^{177}Hf(α,3nγ) 1979Do02

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	E. Achterberg, O. A. Capurro, G. V. Marti	NDS 110, 1473 (2009)	31-May-2008

Target: 91.7% enriched ^{177}Hf, E(α)=38 MeV. Measured Eγ, Iγ, γγ coin, γγ(t), αγ(θ) at seven angles from θ=90° to 155°. Detectors: Ge(Li). Complementary experiments using the ^{164}Dy(^{18}O,4n) reaction. Others: 1976Be47, 1969Mi03, 1965La02.

^{178}W Levels

E(level)[†]	Jπ[‡]	$T_{1/2}$
0.0[#]	0+	
106.10[#] 5	2+	
343.15[#] 7	4+	
694.75[#] 8	6+	
1044.90[@] 9	2−	
1120.69[@] 8	3−	
1142.40[#] 9	8+	
1225.80[@] 9	4−	
1345.25[@] 8	5−	
1380.43 8	(4+)	
1509.27[@] 9	6−	
1556.55[&] 13	6+	
1657.09[@] 9	7−	
1665.55[a] 9	(6+)	
1666.17[#] 10	10+	
1739.33[b] 10	(7−)	9.6 ns 5
1827.89[b] 11	(8−)	
1836.29[a] 10	(7+)	
1889.23[@] 10	8−	
1916.68[&] 12	8+	
1965.20[b] 11	(9−)	
2024.40[a] 10	(8+)	
2042.86[@] 9	9−	
2133.93[b] 11	(10−)	
2228.22[a] 10	(9+)	
2245.22[#] 11	12+	
2328.58[b] 11	(11−)	
2340.72[&] 12	10+	
2357.02[@] 11	10−	
2445.59[a] 10	10+	
2490.54[@] 10	11−	
2547.16[b] 12	(12−)	
2673.79[a] 12	(11+)	
2785.78[b] 12	(13−)	
2804.90[&] 13	12+	
2859.39[#] 12	14+	
2902.78[@] 13	12−	
2995.6?[@] 16	(13−)	
3045.57[b] 13	(14−)	

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^{177}Hf(α,3nγ) 1979Do02 (continued)

^{178}W Levels (continued)

E(level)[†]	Jπ[‡]	$T_{1/2}$	Comments
3054.89 *14*			
3141.58[a] *13*	(13+)		
3237.19 *15*			
3318.81[b] *13*	(15−)		
3320.3[&] *3*	(14+)		
3489.16[#] *13*	16+		
3527.60 *16*		35 ns *3*	Jπ: excitation cross section suggests J>10. E(level): order of the 290-182 γ-ray cascade is consistent with coincidence transition intensity balance, but not with singles transition intensity balance. Authors also report inconsistencies with the transition intensity balances between the 182-, 290-, and 921- and 1090-keV delayed γ rays from (^{18}O,4nγ) data, where the 35-ns isomer is more strongly populated. It may be that an additional branching to the K^π=6+ band involving high-energy transitions was not observed in the (α,3nγ) reaction because of the weaker population to 35-ns isomer.
3614.36[b] *14*	(16−)		

† Deduced by evaluator from a least-squares fit to γ-ray energies.
‡ Assignments were made on the basis of γ-ray angular distributions, rotational structure, and γ-ray decay patterns.
\# K^π=0+ g.s. rotational band.
@ K^π=2− octupole vibrational band.
& K^π=0+ β vibrational band.
a K^π=(6+) band.
b K^π=(7−) band.

γ(^{178}W)

