^{176}Yb(p,3nγ) 1987Br12,1990Dr05

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	E. Browne, Huo Junde	NDS 87, 15 (1999)	1-Nov-1998

1987Br12: 96.7% enriched ^{176}Yb. E(p)=18.3, 20.7, 22.7 MeV. Measured Eγ, Iγ, $\gamma\gamma$ coin, $\gamma\gamma(\theta)$ at eight angles from θ=15° to 90°. Detectors: Ge(Li), bent-crystal spectrometer.
1990Dr05 further analyzed data from 1987Br12, and used results of 1987Br31 for interpreting the level structure in ^{174}Lu.
Others: 1973AnYG, 1980Ke08, 1984Do19, 1984Ke13, 1988Pe08.

^{174}Lu Levels

E(level)	J$^{\pi}$[k]	T$_{1/2}$[l]	Comments
0.0[†]	1$^-$	3.31 y *5*	
44.6966[†] *20*	2$^-$		
111.752[†] *4*	3$^-$		
170.68[#] *7*	6$^-$	142 d *2*	
200.297[†] *6*	4$^-$		
240.817[b] *4*	3$^+$	395 ns *15*	
259.537[b] *10*	4$^+$		
281.167[&] *19*	0$^+$		
311.205[†] *9*	5$^-$		
320.111[&] *8*	2$^+$		
320.14[#] *7*	7$^-$		
365.184[‡] *7*	4$^-$	145 ns *3*	
382.875[&] *24*	1$^+$		
414.376[c] *11*	3$^+$		
420.663[&] *9*	4$^+$		
431.27[@] *7*	7$^+$	<1.5 ns	T$_{1/2}$: other value:≈2 ns (1973AnYG).
432.88[a] *20*	3$^-$		
442.014[†] *16*	6$^-$		
445.431[&] *22*	3$^+$		
456.47[h] *7*	5$^-$		
481.004[‡] *14*	5$^-$		
491.19[#] *7*	8$^-$		
507.67 *7*	(7)		
522.42[d] *5*	1$^-$		
530.97[a] *7*	4$^-$		
531.349[e] *22*	7$^+$		
537.27[@] *7*	8$^+$		
575.661[&] *14*	5$^+$		
591.27[h] *7*	6$^-$		
594.243[&] *18*	6$^+$		
595.567[†] *17*	7$^-$		
619.168[‡] *19*	6$^-$		
621.08[d] *7*	2$^-$		
630.12 *3*	(1$^+$)		
635.36[g] *6*	2$^+$		
652.32 *3*	(2,3,4)		
654.27[a] *7*	5$^-$		

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^{176}Yb(p,3nγ) 1987Br12,1990Dr05 (continued)

^{174}Lu Levels (continued)

E(level)	Jπ[k]	Comments
658.97[e] 7	8+	
672.04[j] 6	(4+)	
676.60[@] 7	9+	
683.31[#] 7	9−	
689.03[g] 6	3+	
747.71[h] 7	7−	
755.37[j] 21	(5+)	
766.368[†] 20	8−	
771.92[f] 7	(8)	
773.90[g] 6	4+	
779.11[‡] 4	7−	
782.20[&] 4	7+	
800.41[a] 8	6−	
805.6?[e] 5	9+	
843.1?[&] 10	8+	
859.91[j] 21	(6+)	
868.91[f] 7	(9)	
877.44[i] 12	7−	
878.43[g] 6	5+	
927.20?[h] 13	8−	
961.16[†] 5	9−	
979.65[j] 21	(7+)	
1005.37[g] 6	6+	1987Br31 reported that the 6+ member of the Kπ=2+ band decays by 119.73 and 224.4 keV transitions, thus E(level)=998.2 keV.
1063.36? 4	9+	

[†] Band(A): Kπ=1− g.s. rotational band. Configuration=((π 7/2[704])-(ν 5/2[512])).
[‡] Band(B): Kπ=4− rotational band. Configuration=((π 7/2(404))+(ν 1/2(521))).
[#] Band(C): Kπ=6− rotational band. Configuration=((π 7/2(404))+(ν 5/2(512))).
[@] Band(D): Kπ=7+ rotational band. Configuration=((π 7/2(404))+(ν 7/2(633))).
[&] Band(E): Kπ=0+ rotational band. Configuration=((π 7/2(404))-(ν 7/2(633))).
[a] Band(F): Kπ=3− rotational band. Configuration=((π 7/2(404))-(ν 1/2(521))).
[b] Band(G): Kπ=2+ rotational band. Configuration=((π 1/2(541))-(ν 5/2(512))).
[c] Band(H): Kπ=3+ rotational band. Configuration=((π 1/2(541))+(ν 5/2(512))).
[d] Band(I): Kπ=1− rotational band. Configuration=((π 5/2(402))-(ν 5/2(512))).
[e] Band(J): Kπ=7+ rotational band. Configuration=((π 9/2(514))+(ν 5/2(512))).
[f] Band(K): K=(8). Possible Configuration=((π 9/2(514))+(ν 7/2(633))).
[g] Band(L): Kπ=2+ rotational band. Configuration=((π 9/2(514))-(ν 5/2(512))).
[h] Band(M): Kπ=5− rotational band. Configuration=((π 5/2(402))+(ν 5/2(512))).
[i] Band(N): Kπ=7− rotational band. Configuration=((π 7/2(404))+(ν 7/2(514))).
[j] Band(O): Kπ=(4+). Possible Configuration=((π 3/2(532))+(ν 5/2(512))).
[k] Jπ assignments are based on γ(θ) and rotational structure.
[l] From Adopted Levels, gammas.

^{176}Yb(p,3nγ) 1987Br12,1990Dr05 (continued)

