	204.16	(7/2$^+$)		Mult.: assigned as E1 by 1998Ma83 based on strength of 178.7 γ rays can the absence of corresponding ce in spectra gated by the 106.0-keV transition. 2002Ha30 argue for E2 multipolarity as the M and N conversion electrons from the 162.0-keV transition mask the L2 and L3 ce lines from the 178.7-keV transition.
190.6 *5*		372.8	(15/2$^-$)	182.2	(13/2$^+$)	E1[a]	
209.4 *5*	5.4 *11*	553.6	(19/2$^-$)	344.2	(17/2$^+$)	E1[a]	
211.2 *3*	16.1 *24*	873.3	(19/2$^+$)	662.1	(17/2$^-$)	E1[a]	
215.7 *3*	33.2 *50*	559.9	(21/2$^+$)	344.2	(17/2$^+$)		
218.2 *5*	3.9 *8*	778.1	(23/2$^-$)	559.9	(21/2$^+$)		
223.0 *5*	1.1 *2*	1046.6	(27/2$^-$)	823.6	(25/2$^+$)		
223.7[@] *3*	45[@] *11*	662.1	(17/2$^-$)	438.4	(13/2$^-$)		
224.5 *5*		778.1	(23/2$^-$)	553.6	(19/2$^-$)		
224.7[@] *3*	15.0[@] *38*	607.6	(15/2$^+$)	382.9	(11/2$^+$)	E2[&]	
228.3 *5*	0.6 *1*	1357.9	(31/2$^-$)	1129.6	(29/2$^+$)		
233.7 *3*	10.2 *15*	616.6		382.9	(11/2$^+$)		
236.4 *5*	<0.5	1708.7	(35/2$^-$)	1472.3	(33/2$^+$)		
239.8 *5*	7.1 *14*	1176.9	(23/2$^+$)	937.1	(21/2$^-$)	E1[a]	
248.7 *5*	<0.5	2094.5	(39/2$^-$)	1845.8	(37/2$^+$)		
253.5 *5*	1.2 *3*	1123.7		870.2			
253.6 *5*	4.6 *9*	870.2		616.6			17/2$^+$ to 13/2$^+$ transition shown in table IV of 2002Ha30 is a misprint. It should be 17/2$^-$ to 13/2$^-$.
257.4 *5*	3.0 *6*	1515.5	(27/2$^+$)	1258.1	(25/2$^-$)		
262.6 *5*	9.1 *18*	870.2		607.6	(15/2$^+$)		
263.7 *3*	27.8 *42*	823.6	(25/2$^+$)	559.9	(21/2$^+$)		
265.7 *5*	8.9 *18*	873.3	(19/2$^+$)	607.6	(15/2$^+$)		
268.5 *5*	1.4 *3*	1046.6	(27/2$^-$)	778.1	(23/2$^-$)		
269.7 *5*	0.6 *1*	1437.5		1167.8			
275.0 *3*	30.7 *46*	937.1	(21/2$^-$)	662.1	(17/2$^-$)		
279.9 *5*	<0.5	1782.0		1502.1			
294.5 *5*	5.4 *11*	1167.8		873.3	(19/2$^+$)		
297.6 *5*	2.6 *5*	1167.8		870.2			
303.7 *5*	4.8 *10*	1176.9	(23/2$^+$)	873.3	(19/2$^+$)		
306.0 *3*	13.6 *20*	1129.6	(29/2$^+$)	823.6	(25/2$^+$)		
311.3 *5*	1.3 *3*	1357.9	(31/2$^-$)	1046.6	(27/2$^-$)		
321.0 *3*	15.5 *23*	1258.1	(25/2$^-$)	937.1	(21/2$^-$)		
325.2 *5*	0.9 *2*	1502.1		1176.9	(23/2$^+$)		
334.4 *5*	1.1 *2*	1502.1		1167.8			
338.6 *5*	1.4 *3*	1515.5	(27/2$^+$)	1176.9	(23/2$^+$)		
342.7 *5*	5.8 *12*	1472.3	(33/2$^+$)	1129.6	(29/2$^+$)		
350.8 *5*		1708.7	(35/2$^-$)	1357.9	(31/2$^-$)		

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^{226}Ra(α,3nγ) 2002Ha30,1998Ma83 (continued)

$\gamma(^{227}Th)$ (continued)

