^{180}Hf(α,2nγ) 1977Je02

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh	NDS 130, 21 (2015)	15-Jul-2015

1977Je02: E=26 MeV. Measured Eγ, Iγ, γγ using two large volume Ge(Li) detectors and a small Ge(Li) detector of better resolution for low-energy γ rays.

1969No05: E=27 MeV. Natural Hf target, measured Eγ, Iγ, ce, αγ(t), lifetime. A total of 7 γ rays reported, five in g.s. band up to 10^+ and two from a 1.4−μs isomer at 2230 keV.

Other: 1965La02: g.s. band reported up to 10^+.

^{182}W Levels

E(level)	Jπ[†]	$T_{1/2}$	Comments
0.0[‡]	0^+		
100.11[‡] *10*	2^+		
329.42[‡] *12*	4^+		
680.47[‡] *14*	6^+		
1144.47[‡] *17*	8^+		
1221.50[#] *12*	2^+		
1257.37[@] *17*	2^+		
1289.19[&] *13*	2^-		
1331.19[#] *13*	3^+		
1373.88[&] *12*	3^-		
1442.90[#] *13*	4^+		
1487.55[&] *13*	4^-		
1510.24[@] *15*	4^+		
1553.25[c] *13*	4^-		
1621.34[&] *13*	5^-		
1623.62[#] *17*	5^+		
1660.45[c] *13*	5^-		
1712.13[‡] *22*	10^+		
1756.83[a] *14*	6^+		
1769.05[c] *13*	6^-		
1809.85[g] *16*	5^-		
1810.93[&] *14*	6^-		
1829.64[d] *13*	6^-		
1917.24[c] *16*	7^-		
1960.41[d] *13*	7^-		
1971.23[a] *18*	7^+		
1978.52[e] *21*	(7^-)		
1993.84[&] *16*	(7^-)		
2087.75 *17*			
2114.50[d] *15*	(8^-)		
2120.58[f] *16*	(8^-)		
2131.4[g] *3*	7^-		
2204.72[e] *23*	(8^-)		
2212.93[a] *20*	(8^+)		
2225.53[&] *17*	(8^-)		
2230.80[b] *22*	10^+	1.4 μs *1*	$T_{1/2}$: From 1969No05. Additional information 1.

Continued on next page (footnotes at end of table)

^{180}Hf(α,2nγ) 1977Je02 (continued)

^{182}W Levels (continued)

E(level)	J$^{\pi}$[†]	Comments
2274.2[d] *3*	(9$^-$)	
2324.0[g] *3*	(8$^-$)	
2328.24[f] *18*	(9$^-$)	
2334.4 *3*		J$^{\pi}$: (11$^-$) proposed in level-scheme figure 4 of 1977Je02 seems incorrect since 355.9γ to (7$^-$).
2372.74[‡] *24*	12$^+$	
2446.14[&] *19*	(9$^-$)	
2456.02[e] *25*	(9$^-$)	
2480.35[a] *23*	(9$^+$)	
2487.55 *20*		
2493.10[b] *24*	(11$^+$)	
2564.34[f] *20*	(10$^-$)	
2711.4 *3*		
2731.3[e] *3*	(10$^-$)	
2739.6[&] *4*	(10$^-$)	
2770.8[a] *3*	(10$^+$)	g_K=+0.96 *19* or −0.46 *19* for Iγ(558.2)/Iγ(290.4)=0.57 *30*; +1.02 *26* or −0.53 *26* for Iγ(558.2)/Iγ(290.4)=0.48 *30*.
2776.2[b] *3*	(12$^+$)	
2824.54[f] *23*	(11$^-$)	
2980.64[&] *22*	(11$^-$)	
3030.1[e] *3*	(11$^-$)	
3079.4[b] *3*	(13$^+$)	g_K=−0.27 *13* (sign of mixing ratio is negative from $\gamma(\theta)$ data for 11$^+$ to 10$^+$ and 12$^+$ to 11$^+$ transitions in K^{π}=10$^+$ band.
3104.3[f] *4*	(12$^-$)	
3112.8?[‡] *3*	(14$^+$)	
3399.6[b] *3*	(14$^+$)	
3736.6?[b] *11*	(15$^+$)	

† As proposed by 1977Je02 based on $\gamma(\theta)$ data, band assignments and previous assignments in β decay. The assignments are consistent with those in Adopted Levels, with only the difference of parentheses in a few cases.

‡ Band(A): K^{π}=0$^+$, g.s. band.

Band(B): K^{π}=2, γ band.

@ Band(C): K^{π}=0 band. This band is probably not a β-vibrational band (2001Ga02).

& Band(D): K^{π}=2$^-$, octupole band.

a Band(E): π5/2[402]$\otimes\pi$7/2[404], K^{π}=6$^+$.

b Band(F): ν9/2[624]$\otimes\nu$11/2[615], K^{π}=10$^+$.

c Band(G): ν9/2[624]$\otimes\nu$1/2[510], K^{π}=4$^-$.

d Band(H): ν9/2[624]$\otimes\nu$3/2[512], K^{π}=6$^-$.

e Band(I): π9/2[514]$\otimes\pi$5/2[402], K^{π}=7$^-$.

f Band(J): ν9/2[624]$\otimes\nu$7/2[503], K^{π}=8$^-$.

g Band(K): ν9/2[624]$\otimes\nu$1/2[510], K^{π}=5$^-$.

