^{179}Hf(α,2nγ),^{180}Hf(α,3nγ) 1973Li17

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	S. -c. Wu	NDS 106, 367 (2005)	31-Aug-2005

1973Li17: ^{179}Hf(α,2nγ), ^{180}Hf(α,3nγ), E(α)=29-43 MeV; enriched targets; Ge(Li) detector system; measured σ(Eα, Eγ, θ(γ)), $\alpha\gamma$-delay, $\gamma\gamma$-coin.; deduced band structures.
Other: 1976Be47.
Additional information 1.

^{181}W Levels

E(level)[†]	J$^{\pi}$[‡]	T$_{1/2}$[#]	Comments
0.0[a]	9/2$^+$		
113.3[a]	11/2$^+$		
251.2[a]	13/2$^+$		
365.5[@c]	5/2$^-$		
409.0[b]	7/2$^-$		
414.5[a]	15/2$^+$		
475.4[@]	7/2$^-$		
528.3[bc]	9/2$^-$		
599.6[a]	17/2$^+$		
609.1[@]	9/2$^-$		
661.3[&]	7/2$^-$		
674.9[b]	11/2$^-$		
761.5[@]	11/2$^-$		
804.4[&c]	9/2$^-$		
814.4[a]	19/2$^+$		
847.9[b]	13/2$^-$		
953.6	7/2$^+$		Possible band head of 7/2$^+$[633].
974.4[&]	11/2$^-$		
1039.2[a]	21/2$^+$		
1046.0[b]	15/2$^-$		
1267.9[b]	17/2$^-$		
1310.4[a]	23/2$^+$		
1512.6[b]	19/2$^-$		
1560.4[a]	25/2$^+$		
1653.3[c]	(19/2,21/2)	≈110 ns	
1745.1?		≈50 ns	
1777[b]	21/2$^-$		
1899.4[a]	27/2$^+$		
2061.3			
2156.0[a]	29/2$^+$		
2577.5[a]	31/2$^+$		
2824.1?[a]	33/2$^+$		

[†] From level diagram in 1973Li17.
[‡] From $\gamma\gamma$-coin and band structures.
[#] From delayed $\alpha\gamma$-coin.
[@] Band(A): 5/2$^-$[512] band.
[&] Band(B): 7/2$^-$[503] band.

Continued on next page (footnotes at end of table)

^{179}Hf(α,2nγ),^{180}Hf(α,3nγ) 1973Li17 (continued)

^{181}W Levels (continued)

[a] Band(C): $9/2^+[624]$ ground state band.
[b] Band(D): $7/2^-[514]$ band. Members of this rotational band are not well supported by coincidence data. No coincidences connect M1 or E2 γ's.
[c] Transition intensity through level cannot be balanced.

$\gamma(^{181}W)$

The 275.5- and 429.8-keV γ's are in coincidence with each other and the 91.8-keV γ. They are not delayed and possibly comprise a band built on the 1745-keV level.