E_γ	I_γ[†]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[‡]	α[&]	Comments
73.78 *5*	16 *1*	1739.33	(7−)	1665.55	(6+)	E1	0.811	B(E1)(W.u.)=3.06×10^{-5} *16* Mult.: from α exp ≤1.0 (determined from transition intensity balance in delayed spectrum); A_2=−0.37 *2*, A_4=−0.02 *2*.
88.59[#] *5*	4.3 *2*	1827.89	(8−)	1739.33	(7−)			
106.10 *5*	32 *2*	106.10	2+	0.0	0+	E2	3.09	Mult.: A_2=0.07 *1*, A_4=−0.03 *1*.
x131.15 *5*	1.00 *7*							
137.34 *5*	8.4 *5*	1965.20	(9−)	1827.89	(8−)	M1,E2	1.5 *4*	Mult.: A_2=−0.64 *5*, A_4=0.06 *5*.
x150.11 *5*	1.00 *9*							
x157.90 *5*	1.6 *1*							
163.98 *5*	0.97 *7*	1509.27	6−	1345.25	5−	E2,M1	0.9 *3*	Mult.: A_2=0.30 *6*.
168.71 *5*	3.6 *2*	2133.93	(10−)	1965.20	(9−)	M1,E2	0.8 *3*	Mult.: A_2=−0.79 *4*, A_4=0.04 *5*.
170.82 *5*	5.9 *3*	1836.29	(7+)	1665.55	(6+)	M1,E2	0.8 *3*	Mult.: A_2=−0.54 *2*, A_4=0.02 *2*.
x175.95 *8*	0.76 *9*							
180.90 *5*	1.8 *1*	1225.80	4−	1044.90	2−			
182.30 *5*	1.4 *1*	3237.19		3054.89				
188.09 *5*	1.8 *1*	2024.40	(8+)	1836.29	(7+)			Mult.: A_2=−0.7 *1*.
194.69 *5*	1.8 *1*	2328.58	(11−)	2133.93	(10−)	M1,E2	0.53 *19*	Mult.: A_2=−0.71 *3*, A_4=0.05 *5*.
x201.77 *5*	2.5 *2*							Mult.: A_2=−0.14 *4*.
203.73 *9*	1.1 *2*	2228.22	(9+)	2024.40	(8+)	E2,M1	0.46 *18*	Mult.: A_2=−0.29 *9*.
x208.05 *5*	1.40 *9*							
217.55 *6*	0.56 *6*	2445.59	10+	2228.22	(9+)			
218.86 *5*	1.35 *9*	2547.16	(12−)	2328.58	(11−)	E2,M1	0.37 *15*	Mult.: A_2=−0.2 *1*.
224.55 *5*	2.8 *2*	1345.25	5−	1120.69	3−	E2	0.210	Mult.: A_2=0.021 *3*.

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^{177}Hf(α,3nγ) 1979Do02 (continued)

γ(^{178}W) (continued)

