

(HI,xn γ) [1995Re18,1974Ne16](#)

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	M. S. Basunia	NDS 195,368 (2024)	1-Dec-2023

Other: [1999ReZV](#).

[1995Re18](#): Two experiments were performed: 1) $^{169}\text{Tm}(^{26}\text{Mg},4n\gamma)$, $E(\text{beam})=128$ MeV; $E\gamma$, $\gamma\gamma$ coincidences with the Compact Ball of 20 Compton-suppressed Ge detectors – at Oak Ridge National Laboratory. 2) $^{159}\text{Tb}(^{36}\text{S},4n\gamma)$, $E=165$ MeV; Measured $E\gamma$, DCO ratios (not listed), $\gamma\gamma$ coincidence, etc. with an array of 12 Compton-suppressed Ge detectors, surrounded by of 50 BGO elements. Deduced excited levels, spin-parity.

[1974Ne16](#): $^{181}\text{Ta}(^{16}\text{O},6n\gamma)$, $E=109, 116, \text{ and } 122$ MeV; $^{182}\text{W}(^{14}\text{N},5n\gamma)$, $E=86, 93, 105$ MeV. Excitation functions, measured $E\gamma$, $I\gamma$, γ intensity ratios at 0 and 90° . No coincidence data were measured and the authors note that the placements of γ transitions in the level scheme are tentative.

 ^{191}Tl Levels

@B@0@0@@@@ @B@0@1@@@@@1 Proposed by [1995Re18](#) as a single-particle like structure (Structure 3), based on the $13/2^+$, 1000.8+x keV state.

E(level) [†]	J $\pi^{\ddagger}$	T _{1/2}	Comments
297 [#] 7	9/2 ⁻	5.22 min 16	Additional information 2 . E(level): From 2021Ko07 – NUBASE. Also 297 keV 7 in ^{195}Bi α decay (183 s). T _{1/2} : From Adopted Levels.
684.4 [#] 4	11/2 ⁻		
1009.7 [#] 4	13/2 ⁻		
1297.8 [@] 5	13/2 ⁺		
1437.1 [#] 5	15/2 ⁻		
1702.5 [@] 5	15/2 ⁺		
1758.4 [#] 5	17/2 ⁻		
1927.7 6	(17/2 ⁻)		
2008.5 [@] 5	17/2 ⁺		
2075.0 ^{&} 6	17/2 ⁺		
2181.5 [@] 5	19/2 ⁺		
2229.9 [#] 6	19/2 ⁻		
2318.9 [@] 6	(21/2 ⁺)		
2327.0 ^a 6	21/2 ⁺		
2385.6 6	(19/2 ⁻)		
2405.8 ^b 6	19/2 ⁻		
2429.7 ^{&} 6	19/2 ⁺		
2484.5 [@] 6	(21/2 ⁺)		
2598.4 [#] 6	21/2 ⁻		
2620.4 ^b 7	21/2 ⁻		
2639.9 ^a 6	23/2 ⁺		
2674.0 [@] 6	(23/2 ⁺)		
2736.4 ^{&} 6	(21/2 ⁺)		
2849.9 [#] 7	23/2 ⁻		
2859.8 ^b 7	23/2 ⁻		
2880.5 ^{&} 6	(23/2 ⁺)		
2953.5 [@] 6	(25/2 ⁺)		

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(HI,xn γ) 1995Re18,1974Ne16 (continued) ^{191}Tl Levels (continued)

E(level) [†]	J ^π [‡]	E(level) [†]	J ^π [‡]	E(level) [†]	J ^π [‡]	E(level) [†]	J ^π [‡]
2966.6 ^a 6	25/2 ⁺	3444.4 [#] 8	27/2 ⁻	4192.7 [#] 8	31/2 ⁻	5074.9 ^a 12	41/2 ⁺
3075.2 [#] 7	25/2 ⁻	3593.4 [@] 7	(29/2 ⁺)	4322.2 ^a 8	35/2 ⁺	5424.3 [#] 10	37/2 ⁻
3091.8 ^b 8	25/2 ⁻	3672.4 ^a 7	29/2 ⁺	4511.5 ^a 8	37/2 ⁺	5429.4 ^a 12	43/2 ⁺
3128.9 ^{&} 7	(25/2 ⁺)	3761.0 [#] 8	29/2 ⁻	4564.5 [#] 9	33/2 ⁻	5792.4 ^a 13	(45/2 ⁺)
3321.4 [@] 7	(27/2 ⁺)	3961.6 ^a 8	31/2 ⁺	4791.7 ^a 12	39/2 ⁺		
3341.8 ^a 7	27/2 ⁺	4121.3 ^a 8	33/2 ⁺	5028.7 [#] 10	35/2 ⁻		