E_γ	I_γ[†]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[‡]	δ	α[&]	Comments
43.5	160 *CA*	409.0	7/2$^-$	365.5	5/2$^-$	M1+E2[@]	0.10[@] *3*	11.2 *11*	α(L)= 7.37; α(M)= 1.674 E_γ: from level scheme of 1973Li17.
91.8[a]	1081	1745.1?		1653.3	(19/2,21/2)	(E1)		0.472	α(K)= 0.384; α(L)= 0.0682; α(M)=0.01552; α(N+..)=0.00451 I_γ: 933 (α,2nγ). Mult.: intensity balance through lower levels requires E1 assignment. A_2=−0.03 *8*, A_4=−0.10 *20*.
109.8[#]	344	475.4	7/2$^-$	365.5	5/2$^-$	M1+E2[@]	0.38[@] *7*	3.61 *5*	α(K)= 3.11; α(L)= 0.493; α(M)= 0.1119; α(N+..)= 0.0343 I_γ: 897 (α,2nγ). A_2=−0.31 *13*, A_4=+0.04 *17*.
113.3	2240	113.3	11/2$^+$	0.0	9/2$^+$	D			A_2=−0.46 *3*, A_4=−0.01 *4*. I_γ: 2240 (α,2nγ).
119.4	170	528.3	9/2$^-$	409.0	7/2$^-$	[M1]		2.94	α(K)= 2.440; α(L)= 0.388; α(M)= 0.0880; α(N+..)= 0.0270 I_γ: 245 (α,2nγ).
133.7[#]	96	609.1	9/2$^-$	475.4	7/2$^-$	[M1]		2.128	α(K)= 1.765; α(L)= 0.280; α(M)= 0.0638; α(N+..)=0.01948
137.8	2539	251.2	13/2$^+$	113.3	11/2$^+$	D			I_γ: 2451 (α,2nγ). A_2=−0.50 *3*, A_4=−0.05 *4*.
143.1	67	804.4	9/2$^-$	661.3	7/2$^-$	[M1]		1.758	α(K)= 1.458; α(L)= 0.2311; α(M)= 0.0526; α(N+..)=0.01603 I_γ: 65 (α,2nγ).
146.6	213	674.9	11/2$^-$	528.3	9/2$^-$	D			I_γ: 336 (α,2nγ). A_2=−0.45 *30*, A_4=+0.04 *40*.
152.4	99	761.5	11/2$^-$	609.1	9/2$^-$	[M1]			I_γ: 101 (α,2nγ). A_2=+0.25 *26*, A_4=+0.60 *39*.
163.3	1955	414.5	15/2$^+$	251.2	13/2$^+$	D			I_γ: 1992 (α,2nγ). A_2=−0.51 *3*, A_4=−0.06 *4* for 163.3+164.8. Eγ=164.8 is unassigned.
170.0	124	974.4	11/2$^-$	804.4	9/2$^-$	(D)			I_γ: 151 (α,2nγ). A_2=−0.62 *25*, A_4=−0.21 *35*.
172.9	121	847.9	13/2$^-$	674.9	11/2$^-$	(D)			I_γ: 98 (α,2nγ). A_2=−0.59 *30*, A_4=−0.04 *35* for 171.5+172.9. Eγ=171.5 is unassigned.
185.1	1210	599.6	17/2$^+$	414.5	15/2$^+$	D			I_γ: 1159 (α,2nγ). A_2=−0.54 *6*, A_4=−0.01 *8*.
186.2	21	661.3	7/2$^-$	475.4	7/2$^-$	E2[@]		0.397	α(K)= 0.695; α(L)= 0.1100; α(M)= 0.0250; α(N+..)=0.00753 E_γ: from level scheme of 1973Li17.
198.1[#]	109	1046.0	15/2$^-$	847.9	13/2$^-$	[M1]		0.705	α(K)= 0.585; α(L)= 0.0925; α(M)=0.02101; α(N+..)=0.00631
214.7	881	814.4	19/2$^+$	599.6	17/2$^+$	D			I_γ: 1013 (α,2nγ). A_2=−0.41 *4*, A_4=−0.07 *6* for 214.7+215.2. Eγ=215.2 is unassigned.
221.9[#]	62	1267.9	17/2$^-$	1046.0	15/2$^-$	[M1]		0.514	α(K)= 0.427; α(L)= 0.0673; α(M)=0.01530; α(N+..)=0.00458 I_γ: 210 (α,2nγ).

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^{179}Hf(α,2nγ),^{180}Hf(α,3nγ) 1973Li17 (continued)

$\gamma(^{181}W)$ (continued)

