

$^{178}\text{Hf}(n,\gamma)$ E=7.78 eV res 1973Ca02

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

Target: natural hafnium. Measured E_γ and I_γ of primary and secondary γ rays. Detector:Ge(Li).

 ^{179}Hf Levels

E(level) [‡]	J^π [†]	$T_{1/2}$	Comments
0.0	9/2 ⁺		
214.07 19	7/2 ⁻		
336.1 12	9/2 ⁻		
374.5 3	1/2 ⁻	18.67 s 4	$T_{1/2}$: from Adopted Levels.
420.4 3	3/2 ⁻		
475.9 3	5/2 ⁻		
517.7 3	5/2 ⁻		
581.5 6	7/2 ⁻		
614.2 3	1/2 ⁻		
615.2 11	7/2 ⁻		
679.60 25	3/2 ⁻		
700.47 25	5/2 ⁻		
719.9 3	3/2 ⁻		
787.5 4	5/2 ⁻		
871.2 4	7/2 ⁻		
1004.03 19	5/2 ⁺		
1296.3 3	(3/2 ⁻ , 5/2, 7/2 ⁻)		
1432.8 4	3/2 ⁻		
1572.1 3	3/2 ⁻		
1667 3	3/2 ⁺		
1705.6 3	(3/2) ⁻		
1725.9 3	3/2 ⁻		
1755.42 22	3/2 ⁻		probable unresolved 1755+1756 doublet; see Adopted Levels, Gammas.
1762.49 23	(3/2) ⁻		
1783.17 23	1/2, 3/2, 5/2 ⁺		
1821.3 3	(1/2 ⁻ , 3/2)		
1846.8 4	(3/2 ⁻)		
1912.8 4	3/2 ⁻		
1929.7 11	1/2 ⁺ , 3/2 ⁺		
2042.5 11	(1/2, 3/2)		
2050.0 11	1/2, 3/2, 5/2 ⁺		
2081.0 3	(1/2, 3/2)		
2092.9 4			
2142.0 11	(1/2, 3/2)		
2168.2 11	1/2, 3/2, 5/2 ⁺		
2182.4 10	1/2, 3/2, 5/2 ⁺		
6100.5 [#] 5	1/2 ⁺ [#]		

[†] From Adopted Levels.

[‡] Calculated by evaluator from a least-squares fit to secondary γ -ray energies.

[#] Weighted average from E_γ of 4337.3 γ , 4346.1 γ , 4373.9 γ , and 5726.1 γ , and the energies of the corresponding levels populated by these primary γ rays. Neutron resonance capture state. $J^\pi=1/2^+$ for s-wave capture.

$^{178}\text{Hf}(n,\gamma)$ E=7.78 eV res **1973Ca02** (continued)