[†] From least-squares adjustment to the γ -ray energies, holding 297 keV 7 level energy fixed. ΔE for levels depopulate through 297 keV 7 does not include $\Delta E=7$ keV.

[‡] From 1995Re18 (Fig. 1), based on DCO ratios (not listed). Band structures and J^π values suggested in 1995Re18, 1974Ne16 interpreted the 9/2[505] and 13/2[606] rotational bands as originated from a nucleus with an oblate deformation. 1995Re18 added considerably to the known level structure, proposing several band structures, and assigning tentative J^π values to their levels. These are based mostly on the assumptions of a regular sequence of the levels in the identified bands and band-like structures, and that the connecting transitions are mostly of stretched dipole and quadrupole character.

[#] Band(A): 9/2[505] $\pi=-$ rotational band. Suggested in 1974Ne16. Considerably expanded in 1995Re18 (Structure 1), interpreted it as a high-K, strongly coupled band. See this reference for detailed discussion. See also 1977Ta01 for corresponding bands in ^{193}Tl , ^{195}Tl , ^{197}Tl and comparison with theory.

[@] Band(B): 13/2⁺ single-particle like structure (1995Re18).

[&] Band(C): 17/2⁺ band fragment. This band fragment is part of the larger Structure 3 in 1995Re18, based on the 1778.1+x keV 17/2⁺ state.

^a Band(D): $\pi=+$ rotational band, possible conf. 13/2[606] (1995Re18). Described by 1995Re18 as a probably high-K, strongly coupled, band-like structure (Structure 2), with a possible oblate 13/2[606] configuration.

^b Band(E): 19/2⁻ band fragment Described by 1995Re18 as a single-particle like structure (Structure 3a).

 $\gamma(^{191}\text{Tl})$

Anisotropies (R parameter) $R=I_\gamma(0^\circ)/I_\gamma(90^\circ)$ (1974Ne16). The R value provides indication for the sign of the A_2 parameter of the angular distribution of the γ ray: $R>1.0$ indicates a positive A_2 , $R<1$, indicates a negative A_2 (1974Ne16).

E_γ [†]	$E_i(\text{level})$	J_i^π	E_f	J_f^π
106.6 2	2181.5	19/2 ⁺	2075.0	17/2 ⁺
137.3 2	2318.9	(21/2 ⁺)	2181.5	19/2 ⁺
144.2 2	2880.5	(23/2 ⁺)	2736.4	(21/2 ⁺)
145.5 2	2327.0	21/2 ⁺	2181.5	19/2 ⁺
159.6 2	4121.3	33/2 ⁺	3961.6	31/2 ⁺
165.5 2	2484.5	(21/2 ⁺)	2318.9	(21/2 ⁺)
173.0 2	2181.5	19/2 ⁺	2008.5	17/2 ⁺
175.9 2	2405.8	19/2 ⁻	2229.9	19/2 ⁻
189.2 2	4511.5	37/2 ⁺	4322.2	35/2 ⁺
189.6 2	2674.0	(23/2 ⁺)	2484.5	(21/2 ⁺)
192.5 2	3321.4	(27/2 ⁺)	3128.9	(25/2 ⁺)
193.0 ^a 2	2598.4	21/2 ⁻	2405.8	19/2 ⁻
200.9 2	4322.2	35/2 ⁺	4121.3	33/2 ⁺
212.8 2	2598.4	21/2 ⁻	2385.6	(19/2 ⁻)
214.6 2	2620.4	21/2 ⁻	2405.8	19/2 ⁻
225.3 2	3075.2	25/2 ⁻	2849.9	23/2 ⁻
225.4 ^a 2	2405.8	19/2 ⁻	2181.5	19/2 ⁺
232.0 2	3091.8	25/2 ⁻	2859.8	23/2 ⁻