^{180}Hf(α,2nγ) 1977Je02 (continued)

γ(^{182}W)

E_γ	I_γ[†]	E_i(level)	J_i^π	E_f	J_f^π	Mult.	Comments
84.7 *1*	3.8 *3*	1373.88	3⁻	1289.19	2⁻		A_2=+0.15 *4*
100.1 *1*	35 *3*	100.11	2⁺	0.0	0⁺	[‡]	A_2=+0.05 *3*
107.0 *2*	1.19 *8*	1660.45	5⁻	1553.25	4⁻		
108.4 *2*	4.0 *3*	1769.05	6⁻	1660.45	5⁻		
111.1 *3*	0.4 *2*	1621.34	5⁻	1510.24	4⁺		
113.5 *1*	10.6 *9*	1487.55	4⁻	1373.88	3⁻	D[@]	A_2=−0.41 *1*
116.4 *2*	0.54 *4*	1373.88	3⁻	1257.37	2⁺		
130.8 *1*	3.1 *3*	1960.41	7⁻	1829.64	6⁻	D+Q[@]	A_2=−0.72 *3*
133.8 *1*	4.1 *3*	1621.34	5⁻	1487.55	4⁻	D[@]	A_2=−0.21 *11*
145.4 *2*	2.3 *5*	1769.05	6⁻	1623.62	5⁺	D[@]	A_2=−0.30 *15*
147.8 *1*	2.5 *5*	1769.05	6⁻	1621.34	5⁻		
148.9 *2*	0.7 *4*	1978.52	(7⁻)	1829.64	6⁻		
150.2[a] *1*	1.1 *2*	1660.45	5⁻	1510.24	4⁺		
152.4 *1*	10.0 *10*	1373.88	3⁻	1221.50	2⁺	D[@]	A_2=−0.19 *3*
154.1 *1*	1.1 *2*	2114.50	(8⁻)	1960.41	7⁻	D+Q[@]	A_2=−0.97 *16*
156.4 *1*	8.7 *7*	1487.55	4⁻	1331.19	3⁺	D[@]	A_2=−0.12 *5*
160.2 *1*	1.2 *1*	2120.58	(8⁻)	1960.41	7⁻	D+Q[@]	A_2=−0.95 *11*
169.2 *1*	4.0 *3*	1829.64	6⁻	1660.45	5⁻	D[@]	A_2=−0.11 *5*
172.9 *1*	3.0 *3*	1660.45	5⁻	1487.55	4⁻		
178.5 *1*	3.5 *3*	1621.34	5⁻	1442.90	4⁺	D[@]	A_2=−0.20 *8*
179.4 *1*	1.92 *15*	1553.25	4⁻	1373.88	3⁻		A_2=+0.23 *8*
186.7[a] *2*	0.56 *8*	1810.93	6⁻	1623.62	5⁺	D[@]	A_2=−0.8 *6*
189.6 *1*	1.2 *1*	1810.93	6⁻	1621.34	5⁻		
191.4 *1*	2.9 *2*	1960.41	7⁻	1769.05	6⁻	D[@]	A_2=−0.25 *1*
198.4 *1*	5.3 *4*	1487.55	4⁻	1289.19	2⁻		
203.6 *1*	1.62 *13*	1960.41	7⁻	1756.83	6⁺		
206.1 *2*	0.46 *7*	1829.64	6⁻	1623.62	5⁺		
207.7 *1*	1.32 *11*	2328.24	(9⁻)	2120.58	(8⁻)	D+Q[@]	A_2=−0.77 *20*
209.9 *2*	0.50 *5*	1978.52	(7⁻)	1769.05	6⁻		A_2=+0.7 *5*
213.6 *2*	1.7 *3*	2328.24	(9⁻)	2114.50	(8⁻)	D[@]	A_2=−0.5 *3*
214.4 *1*	5.4 *4*	1971.23	7⁺	1756.83	6⁺		
215.4 *1*	3.3 *3*	1769.05	6⁻	1553.25	4⁻		
217.5 *1*	2.03 *16*	1660.45	5⁻	1442.90	4⁺	D[@]	A_2=−0.32 *10*
221.2 *2*	1.50 *15*	1978.52	(7⁻)	1756.83	6⁺		
222.0 *1*	6.4 *6*	1553.25	4⁻	1331.19	3⁺		
226.2 *1*	6.1 *6*	2204.72	(8⁻)	1978.52	(7⁻)		
229.3 *1*	100	329.42	4⁺	100.11	2⁺	(Q)[‡#]	A_2=+0.26 *6*
236.1 *1*	2.12 *21*	2564.34	(10⁻)	2328.24	(9⁻)		
241.7 *1*	2.57 *21*	2212.93	(8⁺)	1971.23	7⁺		A_2=+0.10 *4*
247.5 *1*	7.9 *6*	1621.34	5⁻	1373.88	3⁻	(Q)[#]	A_2=+0.33 *9*
251.3 *1*	5.8 *5*	2456.02	(9⁻)	2204.72	(8⁻)		
256.6 *1*	5.6 *4*	1809.85	5⁻	1553.25	4⁻		
260.2 *1*	1.20 *10*	2824.54	(11⁻)	2564.34	(10⁻)	D+Q[@]	A_2=−1.12 *3*
262.3 *1*	4.6 *4*	2493.10	(11⁺)	2230.80	10⁺	D+Q[@]	A_2=−0.81 *4*
264.0 *1*	2.56 *20*	1553.25	4⁻	1289.19	2⁻	(Q)[#]	A_2=+0.25 *9*
267.4 *1*	0.83 *9*	2480.35	(9⁺)	2212.93	(8⁺)		
275.3 *2*	1.34 *13*	2731.3	(10⁻)	2456.02	(9⁻)	D+Q[@]	A_2=−1.1 *7*
276.4 *1*	1.90 *20*	1829.64	6⁻	1553.25	4⁻		
279.8 *3*	1.17 *23*	3104.3	(12⁻)	2824.54	(11⁻)		A_2=+0.4 *3*

