^{176}Yb(α,2nγ) 1977Kh01

History

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

1977Kh01: ^{176}Yb(α,2nγ), E(α)=24-35 MeV. Obtained γ singles and $\gamma\gamma$-coincidence spectra using the McMaster FN tandem accelerator. Obtained γ angular distributions, excitation functions and delayed γ spectra using the Michigan State University Cyclotron. Measured Eγ, Iγ, and, for isomeric states, $T_{1/2}$. Expanded the previously known level scheme with: a) levels 10^+ to 14^+ of the gs band; b) the $K^\pi=14^-$ isomer; c) rotational bands based, respectively, on the $K^\pi=8^-_2$, 5^- and 6^+ states. Identified new isomeric states at 1554 keV with $T_{1/2}$=78 *1* ns, and at 2574 keV with $T_{1/2}$=68 *2* μs.

^{178}Hf Levels

Band level assignments in 1977Kh01 based on level and γ-ray sequence systematics, and $\gamma\gamma$-coincidence data.

E(level)[†]	J$^\pi$[‡]	$T_{1/2}$	Comments
0.0[#]	0^+		
93.2[#] *10*	2^+		
306.6[#] *15*	4^+		
632.1[#] *16*	6^+		
1058.5[#] *18*	8^+		
1147.3[@] *18*	8^-	4.0 s *2*	$T_{1/2}$: from Adopted Levels.
1364.0[@] *19*	9^-		
1478.8[&] *21*	8^-		
1513.8[a] *16*	4^+		
1553.9[b] *16*	6^+	78 ns *1*	g factor=0.959 *8*, (1980Wa23) uncorrected for diamagnetism and Knight shift, from time-differential precession spectra. 1980Wa23 deduce g_K=1.044 *19*, assuming g_R=0.45 *10*. That g_K factor is consistent with a predominately two-quasiproton configuration (1980Wa23). 1978Fa17 obtain g=0.970 *15*, deduce g_K=1.034 *17* and g_R=0.59 *3*.
1570.9[#] *21*	10^+		
1601.4[@] *19*	10^-		
1636.9[c] *17*	5^-	0.40 ns *10*	$T_{1/2}$: from 1982Ko08.
1697.4[&] *22*	9^-		
1741.6[b] *19*	7^+		
1781.4[c] *19*	6^-		
1859.0[@] *20*	11^-		
1939.0[&] *21*	10^-		
1948.1[c] *19*	7^-		
1952.0[b] *21*	8^+		
2136.3[@] *21*	12^-		
2137.5[c] *21*	8^-		
2150.6[#] *23*	12^+		
2183.3[b] *21*	9^+		
2202.3[&] *21*	11^-		
2433.1[@] *21*	13^-		
2433.8[b] *21*	10^+		
2447.3[d] *22*	16^+	31 y *1*	$T_{1/2}$: from Adopted Levels.
2485.2[&] *23*	12^-		
2573.4[e] *22*	14^-	68 μs *2*	
2700.4[b] *22*	11^+		

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^{176}Yb(α,2nγ) 1977Kh01 (continued)

^{178}Hf Levels (continued)

E(level)[†]	Jπ[‡]
2748.9[@] *23*	(14⁻)
2777.5[#] *25*	14⁺
2785.1[&] *23*	(13⁻)

† from least-squares fit to the listed γ ray energies.
‡ Spin/parity values are assigned on the basis of angular distributions and excitation functions.
# Band(A): $K^\pi=0^+$ gs rotational band.
@ Band(B): $K^\pi=8^-$ band based on the 1147-keV $T_{1/2}$=4.0 s isomeric state. Conf: 64%(ν7/2[514]+ν9/2[624])⊗36%(π7/2[404]+π9/2[514]) (1977Kh01).
& Band(C): Second $K^\pi=8^-$ band based on the 1479-keV state. Conf: 36%(ν7/2[514]+ν9/2[624])⊗64%(π7/2[404]+π9/2[514]) (1977Kh01).
a Band(D): $K^\pi=4^+$ band based on the 1514-keV state. Conf: ν1/2[510]+ν7/2[514] (1977Kh01).
b Band(E): $K^\pi=6^+$ band based on the 1554-keV $T_{1/2}$=78 ns isomeric state. Conf: 31%(ν7/2[514]+ν5/2[512])⊗69%(π7/2[404]+π5/2[402]) (1977Kh01).
c Band(F): $K^\pi=5^-$ band based on the 1637-keV state. Conf: ν1/2[510]+ν9/2[624] (1977Kh01).
d Band(G): $K^\pi=16^+$ band based on the 2447-keV $T_{1/2}$=31 y *4*-qp isomeric state. Conf: ν7/2[514]+ν9/2[624]+π7/2[404]+π9/2[514] (1977Kh01).
e Band(H): $K^\pi=14^-$ band based on the 2573-keV $T_{1/2}$=68 μs 4-qp isomeric state. Conf: ν7/2[514]+ν9/2[624]+π7/2[404]+π5/2[402] (1977Kh01).

