^{178}Hf(α,3nγ) 1973Li06

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Coral M. Baglin	NDS 110, 265 (2009)	15-Nov-2008

E=39 MeV.

Target:≈94.7% enriched ^{178}Hf. Projectile: α′s, E=26-43 MeV. Measured Eγ and Iγ for Eα=39 MeV at θ=125°, γγ coin, α-γ(θ) (90 ns resolving time);Ge(Li) detectors. Data discussed further in 1976Be47.

Experimental level energies of perturbed even-parity rotational bands are explained in terms of Coriolis mixing between all the $i_{13/2}$ (N=6) Nilsson orbitals. Relative γ-ray transition probabilities were calculated using Coriolis-mixed wave functions, and compared with experimental values.

^{179}W Levels

J(α),$T_{1/2}$(β) from Adopted Levels.

E(level)[†]	Jπ[‡]	$T_{1/2}$	E(level)[†]	Jπ[‡]	E(level)[†]	Jπ[‡]
0.0[#]	7/2−		748.46[a] 8	17/2+	1853.42[#] 17	25/2−
119.92[#] 5	9/2−		823.26[@] 16	11/2−	1874.26?[e] 16	(23/2+)
221.92[@] 7	1/2−	6.40 min 7	834.12[#] 10	17/2−	1987.85[a] 13	27/2+
264.59[#] 5	11/2−		857.09[@] 18	13/2−	2013.04?[d] 18	(23/2+)
304.75[@] 11	3/2−		960.99[a] 10	19/2+	2038.76?[c] 19	(25/2−)
308.99[a] 5	9/2+		1064.53[#] 11	19/2−	2120.74[a] 14	29/2+
318.49[@] 11	5/2−		1123.47[a] 11	21/2+	2141.9[#] 11	27/2−
372.87[a] 6	11/2+		1224.76[@] 19	15/2−	2262.59?[c] 21	(27/2−)
429.8[&] 1	5/2−		1272.79[@] 21	17/2−	2273.19?[@] 25	25/2−
432.60[#] 7	13/2−		1311.92[#] 14	21/2−	2292.74?[d] 23	(25/2+)
468.71[a] 6	13/2+		1425.21[a] 12	23/2+	2441.82[#] 20	29/2−
477.84[b] 8	7/2+		1576.5[#] 10	23/2−	2505.63?[c] 21	(29/2−)
508.86[@] 12	7/2−		1583.22[a] 12	25/2+	2586.94?[d] 21	(27/2+)
530.60[&] 15	7/2−		1632.66?[e] 13	(21/2+)	2739.5[#] 11	31/2−
533.39[@] 15	9/2−		1698.47?[@] 21	19/2−	2894.04?[d] 23	(29/2+)
606.24[a] 7	15/2+		1754.89[@] 23	21/2−	3210.54?[d] 25	(31/2+)
622.93[#] 9	15/2−		1833.06?[c] 16	(23/2−)		

[†] From least-squares fit to Eγ.

[‡] Authors′ values (J from level scheme drawing In fig. 3 of 1973Li06, π from authors′ band assignment), except As noted. The values are based on earlier literature, deduced collective band structure and multipolarities implied by measured γ(θ).

[#] Band(A): 7/2[514] g.s. band.

[@] Band(B): 1/2[521] band.

[&] Band(C): 5/2[512] band.

[a] Band(D): 9/2[624] Coriolis-mixed band.

[b] Band(E): 7/2[633] band.

[c] Band(F): 7/2[514]⊗$i^2_{13/2}$ band. Level and band assignment suggested by evaluator, consistent with Adopted Levels, Gammas.

[d] Band(G): K^π=(23/2)$^+$ band. Level and band assignment suggested by evaluator, consistent with Adopted Levels, Gammas.

[e] Band(H): K^π=21/2$^+$ band. Level and band assignment suggested by evaluator, consistent with Adopted Levels, Gammas.