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^{180}Hf(α,2nγ) 1977Je02 (continued)

γ(^{182}W) (continued)

E_γ	I_γ[†]	E_i(level)	J^π_i	E_f	J^π_f	Mult.	α[&]	Comments
281.5 *1*	5.1 *4*	1769.05	6⁻	1487.55	4⁻	(Q)[#]		A_2=+0.24 *16*
283.0 *1*	1.60 *20*	2776.2	(12⁺)	2493.10	(11⁺)	D+Q[@]		A_2=−0.8 *3*
286.6 *1*	2.2 *3*	1660.45	5⁻	1373.88	3⁻	(Q)[#]		A_2=+0.33 *17*
290.4 *2*	1.5 *3*	2770.8	(10⁺)	2480.35	(9⁺)			$(g_K-g_R)/Q_0$=0.11 *3* or 0.12 *4* for Iγ(558.2)/Iγ(290.4)=0.57 *30* or 0.48 *30*, respectively.
295.9 *1*	2.50 *20*	1917.24	7⁻	1621.34	5⁻	(Q)[#]		A_2=+0.38 *13*
298.8 *1*	1.2 *3*	3030.1	(11⁻)	2731.3	(10⁻)			A_2=+0.36 *15*
299.8 *2*	1.90 *20*	1960.41	7⁻	1660.45	5⁻			
302 *1*	1.3 *5*	3079.4	(13⁺)	2776.2	(12⁺)	D[@]		A_2=−0.22 *14* $(g_K-g_R)/Q_0$=0.081 *20* for Iγ(586.0)/Iγ(302.0)=0.2 *1*.
313.6 *3*	0.4 *1*	1756.83	6⁺	1442.90	4⁺			
318.7 *1*	5.6 *5*	2087.75		1769.05	6⁻			A_2=+0.51 *7*
320.2 *2*	1.10 *20*	3399.6	(14⁺)	3079.4	(13⁺)			
323.4 *1*	5.5 *5*	1810.93	6⁻	1487.55	4⁻	(Q)[#]		A_2=+0.41 *13*
337[a] *1*	0.3 *2*	3736.6?	(15⁺)	3399.6	(14⁺)			
339.1 *1*	2.78 *22*	1960.41	7⁻	1621.34	5⁻	(Q)[#]		A_2=+0.43 *6*
341.6 *1*	1.72 *14*	1829.64	6⁻	1487.55	4⁻			
345.4 *1*	2.24 *23*	2114.50	(8⁻)	1769.05	6⁻	(Q)[#]		A_2=+0.52 *9*
351.1 *1*	80 *6*	680.47	6⁺	329.42	4⁺	(Q)[‡#]		A_2=+0.28 *7*
355.9 *2*	3.2 *6*	2334.4		1978.52	(7⁻)			
357.0 *2*	5.6 *8*	2274.2	(9⁻)	1917.24	7⁻	(Q)[#]		A_2=+0.44 *19*
362.4 *3*	1.30 *15*	2131.4	7⁻	1769.05	6⁻			
372.5 *1*	2.74 *22*	1993.84	(7⁻)	1621.34	5⁻	(Q)[#]		A_2=+0.30 *12*
399.8 *1*	5.6 *5*	2487.55		2087.75				A_2=+0.50 *17*
406.8 *2*	1.3 *5*	2324.0	(8⁻)	1917.24	7⁻			
414.6 *1*	2.66 *21*	2225.53	(8⁻)	1810.93	6⁻	(Q)[#]		A_2=+0.16 *8*
437.2 *1*	2.76 *22*	2711.4		2274.2	(9⁻)			
452.3 *1*	2.12 *17*	2446.14	(9⁻)	1993.84	(7⁻)	(Q)[#]		A_2=+0.5 *4*
464.0 *1*	48 *4*	1144.47	8⁺	680.47	6⁺	(Q)[‡#]		A_2=+0.29 *9*
514.1 *3*	1.2 *3*	2739.6	(10⁻)	2225.53	(8⁻)			
518.5 *1*	6.3 *5*	2230.80	10⁺	1712.13	10⁺	(M1)[‡]	0.0514	α(K)exp=0.6 *2* (1969No05) α(K)=0.0429 *6*; α(L)=0.00659 *10*; α(M)=0.001495 *21* α(N)=0.000360 *5*; α(O)=5.89×10^{-5} *9*; α(P)=4.24×10^{-6} *6* Mult.: α(K)exp is consistent with M1, E1+M2 (50% admixture of both) or M2+E3 (25% M2+75% E3). The half-life of the 2230 level makes E3, M3 or higher multipolarities unlikely. M2 is also unlikely since the transition is expected to be highly K-forbidden and the forbiddenness factor of 10^3 is much smaller than expected for M2 transition and ΔK-L=6.
534.5 *1*	0.97 *9*	2980.64	(11⁻)	2446.14	(9⁻)			
558.2 *4*	0.85 *17*	2770.8	(10⁺)	2212.93	(8⁺)	(Q)[#]		A_2=+0.5 *4*
567.5 *1*	22.2 *18*	1712.13	10⁺	1144.47	8⁺			A_2=+0.27 *9* I_γ: uncertainty in Eγ, Iγ table 1 of 1977Je02 seems too low to be consistent with others in the table. Evaluators have increased this by a factor of 10.