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(HI,xn γ) 1995Re18,1974Ne16 (continued) $\gamma(^{191}\text{Tl})$ (continued)

E_γ [†]	I_γ [@]	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
239.4 3		2859.8	23/2 ⁻	2620.4	21/2 ⁻	
244.2 3		2674.0	(23/2 ⁺)	2429.7	19/2 ⁺	
248.2 3		2429.7	19/2 ⁺	2181.5	19/2 ⁺	
248.4 3		3128.9	(25/2 ⁺)	2880.5	(23/2 ⁺)	
251.5 3		2849.9	23/2 ⁻	2598.4	21/2 ⁻	
252.0 3		2736.4	(21/2 ⁺)	2484.5	(21/2 ⁺)	
269.2 ^a 3		2674.0	(23/2 ⁺)	2405.8	19/2 ⁻	
272.0 3		3593.4	(29/2 ⁺)	3321.4	(27/2 ⁺)	
279.5 ^{&} 3		2953.5	(25/2 ⁺)	2674.0	(23/2 ⁺)	
279.5 ^{&‡} 10		4791.7	39/2 ⁺	4511.5	37/2 ⁺	
282.5 [‡] 10		5074.9	41/2 ⁺	4791.7	39/2 ⁺	
282.8 ^a 3		2880.5	(23/2 ⁺)	2598.4	21/2 ⁻	
288.1 3		1297.8	13/2 ⁺	1009.7	13/2 ⁻	
289.1 3		3961.6	31/2 ⁺	3672.4	29/2 ⁺	
303.4 3		2484.5	(21/2 ⁺)	2181.5	19/2 ⁺	
306.0 3	24 3	2008.5	17/2 ⁺	1702.5	15/2 ⁺	E_γ : Other: 306.4 keV (1974Ne16). R=0.26 +4-2.
306.6 3		2736.4	(21/2 ⁺)	2429.7	19/2 ⁺	
312.8 3		2639.9	23/2 ⁺	2327.0	21/2 ⁺	
^x 313.0 [#]	13 2					
316.6 3		3761.0	29/2 ⁻	3444.4	27/2 ⁻	
321.0 3		2639.9	23/2 ⁺	2318.9	(21/2 ⁺)	
321.3 3		1758.4	17/2 ⁻	1437.1	15/2 ⁻	
325.2 3	32 3	1009.7	13/2 ⁻	684.4	11/2 ⁻	E_γ : Other: 325.6 (1974Ne16). R=0.24 10.
326.7 3		2966.6	25/2 ⁺	2639.9	23/2 ⁺	
330.6 3		3672.4	29/2 ⁺	3341.8	27/2 ⁺	
354.4 4		2429.7	19/2 ⁺	2075.0	17/2 ⁺	
354.5 4		5429.4	43/2 ⁺	5074.9	41/2 ⁺	
363.0 4		5792.4	(45/2 ⁺)	5429.4	43/2 ⁺	
367.8 4		3321.4	(27/2 ⁺)	2953.5	(25/2 ⁺)	
368.7 4		2598.4	21/2 ⁻	2229.9	19/2 ⁻	
369.1 4		3444.4	27/2 ⁻	3075.2	25/2 ⁻	
371.7 4		4564.5	33/2 ⁻	4192.7	31/2 ⁻	
372.4 4		2075.0	17/2 ⁺	1702.5	15/2 ⁺	
375.0 4		3341.8	27/2 ⁺	2966.6	25/2 ⁺	
387.4 4	100	684.4	11/2 ⁻	297	9/2 ⁻	E_γ : Other: 387.6 (1974Ne16). R=0.25 8.
390.4 4		4511.5	37/2 ⁺	4121.3	33/2 ⁺	
395.5 4		5424.3	37/2 ⁻	5028.7	35/2 ⁻	
404.6 4	36 3	1702.5	15/2 ⁺	1297.8	13/2 ⁺	E_γ : Other: 405.0 keV (1974Ne16). R=0.08 +30-8.
422.9 4		2181.5	19/2 ⁺	1758.4	17/2 ⁻	
427.3 4	16 4	1437.1	15/2 ⁻	1009.7	13/2 ⁻	E_γ : 427.8 keV (1974Ne16).
431.7 4		4192.7	31/2 ⁻	3761.0	29/2 ⁻	
^x 434.5 [#]	20 4					R=0.06 +30-6. 1974Ne16 tentatively placed this γ -ray between a possible (15/2 ⁻) level at 1148+x keV, and the (13/2 ⁻) 713+x keV level. The former level was not confirmed by 1995Re18.
449.0 5		4121.3	33/2 ⁺	3672.4	29/2 ⁺	
457.8 5		2385.6	(19/2 ⁻)	1927.7	(17/2 ⁻)	
458.6 5		2639.9	23/2 ⁺	2181.5	19/2 ⁺	
464.0 5		5028.7	35/2 ⁻	4564.5	33/2 ⁻	
471.6 5		2229.9	19/2 ⁻	1758.4	17/2 ⁻	