$\gamma(^{174}Lu)$

E_γ †	I_γ †	E_i(level)	J_i^π	E_f	J_f^π	Mult.	δ	Comments
18.72[b]		259.537	4^+	240.817	3^+			
x43.097 2	50 10							
x43.366 3	12 3							
44.697‡ 2	4.5×10^2‡ 10	44.6966	2^-	0.0	1^-			
53.665#‡ 2	>1.9#‡	689.03	3^+	635.36	2^+			
60.8[c]		843.1?	8^+	782.20	7^+			
x63.31 4	1.8 11							
x65.09 2	3.8 4							This γ ray may be placed de-exciting the 376.7 level.
67.058 3	25 3	111.752	3^-	44.6966	2^-			
x67.67 3	1.3 3							This γ ray may be placed de-exciting the 432.9 level.
67.7 2		432.88	3^-	365.184	4^-			E_γ: from 1987Br31.
x68.88 4	0.9 2							
76.36 3	2.9 3	507.67	(7)	431.27	7^+			
x82.99 1	0.5 1							
83.3#@ 2	1.2#@ 3	755.37	(5^+)	672.04	(4^+)			
84.92#@ 2	2.2#d@ 3	773.90	4^+	689.03	3^+			
x86.275 11	4.4 2							
88.544 5	10.2 4	200.297	4^-	111.752	3^-	D+Q[e]		
x90.16 4	0.7 1							
x95.110 10	1.6 3							
x95.275 15	1.1 1							
96.990 10	1.1 1	868.91	(9)	771.92	(8)			
x97.330 10	0.7 1							
98.66 4	1.5 2	621.08	2^-	522.42	1^-			
99.704 10	2.0 1	530.97	4^-	432.88	3^-	D+Q[e]	+0.36[e] 10	
100.557 8	2.6 2	420.663	4^+	320.111	2^+			
101.70 2	1.3 1	382.875	1^+	281.167	0^+			
x103.35 2	1.1 1							
104.528g# 7	4.3g# 2	859.91	(6^+)	755.37	(5^+)			
104.528g# 7	4.3g# 2	878.43	5^+	773.90	4^+			
105.654 9	1.7 1	365.184	4^-	259.537	4^+	(E1)[f]		
105.994‡ 5	2.3‡ 3	537.27	8^+	431.27	7^+			
x106.019 5	2.3 3							
x107.387 8	3.3 4							This γ ray may be placed de-exciting the 561.3 level.
x108.75 3	0.7 1							
109.45 2	2.3 1	420.663	4^+	311.205	5^-			
110.906‡ 9	6.8‡ 3	311.205	5^-	200.297	4^-			
111.126‡ 9	13.1‡ 5	431.27	7^+	320.14	7^-			
111.73‡ 2	1.2‡ 1	111.752	3^-	0.0	1^-			
112.96 3	1.6 1	771.92	(8)	658.97	8^+			
x113.900 10	3.8 6							
x115.19 4	0.7 1							
115.820 12	3.5 2	481.004	5^-	365.184	4^-			
x117.13 2	1.5 1							I_γ: contains contribution from ^{175}Lu impurity.
119.74@ 2	0.6@ 1	979.65	(7^+)	859.91	(6^+)			
121.56 3	1.2 2	658.97	8^+	537.27	8^+			
x122.09 2	1.4 2							
123.296 11	2.0 1	654.27	5^-	530.97	4^-	D+Q[e]	+0.33[e] 5	

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^{176}Yb(p,3nγ) 1987Br12,1990Dr05 (continued)

γ(^{174}Lu) (continued)

E_γ †	I_γ †	E_i(level)	J_i^π	E_f	J_f^π	Mult.	δ	Comments
124.360 *8*	2.9 *2*	365.184	4^-	240.817	3^+	(E1)		
125.32 *2*	2.0 *1*	445.431	3^+	320.111	2^+			
126.95 *2*	1.1 *1*	1005.37	6^+	878.43	5^+			
x127.68 *2*	1.7 *2*							
x127.93 *5*	1.5 *5*							E_γ: from authors′ labelled spectrum. Eγ=112.933 *45* given by 1987Br12 in table 1 is a typographical error.
128.014‡ *9*	1.0‡ *2*	658.97	8^+	530.97	4^-			
129.065 *2*	100.0 *12*	240.817	3^+	111.752	3^-	(E1)[f]		δ: δ=−0.09 *10*, γ(θ) (1987Br12).
x130.340 *15*	1.3 *4*							
130.804 *15*	5.0 *2*	442.014	6^-	311.205	5^-			
134.78 *2*	1.1 *1*	591.27	6^-	456.47	5^-			I_γ: multiplet (contains contribution from ^{175}Lu impurity).
x137.30 *5*	0.6 *1*							
138.164 *13*	2.4 *1*	619.168	6^-	481.004	5^-			
138.502 *17*	1.2 *1*	773.90	4^+	635.36	2^+			
x139.01 *2*	1.0 *1*							
139.322 *11*	1.6 *2*	676.60	9^+	537.27	8^+			
x139.78 *4*	1.1 *1*							
146.218#h *11*	0.7# *1*	805.6?	9^+	658.97	8^+			
x148.86 *4*	0.9 *1*							This γ ray may be placed de-exciting the 838.0 level.
149.457 *5*	19.0 *4*	320.14	7^-	170.68	6^-	D+Q[e]	−3.0[e] *2*	
151.28 *4*	2.7 *1*	658.97	8^+	507.67	(7)			
153.550 *10*	3.1 *1*	595.567	7^-	442.014	6^-			
154.830‡ *10*	5.5‡ *2*	414.376	3^+	259.537	4^+			
154.998‡ *10*	4.8‡ *2*	575.661	5^+	420.663	4^+			
155.59 *2*	0.8 *2*	200.297	4^-	44.6966	2^-			
156.34#@ *2*	1.7#@ *2*	747.71	7^-	591.27	6^-			
159.94 *3*	1.1 *1*	779.11	7^-	619.168	6^-			
x163.01 *2*	3.5 *2*							
164.885 *10*	5.1 *1*	365.184	4^-	200.297	4^-	(M1,E2)[f]		
167.93#h *3*	1.0# *1*	658.97	8^+	491.19	8^-			
x170.07 *3*	0.7 *2*							
170.798‡ *10*	0.8‡ *3*	766.368	8^-	595.567	7^-			
x170.826 *10*	0.6 *2*							
171.060‡ *10*	2.1‡ *3*	491.19	8^-	320.14	7^-			
x171.423 *10*	1.8 *2*							
x172.58 *2*	1.2 *1*							
173.580[g] *15*	3.4[g] *1*	414.376	3^+	240.817	3^+			
173.580[g] *15*	3.4[g] *1*	594.243	6^+	420.663	4^+			
x176.09 *5*	0.7 *1*							
179.34#h *4*	0.7# *1*	927.20?	8^-	747.71	7^-			
x181.50 *5*	0.6 *2*							This γ ray may be placed de-exciting the 960.7 level.
x187.98[a] *3*	3.3 *10*							
188.06‡ *3*	4.5‡ *10*	782.20	7^+	594.243	6^+			
x190.813 *10*	0.6 *1*							
192.123 *10*	1.2 *1*	683.31	9^-	491.19	8^-	D+Q[e]	−3.2[e] *6*	
x193.647 *10*	1.2 *1*							
194.67 *6*	0.6 *1*	961.16	9^-	766.368	8^-			
196.112 *10*	33.0 *4*	240.817	3^+	44.6966	2^-	(E1)[f]		Mult.: δ=−0.13 *+15−30*, γ(θ) (1987Br12).
199.45 *2*	1.8 *1*	311.205	5^-	111.752	3^-			