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^{180}Hf(α,2nγ) 1977Je02 (continued)

γ(^{182}W) (continued)

E_γ	I_γ[†]	E_i(level)	J^π_i	E_f	J^π_f	Mult.	Comments
586.2 *1*	2.13 *17*	3079.4	(13$^+$)	2493.10	(11$^+$)	(Q)[#]	A_2=+0.35 *24*
660.6 *1*	4.9 *4*	2372.74	12$^+$	1712.13	10$^+$		
740.1 *2*	0.65 *7*	3112.8?	(14$^+$)	2372.74	12$^+$		
927.6 *2*	1.77 *18*	1257.37	2$^+$	329.42	4$^+$		
943.3[a] *4*	0.89 *18*	1623.62	5$^+$	680.47	6$^+$		
1001.8 *1*	3.5 *3*	1331.19	3$^+$	329.42	4$^+$		
1076.4 *1*	6.0 *5*	1756.83	6$^+$	680.47	6$^+$		
1086.5 *1*	7.3 *6*	2230.80	10$^+$	1144.47	8$^+$		Additional information 2.
1113.5 *1*	5.6 *5*	1442.90	4$^+$	329.42	4$^+$		
1121.4 *1*	24.5 *20*	1221.50	2$^+$	100.11	2$^+$		
1157.7 *4*	2.33 *19*	1257.37	2$^+$	100.11	2$^+$		I_γ: total for 1158 doublet; about 1 unit of intensity should be assigned from the decay of 1487 level (evaluators).
1180.5 *4*	3.2 *3*	1510.24	4$^+$	329.42	4$^+$		
1189.1 *2*	10.3 *8*	1289.19	2$^-$	100.11	2$^+$		
1221.8 *4*	16.6 *13*	1221.50	2$^+$	0.0	0$^+$		
1230.9 *2*	13.9 *11*	1331.19	3$^+$	100.11	2$^+$		
1257.2 *4*	3.4 *3*	1257.37	2$^+$	0.0	0$^+$		
1273.9 *4*	2.9 *5*	1373.88	3$^-$	100.11	2$^+$		I_γ: 0.94 expected from branching ratios in Adopted Gammas.
1293.9 *4*	5.1 *4*	1623.62	5$^+$	329.42	4$^+$		
1342.3 *2*	5.2 *4*	1442.90	4$^+$	100.11	2$^+$		
1410.9 *5*	0.77 *16*	1510.24	4$^+$	100.11	2$^+$		
1426.8 *5*	5.1 *5*	1756.83	6$^+$	329.42	4$^+$		
1454.3[a] *5*	1.75 *19*	1553.25	4$^-$	100.11	2$^+$		I_γ: too high an intensity as compared to values in β^- and ε decays; possibly an incorrect assignment; also 4$^-$ to 2$^+$ is not expected to be strong; only 0.027 expected from adopted branching ratios. Placement questioned by the evaluators.

[†] Large discrepancies between these values and the adopted branchings are observed.
[‡] K-conversion electron lines seen by 1969No05, also L-conversion for 100γ and 229γ.
[#] Positive A_2 and magnitude consistent with ΔJ=2, quadrupole (expected to be E2), since A_4 values are not available, these assignments are not considered as unique by the evaluators.
[@] Negative A_2 indicates ΔJ=1, dipole or dipole+quadrupole (when magnitude of $A_2 > \approx 0.3$). In the latter case the transition is expected to be M1+E2.
[&] From BrIcc v2.3b (16-Dec-2014) 2008Ki07, "Frozen Orbitals" appr.
[a] Placement of transition in the level scheme is uncertain.