^{178}Hf(α,3nγ) 1973Li06 (continued)

γ(^{179}W)

Eγ	Iγ[†]	Ei(level)	J^π_i	E_f	J^π_f	Mult.[‡]	α[a]	Comments
[x]71.3[@] 1	15							
[x]73.9[@] 1	48							Mult.: A_2=−0.06 5, A_4=−0.19 7.
82.9 1	17	304.75	$3/2^-$	221.92	$1/2^-$	D+Q		Mult.: A_2=+0.14 12, A_4=+0.13 13.
95.82 7	187	468.71	$13/2^+$	372.87	$11/2^+$	D+Q		Mult.: A_2=−0.40 7, A_4=+0.10 8.
96.5 1	23	318.49	$5/2^-$	221.92	$1/2^-$			
100.8 1	19	530.60	$7/2^-$	429.8	$5/2^-$			
[x]105.2[@] 1	29							
108.26 7	75	372.87	$11/2^+$	264.59	$11/2^-$	D		Mult.: A_2=+0.02 9, A_4=+0.10 12; consistent with ΔJ=0, Δπ=yes placement.
[x]109.9[@] 1	17							
[x]113.2[@] 1	19							
119.93 7	673	119.92	$9/2^-$	0.0	$7/2^-$	D+Q		Mult.: A_2=−0.04 6, A_4=+0.12 6.
[x]120.68[@] 7	52							
[x]124.9[@] 1	17							
[x]129.4[@] 1	15							
132.8 1	4	2120.74	$29/2^+$	1987.85	$27/2^+$			
137.54 7	383	606.24	$15/2^+$	468.71	$13/2^+$	D+Q		Mult.: A_2=−0.49 5, A_4=+0.08 4.
138.78[#c] 7	37	2013.04?	$(23/2^+)$	1874.26?	$(23/2^+)$	[M1]	1.86	Mult.: A_2=+0.49 24, A_4=−0.1 3.
142.26 7	231	748.46	$17/2^+$	606.24	$15/2^+$	D+Q		Mult.: A_2=−0.35 7, A_4=+0.13 7.
144.68 7	102	264.59	$11/2^-$	119.92	$9/2^-$	D+Q		Mult.: A_2=−0.03 7, A_4=+0.27 8.
[x]150.1[@] 1	12							
158.1 1	19	1583.22	$25/2^+$	1425.21	$23/2^+$			
159.70 7	71	468.71	$13/2^+$	308.99	$9/2^+$			
162.4 1	58	1123.47	$21/2^+$	960.99	$19/2^+$	D+Q		Mult.: A_2=−0.7 4, A_4=−0.2 4.
168.0 1	31	432.60	$13/2^-$	264.59	$11/2^-$			Mult.: A_2=−0.04 20, A_4=−0.4 3.
168.9[&] 1	12	477.84	$7/2^+$	308.99	$9/2^+$			
[x]170.9[@] 1	15							
[x]178.8 1	17							Contains contribution from (α,2nγ).
[x]181.5[@] 1	19							
189.09 7	1000	308.99	$9/2^+$	119.92	$9/2^-$	D(+Q)		Mult.: A_2=+0.17 3, A_4=+0.06 4.
190.3[b] 1	69[b]	508.86	$7/2^-$	318.49	$5/2^-$			
190.3[b] 1	69[b]	622.93	$15/2^-$	432.60	$13/2^-$			
[x]196.6[@] 1	31					D(+Q)		Mult.: A_2=−0.46 16, A_4=+0.26 20.
200.4[#c] 1	124	1833.06?	$(23/2^-)$	1632.66?	$(21/2^+)$	D		Mult.: A_2=−0.31 10, A_4=+0.01 12.
[x]201.5[@] 1	53							
204.15[b] 7	124[b]	468.71	$13/2^+$	264.59	$11/2^-$			Mult.: A_2=+0.28 10, A_4=+0.20 24 for doubly-placed G.
204.15[b] 7	124[b]	508.86	$7/2^-$	304.75	$3/2^-$			Mult.: A_2=+0.28 10, A_4=+0.20 24 for doubly-placed G.
205.7[#c] 1	35	2038.76?	$(25/2^-)$	1833.06?	$(23/2^-)$			
[x]206.6[@] 1	50							
211.2 1	46	834.12	$17/2^-$	622.93	$15/2^-$			Mult.: A_2=−0.05 19.
212.5 1	172	960.99	$19/2^+$	748.46	$17/2^+$	D+Q		Mult.: A_2=−0.59 18, A_4=+0.04 19.
214.9 1	148	533.39	$9/2^-$	318.49	$5/2^-$			Mult.: A_2=+0.23 8, A_4=−0.12 9 for contaminated line. Contains contribution from (α,2nγ).
[x]219.6[@] 1	25							
221.92 7		221.92	$1/2^-$	0.0	$7/2^-$			Iγ: 33 for isomeric transition.
223.7[#c] 1	40	2262.59?	$(27/2^-)$	2038.76?	$(25/2^-)$			
230.4[&] 1	15	1064.53	$19/2^-$	834.12	$17/2^-$			