E_γ	I_γ[†]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[‡]	δ	α[&]	Comments
224.9	436	1039.2	$21/2^+$	814.4	$19/2^+$	(D)			A_2=−0.17 *31*, A_4=−0.01 *47* for 224.9+225.1. Eγ=225.1 is from ^{180}W.
243.5	472	609.1	$9/2^-$	365.5	$5/2^-$	Q			I_γ: 413 (α,2nγ). A_2=+0.25 *5*, A_4=−0.06 *9*.
250.1[#]	220 *CA*	1560.4	$25/2^+$	1310.4	$23/2^+$	[M1]		0.369	α(K)= 0.307; α(L)= 0.0483; α(M)=0.01097; α(N+..)=0.00327 I_γ: the intensity reported by 1973Li17 (Iγ=888) is too large compared to the total intensity deexciting 1310-keV level. Also, the B(M1) is an order of magnitude smaller (relative to 521-keV B(E2)) than for other transitions in this band. Iγ=220 has been calculated by evaluator assuming B(E2)/B(M1)=1400 from the systematics of the other band members. I_γ: 702 (α,2nγ). A_2=+0.15 *4*, A_4=−0.05 *7* for 250.1+251.2.
251.2	1071	251.2	$13/2^+$	0.0	$9/2^+$				A_2=+0.15 *4*, A_4=−0.05 *7* for 250.1+251.2.
256.5	54	2156.0	$29/2^+$	1899.4	$27/2^+$	[M1]		0.345	α(K)= 0.286; α(L)= 0.0450; α(M)=0.01023; α(N+..)=0.00305
265.9	322	674.9	$11/2^-$	409.0	$7/2^-$	Q			I_γ: 316 (α,2nγ). A_2=+0.35 *5*, A_4=−0.13 *10*.
271.2	221	1310.4	$23/2^+$	1039.2	$21/2^+$	D			I_γ: 348 (α,2nγ). A_2=−0.70 *13*, A_4=−0.02 *15*.
[x]275.5	551					(Q)			I_γ: 408 (α,2nγ). A_2=+0.24 *13*, A_4=−0.14 *26* for 275.5+276.4. Eγ=276.4 is from ^{180}W.
286.2[#]	134	761.5	$11/2^-$	475.4	$7/2^-$	[E2]		0.0988	α(K)= 0.0650; α(L)= 0.0257; α(M)=0.00628; α(N+..)=0.00183
296.4[#a]	175	661.3	$7/2^-$	365.5	$5/2^-$	M1+E2[@]	≈0.8[@]		A_2=+0.42 *12*, A_4=+0.31 *24*.
301.2	2127	414.5	$15/2^+$	113.3	$11/2^+$	Q			I_γ: 2027 (α,2nγ). A_2=+0.21 *2*, A_4=−0.09 *4* for 300.0+301.2. Eγ=300.0 is from ^{180}W.
319.7	658	847.9	$13/2^-$	528.3	$9/2^-$	Q			I_γ: 513 (α,2nγ). A_2=+0.11 *2*, A_4=+0.48 *3*.
339.1	59	1899.4	$27/2^+$	1560.4	$25/2^+$	[M1]		0.1622	α(K)= 0.1349; α(L)=0.02107; α(M)=0.00477; α(N+..)=0.00142
348.5	1916	599.6	$17/2^+$	251.2	$13/2^+$	Q			I_γ: 2044 (α,2nγ). A_2=+0.29 *3*, A_4=−0.12 *9*.
365.5	2433	365.5	$5/2^-$	0.0	$9/2^+$	M2[@]		0.472	α(K)= 0.374; α(L)= 0.0751; α(M)=0.01755; α(N+..)=0.00526 I_γ: 2580 (α,2nγ). A_2=−0.00 *2*, A_4=−0.02 *4*.
371.1	322	1046.0	$15/2^-$	674.9	$11/2^-$	Q			I_γ: 317 (α,2nγ). A_2=+0.43 *6*, A_4=−0.10 *12*.
400.0	1974	814.4	$19/2^+$	414.5	$15/2^+$	Q			I_γ: 2500 (α,2nγ). A_2=+0.29 *9*, A_4=−0.12 *12*.
409.0	85	409.0	$7/2^-$	0.0	$9/2^+$	[E1]		0.01111	α(K)=0.00931; α(L)=0.00139; α(M)=0.00032
420.0	190	1267.9	$17/2^-$	847.9	$13/2^-$	[E2]		0.0331	α(K)=0.02439; α(L)=0.00665; α(M)=0.00159; α(N+..)=0.00046 I_γ: 352 (α,2nγ).
[x]429.8 *4*	448					(Q)			I_γ: 431 (α,2nγ). A_2=+0.13 *6*, A_4=−0.16 *10*.
439.6	1375	1039.2	$21/2^+$	599.6	$17/2^+$	Q			I_γ: 1212 (α,2nγ). A_2=+0.35 *3*, A_4=−0.12 *4*.

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$\gamma(^{181}W)$ (continued)