E_γ	I_γ[†]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[‡]	α[&]	Comments
225.83 5	3.5 2	1965.20	(9⁻)	1739.33	(7⁻)	E2	0.206	Mult.: A_2=0.30 3, A_4=−0.04 4.
228.54 15	1.5 1	2673.79	(11⁺)	2445.59	10⁺			Mult.: A_2=−0.3 1.
[x]231.17 10	1.6 3							
[x]234.16[#] 6	4.5 4							
237.01 5	100 6	343.15	4⁺	106.10	2⁺	E2	0.1765	Mult.: A_2=0.17 1, A_4=−0.04 1.
239.11[#] 6	4.1 3	2785.78	(13⁻)	2547.16	(12⁻)			Mult.: A_2=−0.18 5.
260.46 13	0.27 3	3045.57	(14⁻)	2785.78	(13⁻)			
[x]269.24 5	0.8 1							
283.51 5	6.2 4	1509.27	6⁻	1225.80	4⁻	E2	0.1008	Mult.: A_2=0.32 2, A_4=−0.07 2.
285.09 5	2.7 2	1665.55	(6⁺)	1380.43	(4⁺)	E2	0.0991	Mult.: A_2=0.16 3, A_4=−0.05 4.
290.41[@] 5	4.6 3	3527.60		3237.19				Mult.: A_2=−0.09 2, A_4=−0.02 2.
306.05 5	5.74 3	2133.93	(10⁻)	1827.89	(8⁻)	E2	0.0801	Mult.: A_2=0.22 4.
311.81 5	5.6 4	1657.09	7⁻	1345.25	5⁻			Mult.: A_2=0.3 1.
[x]345.63 5	1.3 1							
[x]348.29 9	1.3 1							
351.56 5	66 4	694.75	6⁺	343.15	4⁺	E2	0.0536	Mult.: A_2=0.18 1, A_4=−0.06 2.
358.76 5	5.4 3	2024.40	(8⁺)	1665.55	(6⁺)			Mult.: A_2=0.26 2, A_4=−0.05 2.
363.39 6	4.7 4	2328.58	(11⁻)	1965.20	(9⁻)	E2	0.0488	Mult.: A_2=0.31 9.
379.96 5	4.8 3	1889.23	8⁻	1509.27	6⁻	E2	0.0431	Mult.: A_2=0.29 2, A_4=−0.02 4.
385.78 5	4.0 2	2042.86	9⁻	1657.09	7⁻	E2	0.0413	Mult.: A_2=0.27 5, A_4=0.03 3.
392.04 5	4.4 3	2228.22	(9⁺)	1836.29	(7⁺)	E2	0.0396	Mult.: A_2=0.29 4, A_4=−0.05 5.
413.19 5	3.8 2	2547.16	(12⁻)	2133.93	(10⁻)	E2	0.0343	Mult.: A_2=0.33 5.
421.11 5	2.1 1	2445.59	10⁺	2024.40	(8⁺)			Mult.: A_2=0.3 1.
[x]423.94 5	1.05 8							
[x]434.63 5	1.3 1							
445.52 6	1.10 9	2673.79	(11⁺)	2228.22	(9⁺)			
447.67[a] 5	37[a] 2	1142.40	8⁺	694.75	6⁺	E2	0.0278	Mult.: A_2=0.23 2, A_4=−0.06 2.
447.67[a] 5	37[a] 2	2490.54	11⁻	2042.86	9⁻	E2	0.0278	Mult.: A_2=0.23 2, A_4=−0.06 2.
456.95 5	3.1 2	2785.78	(13⁻)	2328.58	(11⁻)	E2	0.0264	Mult.: A_2=0.32 4, A_4=−0.12 5.
460.94 22	0.20 2	3320.3	(14⁺)	2859.39	14⁺			
[x]465.36 6	2.1 1					E2	0.0252	Mult.: A_2=0.35 9, A_4=0.06 8.
467.79[a] 5	3.3[a] 3	2357.02	10⁻	1889.23	8⁻	E2	0.0248	Mult.: A_2=0.30 2, A_4=−0.01 3.
467.79[a] 5	3.3[a] 3	3141.58	(13⁺)	2673.79	(11⁺)	E2	0.0248	Mult.: A_2=0.30 2, A_4=−0.01 3.
[x]496.09 5	0.98 8							
498.31 5	2.3 1	3045.57	(14⁻)	2547.16	(12⁻)			
505.1[b]		2995.6?	(13⁻)	2490.54	11⁻			
514.75 8	0.7 1	1657.09	7⁻	1142.40	8⁺			
523.77 6	22 1	1666.17	10⁺	1142.40	8⁺	E2	0.0187	Mult.: A_2=0.24 4, A_4=−0.08 6.
533.03 5	1.4 1	3318.81	(15⁻)	2785.78	(13⁻)	E2	0.0179	Mult.: A_2=0.37 8.
545.76 6	2.0 1	2902.78	12⁻	2357.02	10⁻	E2	0.01694	Mult.: A_2=0.4 1.
559.68 6	0.99 9	2804.90	12⁺	2245.22	12⁺			
568.79 7	1.1 1	3614.36	(16⁻)	3045.57	(14⁻)			
579.05 5	11.3 6	2245.22	12⁺	1666.17	10⁺	E2	0.01471	Mult.: A_2=0.30 2, A_4=−0.04 2.
614.17 5	5.3 3	2859.39	14⁺	2245.22	12⁺	E2	0.01282	Mult.: A_2=0.29 6.
629.77 5	2.3 1	3489.16	16⁺	2859.39	14⁺			
650.40 6	4.7 3	1345.25	5⁻	694.75	6⁺	E1	0.00409	Mult.: A_2=−0.19 4.
674.55 7	0.85 7	2340.72	10⁺	1666.17	10⁺			
774.27 8	0.96 9	1916.68	8⁺	1142.40	8⁺			
777.53 5	6.1 4	1120.69	3⁻	343.15	4⁺	E1	0.00287	Mult.: A_2=−0.09 2.
824.38 7	0.9 1	2490.54	11⁻	1666.17	10⁺			Mult.: A_2=−0.5 2.
861.8 1	1.3 1	1556.55	6⁺	694.75	6⁺			Mult.: A_2=−0.42 7.
882.8 1	4.3 3	1225.80	4⁻	343.15	4⁺			Mult.: A_2=0.10 4.
900.4 1	1.7 1	2042.86	9⁻	1142.40	8⁺	E1,M2	0.017 15	Mult.: A_2=−0.34 7.
920.9 2	1.45 8	3054.89		2133.93	(10⁻)			