Continued on next page (footnotes at end of table)

^{178}Hf(α,3nγ) 1973Li06 (continued)

γ(^{179}W) (continued)

E_γ	I_γ[†]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[‡]	Comments
233.38 *7*	333	606.24	$15/2^+$	372.87	$11/2^+$		Mult.: A_2=+0.12 *9*, A_4=−0.16 *10*.
[x]238.4[@] *1*	42						
241.6[#c] *1*	146	1874.26?	$(23/2^+)$	1632.66?	$(21/2^+)$		
242.9[#c] *1*	17	2505.63?	$(29/2^-)$	2262.59?	$(27/2^-)$		
[x]248.3[@] *1*	15						
252.96 *7*	400	372.87	$11/2^+$	119.92	$9/2^-$	D(+Q)	Mult.: A_2=−0.08 *9*, A_4=+0.13 *9*.
[x]255.5[@] *1*	31						
[x]256.7[@] *1*	31						
264.62 *7*	612	264.59	$11/2^-$	0.0	$7/2^-$		E_γ,I_γ: for possible doublet. Mult.: A_2=+0.11 *5*, A_4=0.00 *6* for possible doublet.
[x]265.6[@] *1*	≈42						
279.73[b] *7*	470[b]	748.46	$17/2^+$	468.71	$13/2^+$		Mult.: A_2=+0.16 *9*, A_4=−0.02 *7* for γ which May Be doublet. 1973Li06 place this γ from the 748 level only; however, a γ with this energy is also expected from the tentative 2291 level.
279.73[b#c]	[b]	2292.74?	$(25/2^+)$	2013.04?	$(23/2^+)$		I_γ: 470 for possible doublet.
294.2[#c] *1*	33	2586.94?	$(27/2^+)$	2292.74?	$(25/2^+)$		
301.7 *1*	38	1425.21	$23/2^+$	1123.47	$21/2^+$		
[x]306.2[@] *1*	56						
307.1[#c] *1*	21	2894.04?	$(29/2^+)$	2586.94?	$(27/2^+)$		
308.97 *7*	675	308.99	$9/2^+$	0.0	$7/2^-$	D(+Q)	Mult.: A_2=−0.16 *8*, A_4=+0.03 *9*.
312.65 *7*	337	432.60	$13/2^-$	119.92	$9/2^-$	Q	Mult.: A_2=+0.27 *6*, A_4=−0.09 *12*.
314.4 *1*	31	823.26	$11/2^-$	508.86	$7/2^-$		Mult.: A_2=+0.17 *24*, A_4=0.0 *4*.
316.5[#c] *1*	15	3210.54?	$(31/2^+)$	2894.04?	$(29/2^+)$		
[x]322.8[@] *1*	52						
323.7 *1*	104	857.09	$13/2^-$	533.39	$9/2^-$	(Q)	Mult.: A_2=+0.20 *17*, A_4=−0.10 *15*.
354.7 *1*	396	960.99	$19/2^+$	606.24	$15/2^+$	Q	Mult.: A_2=+0.20 *5*, A_4=−0.03 *7*.
358.4 *1*	433	622.93	$15/2^-$	264.59	$11/2^-$		a possible alternative placement exists from the 477.8 level. Mult.: A_2=+0.27 *11*, A_4=−0.10 *13* for possible doublet.
375.1 *1*	312	1123.47	$21/2^+$	748.46	$17/2^+$	Q	Mult.: A_2=+0.24 *8*, A_4=−0.13 *13*.
401.5[b] *1*	379[b]	834.12	$17/2^-$	432.60	$13/2^-$		Mult.: A_2=+0.23 *8*, A_4=−0.13 *14* for doublet.
401.5[b] *1*	379[b]	1224.76	$15/2^-$	823.26	$11/2^-$		Mult.: A_2=+0.23 *8*, A_4=−0.13 *14* for doublet.
404.7[&] *1*	15	1987.85	$27/2^+$	1583.22	$25/2^+$		
[x]411.1[@] *1*	56						
415.7 *1*	219	1272.79	$17/2^-$	857.09	$13/2^-$		Contains contribution from (α,4nγ). Mult.: A_2=+0.15 *11*, A_4=+0.02 *19* for contaminated G.
[x]424.7 *1*	21						
429.8 *1*	85	429.8	$5/2^-$	0.0	$7/2^-$		Mult.: A_2=+0.10 *15*, A_4=+0.02 *20*.
441.6 *1*	304	1064.53	$19/2^-$	622.93	$15/2^-$	Q	Mult.: A_2=+0.31 *5*, A_4=−0.05 *6*.
[x]442.7 *1*	25						
[x]456.2[@] *1*	42						
459.8 *1*	191	1583.22	$25/2^+$	1123.47	$21/2^+$	Q	Mult.: A_2=+0.31 *9*, A_4=−0.08 *19*.
464.2 *1*	224	1425.21	$23/2^+$	960.99	$19/2^+$	Q	Mult.: A_2=+0.26 *9*, A_4=−0.08 *15*.
467.0[#c] *1*	52	2505.63?	$(29/2^-)$	2038.76?	$(25/2^-)$		
473.7[#c] *1*	67	1698.47?	$19/2^-$	1224.76	$15/2^-$		
477.8[b] *1*	287[b]	477.84	$7/2^+$	0.0	$7/2^-$		
477.8[b] *1*	287[b]	1311.92	$21/2^-$	834.12	$17/2^-$		Mult.: A_2=+0.34 *7*, A_4=−0.03 *9* for doubly-placed line.
482.1 *1*	81	1754.89	$21/2^-$	1272.79	$17/2^-$		Mult.: A_2=+0.15 *18*, A_4=−0.2 *3*.
512	≈200	1576.5	$23/2^-$	1064.53	$19/2^-$		