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(HI,xn γ) 1995Re18,1974Ne16 (continued) $\gamma(^{191}\text{Tl})$ (continued)

$E_\gamma^\dagger$	$I_\gamma^\oplus$	$E_i(\text{level})$	J_i^π	E_f	J_f^π	Comments
476.8 5		3075.2	25/2 ⁻	2598.4	21/2 ⁻	
490.4 5		1927.7	(17/2 ⁻)	1437.1	15/2 ⁻	
564.1 [‡] 10		5074.9	41/2 ⁺	4511.5	37/2 ⁺	
571.6 6		2008.5	17/2 ⁺	1437.1	15/2 ⁻	
594.6 6		3444.4	27/2 ⁻	2849.9	23/2 ⁻	
613.7 6	40 5	1297.8	13/2 ⁺	684.4	11/2 ⁻	E_γ : Other: 614.2 keV (1974Ne16). R=0.30 +5-2.
620.0 6		3961.6	31/2 ⁺	3341.8	27/2 ⁺	
639.6 6		2966.6	25/2 ⁺	2327.0	21/2 ⁺	
647.3 7		2405.8	19/2 ⁻	1758.4	17/2 ⁻	
685.8 7		3761.0	29/2 ⁻	3075.2	25/2 ⁻	
702.0 7		3341.8	27/2 ⁺	2639.9	23/2 ⁺	
706.2 7		3672.4	29/2 ⁺	2966.6	25/2 ⁺	
710.9 7		2008.5	17/2 ⁺	1297.8	13/2 ⁺	
712.6 7	24 6	1009.7	13/2 ⁻	297	9/2 ⁻	E_γ : Other: 713.2 6 (1974Ne16). R=1.20 +9-4.
^x 730.0 [#] 7	15 5					
748.6 8		4192.7	31/2 ⁻	3444.4	27/2 ⁻	
748.8 8	19 4	1758.4	17/2 ⁻	1009.7	13/2 ⁻	E_γ : Other: 749.6 7 (1974Ne16). R=1.35 +8-4.
752.8 8		1437.1	15/2 ⁻	684.4	11/2 ⁻	
777.4 8		2075.0	17/2 ⁺	1297.8	13/2 ⁺	
792.8 8		2229.9	19/2 ⁻	1437.1	15/2 ⁻	
803.2 8		4564.5	33/2 ⁻	3761.0	29/2 ⁻	
836.5 8		5028.7	35/2 ⁻	4192.7	31/2 ⁻	
839.8 8		2598.4	21/2 ⁻	1758.4	17/2 ⁻	
859.9 9		5424.3	37/2 ⁻	4564.5	33/2 ⁻	
918.5 9		1927.7	(17/2 ⁻)	1009.7	13/2 ⁻	
948.3 10		2385.6	(19/2 ⁻)	1437.1	15/2 ⁻	

[†] E_γ from 1995Re18. An uncertainty of $\approx 0.1\%$ has been assigned to the γ -ray energies, with a minimum of 0.2 keV, based on the private communication (1999ReZV) with the first author of 1995Re18, except where noted.

[‡] The energy of the 564.1-keV crossover transition disagrees by 2.1 keV with the sum of the cascade formed by the 279.5+282.5 keV γ rays. It is not possible to resolve this discrepancy with the available data. Therefore the error for all three transitions has been increased arbitrarily to 1 keV.

