(HI,xnγ) 1989IrZZ,1981Li15,1977Bo14

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	C. M. Baglin[1], E. A. Mccutchan[2], S. Basunia[1]	NDS 153, 1 (2018)	1-Oct-2018

See separate dataset for ^{128}Te(^{48}Ca,6nγ).

2013Sm02: ^{124}Sn(^{50}Ti,4nγ), E=195 MeV. Target was 1.0 mg/cm^2 thick ^{124}Sn mounted on Yale plunger device with a 13 mg/cm^2 thick Au stopper foil. Measured level mean lifetimes by recoil-distance Doppler-shift (RDDS) method using YRAST-Ball array at the SPEEDY setup at WNSL facility in Yale.

2006Co20: ^{158}Gd(^{16}O,4nγ), E=80 MeV; pulsed beam (≈1.5 ns pulse width) from TANDEM-linac facility; 2 coaxial HPGe detectors and 2 low-energy photon spectrometer (LEPS) detectors; measured γ-(LINAC radiofrequency) coin with respect to pulsed LINAC beam; generalized centroid shift method; determined $T_{1/2}$ 101 level.

1993Le03, 1992Le12, 1990Ba47: ^{130}Te(^{44}Ca,4nγ), E=195 MeV.

1989IrZZ, 1999Li42: ^{124}Sn(^{50}Ti,4nγ), E=205 MeV; measured Eγ, γγ coin, Iγ, DCO ratios (θ=37°, 79°). 1989IrZZ include two band fragments absent In 1999Li42. 1999Li42 discuss corrections for DCO ratios that result from detector efficiency.

1988Ta18: ^{170}Er(^{22}Ne,Cxnγ), E=220 MeV.

1982BaZH: ^{158}Gd(^{16}O,4nγ), E=84 MeV; measured Eγ, γγ coin, γ(θ).

Additional information 1.

1981Li15: ^{158}Gd(^{16}O,4nγ), E=80 MeV; 92% ^{158}Gd target, Ge(Li), spectrometer + Si(Li); measured Eγ, Iγ, γγ coin, γ(θ), I(ce); cranked shell-model analysis.

1979Dr08: ^{162}Dy(^{12}C,4nγ), ^{160}Gd(^{16}O,6nγ), E not stated by authors; measured Eγ, γγ(t), nγ(t).

1977Bo14: ^{124}Sn(^{50}Ti,4nγ), E=198 MeV; measured $T_{1/2}$ using the recoil-distance Doppler-shift method.

1982Pe10: ^{160}Gd(^{16}O,6nγ), E=90-134 MeV; measured Eγ, Iγ, γγ coin. Deduced average γ-multiplicity for the γ rays deexciting the 4$^+$ through 16$^+$ members of g.s. band at five bombarding energies; values range from 7.4 to 15.9 for individual transitions.

Studies of continuum γ rays: see 1993Le03 (lifetimes), 1992Le12 (2-dimensional energy correlations), 1990Ba47 (γ strength functions).

Other: 1985Ba48.

^{170}Hf Levels

E(level)†	Jπ‡	$T_{1/2}$#	Comments
0.0@	0$^+$		
100.8@	2$^+$	1.21 ns *4*	$T_{1/2}$: from γ-rf coin (2006Co20). Other: 1.2 ns *3* from recoil-distance Doppler-shift (1977Bo14).
322.0@	4$^+$	60.5 ps	$T_{1/2}$: other: 62 ps *7* from RDDM in 1977Bo14.
642.8@	6$^+$	9.13 ps *29*	$T_{1/2}$: other: 10.8 ps *9* from RDDM in 1977Bo14.
1043.1@	8$^+$	2.77 ps *9*	$T_{1/2}$: other: 3.2 ps *3* from RDDM in 1977Bo14.
1372.9	5$^{(-)}$		
1505.2@	10$^+$	1.25 ps *8*	$T_{1/2}$: other: 1.52 ps *19* from RDDM in 1977Bo14.
1725.9	7$^{(-)}$		
1773.8d	(6$^+$)	<5 ns	Jπ,$T_{1/2}$: from 1979Dr08.
1799.5a	6$^{(-)}$		
1966.8d	(7$^+$)		Jπ: from 1979Dr08.
2016.1@	12$^+$	0.75 ps *9*	$T_{1/2}$: other: 1.01 ps *13* from RDDM in 1977Bo14.
2109.3a	8$^{(-)}$		
2183.8	(8$^-$)	23 ns *2*	Jπ,$T_{1/2}$: from 1979Dr08. Possible configuration (π 7/2[404])+(π 9/2[514]).
2476.6a	10$^{(-)}$		
2483.5&	11$^-$		
2567.0@	14$^+$	0.53 ps *8*	$T_{1/2}$: other: 0.66 ps *15* from RDDM in 1977Bo14.
2689.1b	11$^-$		
2878.5e	12$^{(-)}$		