$\gamma(^{179}\text{Hf})$						
E_γ^\dagger	I_γ^\ddagger	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
161.1 5	27@ 11	581.5	7/2 ⁻	420.4	3/2 ⁻	
171.3 ^a 5	2.2@ 8	787.5	5/2 ⁻	615.2	7/2 ⁻	
182.7 ^a 5	1.2@ 5	517.7	5/2 ⁻	336.1	9/2 ⁻	
193.3 5	24@ 10	614.2	1/2 ⁻	420.4	3/2 ⁻	
202.3 5	14@ 6	719.9	3/2 ⁻	517.7	5/2 ⁻	
214.1 2	100	214.07	7/2 ⁻	0.0	9/2 ⁺	
224.7 5	0.46@ 18	700.47	5/2 ⁻	475.9	5/2 ⁻	
^x 232.3 5	0.9@ 4					
^x 234.6 5	0.54@ 22					
239.2 5	4.3@ 17	614.2	1/2 ⁻	374.5	1/2 ⁻	
244.4 5	1.3@ 5	719.9	3/2 ⁻	475.9	5/2 ⁻	
258.8 5	10@ 4	679.60	3/2 ⁻	420.4	3/2 ⁻	
269.9 5	2.0@ 8	787.5	5/2 ⁻	517.7	5/2 ⁻	
279.1 5	2.1@ 8	615.2	7/2 ⁻	336.1	9/2 ⁻	
299.7 5	4.4@ 18	719.9	3/2 ⁻	420.4	3/2 ⁻	
304.0 5	55@ 22	517.7	5/2 ⁻	214.07	7/2 ⁻	
^x 311.9 2	0.57 11					
^x 314.8 2	0.41 8					
^x 318.9 2	0.36 7					
^x 325.6 2	4.2 8					May deexcite 701 level as in (n, γ) E=thermal.
^x 332.0 2	5.0 10					
^x \approx 338.0 [#]	1.10 22					
345.4 2	1.0 2	719.9	3/2 ⁻	374.5	1/2 ⁻	
^x 352.9 2	0.28 6					
^x 372.6 2	0.48 10					
^x 386.0 2	0.40 8					
^x 395.1 2	0.5 1					
^x 402.5 2	0.72 14					
^x 409.8 2	0.25 5					
^x 413.1 2	0.56 11					May deexcite 788 level as in (n, γ) E=thermal.
^x 429.6 2	0.62 12					
^x 456.1 2	0.43 9					
^x \approx 465.4 [#]	0.87 17					
^x 470.8 [#]	1.0 2					
^x 478.0 2	0.26 5					
^x \approx 483.2 [#]	1.0 4					May deexcite 1669 level as in (n, γ) E=thermal.
^x \approx 485.9 [#]	1.5 6					May deexcite 701 level as in (n, γ) E=thermal.
\approx 508.3 ^a	9.7 20	719.9	3/2 ⁻	214.07	7/2 ⁻	I_γ : far too large for this placement based on adopted branching. May deexcite 1669 level as in (n, γ) E=thermal.
^x 518.5 2	1.20 24					
^x 528.6 2	1.3 3					
^x 548.6 2	0.80 16					
^x \approx 571.7 [#]	1.9 8					
\approx 573.5	0.31 12	787.5	5/2 ⁻	214.07	7/2 ⁻	
^x 582.5 2	0.25 5					
^x 589.3 2	1.3 3					
596.0 2	0.30 6	1296.3	(3/2 ⁻ ,5/2,7/2 ⁻)	700.47	5/2 ⁻	
^x 612.8 2	0.120 24					
616.6 2	0.20 4	1296.3	(3/2 ⁻ ,5/2,7/2 ⁻)	679.60	3/2 ⁻	
^x 635.1 2	1.4 3					

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$^{178}\text{Hf}(n,\gamma)$ E=7.78 eV res **1973Ca02** (continued) $\gamma(^{179}\text{Hf})$ (continued)