E_γ	I_γ [†]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[‡]	α[&]	Comments
466.6	263	1512.6	19/2$^-$	1046.0	15/2$^-$	Q		A_2=+0.40 *6*, A_4=+0.01 *13*.
475.4[a]	50	475.4	7/2$^-$	0.0	9/2$^+$			
496.0	905	1310.4	23/2$^+$	814.4	19/2$^+$	Q		A_2=+0.39 *3*, A_4=−0.19 *9*.
509.0	100	1777	21/2$^-$	1267.9	17/2$^-$	[E2]	0.02032	α(K)=0.01549; α(L)=0.00363
521.3	601	1560.4	25/2$^+$	1039.2	21/2$^+$	Q		A_2=+0.42 *4*, A_4=−0.21 *8*.
548.7	349	2061.3		1512.6	19/2$^-$			A_2=+0.34 *14*, A_4=−0.38 *28*.
589.0	430	1899.4	27/2$^+$	1310.4	23/2$^+$	Q		A_2=+0.40 *4*, A_4=−0.21 *9*.
595.6	692	2156.0	29/2$^+$	1560.4	25/2$^+$	[E2]	0.0372	α(K)= 0.0309; α(L)=0.00473
661.3	377	661.3	7/2$^-$	0.0	9/2$^+$			A_2=+0.00 *10*, A_4=−0.08 *18*.
668.1[a]	140	2824.1?	33/2$^+$	2156.0	29/2$^+$	[E2]	0.01071	α(K)=0.00847; α(L)=0.00168
678.1	125	2577.5	31/2$^+$	1899.4	27/2$^+$	[E2]	0.01035	α(K)=0.00821; α(L)=0.00161
838.9	750	1653.3	(19/2,21/2)	814.4	19/2$^+$			
953.6	40	953.6	7/2$^+$	0.0	9/2$^+$			
1053.7	170	1653.3	(19/2,21/2)	599.6	17/2$^+$			

[†] Intensities are reported from (α,3nγ), E(α)=29 MeV. Intensities for (α,2nγ) at E(α)=35 MeV are given as comments. Intensity errors were estimated to be 8% for strong transitions (1973Li17).

[‡] Except a few transitions which are noted, multipolarities are from angular distributions of γ-transitions.

[#] Possibly a doublet (1973Li17).

[@] From ^{181}Re ε decay.

[&] 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] Placement of transition in the level scheme is uncertain.

[x] γ ray not placed in level scheme.

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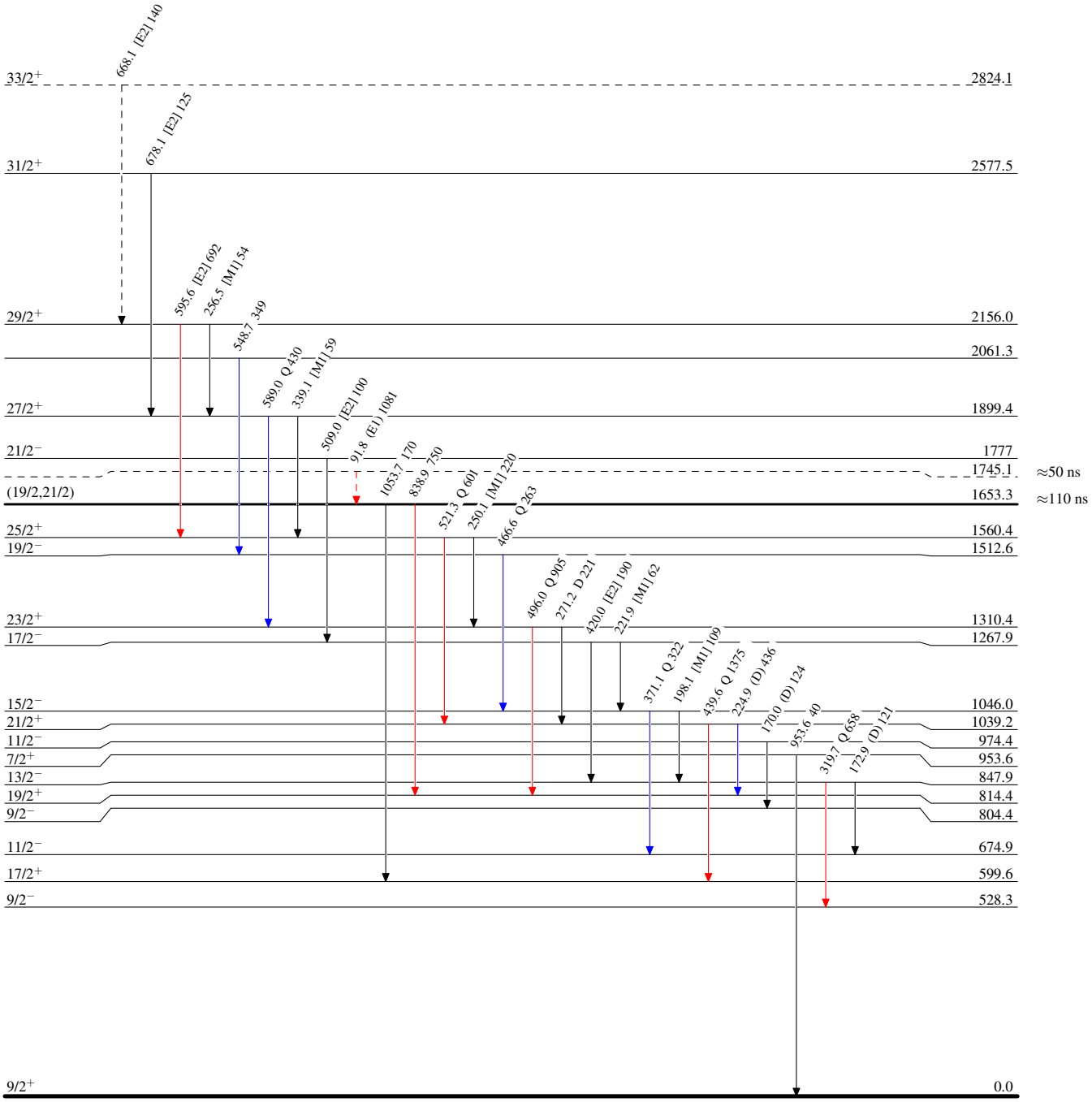
Level Scheme