Continued on next page (footnotes at end of table)

^{178}Hf(α,3nγ) 1973Li06 (continued)

γ(^{179}W) (continued)

E_γ	I_γ[†]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[‡]	Comments
[x]517.3[@] *1*	48						
518.3[#c] *1*	48	2273.19?	25/2$^-$	1754.89	21/2$^-$		
537.6 *1*	102	2120.74	29/2$^+$	1583.22	25/2$^+$	Q	Mult.: A_2=+0.29 *12*, A_4=−0.09 *25*.
541.5 *1*	164	1853.42	25/2$^-$	1311.92	21/2$^-$	(Q)	Mult.: A_2=+0.37 *20*, A_4=−0.4 *3*.
[x]543.8[@] *1*	25						
562.5 *1*	93	1987.85	27/2$^+$	1425.21	23/2$^+$	(Q)	Mult.: A_2=+0.24 *8*, A_4=−0.1 *3*.
565.4 *1*	158	2141.9	27/2$^-$	1576.5	23/2$^-$		Mult.: A_2=+0.11 *9*, A_4=−0.12 *15*.
573.9[#c] *1*	8	2586.94?	(27/2$^+$)	2013.04?	(23/2$^+$)		
[x]585.6[@] *1*	7						
588.4 *1*	81	2441.82	29/2$^-$	1853.42	25/2$^-$	(Q)	Mult.: A_2=+0.24 *21*, A_4=−0.1 *3*.
597.6 *1*	152	2739.5	31/2$^-$	2141.9	27/2$^-$		
[x]602.6[@] *1*	98						
[x]810.7[@] *1*	110						
[x]843.8[@] *1*	60						
[x]847.5[@] *1*	120						
884.2[#c] *1*	240	1632.66?	(21/2$^+$)	748.46	17/2$^+$		
[x]1014.4[@] *1*	80						
[x]1038.8[@] *1*	62						
[x]1321.5[@] *1*	80						