E_γ †	I_γ ‡	E_i (level)	J_i^π	E_f	J_f^π	Comments
$^x653.4$ 2	2.1 4					
$^x655.7$ 2	2.3 5					
712.9 2	0.54 11	1432.8	3/2 ⁻	719.9	3/2 ⁻	May deexcite 870 level as in (n, γ) E=thermal. E γ in (n, γ) E=thermal does not allow this placement. This placement is not ADOPTED.
$^x729.8$ 2	4.3 9					
$^x761.5$ 2	1.10 22					
$^x765.1$ 2	1.9 4					
779.1 2	0.57 11	1783.17	1/2,3/2,5/2 ⁺	1004.03	5/2 ⁺	
$^x\approx 805.8$	0.46 18					
$^x811.1$ 2	1.9 4					
≈ 817.4 #	0.47 19	1432.8	3/2 ⁻	615.2	7/2 ⁻	
≈ 818.5 #	0.55 22	1432.8	3/2 ⁻	614.2	1/2 ⁻	Placed elsewhere in (n, γ) E=thermal; this placement not ADOPTED.
$^x848.3$ 2	0.65 13					
852.3 2	0.87 17	1572.1	3/2 ⁻	719.9	3/2 ⁻	Placed elsewhere in (n, γ) E=thermal; this placement not ADOPTED.
$^x859.0$ 2	1.4 3					
$^x868.0$ 2	1.4 6					
$^x870.3$ 2	1.5 6					May deexcite 870 level as in (n, γ) E=thermal.
$^x873.7$ 2	0.58 12					
$^x894.2$ #	0.46 9					
≈ 914.9	0.54 22	1432.8	3/2 ⁻	517.7	5/2 ⁻	
918.1 2	1.1 4	1705.6	(3/2) ⁻	787.5	5/2 ⁻	Placed elsewhere in (n, γ) E=thermal and In Adopted Levels, Gammas.
$^x922.5$ 2	0.35 14					
956.4 & 2	1.9 & 4	1432.8	3/2 ⁻	475.9	5/2 ⁻	
956.4 & a 2	1.9 & 4	1572.1	3/2 ⁻	615.2	7/2 ⁻	Placed elsewhere in (n, γ) E=thermal.
975.7 # a 2	0.73 15	1846.8	(3/2) ⁻	871.2	7/2 ⁻	Placed elsewhere in (n, γ) E=thermal.
985.7 2	0.94 19	1705.6	(3/2) ⁻	719.9	3/2 ⁻	
$^x997.8$ 2	0.7 3					
1004.0 2	9.7 19	1004.03	5/2 ⁺	0.0	9/2 ⁺	
1012.7 a 2	1.20 24	1432.8	3/2 ⁻	420.4	3/2 ⁻	
$^x1017.2$ 2	1.10 22					
1025.2 # 2	0.30 12	1725.9	3/2 ⁻	700.47	5/2 ⁻	
1035.4 2	2.2 4	1755.42	3/2 ⁻	719.9	3/2 ⁻	Placed elsewhere in (n, γ) E=thermal. associated with upper member of doublet and with a 1250 level In Adopted Levels, Gammas.
1046.3 2	0.90 18	1725.9	3/2 ⁻	679.60	3/2 ⁻	
1054.6 2	6.1 12	1755.42	3/2 ⁻	700.47	5/2 ⁻	
1061.9 2	2.0 4	1762.49	(3/2) ⁻	700.47	5/2 ⁻	
1078.1 a 2	1.5 3	2081.0	(1/2,3/2)	1004.03	5/2 ⁺	Placed from a 1078 level in (n, γ) E=thermal.
1082.4 & 2	0.88 & 18	1296.3	(3/2 ⁻ ,5/2,7/2 ⁻)	214.07	7/2 ⁻	
1082.4 & 2	0.88 & 18	1783.17	1/2,3/2,5/2 ⁺	700.47	5/2 ⁻	
1095.9 2	0.33 13	1572.1	3/2 ⁻	475.9	5/2 ⁻	Placed elsewhere in (n, γ) E=thermal; this placement not ADOPTED.
$^x1099.6$ 2	0.33 13					
1103.6 2	0.33 13	1783.17	1/2,3/2,5/2 ⁺	679.60	3/2 ⁻	
1111.7 2	2.0 4	1725.9	3/2 ⁻	614.2	1/2 ⁻	
$^x1117.5$ 2	0.54 11					
1121.0 2	2.0 4	1821.3	(1/2 ⁻ ,3/2)	700.47	5/2 ⁻	
1141.3 & 2	2.5 & 5	1755.42	3/2 ⁻	614.2	1/2 ⁻	
1141.3 & a 2	2.5 & 5	1821.3	(1/2 ⁻ ,3/2)	679.60	3/2 ⁻	
1151.6 2	0.89 18	1572.1	3/2 ⁻	420.4	3/2 ⁻	

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$^{178}\text{Hf}(n,\gamma) E=7.78 \text{ eV res}$ **1973Ca02** (continued) $\gamma(^{179}\text{Hf})$ (continued)