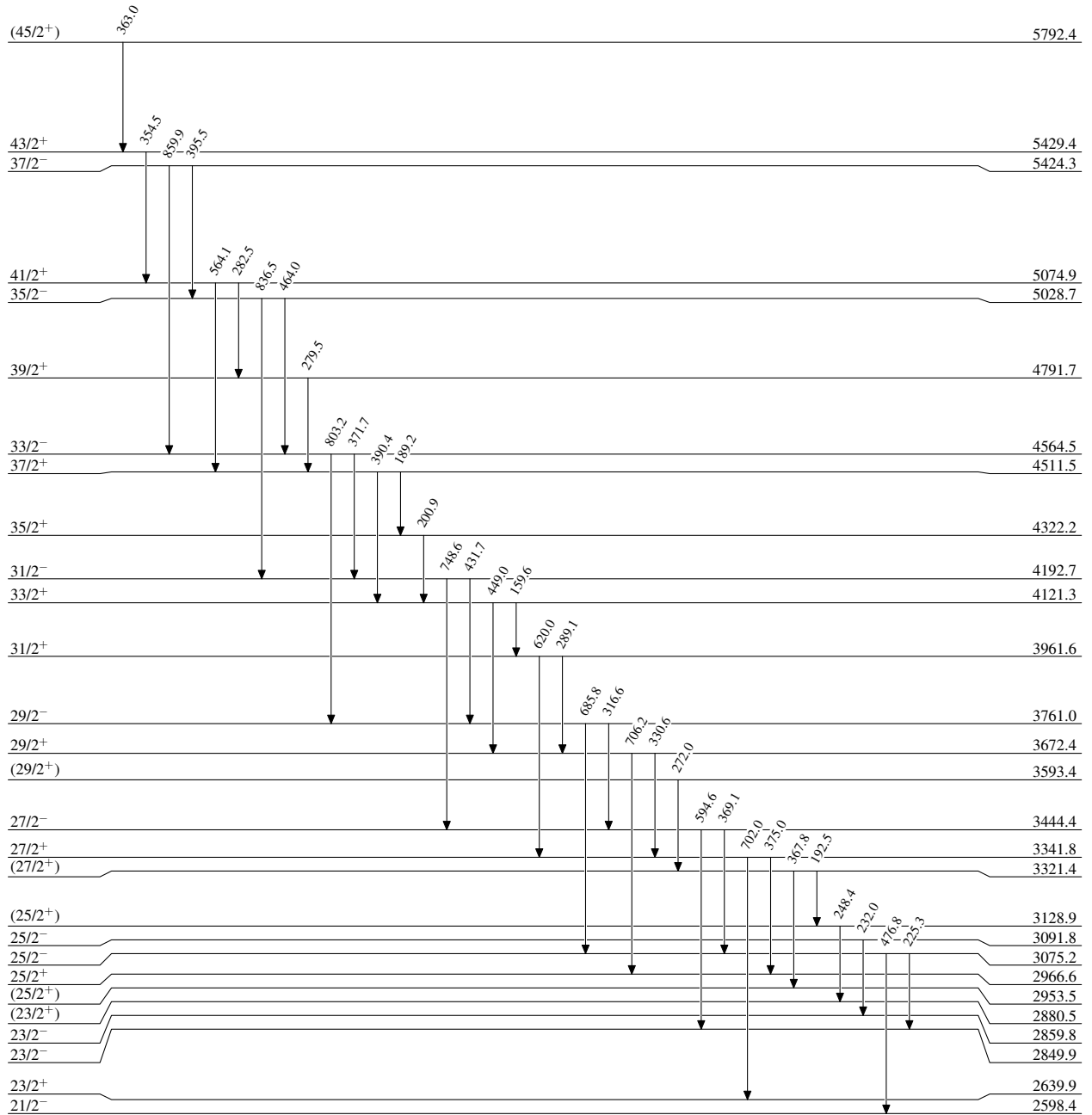
[#] γ ray reported only by 1974Ne16.

[@] γ -ray intensities, relative to I(387)=100, from 1974Ne16 ($\theta=90^\circ$).

[&] Multiply placed.

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

^x γ ray not placed in level scheme.