E_γ †	I_γ #	E_i(level)	J_i^π	E_f	J_f^π	E_γ †	I_γ #	E_i(level)	J_i^π	E_f	J_f^π
351.5 *5*	<0.5	1867.0		1515.5	$(27/2^+)$	394.5 *5*	1.4 *3*	2013.2	$(33/2^-)$	1618.7	$(29/2^-)$
360.6 *5*	5.4 *11*	1618.7	$(29/2^-)$	1258.1	$(25/2^-)$	396.7 *5*	0.6 *1*	2242.5	$(41/2^+)$	1845.8	$(37/2^+)$
364.9 *5*	<0.5	1867.0		1502.1		401.7[b] *5*	<0.5	2288.8?	$(35/2^+)$	1887.1	$(31/2^+)$
371.6 *5*	<0.5	1887.1	$(31/2^+)$	1515.5	$(27/2^+)$	412.6 *5*	<0.5	2655.1	$(45/2^+)$	2242.5	$(41/2^+)$
373.5 *5*	1.8 *4*	1845.8	$(37/2^+)$	1472.3	$(33/2^+)$	423.5 *5*	<0.5	2436.7	$(37/2^-)$	2013.2	$(33/2^-)$
385.8 *5*		2094.5	$(39/2^-)$	1708.7	$(35/2^-)$						

† From 2002Ha30, except where noted. $\Delta(E\gamma)$ assigned as 0.3 keV for $I\gamma>10$ and 0.5 keV for $I\gamma<10$, based on a general statement by 2002Ha30.

‡ From the Adopted Gammas.

From 2002Ha30. $\Delta(I\gamma)$ assigned as ≈15% for strong transitions ($I\gamma>10$) and ≈20% for weaker transitions ($I\gamma<10$), based on general statement by 2002Ha30.

@ Doublet transition, uncertainty in intensity is 25%.

& Strong L-subshell conversion electrons (1998Ma83).

a From observation of strong transition in γ-ray spectra in absence of corresponding transition in ce spectra (1998Ma83).

b Placement of transition in the level scheme is uncertain.