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^{176}Yb(p,3nγ) 1987Br12,1990Dr05 (continued)

γ(^{174}Lu) (continued)

E_γ †	I_γ †	E_i(level)	J_i^π	E_f	J_f^π	Mult.	Comments
208.365 *8*	17.1 *3*	320.111	2^+	111.752	3^-		
x208.77 *2*	2.9 *4*						
x209.41 *6*	0.5 *1*						
211.24# *2*	1.1# *1*	531.349	7^+	320.14	7^-		
x212.340 *10*	3.3 *1*						
x213.97 *3*	0.5 *1*						
x218.40 *3*	1.1 *2*						
x219.33 *5*	0.8 *1*						
220.34h *4*	1.0 *1*	1063.36?	9^+	843.1?	8^+		
x221.25 *6*	0.5 *1*						
223.03 *2*	1.4 *1*	654.27	5^-	431.27	7^+		
x227.50 *6*	1.0 *1*						
231.44# *3*	2.1# *1*	1005.37	6^+	773.90	4^+		
x235.59 *3*	2.3 *1*						
237.95 *3*	2.7 *1*	652.32	(2,3,4)	414.376	3^+		
241.73 *4*	1.4 *1*	442.014	6^-	200.297	4^-		
245.30 *3*	1.5 *1*	676.60	9^+	431.27	7^+		
247.24 *2*	3.0 *1*	630.12	(1^+)	382.875	1^+		
253.435 *10*	15.5 *3*	365.184	4^-	111.752	3^-	(M1,E2)f	
253.9&		619.168	6^-	365.184	4^-		
x256.02 *2*	2.1 *4*						
260.585 *5*	29.3 *5*	431.27	7^+	170.68	6^-	De	
264.24 *3*	1.7 *1*	771.92	(8)	507.67	(7)		
x267.44 *3*	2.2 *1*						
269.45 *3*	1.3 *2*	800.41	6^-	530.97	4^-		
x272.93 *3*	1.6 *3*						
x275.92 *4*	1.7 *2*						
x276.79 *8*	0.7 *2*						
281.16g *2*	13.7g *3*	281.167	0^+	0.0	1^-		
281.16gh *2*	13.7g *3*	1063.36?	9^+	782.20	7^+		
283.05h *7*	1.2 *1*	594.243	6^+	311.205	5^-		
284.38 *3*	1.8 *2*	595.567	7^-	311.205	5^-		
285.800# *10*	10.2# *2*	456.47	5^-	170.68	6^-		
291.14# *4*	2.0# *2*	747.71	7^-	456.47	5^-		
x294.34 *5*	1.2 *1*						
298.2&		779.11	7^-	481.004	5^-		
x305.93 *3*	1.7 *1*						This γ ray may be placed de-exciting the 843.1 level.
308.900 *15*	10.8 *2*	420.663	4^+	111.752	3^-		
310.04 *4*	4.1 *1*	630.12	(1^+)	320.111	2^+		
x312.50 *5*	1.0 *1*						
x314.34 *5*	1.0 *1*						
x317.12 *6*	2.1 *2*						
x317.92 *9*	0.6 *1*						
x318.99 *6*	0.9 *3*						
320.09‡ *3*	4.5‡ *6*	320.111	2^+	0.0	1^-		
320.51‡ *2*	4.2‡ *6*	491.19	8^-	170.68	6^-		
x321.12 *3*	2.9 *4*						
324.36 *7*	1.0 *1*	766.368	8^-	442.014	6^-		
x325.67 *5*	1.6 *2*						
x330.33 *8*	0.7 *1*						
x332.50 *6*	1.2 *1*						
x333.92 *5*	1.6 *1*						

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^{176}Yb(p,3nγ) 1987Br12,1990Dr05 (continued)

$\gamma(^{174}Lu)$ (continued)

E_γ †	I_γ †	E_i(level)	J_i^π	E_f	J_f^π	Comments
335.8#@h 2	0.7#@ 1	927.20?	8$^-$	591.27	6$^-$	
338.18h 7	0.6 1	382.875	1$^+$	44.6966	2$^-$	
340.69 5	2.5 1	771.92	(8)	431.27	7$^+$	
x349.65 3	6.2 2					
x351.41 6	1.1 2					
x357.08 5	7.3 2					
360.67# 6	1.5# 1	531.349	7$^+$	170.68	6$^-$	
363.04 4	2.6 2	683.31	9$^-$	320.14	7$^-$	
x364.09 5	3.0 2					
365.72 6	1.3 1	961.16	9$^-$	595.567	7$^-$	Probably a composite line.
x371.08 8	1.0 1					
x382.72 8	0.8 1					
386.2@ 3	1.3@ 3	877.44	7$^-$	491.19	8$^-$	
x389.28 5	2.2 2					
x399.96 7	1.1 2					
x403.66 5	0.4 1					
411.49 5	5.1 3	652.32	(2,3,4)	240.817	3$^+$	
x416.84 5	6.3 3					
420.67# 5	2.3# 3	591.27	6$^-$	170.68	6$^-$	
x425.25 6	2.6 2					
x427.20 10	0.7 1					
427.2# 1	0.7#d 1	747.71	7$^-$	320.14	7$^-$	
431.22# 6	2.6# 2	672.04	(4$^+$)	240.817	3$^+$	
436.21#@ 11	0.6#@ 1	927.20?	8$^-$	491.19	8$^-$	
x440.04 6	3.1 3					
x442.68 7	1.6 2					This γ ray may be placed de-exciting the 1126.0 level.
446.16# 10	1.3# 2	877.44	7$^-$	431.27	7$^+$	
462.7#h 1	0.7# 2	773.90	4$^+$	311.205	5$^-$	
x514.82 4	11.8 5					
x519.92 7	2.7 2					
522.42 5	9.8 3	522.42	1$^-$	0.0	1$^-$	
523.68# 7	3.4# 2	635.36	2$^+$	111.752	3$^-$	
x534.78 13	0.8 2					
557.3@ 5	0.7@ 2	877.44	7$^-$	320.14	7$^-$	
x573.08 9	2.2 3					
x586.96 8	3.2 4					
590.61# 8	3.5# 5	635.36	2$^+$	44.6966	2$^-$	
x596.09 7	5.0 5					
706.9@ 5	0.8@ 2	877.44	7$^-$	170.68	6$^-$	

† From Ge(Li) measurement of 1987Br12, except as noted.
‡ From bent-crystal measurement of 1987Br12.
# Placed on level scheme by 1990Dr05.
@ Reported by 1990Dr05 only.
& Observed in $\gamma\gamma$ coin only.
a It has not been established whether the 187.98γ or the 188.06γ is the one that deexcites the 782 level.
b Not seen, but required by $\gamma\gamma$. Value has been rounded-off from E(level) difference.
c From E(level) difference. Not observed but required by level scheme.
d Multiplet.