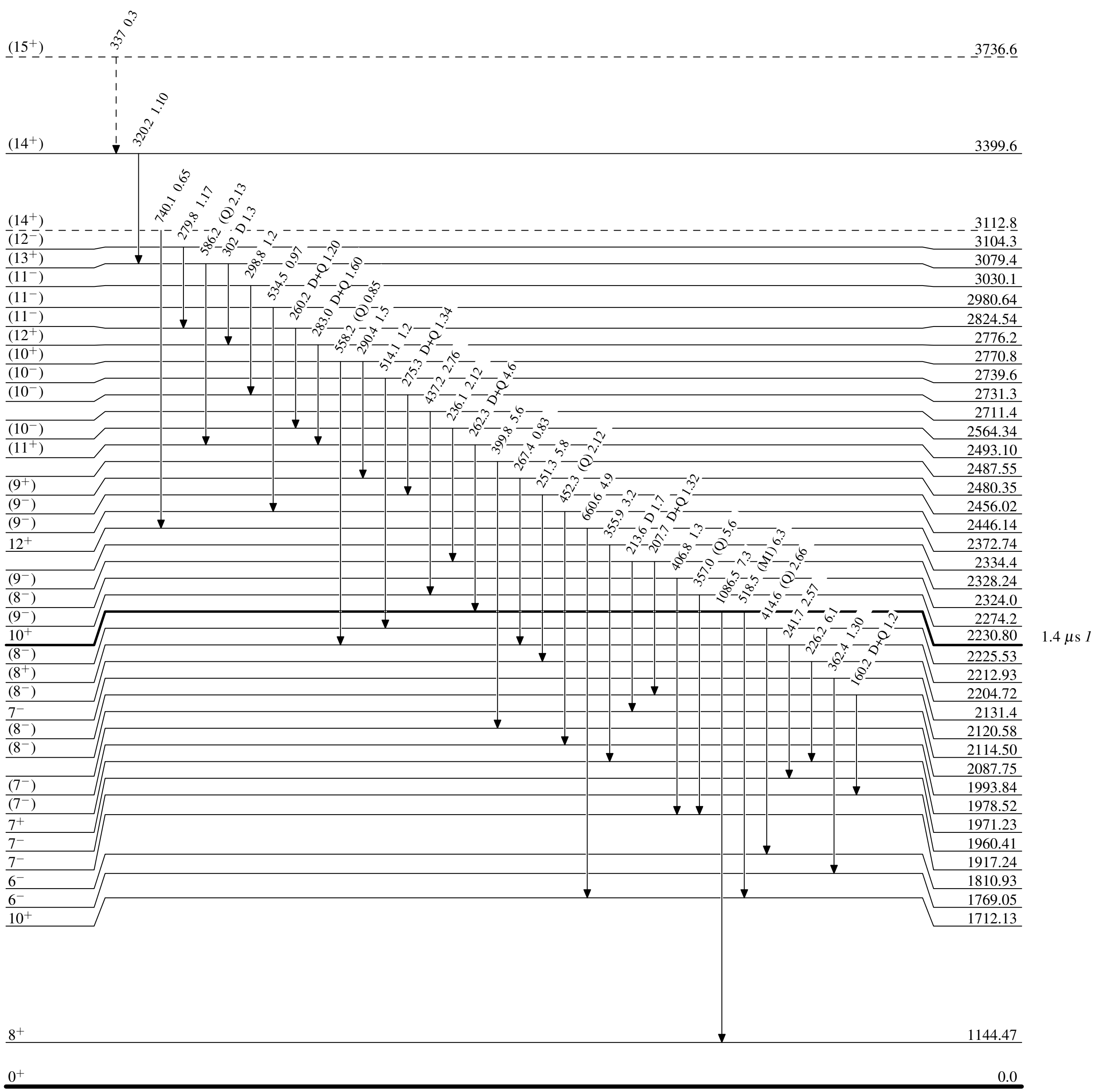
^{180}Hf(α,2nγ) 1977Je02

Level Scheme

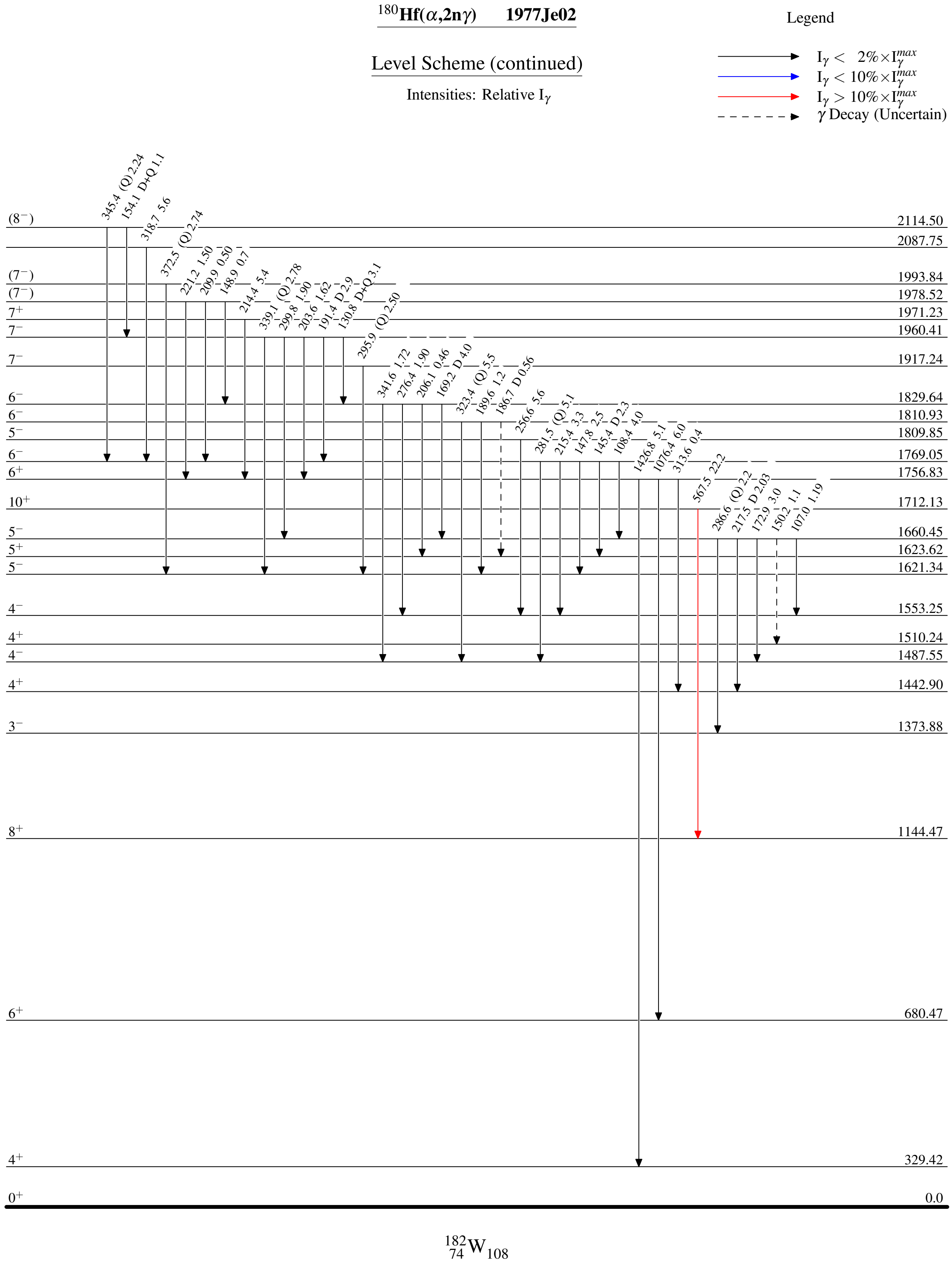
Intensities: Relative I_γ

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)