γ(^{178}Hf)

No uncertainties provided for γ-ray energies or intensities, except for the energy of the 126-keV transition.

E_γ	I_γ[†]	E_i(level)	J_i^π	E_f	J_f^π	Mult.	α[‡]	Comments
40 *1*		1553.9	6⁺	1513.8	4⁺			E_γ: deduced by evaluators on the basis of the level scheme proposed in 1977Kh01, where the transition is shown in the drawing.
88.9	28	1147.3	8⁻	1058.5	8⁺			
93.2	22	93.2	2⁺	0.0	0⁺			
123.1	1.5	1636.9	5⁻	1513.8	4⁺			
126.1 *3*	0.09	2573.4	14⁻	2447.3	16⁺	[M2]	15.5 *3*	B(M2)(W.u.)=0.0142 *6* Mult.: assumed in 1977Kh01, from proposed spins of 14⁻ and 16⁺ for the connected isomeric states.
140.3	0.43	2573.4	14⁻	2433.1	13⁻	M1	1.523	B(M1)(W.u.)=1.76×10⁻⁸ *7* Mult.: from α=1.5 *5*, determined from transition intensity balance in a γ-ray spectrum measured between 6 and 230 μs after irradiation (1977Kh01).
144.6	1.6	1781.4	6⁻	1636.9	5⁻			
166.8	0.26	1948.1	7⁻	1781.4	6⁻			
187.7	3.6	1741.6	7⁺	1553.9	6⁺			
189.8[#]		2137.5	8⁻	1948.1	7⁻			
210.3	2.7	1952.0	8⁺	1741.6	7⁺			
213.4	100	306.6	4⁺	93.2	2⁺			
216.7	16	1364.0	9⁻	1147.3	8⁻			
231.4	1.5	2183.3	9⁺	1952.0	8⁺			
237.5	3.9	1601.4	10⁻	1364.0	9⁻			

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^{176}Yb(α,2nγ) 1977Kh01 (continued)

$\gamma(^{178}Hf)$ (continued)

E_γ	I_γ[†]	E_i(level)	J_i^π	E_f	J_f^π	E_γ	I_γ[†]	E_i(level)	J_i^π	E_f	J_f^π
250.6	1.0	2433.8	10^+	2183.3	9^+	481.6	1.1	2433.8	10^+	1952.0	8^+
257.6	1.2	1859.0	11^-	1601.4	10^-	495.0	6.0	1859.0	11^-	1364.0	9^-
266.6	0.36	2700.4	11^+	2433.8	10^+	512.4	7.7	1570.9	10^+	1058.5	8^+
277.3	0.80	2136.3	12^-	1859.0	11^-	517.1	0.49	2700.4	11^+	2183.3	9^+
296.8	0.48	2433.1	13^-	2136.3	12^-	535.0	3.0	2136.3	12^-	1601.4	10^-
311.1	1.9	1948.1	7^-	1636.9	5^-	550.1[#]	0.68	1697.4	9^-	1147.3	8^-
325.6	84	632.1	6^+	306.6	4^+	574.1	2.0	2433.1	13^-	1859.0	11^-
331.5	2.9	1478.8	8^-	1147.3	8^-	575.0	1.4	1939.0	10^-	1364.0	9^-
333.4	1.6	1697.4	9^-	1364.0	9^-	579.7	2.6	2150.6	12^+	1570.9	10^+
337.7	0.99	1939.0	10^-	1601.4	10^-	600.9	0.91	2202.3	11^-	1601.4	10^-
343.3	0.56	2202.3	11^-	1859.0	11^-	612.6	0.49	2748.9	(14^-)	2136.3	12^-
348.5[#]	0.3	2485.2	12^-	2136.3	12^-	626.2	0.82	2485.2	12^-	1859.0	11^-
356.1	1.6	2137.5	8^-	1781.4	6^-	626.9	0.36	2777.5	14^+	2150.6	12^+
406.7	0.16	1553.9	6^+	1147.3	8^-	648.8	0.46	2785.1	(13^-)	2136.3	12^-
426.4	61	1058.5	8^+	632.1	6^+	921.8	5.2	1553.9	6^+	632.1	6^+
437.0	0.29	2573.4	14^-	2136.3	12^-	1207.2	3.0	1513.8	4^+	306.6	4^+
441.8	1.0	2183.3	9^+	1741.6	7^+	1247.3	3.0	1553.9	6^+	306.6	4^+
454.1	7.5	1601.4	10^-	1147.3	8^-	1330.3	3.1	1636.9	5^-	306.6	4^+