Continued on next page (footnotes at end of table)

^{176}Yb(p,3nγ) 1987Br12,1990Dr05 (continued)

$\gamma(^{174}Lu)$ (continued)

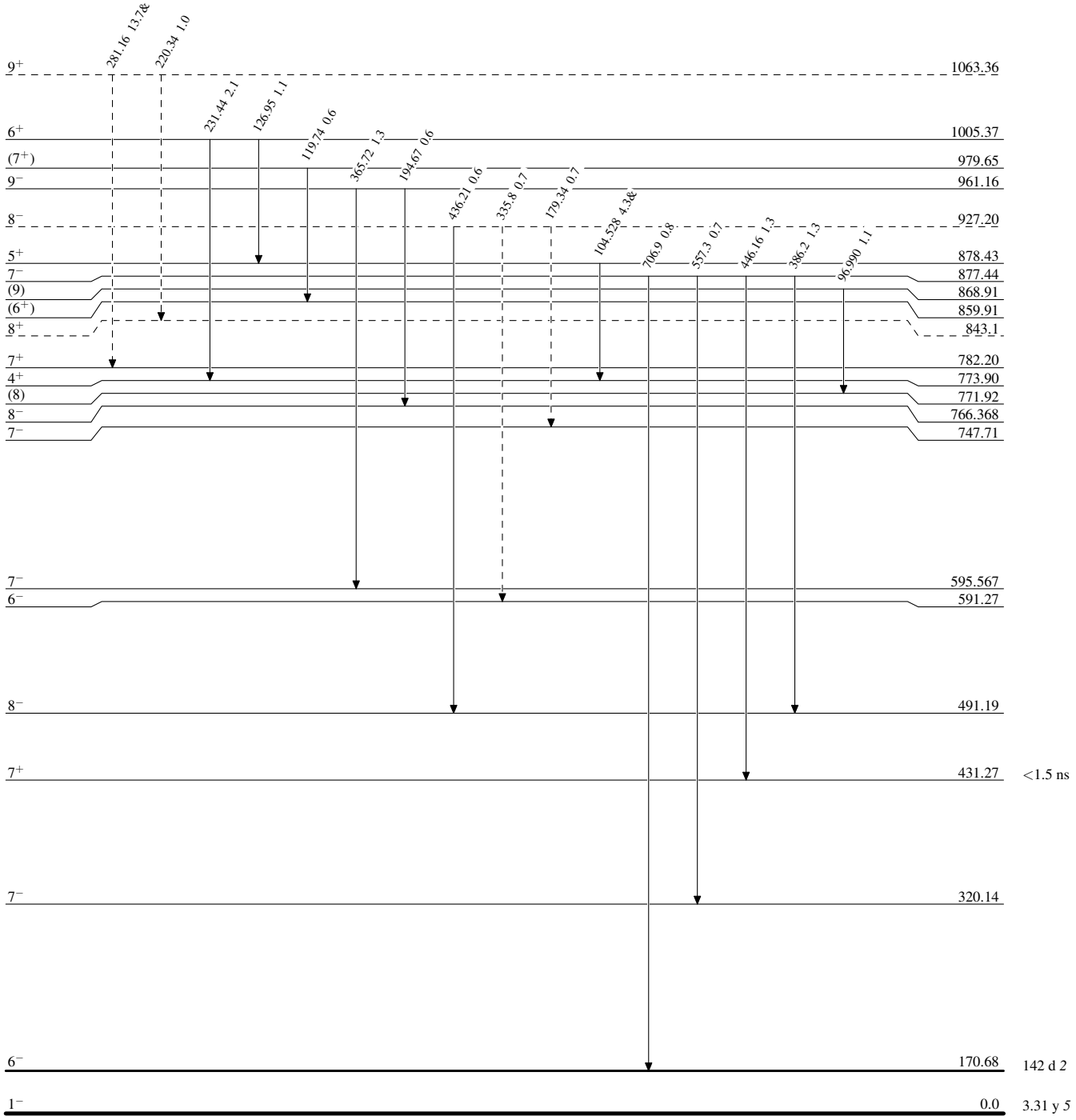
[e] From $\gamma(\theta)$, see 1987Br12.
[f] Inferred from transition-intensity balance by 1980Ke08.
[g] Multiply placed with undivided intensity.
[h] Placement of transition in the level scheme is uncertain.
[x] γ ray not placed in level scheme.

^{176}Yb(p,3nγ) 1987Br12,1990Dr05

Level Scheme

Intensities: Relative I_γ
& Multiply placed: undivided intensity given

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)