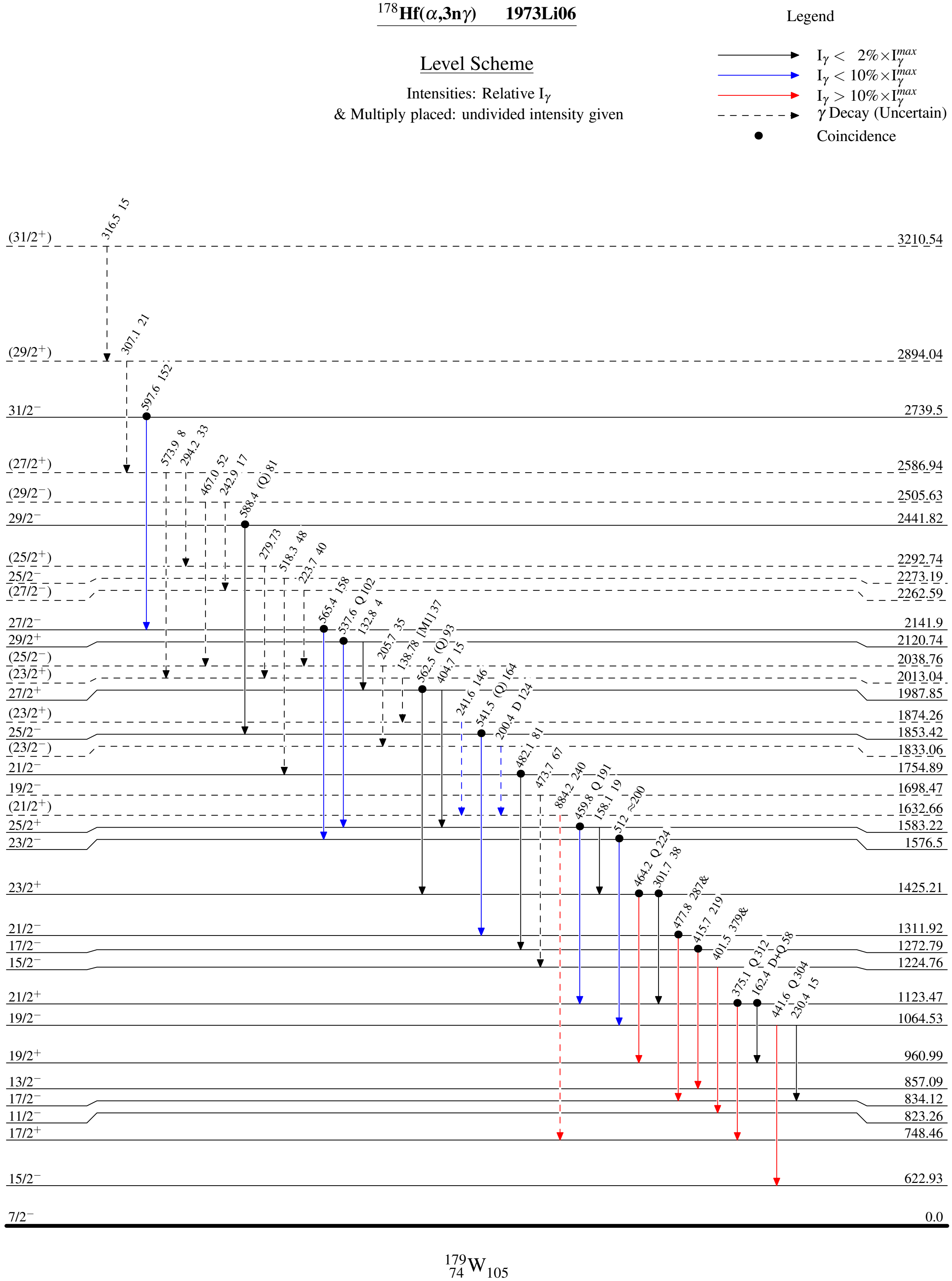
[†] For Eα=39 MeV. $\Delta I\gamma$=6% for intense γ rays.
[‡] Assigned by evaluator based on $\gamma(\theta)$ data.
[#] Unassigned γ In 1973Li06; tentatively placed by evaluator, consistent with Adopted Levels, Gammas.
[@] Unassigned γ ray from 1973Li06.
[&] Placement taken from fig. 3 of 1973Li06.
[a] 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.
[b] Multiply placed with undivided intensity.
[c] Placement of transition in the level scheme is uncertain.
[x] γ ray not placed in level scheme.