[†] Obtained in the ^{176}Yb(α,2n) reaction at E(α)=26 MeV.

[‡] 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.

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

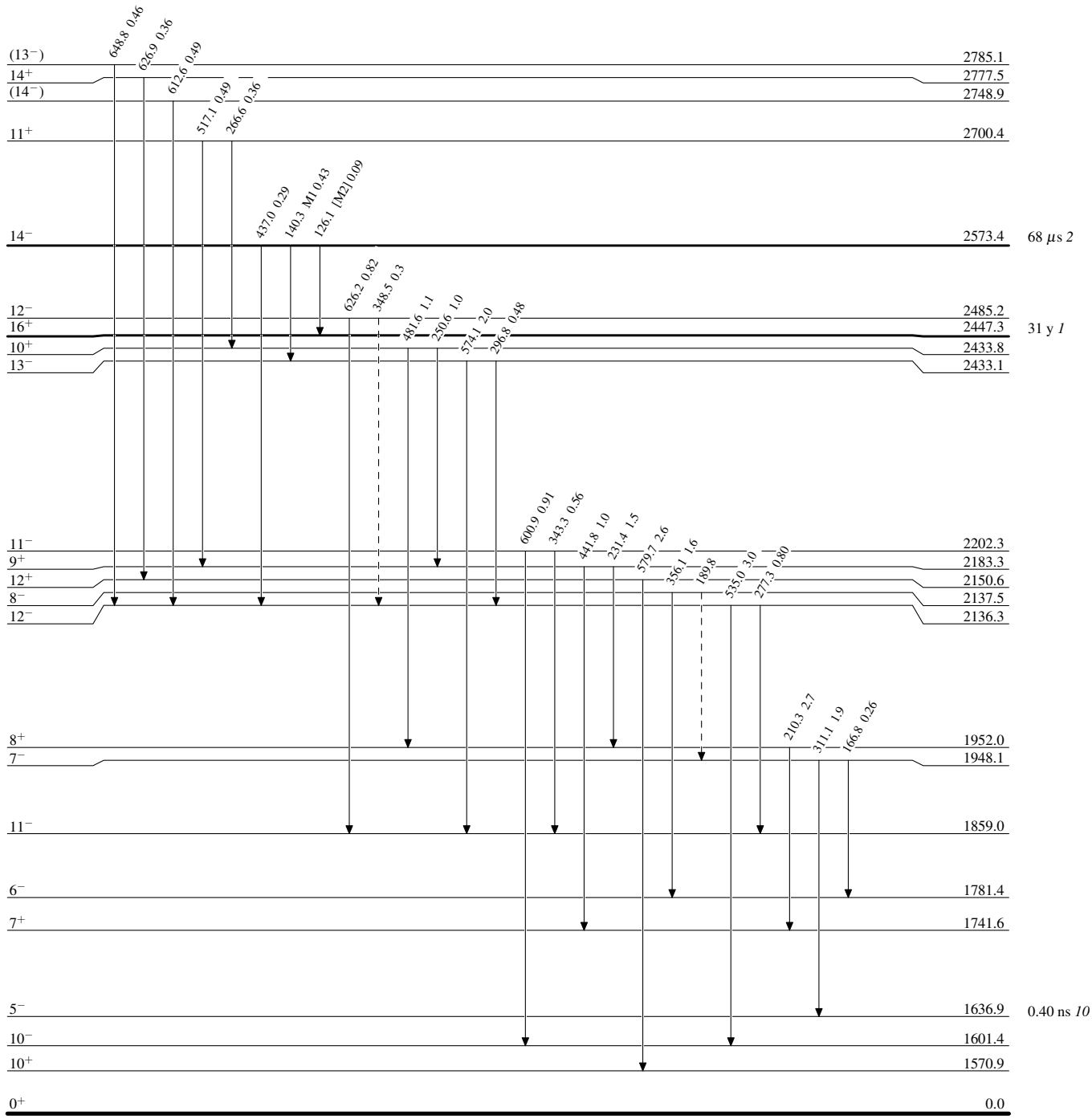
^{176}Yb(α,2nγ) 1977Kh01

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)



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^{176}Yb(α,2nγ) 1977Kh01

Level Scheme (continued)