^{226}**Ra(α,3nγ)** **2002Ha30,1998Ma83**

Level Scheme

Intensities: Relative I_γ

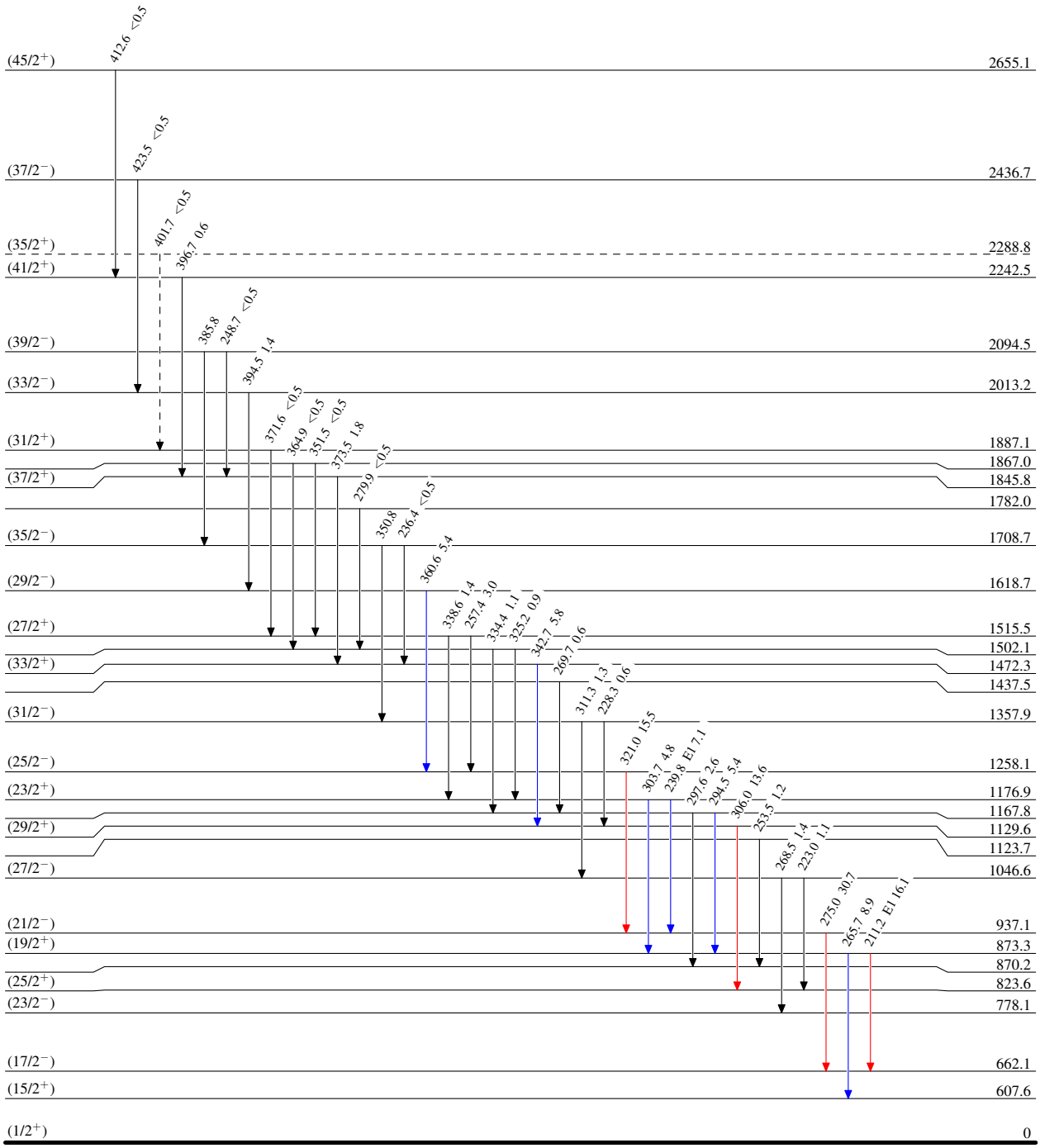
Legend

$I_\gamma < 2\% \times I_\gamma^{max}$

$I_\gamma < 10\% \times I_\gamma^{max}$

$I_\gamma > 10\% \times I_\gamma^{max}$

γ Decay (Uncertain)



$^{227}_{90}Th_{137}$

^{226}Ra(α,3nγ) 2002Ha30,1998Ma83

Level Scheme (continued)