Intensities: Type not specified



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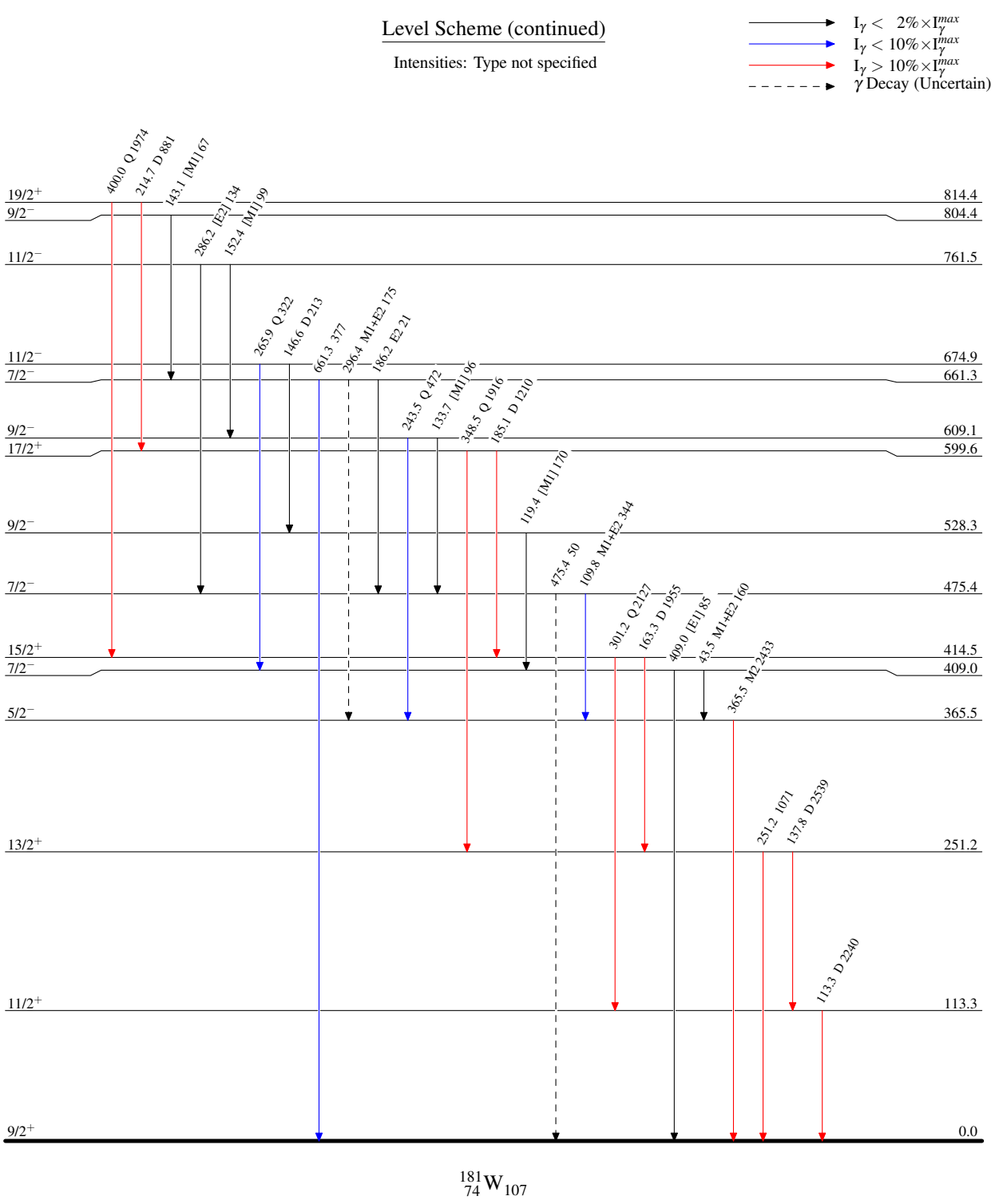
Level Scheme (continued)