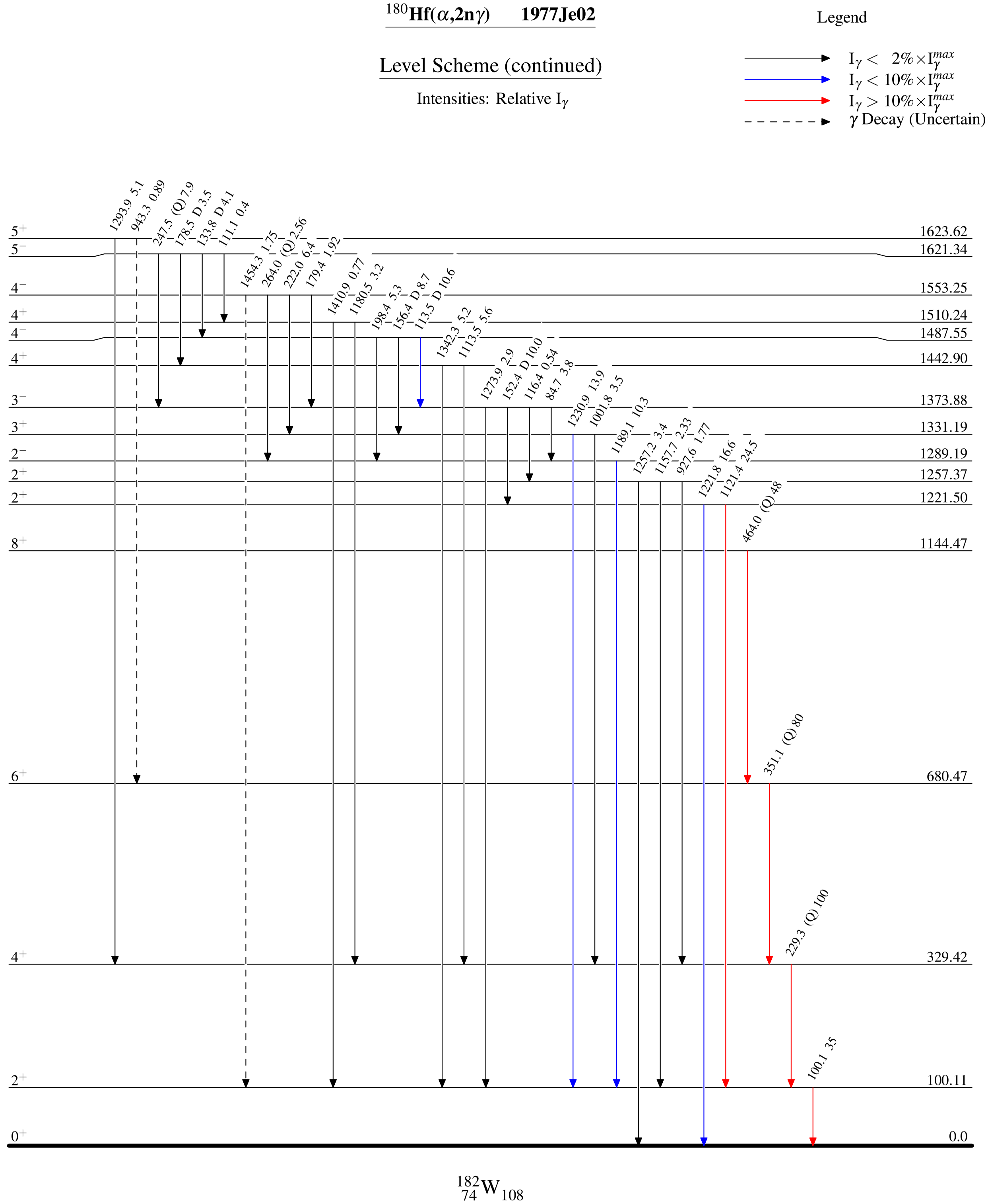
$^{182}_{74}W_{108}$


^{180}Hf(α,2nγ) 1977Je02
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)
(8⁻) 2114.50
2087.75
(7⁻) 1993.84
(7⁻) 1978.52
7⁺ 1971.23
7⁻ 1960.41
7⁻ 1917.24
6⁻ 1829.64
6⁻ 1810.93
5⁻ 1809.85
6⁻ 1769.05
6⁺ 1756.83
10⁺ 1712.13
5⁻ 1660.45
5⁺ 1623.62
5⁻ 1621.34
4⁻ 1553.25
4⁺ 1510.24
4⁻ 1487.55
4⁺ 1442.90
3⁻ 1373.88
8⁺ 1144.47
6⁺ 680.47
4⁺ 329.42
0⁺ 0.0
345.4 (Q) 2.24
154.1 D+Q 1.1
318.7 5.6
372.5 (Q) 2.74
221.2 1.50
209.9 0.50
148.9 0.7
214.4 5.4
339.1 (Q) 2.78
299.8 1.90
203.6 1.62
191.4 D 2.9
130.8 D+Q 3.1
295.9 (Q) 2.50
341.6 1.72
276.4 1.90
206.1 0.46
169.2 D 4.0
323.4 (Q) 5.5
189.6 1.2
186.7 D 0.56
256.6 5.6
281.5 (Q) 5.1
215.4 3.3
147.8 2.5
145.4 D 2.3
108.4 4.0
1426.8 5.1
1076.4 6.0
313.6 0.4
567.5 22.2
286.6 (Q) 2.2
217.5 D 2.03
172.9 3.0
150.2 1.1
107.0 1.19
$^{182}_{74}W_{108}$