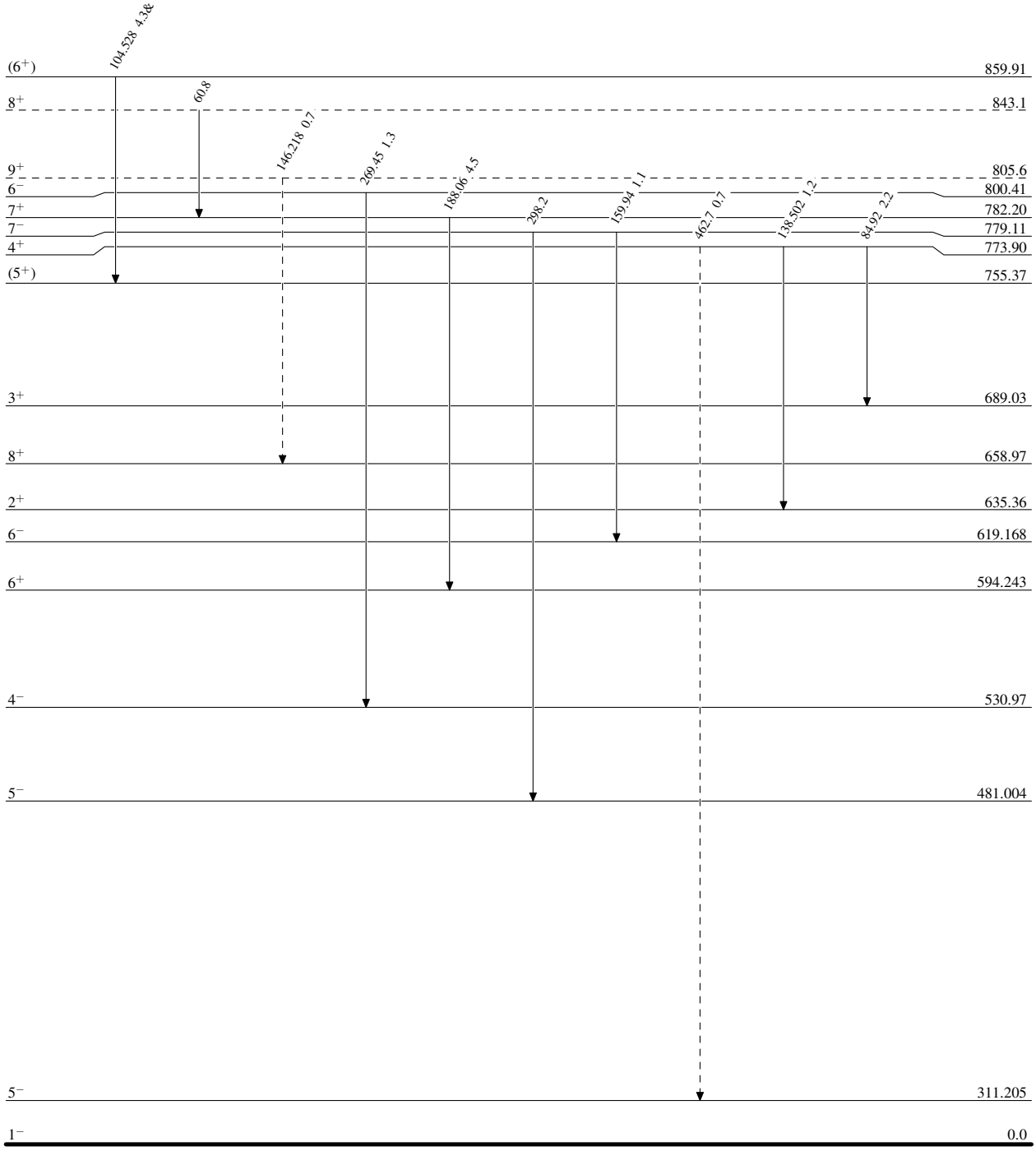
$^{174}_{71}Lu_{103}$

^{176}Yb(p,3nγ) 1987Br12,1990Dr05

Level Scheme (continued)

Intensities: Relative I_γ
& Multiply placed: undivided intensity given

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)



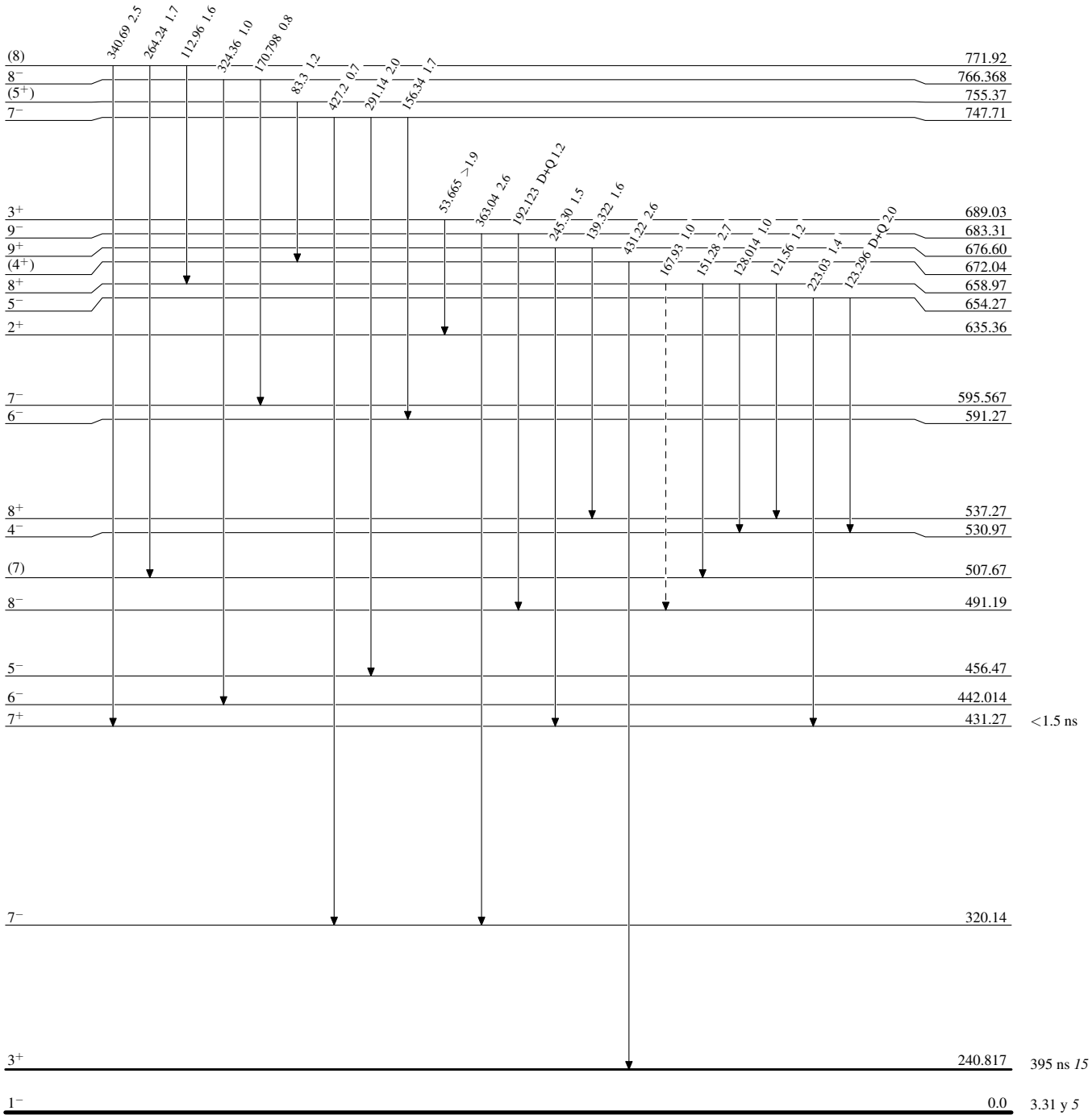
$^{174}_{71}Lu_{103}$

^{176}Yb(p,3nγ) 1987Br12,1990Dr05

Level Scheme (continued)

Intensities: Relative I_γ
& Multiply placed: undivided intensity given

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)