Intensities: Type not specified



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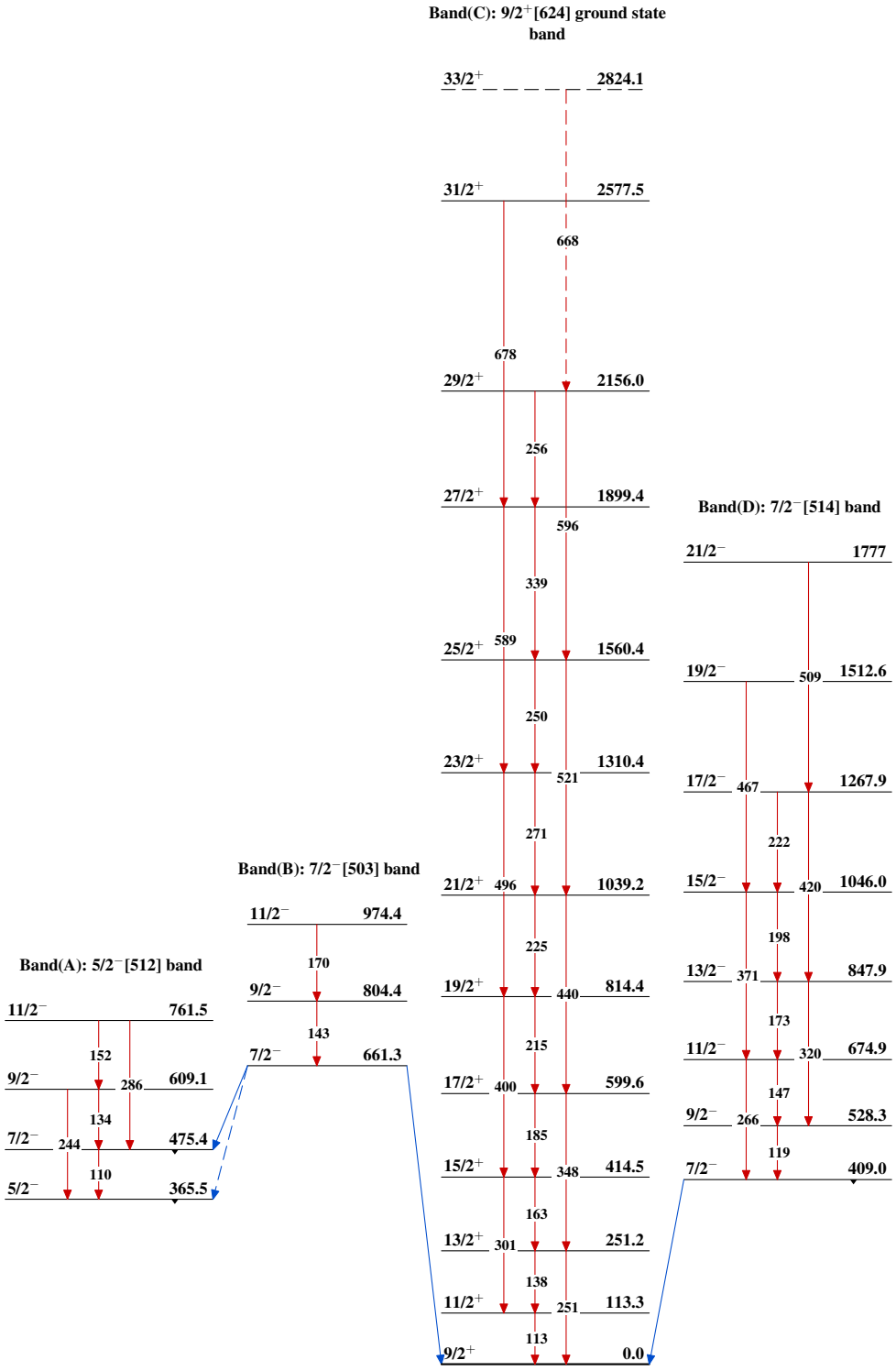

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