^{178}Hf(α,3nγ) 1973Li06

Level Scheme

Intensities: Relative I_γ

& Multiply placed: undivided intensity given

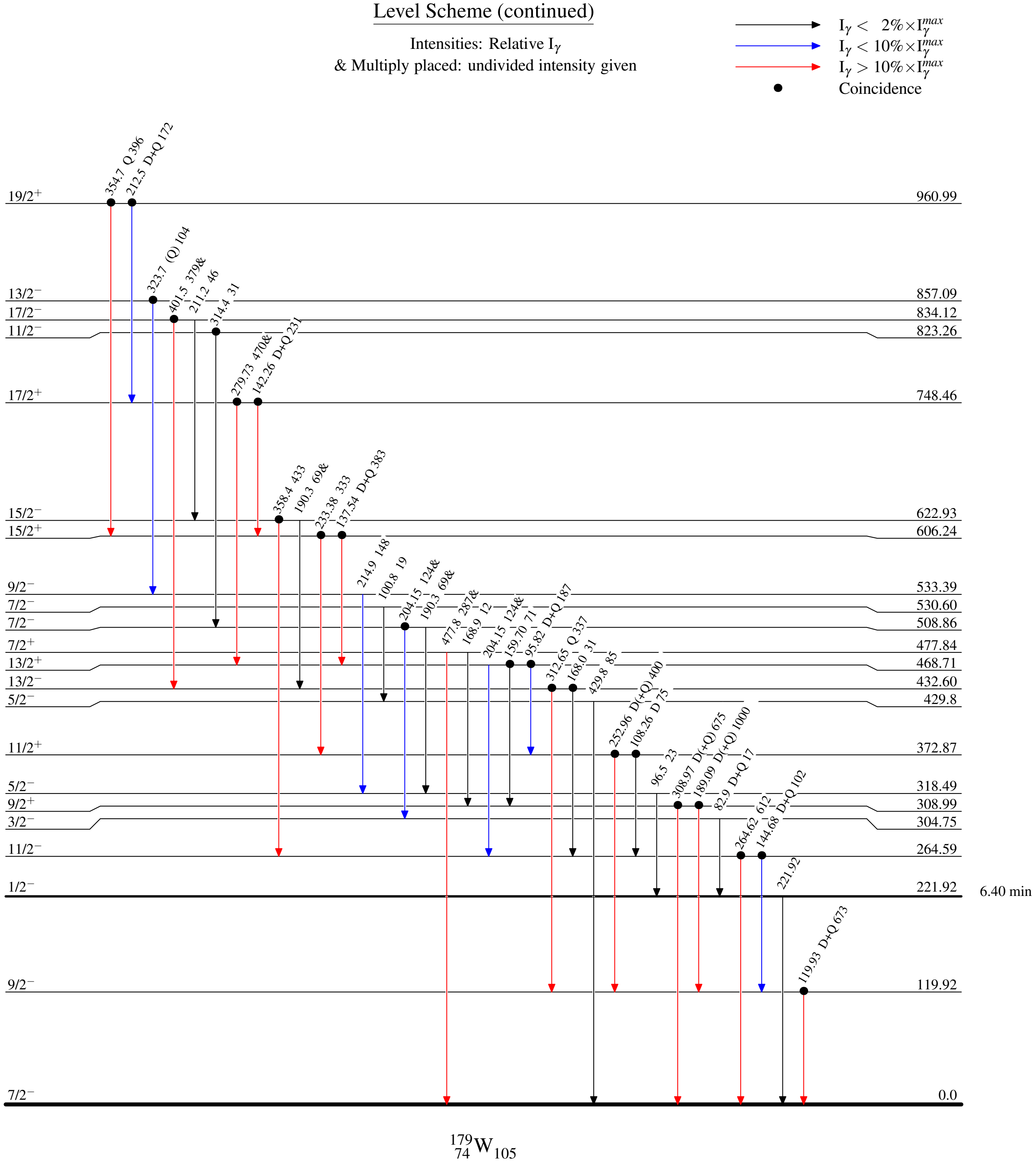


^{178}Hf(α,3nγ) 1973Li06

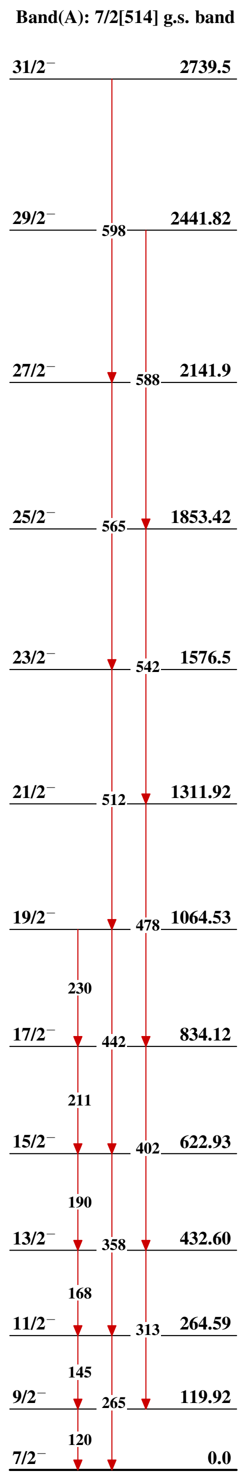
Level Scheme (continued)