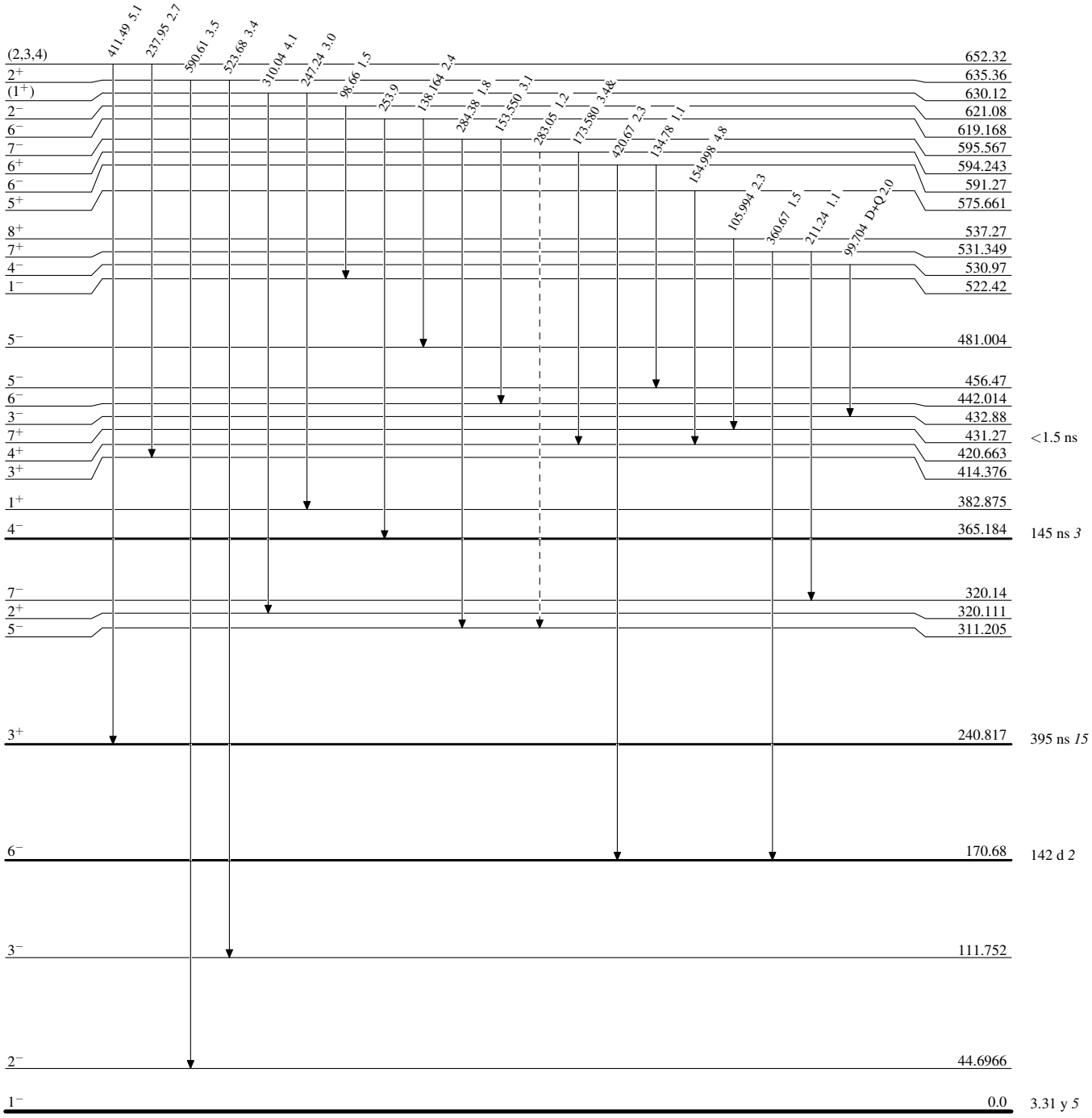
$^{174}_{71}Lu_{103}$

^{176}Yb(p,3nγ) 1987Br12,1990Dr05

Level Scheme (continued)

Intensities: Relative I_γ
& Multiply placed: undivided intensity given

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)