E_γ †	I_γ ‡	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
1167.2 2	1.4 3	1846.8	(3/2 ⁻)	679.60	3/2 ⁻	
^x 1175.2 2	1.6 3					
^x 1183.6 2	1.3 3					
1187.8 2	1.3 3	1705.6	(3/2 ⁻)	517.7	5/2 ⁻	
1192.9 2	0.75 15	1912.8	3/2 ⁻	719.9	3/2 ⁻	
1197.6 2	1.3 5	1572.1	3/2 ⁻	374.5	1/2 ⁻	
1207.0 2	1.6 3	1821.3	(1/2 ⁻ ,3/2)	614.2	1/2 ⁻	
^x ≈1229.4 [#]	0.27 11					
≈1231.6 [#]	0.22 9	1846.8	(3/2 ⁻)	615.2	7/2 ⁻	
1237.6 2	0.84 17	1755.42	3/2 ⁻	517.7	5/2 ⁻	E_γ in (n,γ) E=thermal does not allow this placement. Associated with upper member of doublet In Adopted Levels, Gammas.
1245.1 ^a 2	0.59 12	1762.49	(3/2 ⁻)	517.7	5/2 ⁻	Placed elsewhere in (n,γ) E=thermal.
^x 1266.5 2	1.0 2					
1279.5 2	1.10 22	1755.42	3/2 ⁻	475.9	5/2 ⁻	E_γ in (n,γ) E=thermal does not allow this placement. Associated with upper member of doublet In Adopted Levels, Gammas.
1285.9 ^{#a} 2	1.0 4	1705.6	(3/2 ⁻)	420.4	3/2 ⁻	E_γ in (n,γ) E=thermal does not allow this placement.
^x 1291.3 2	1.0 4					
1293.8 2	1.8 7	2081.0	(1/2,3/2)	787.5	5/2 ⁻	I_γ : $I_\gamma \leq 0.54$ may be from ^{116}In β ⁻ decay. γ placed elsewhere in (n,γ) E=thermal. Not adopted.
1305.3 ^{&a} 2	0.38 ^{&} 8	1725.9	3/2 ⁻	420.4	3/2 ⁻	E_γ in (n,γ) E=thermal does not allow this placement; not adopted.
1305.3 ^{&a} 2	0.38 ^{&} 8	2092.9		787.5	5/2 ⁻	
≈1331.8 ^{&a}	1.4 ^{&} 6	1705.6	(3/2 ⁻)	374.5	1/2 ⁻	placement not adopted; unconfirmed In (n,γ) E=thermal.
≈1331.8 ^{&a}	1.4 ^{&} 6	1912.8	3/2 ⁻	581.5	7/2 ⁻	Placed elsewhere in (n,γ) E=thermal.
≈1334.7 [#]	1.4 6	1755.42	3/2 ⁻	420.4	3/2 ⁻	
1342.1 2	1.3 3	1762.49	(3/2 ⁻)	420.4	3/2 ⁻	
1351.4 ^a 2	1.20 24	1725.9	3/2 ⁻	374.5	1/2 ⁻	
1379.7 ^a 2	0.8 3	1755.42	3/2 ⁻	374.5	1/2 ⁻	Placed elsewhere in (n,γ) E=thermal. Associated with upper member of doublet In Adopted Levels, Gammas.
1381.1 [#] 2	1.1 4	2081.0	(1/2,3/2)	700.47	5/2 ⁻	
1388.0 2	1.5 3	1762.49	(3/2 ⁻)	374.5	1/2 ⁻	
1446.6 2	1.20 24	1821.3	(1/2 ⁻ ,3/2)	374.5	1/2 ⁻	
^x 1463.7 2	1.1 4					
^x 1502.4 2	0.51 10					
1548.4 2	0.33 7	1762.49	(3/2 ⁻)	214.07	7/2 ⁻	
^x 1602.8 2	0.54 22					
1605.0 2	0.54 22	2081.0	(1/2,3/2)	475.9	5/2 ⁻	
^x 1635.0 2	0.55 11					
1660.5 2	0.41 8	2081.0	(1/2,3/2)	420.4	3/2 ⁻	
1672.5 2	1.4 3	2092.9		420.4	3/2 ⁻	
≈1707.0 ^{#a}	0.38 8	2182.4	1/2,3/2,5/2 ⁺	475.9	5/2 ⁻	placed, instead, from 2082 level In (n,γ) E=thermal.
^x ≈1709.4 [#]	0.28 6					May deexcite 2082 level as in (n,γ) E=thermal.
^x 1839 [#] 4	0.17 7					
^x 1862.8 2	0.48 10					
^x ≈1890.6	0.58 12					
^x ≈1892.0	0.58 12					
^x 1933.6 2	0.68 14					
^x 1973.3 2	0.59 24					