Intensities: Relative I_γ

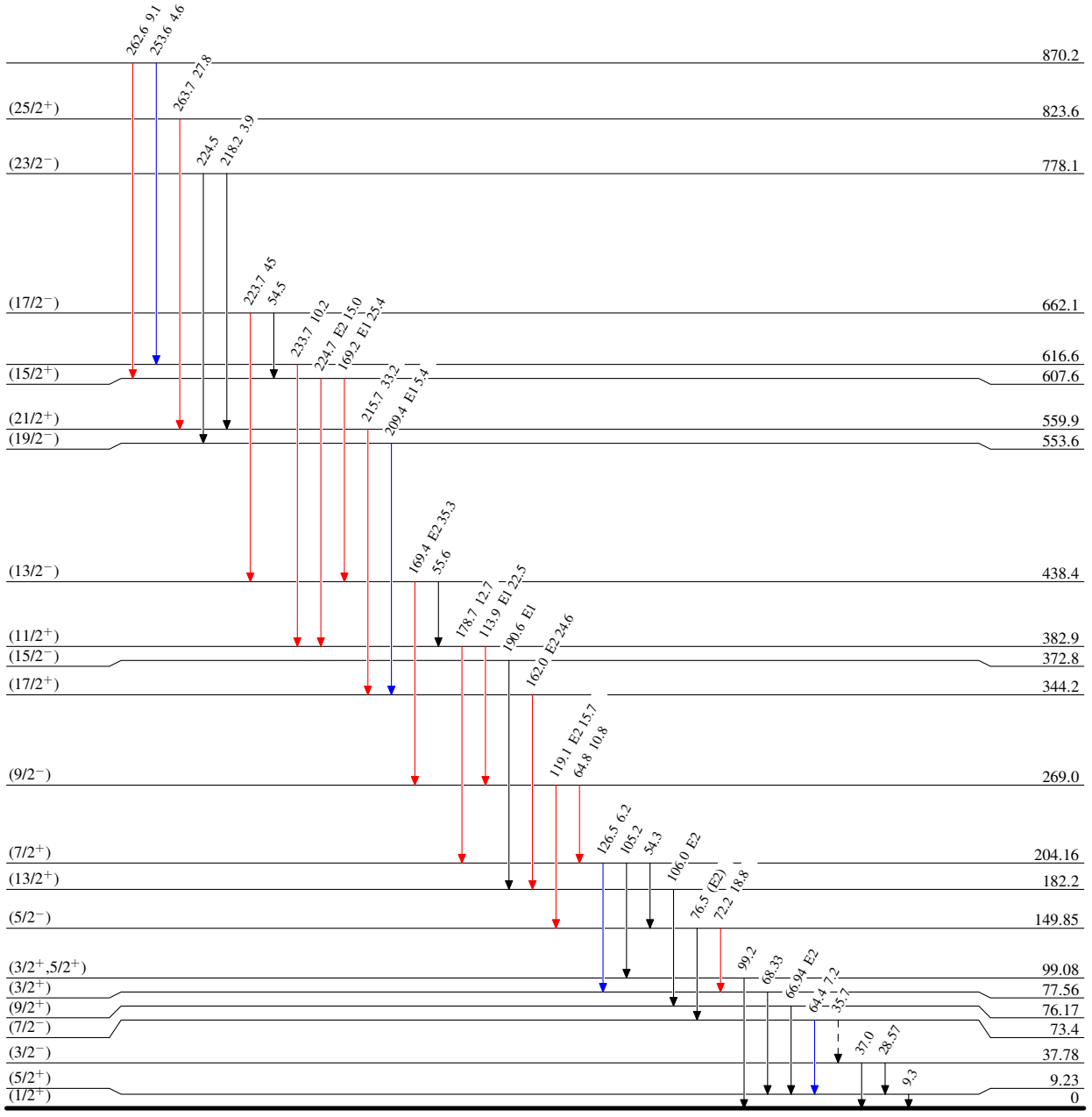
Legend

$I_\gamma < 2\% \times I_\gamma^{max}$

$I_\gamma < 10\% \times I_\gamma^{max}$

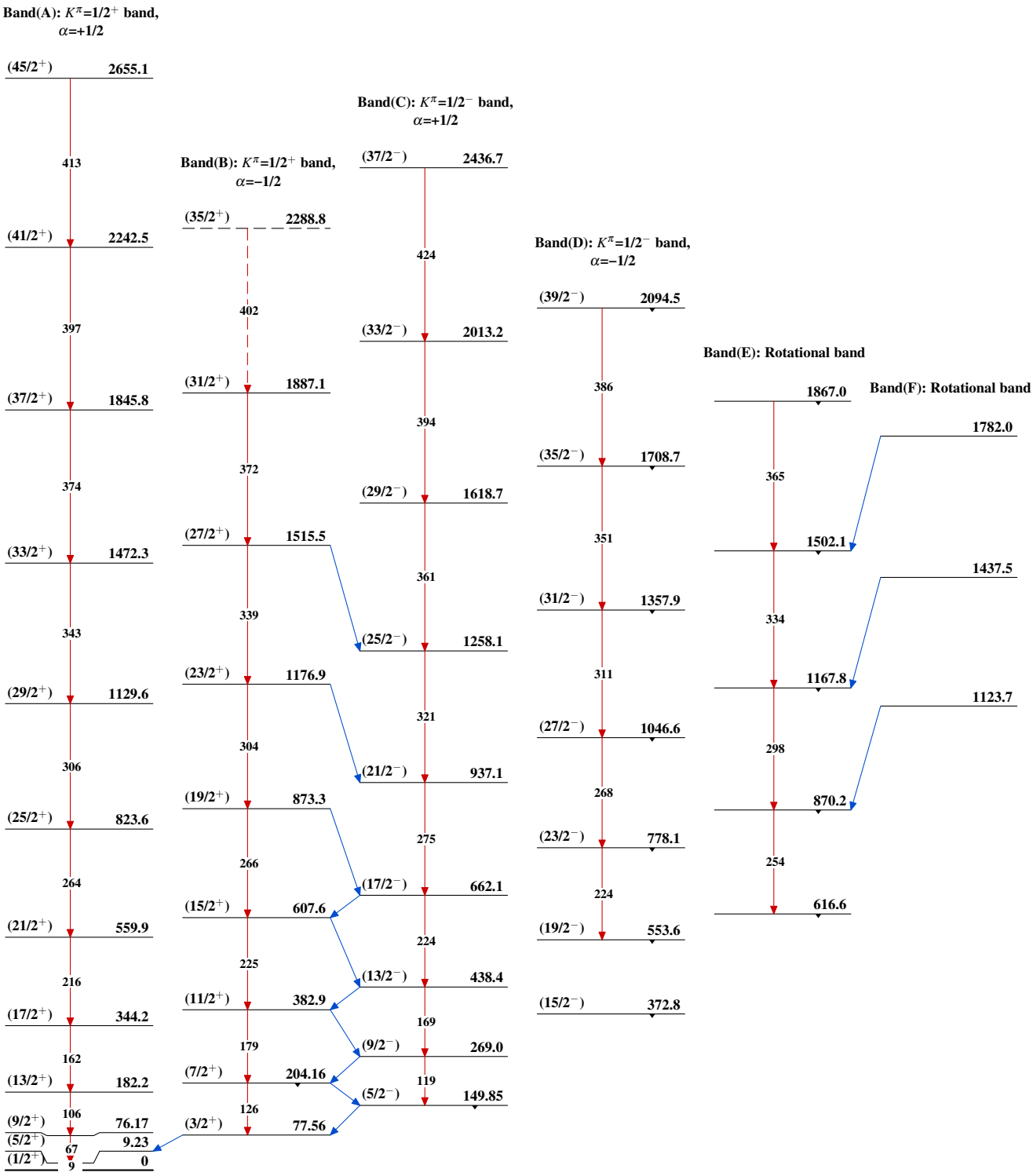
$I_\gamma > 10\% \times I_\gamma^{max}$

γ Decay (Uncertain)



$^{227}_{90}Th_{137}$

^{226}Ra(α,3nγ) 2002Ha30,1998Ma83



$^{227}_{90}Th_{137}$