(HI,xn γ) 1995Re18,1974Ne16**Level Scheme**Intensities: Relative I_γ  $^{191}_{81}\text{Tl}_{110}$

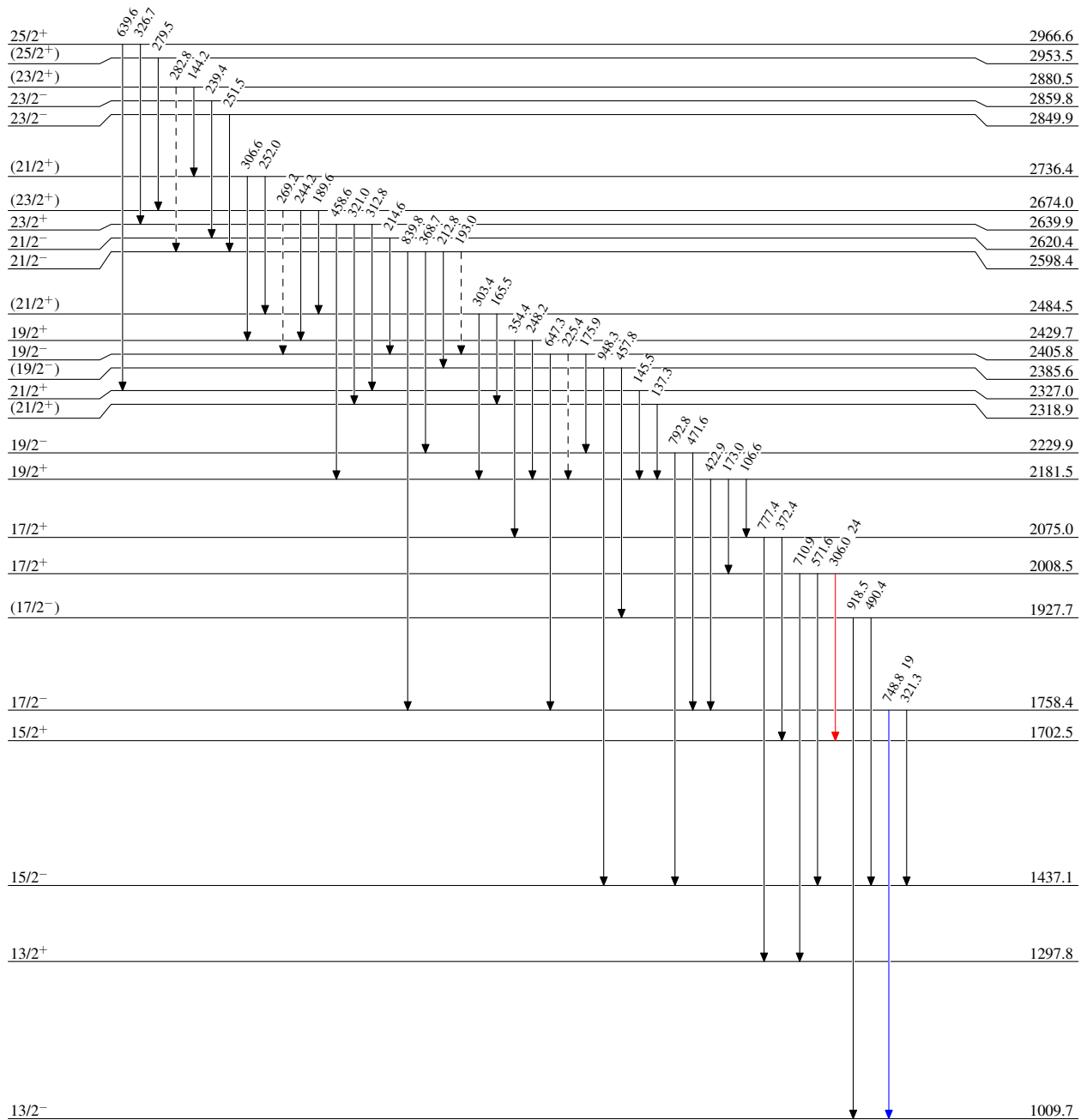
(HI,xn γ) 1995Re18,1974Ne16

Legend

Level Scheme (continued)