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$^{178}\text{Hf}(n,\gamma) E=7.78 \text{ eV res}$ **1973Ca02** (continued) $\gamma(^{179}\text{Hf})$ (continued)

E_γ^\dagger	I_γ^\ddagger	$E_i(\text{level})$	J_i^π	E_f	J_f^π
3918.1 10	11.2 17	6100.5	1/2 ⁺	2182.4	1/2,3/2,5/2 ⁺
3932.4 10	9.8 15	6100.5	1/2 ⁺	2168.2	1/2,3/2,5/2 ⁺
3958.6 10	11.3 17	6100.5	1/2 ⁺	2142.0	(1/2,3/2)
4008.6 10	14.0 21	6100.5	1/2 ⁺	2092.9	
4018.0 10	26 4	6100.5	1/2 ⁺	2081.0	(1/2,3/2)
4050.6 10	6.8 20	6100.5	1/2 ⁺	2050.0	1/2,3/2,5/2 ⁺
4058.1 10	6.8 20	6100.5	1/2 ⁺	2042.5	(1/2,3/2)
4170.9 10	6.1 9	6100.5	1/2 ⁺	1929.7	1/2 ⁺ ,3/2 ⁺
4187.3 [#] 10	6.0 9	6100.5	1/2 ⁺	1912.8	3/2 ⁻
4254.2 15	11.5 17	6100.5	1/2 ⁺	1846.8	(3/2 ⁻)
4279.7 10	3.3 5	6100.5	1/2 ⁺	1821.3	(1/2 ⁻ ,3/2)
4317.6 10	8.4 13	6100.5	1/2 ⁺	1783.17	1/2,3/2,5/2 ⁺
4337.3 10	18 3	6100.5	1/2 ⁺	1762.49	(3/2 ⁻)
4346.1 10	79 12	6100.5	1/2 ⁺	1755.42	3/2 ⁻
4373.9 10	74 11	6100.5	1/2 ⁺	1725.9	3/2 ⁻
4394.8 10	30 5	6100.5	1/2 ⁺	1705.6	(3/2 ⁻)
4434 3	10 3	6100.5	1/2 ⁺	1667	3/2 ⁺
4529.0 10	12.3 18	6100.5	1/2 ⁺	1572.1	3/2 ⁻
4667.8 15	13.1 20	6100.5	1/2 ⁺	1432.8	3/2 ⁻
4804.5 [@] 10	3.0 5	6100.5	1/2 ⁺	1296.3	(3/2 ⁻ ,5/2,7/2 ⁻)
5421.8 10	21 3	6100.5	1/2 ⁺	679.60	3/2 ⁻
5680.6 10	23 4	6100.5	1/2 ⁺	420.4	3/2 ⁻
5726.1 10	100	6100.5	1/2 ⁺	374.5	1/2 ⁻

[†] Corrected for recoil.

[‡] I_γ of primary and secondary γ rays are relative to 100 for 5726.1 γ and 214.1 γ , respectively.

[#] Doublet (broad peak).

[@] 40% uncertainty assigned by evaluator based on 35-50% reported by 1973Ca02.

[&] Multiply placed with undivided intensity.

^a Placement of transition in the level scheme is uncertain.

^x γ ray not placed in level scheme.