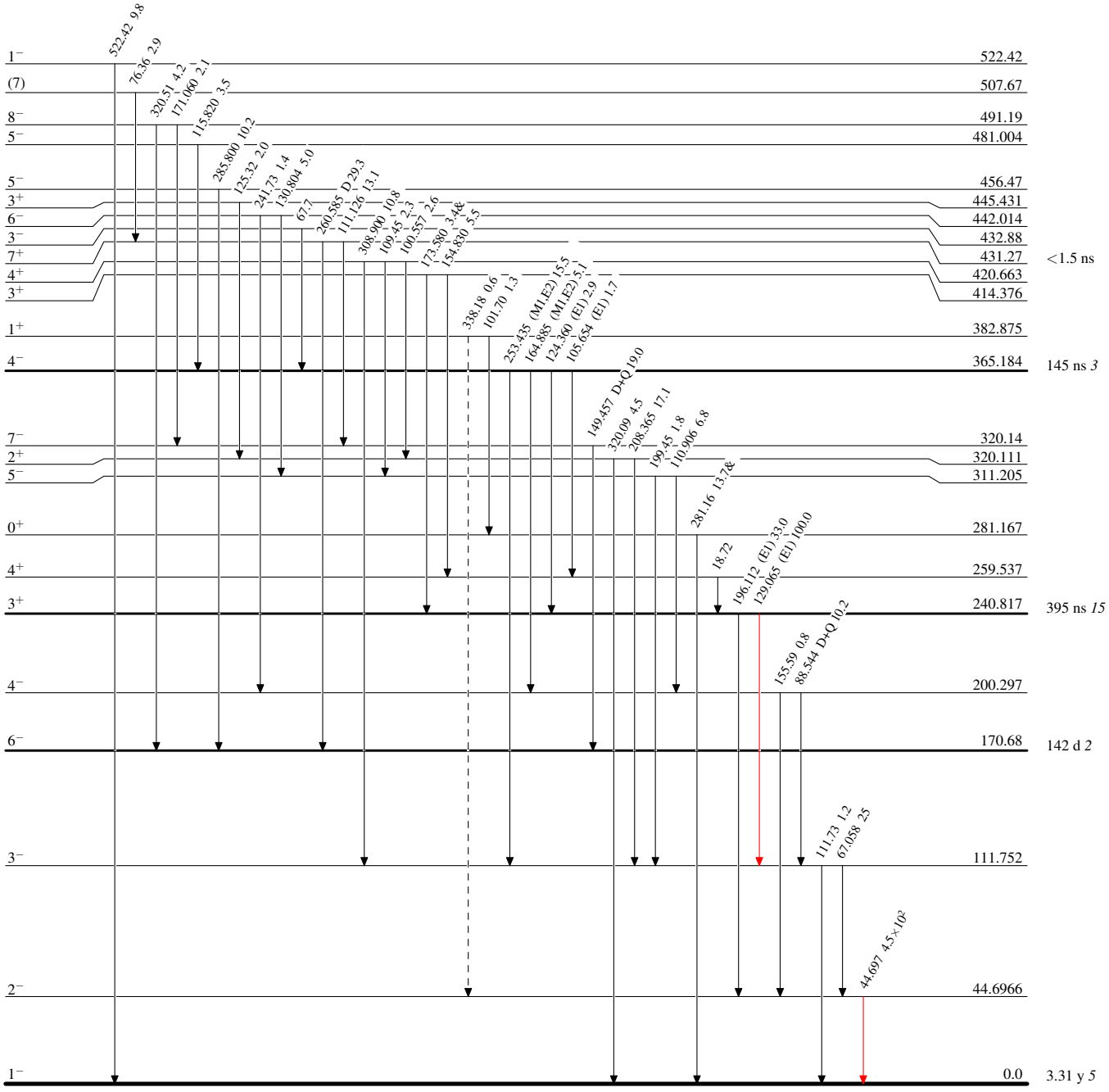
$^{174}_{71}Lu_{103}$

^{176}Yb(p,3nγ) 1987Br12,1990Dr05

Level Scheme (continued)

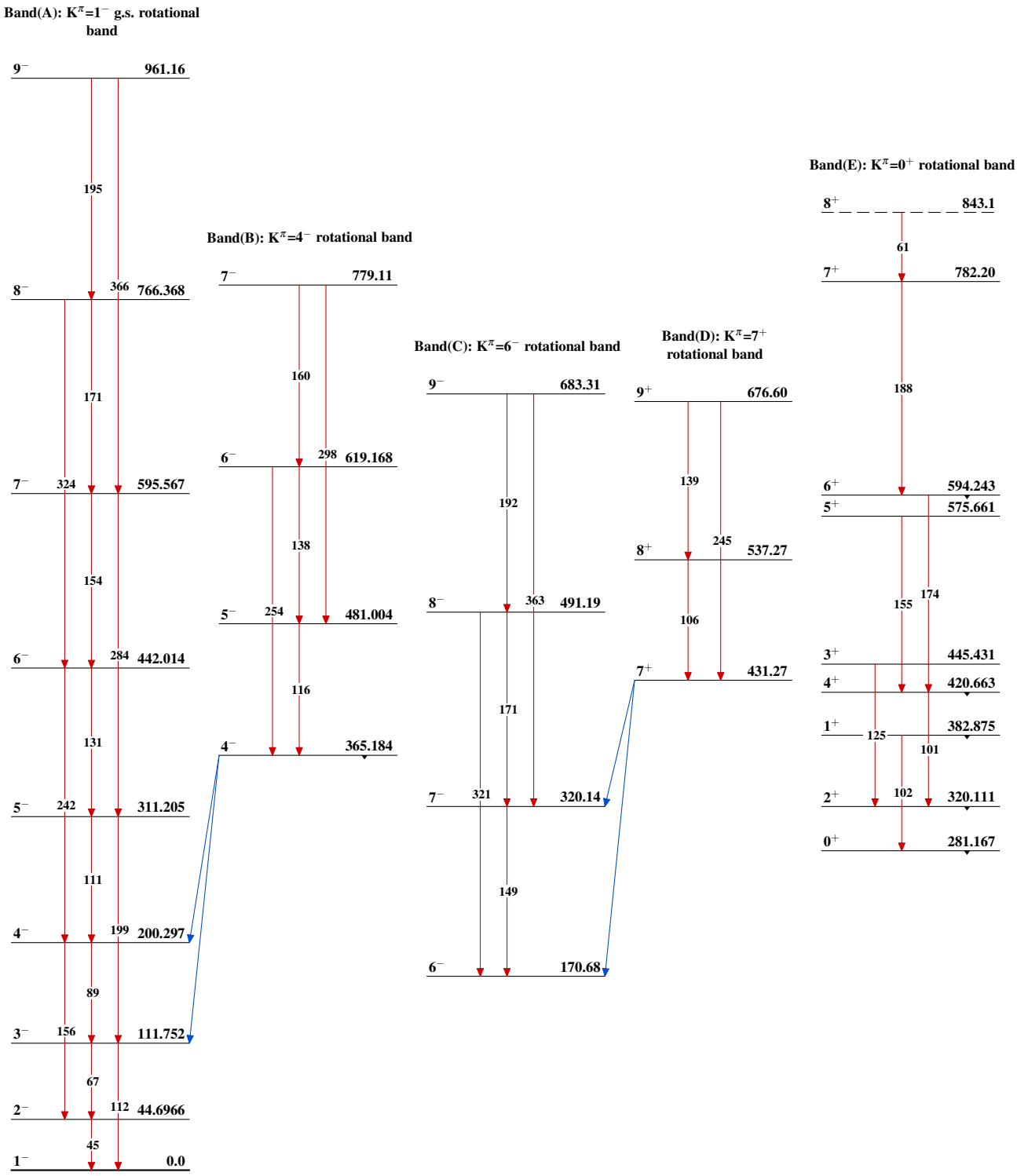
Intensities: Relative I_γ
& Multiply placed: undivided intensity given

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)