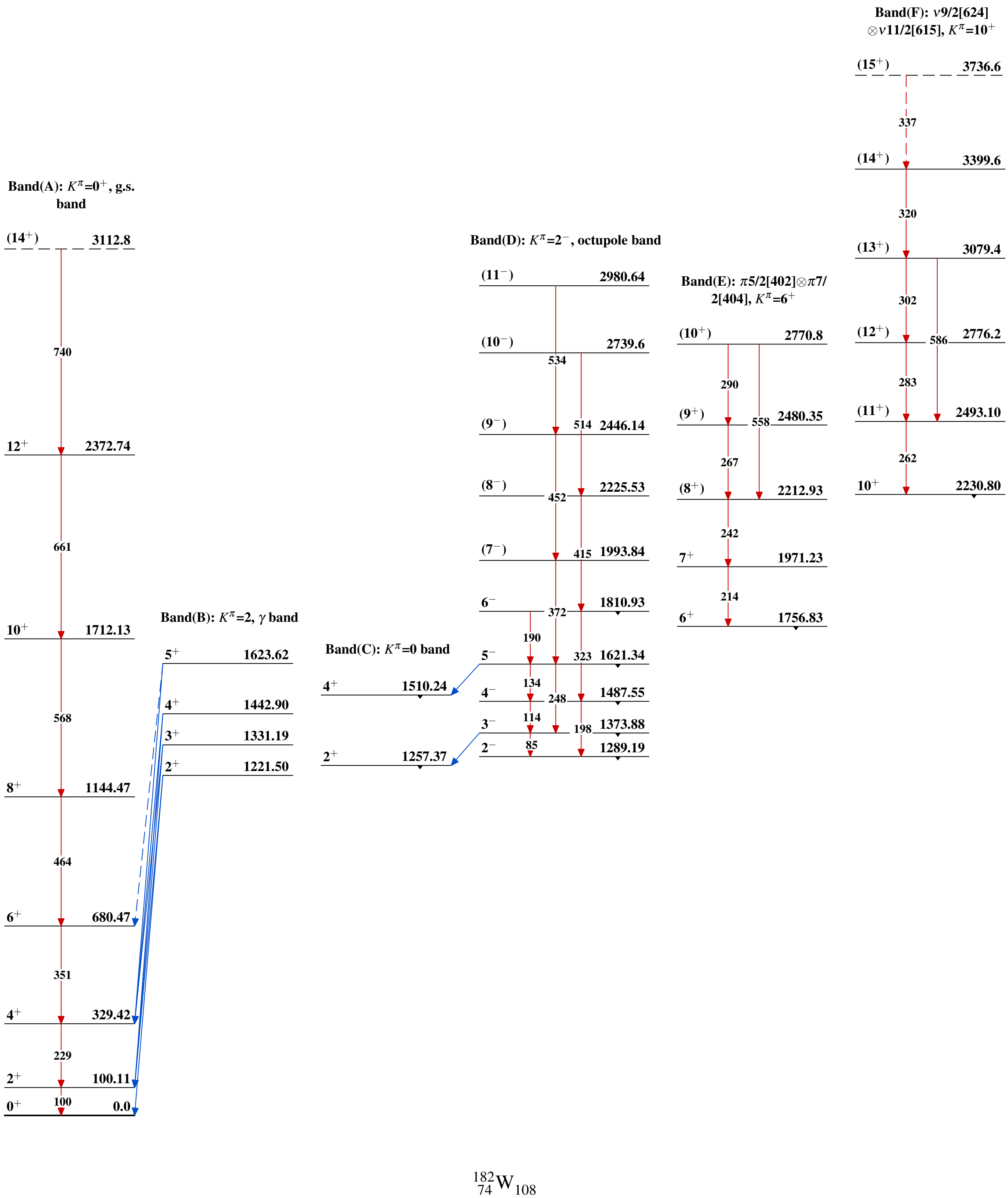
^{180}Hf(α,2nγ) 1977Je02

Level Scheme (continued)

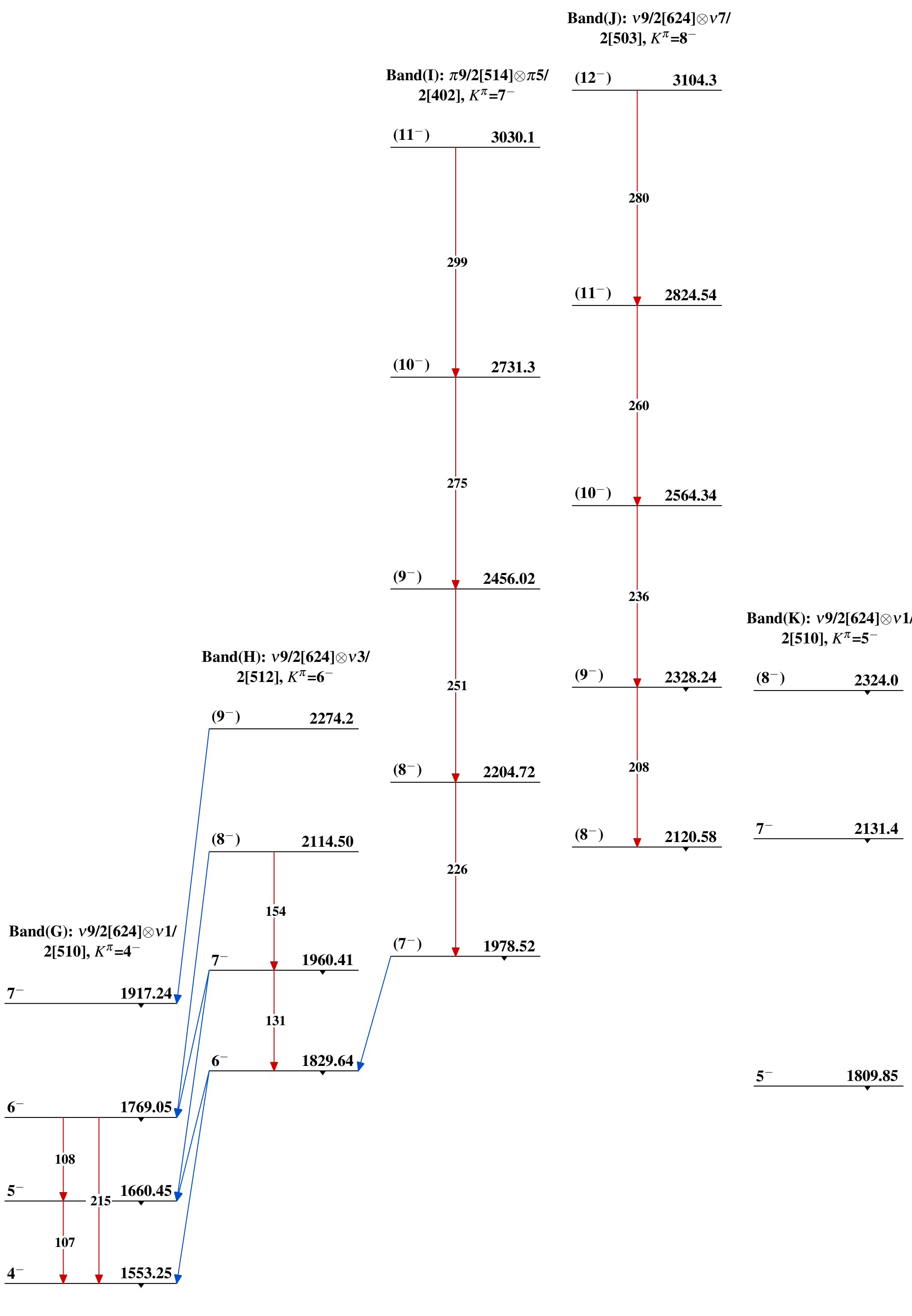
Intensities: Relative I_γ



^{180}Hf(α,2nγ) 1977Je02



^{180}Hf(α,2nγ) 1977Je02 (continued)



$^{182}_{74}W_{108}$