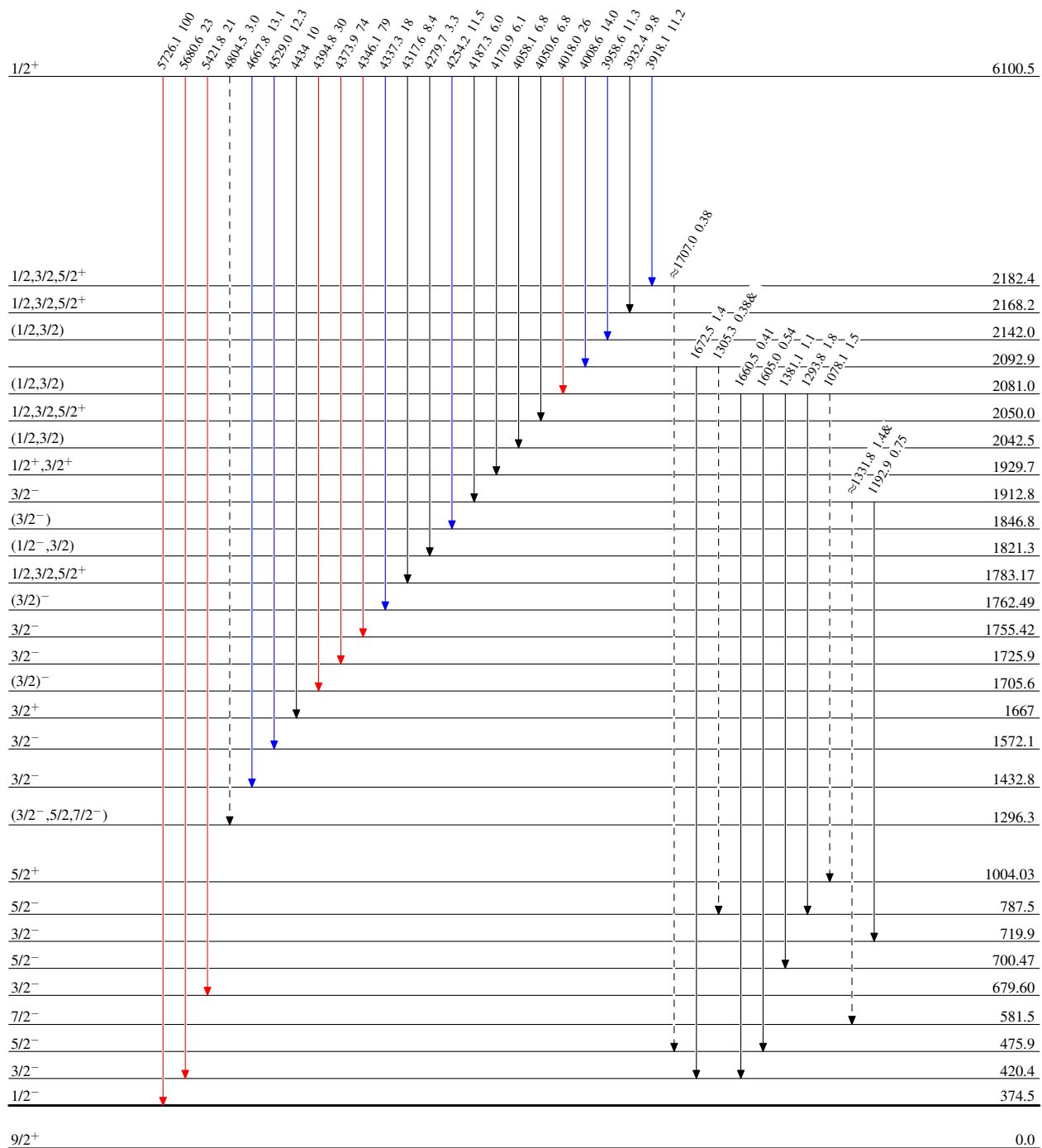
¹⁷⁸Hf(n,γ) E=7.78 eV res 1973Ca02

Level Scheme

Intensities: Relative I_γ
& Multiplied placed: undivided intensity given

Legend

- I_γ < 2% × I_γ^{max}
- I_γ < 10% × I_γ^{max}
- I_γ > 10% × I_γ^{max}
- - - - - γ Decay (Uncertain)