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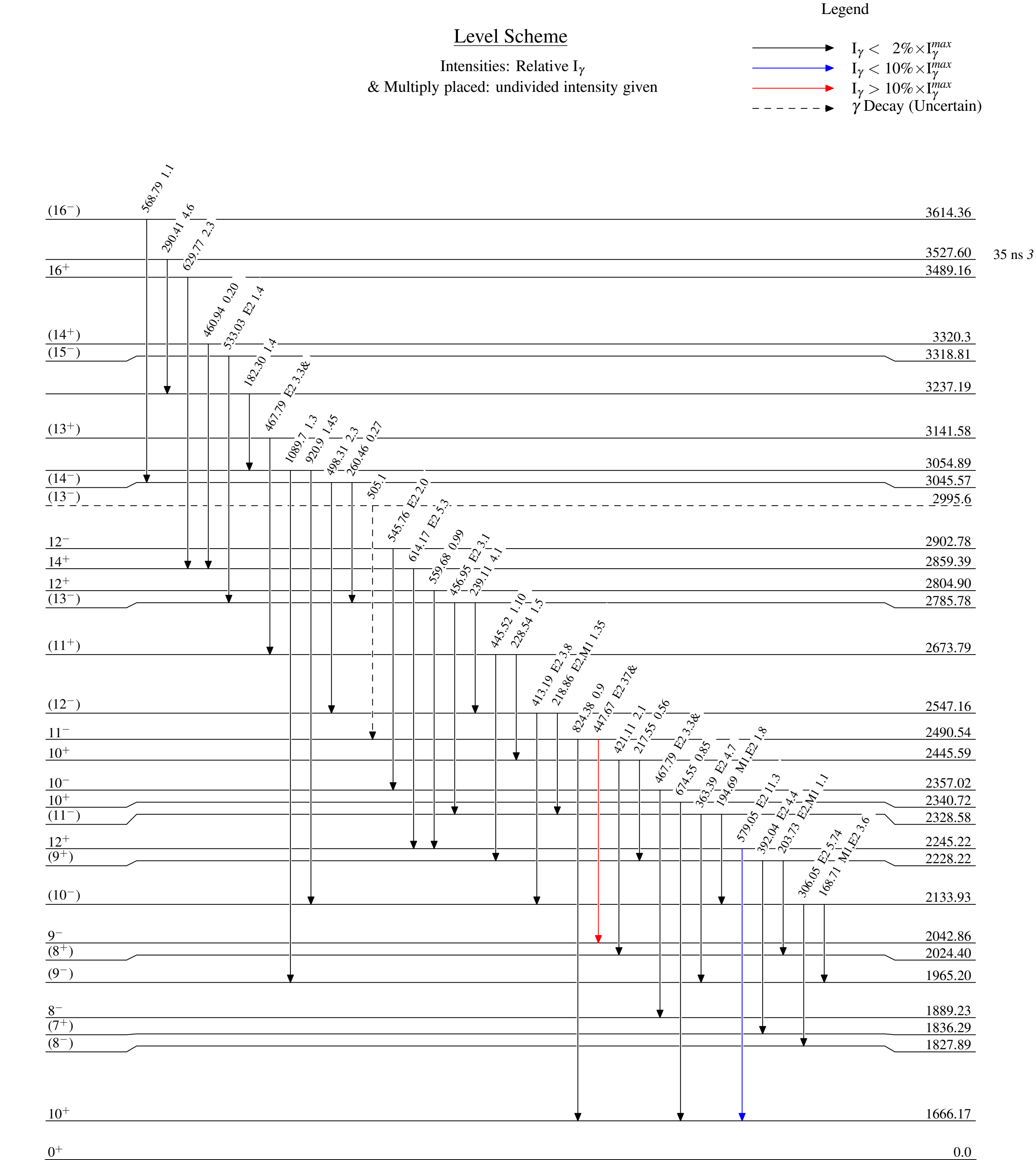
^{177}Hf(α,3nγ) 1979Do02 (continued)

γ(^{178}W) (continued)

E_γ	I_γ [†]	E_i(level)	J_i^π	E_f	J_f^π	Mult. [‡]	α [&]	Comments
938.8 *1*	7.4 *4*	1044.90	2^-	106.10	2^+			
962.4 *1*	3.1 *2*	1657.09	7^-	694.75	6^+			
970.8 *1*	14.7 *8*	1665.55	(6^+)	694.75	6^+	(M1+E2)	0.008 *3*	Mult.: suggested by 1979Do02 based on weak anisotropies observed in their $\gamma(\theta)$ distribution (coefficients not reported).
1002.1 *1*	2.1 *1*	1345.25	5^-	343.15	4^+	E1	1.78×10^{-3}	Mult.: A_2=−0.17 *6*.
1037.0 *1*	3.1 *2*	1380.43	(4^+)	343.15	4^+			
1089.7 *1*	1.3 *14*	3054.89		1965.20	(9^-)			
[x]1206.4 *2*	0.8 *1*							
1274.5[#] *1*	5.0 *3*	1380.43	(4^+)	106.10	2^+			
1322.5 *1*	20 *1*	1665.55	(6^+)	343.15	4^+	(E2)	0.00263	Mult.: suggested by 1979Do02 based on weak anisotropies observed in their $\gamma(\theta)$ distribution (A_2=−0.06 *2*).