Intensities: Relative I_γ

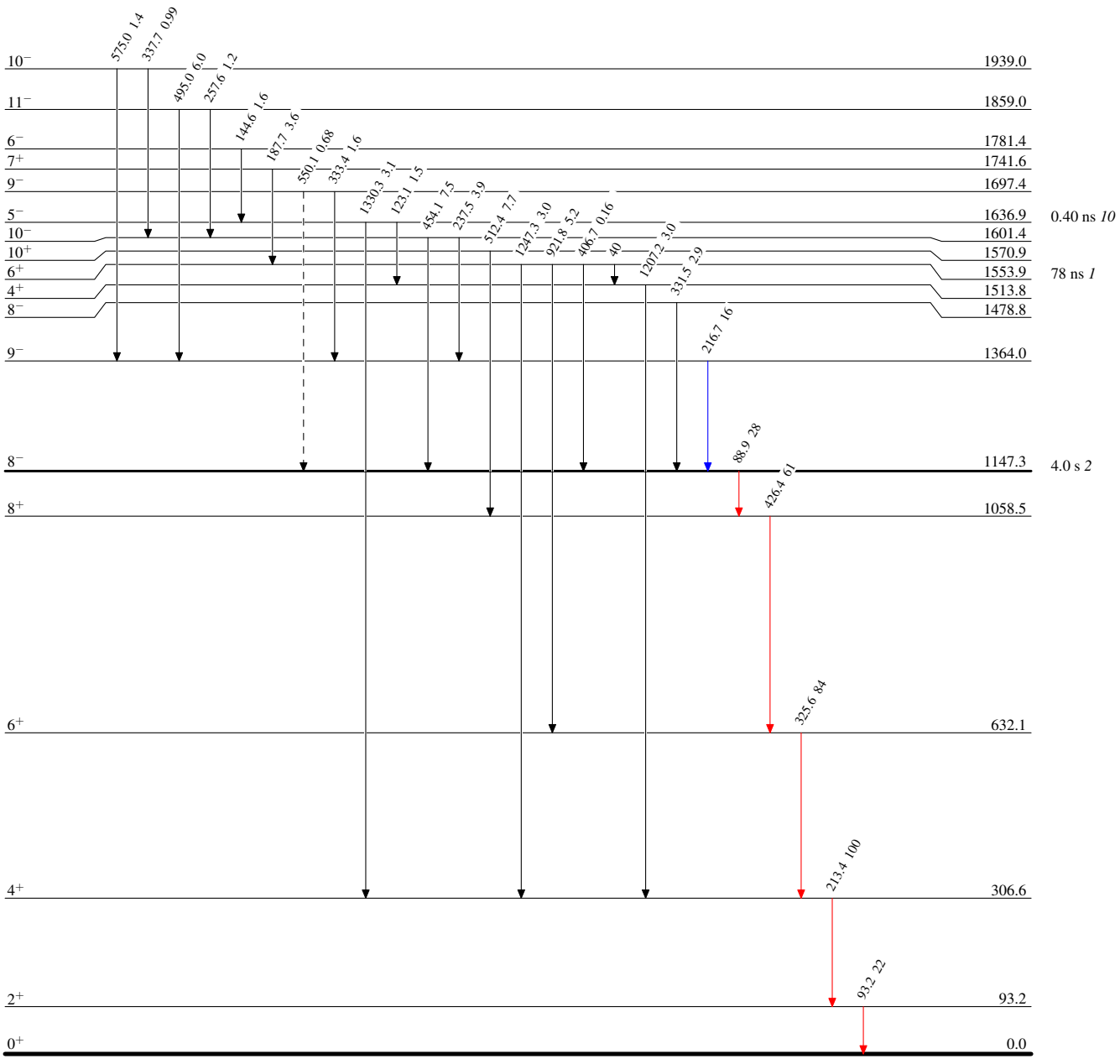
Legend

$I_\gamma < 2\% \times I_\gamma^{max}$

$I_\gamma < 10\% \times I_\gamma^{max}$

$I_\gamma > 10\% \times I_\gamma^{max}$

γ Decay (Uncertain)