18.67 s 4

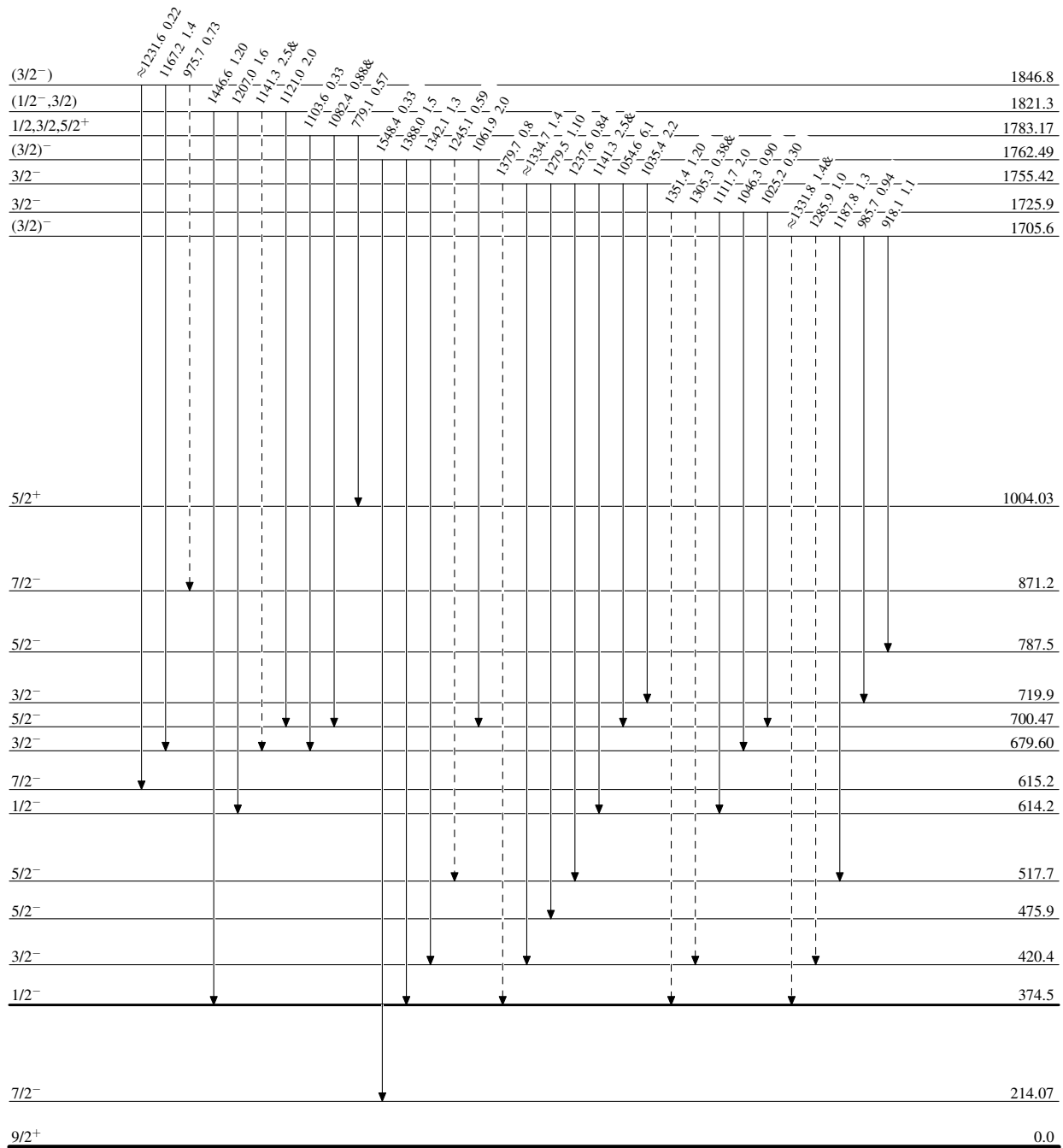
$^{178}\text{Hf}(n,\gamma) E=7.78 \text{ eV res } 1973\text{Ca02}$

Legend

Level Scheme (continued)

Intensities: Relative I_γ
& Multiply placed: undivided intensity given

- ▶ $I_\gamma < 2\% \times I_\gamma^{\max}$
- ▶ $I_\gamma < 10\% \times I_\gamma^{\max}$
- ▶ $I_\gamma > 10\% \times I_\gamma^{\max}$
- - -▶ γ Decay (Uncertain)



18.67 s 4

 $^{179}_{72}\text{Hf}_{107}$

$^{178}\text{Hf}(n,\gamma) E=7.78 \text{ eV res}$ 1973Ca02

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)