Intensities: Relative I_γ
& Multiply placed: undivided intensity given

Legend

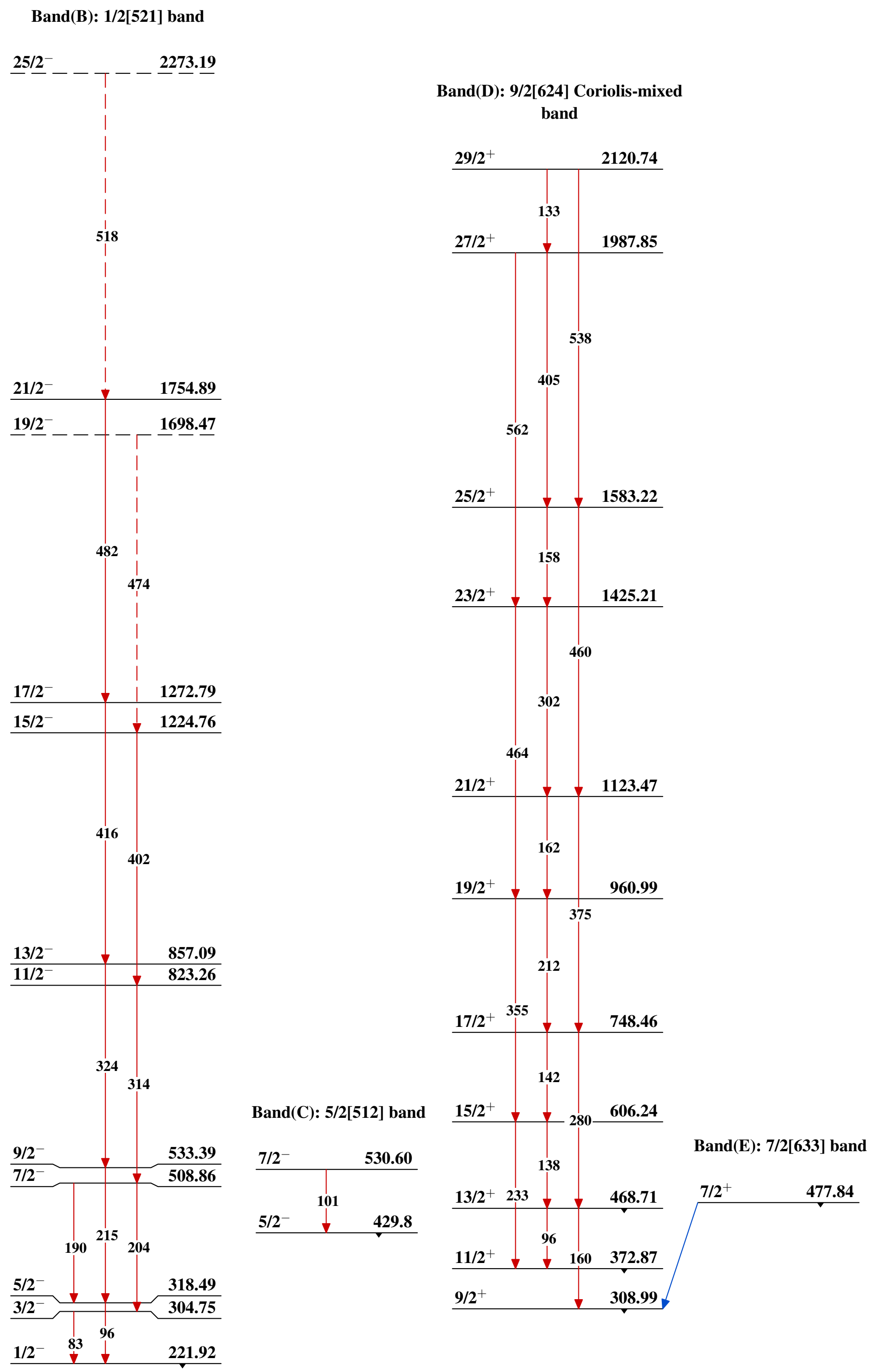


^{178}Hf(α,3nγ) 1973Li06



$^{179}_{74}W_{105}$

^{178}Hf(α,3nγ) 1973Li06 (continued)



$^{179}_{74}W_{105}$

^{178}Hf(α,3nγ) 1973Li06 (continued)