$^{178}_{72}Hf_{106}$

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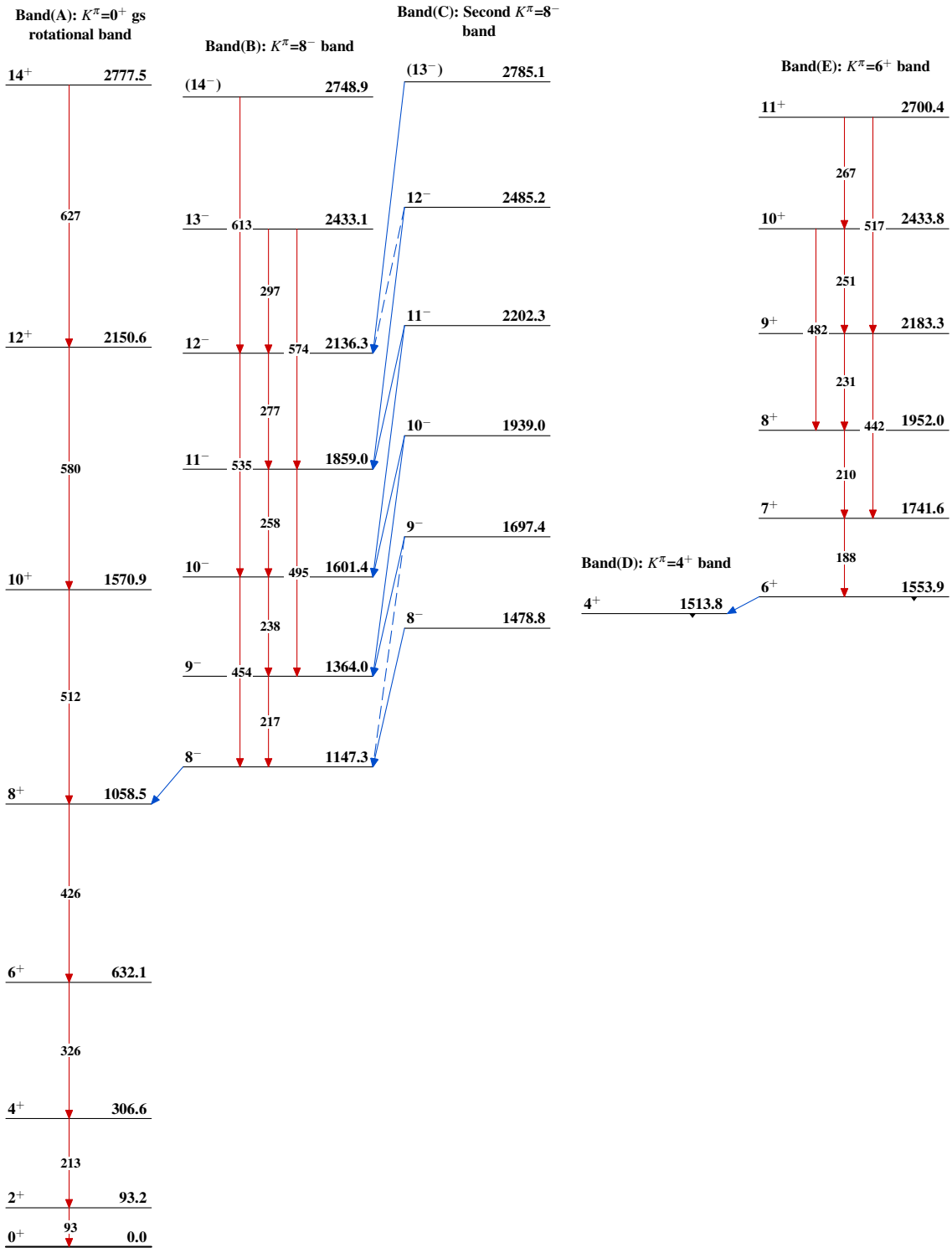
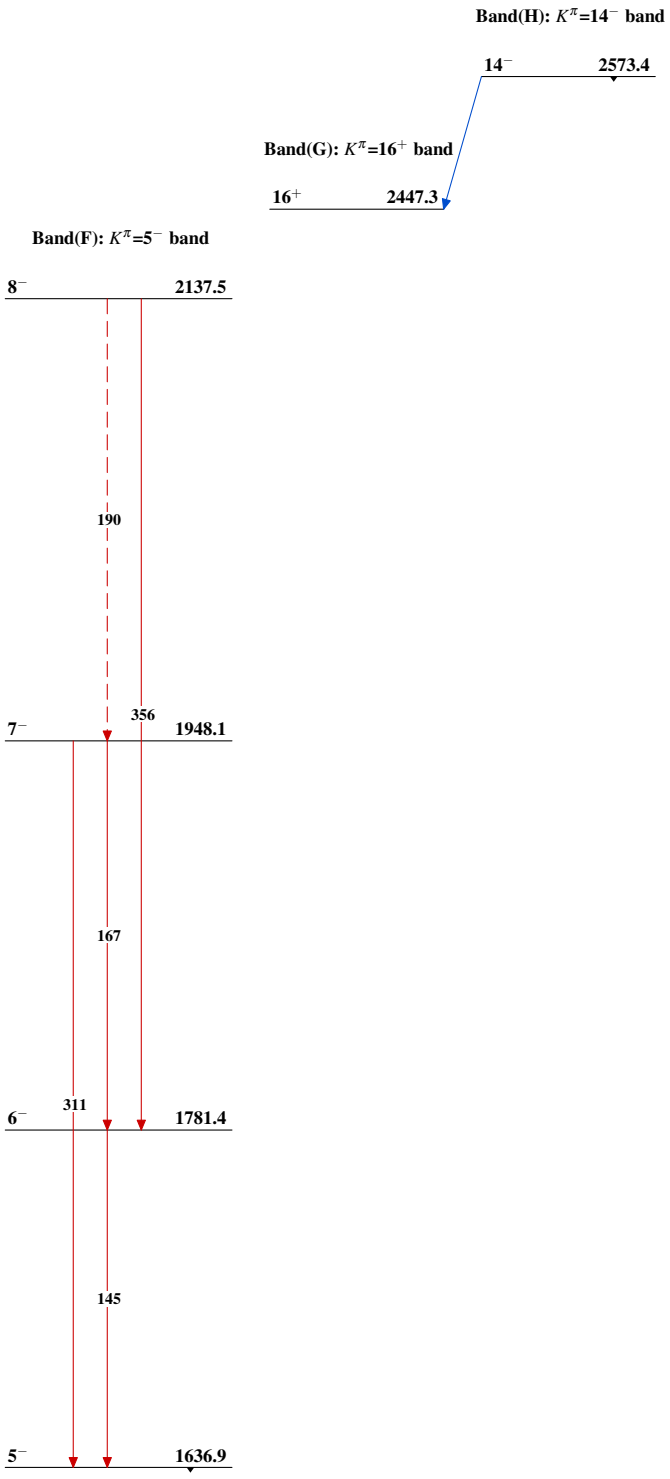


$^{178}_{72}Hf_{106}$

^{176}Yb(α,2nγ) 1977Kh01 (continued)



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