Intensities: Relative I_γ

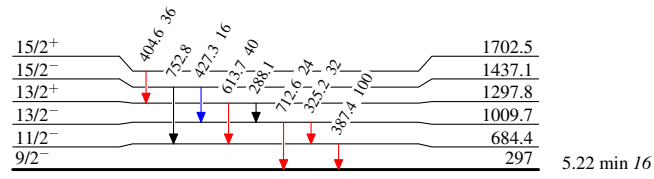
- $\longrightarrow$ $I_\gamma < 2\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma < 10\% \times I_\gamma^{\max}$
 $\longrightarrow$ $I_\gamma > 10\% \times I_\gamma^{\max}$
 $\cdots$ γ Decay (Uncertain)

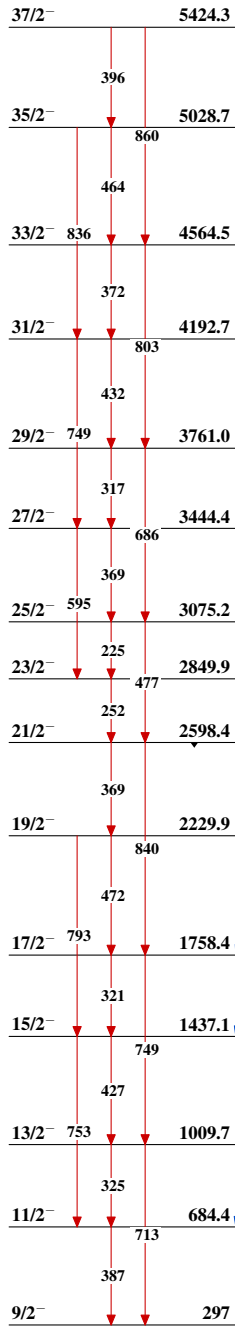
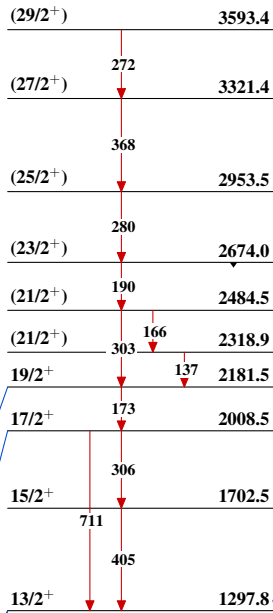
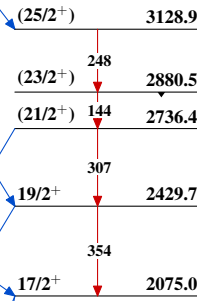
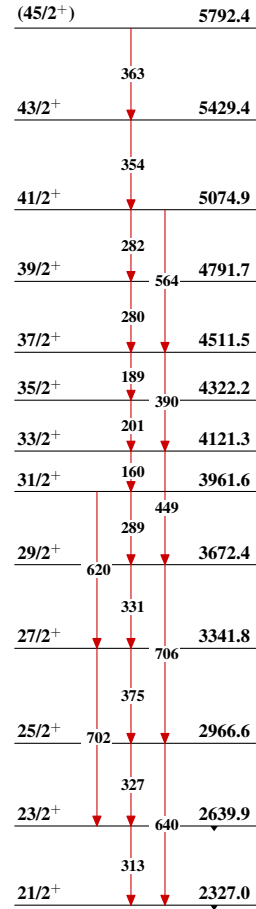
 $^{191}\text{Tl}_{81}^{110}$

(HI,xn γ) 1995Re18,1974Ne16**Level Scheme (continued)**Intensities: Relative I_γ

Legend

- $I_\gamma < 2\% \times I_\gamma^{max}$
- $I_\gamma < 10\% \times I_\gamma^{max}$
- $I_\gamma > 10\% \times I_\gamma^{max}$

 $^{191}_{81}\text{Tl}_{110}$

(HI,xn γ) 1995Re18,1974Ne16**Band(A): 9/2[505] $\pi=-$ rotational band****Band(B): 13/2⁺ single-particle like structure (1995Re18)****Band(C): 17/2⁺ band fragment****Band(D): $\pi=+$ rotational band, possible conf****Band(E): 19/2⁻ band fragment Described by 1995Re18 as a single-particle like structure (Structure 3a)**