[†] Measured at θ=125°.
[‡] From angular distribution coefficients determined in $\alpha\gamma(\theta)$ and decay scheme arguments.
[#] Doublet.
[@] Possible multiplet.
[&] 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] Multiply placed with undivided intensity.
[b] Placement of transition in the level scheme is uncertain.
[x] γ ray not placed in level scheme.

^{177}Hf(α,3nγ) 1979Do02



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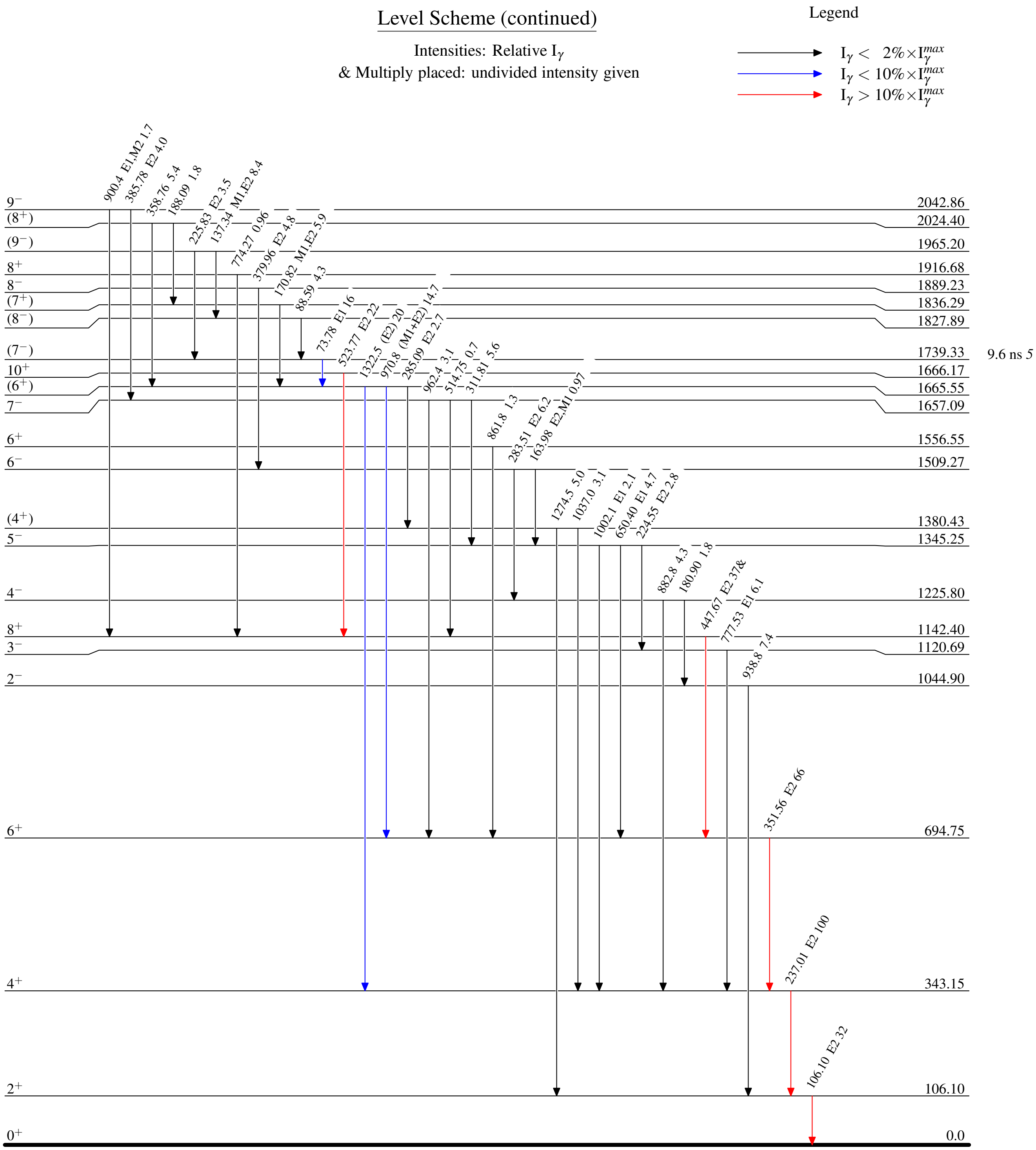
Level Scheme (continued)

Intensities: Relative I_γ
& Multiply placed: undivided intensity given



$^{178}_{74}W_{104}$