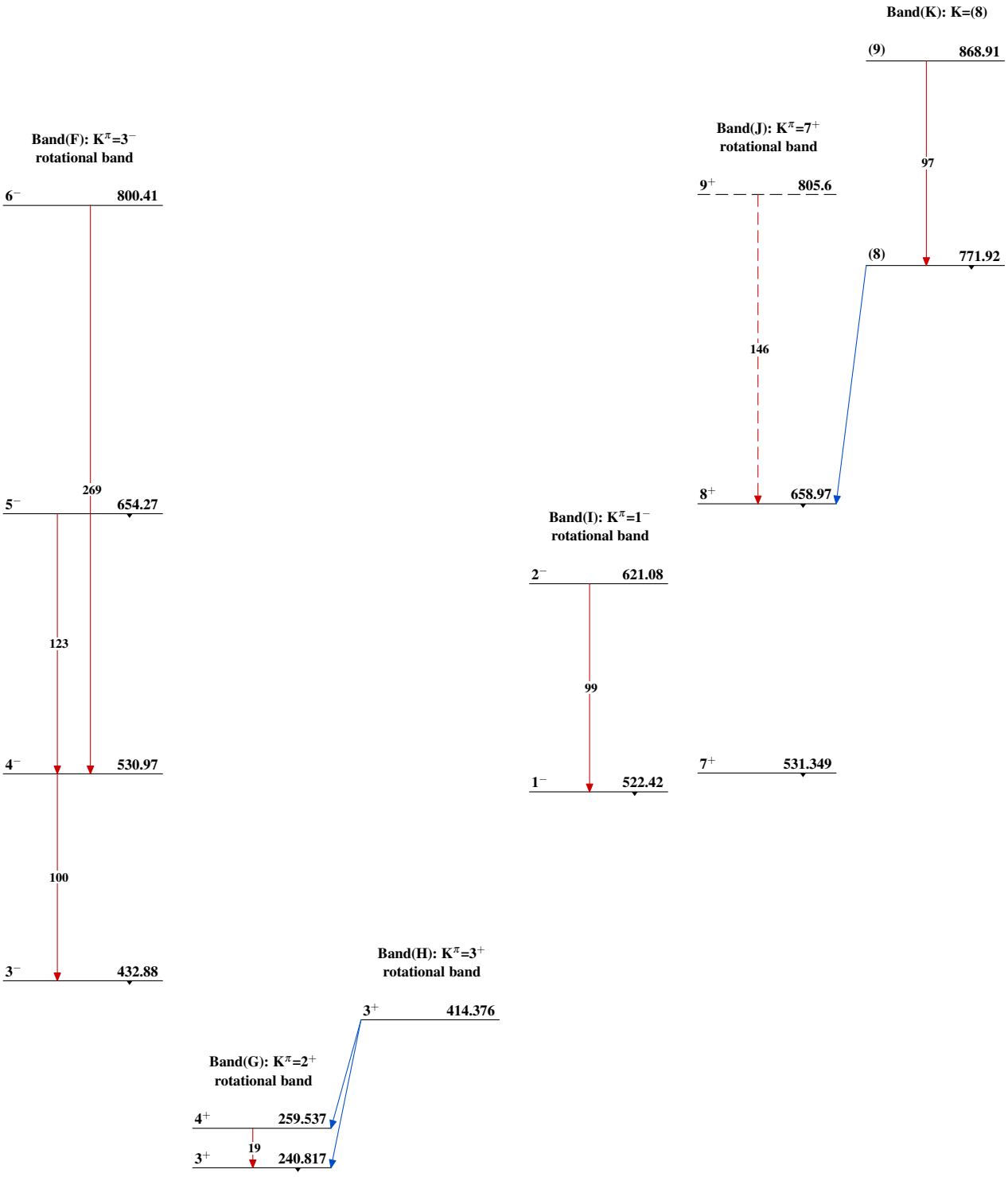
$^{174}_{71}Lu_{103}$

^{176}Yb(p,3nγ) 1987Br12,1990Dr05



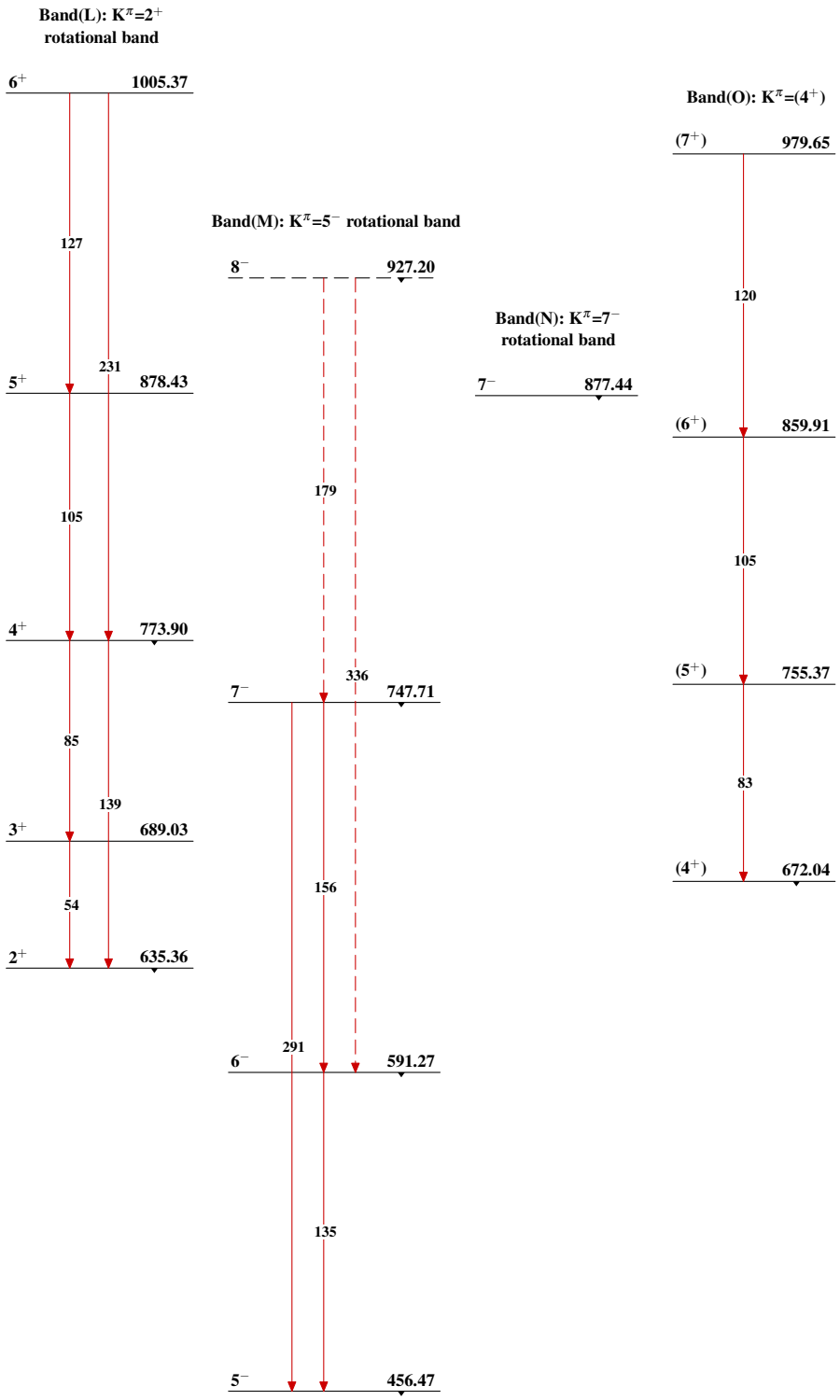
$^{174}_{71}Lu_{103}$

^{176}Yb(p,3nγ) 1987Br12,1990Dr05 (continued)



$^{174}_{71}Lu_{103}$

^{176}Yb(p,3nγ) 1987Br12,1990Dr05 (continued)



$^{174}_{71}Lu_{103}$