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(HI,xnγ) 1989IrZZ,1981Li15,1977Bo14 (continued)

^{170}Hf Levels (continued)

E(level)†	Jπ‡	$T_{1/2}$#	Comments
2931.9&	13−		
3094.4b	13−		
3151.3@	16+	0.38 ps *9*	$T_{1/2}$: other: 0.44 ps *AP* from RDDM in 1977Bo14.
3324.4e	14(−)		
3429.7&	15−		
3532.4c	16+		
3577.6b	15−		
3766.5@	18+	≈0.35 ps	$T_{1/2}$: from RDDM in 1977Bo14.
3834.1e	16(−)		
3965.0&	17−		
4093.5c	18+		
4123.2b	17−		
4138?	+		Jπ: E2 or M1+E2 γ to 16+ (1981Li15).
4364.1f	(19)		
4394.4e	18(−)		
4421.0@	20+	≈0.24 ps	$T_{1/2}$: from RDDM in 1977Bo14.
4529.0&	19−		
4714.9b	(19−)		
4751.0c	20+		
4986.4f	(21)		Jπ: note that adopted J is 2 units higher than that shown here.
4994.3e	20(−)		
5125.9&	21−		
5130.3@	22+		
5343.1b	(21−)		
5638.1e	22(−)		
5653.9f	(23)		
5769.7&	23−		
5902.6@	24+		
6014.8b	(23−)		
6339.2e	24(−)		
6370.3f	(25)		
6476.3&	25−		Jπ: from 1989IrZZ.
6738.4@	26+		
6744.4b	(25−)		
7106.5e	(26−)		
7140.7f	(27)		
7251.6&	27(−)		
7542.5b	(27−)		
7635.5@	(28+)		
7944.6e	(28−)		
7967.6f	(29)		
8098.9&	29(−)		
8410.5b	(29−)		
8589.9@	(30+)		
8851.5e	(30−)		
8853.9f	(31)		

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(HI,xnγ) 1989IrZZ,1981Li15,1977Bo14 (continued)

^{170}Hf Levels (continued)

E(level)[†]	Jπ[‡]
9016.5[&]	(31⁻)
9343.8[b]	(31⁻)
9598.1[@]	(32⁺)
9799.4[f]	(33)
10001.9[&]	(33⁻)
10653.6[@]	(34⁺)

† From least-squares fit to Eγ, allowing equal weight for all Eγ values.
‡ From 1981Li15 and/or 1989IrZZ, based on mult of deexciting γ ray(s) and on deduced band structure.
# From recoil-distance Doppler-shift method in 2013Sm02, except where noted.
@ Band(A): g.s. band. Band also observed by 1985Ba48 but it was attributed to ^{170}Ta.
& Band(B): π=−, α=1 band. May be 7/2[633]⊗5/2[523] configuration At low spin, but first band crossing does not occur At expected frequency and 1981Li15 suggest that band may be so mixed that a pure quasiparticle configuration description is not justified.
[a] Band(C): π=− band.
[b] Band(d): π=−, α=1 band. Note that, In Adopted Levels, J values within this band are 2 units higher than shown here.
[c] Band(E): π=+, α=0 band.
[d] Band(F): Kπ=(6⁺) band. Possible configuration (π 7/2[404])+(π 5/2[402]) (1979Dr08).
[e] Band(D): π=(−), α=0 sequence.
[f] Band(G): α=(1) band. Note that adopted Jπ values are 2 units higher than shown here.

γ(^{170}Hf)

Experimental conversion coefficient data are from relative Iγ and I(ce(K)) (1981Li15) normalized so that α(K)(654γ)=0.00815 (E2 theory). γ(θ) data are also from 1981Li15.

Eγ[†]	Iγ[‡]	Ei(level)	J_i^π	Ef	J_f^π	Mult.[#]	α[c]	Comments
100.8		100.8	2⁺	0.0	0⁺			Eγ: from fig. 2 of 1981Li15.
189.4		2878.5	12(−)	2689.1	11⁻			
193		1966.8	(7⁺)	1773.8	(6⁺)			Eγ: from 1979Dr08.
217		2183.8	(8⁻)	1966.8	(7⁺)			Eγ: from 1979Dr08.
221.2	100	322.0	4⁺	100.8	2⁺	E2[a]	0.206	A2=+0.27 *4*, A4=−0.05 *4*.
230.0		3324.4	14(−)	3094.4	13⁻			
309.8		2109.3	8(−)	1799.5	6(−)			
320.8	91.8	642.8	6⁺	322.0	4⁺	E2[a]	0.0649	A2=+0.27 *3*, A4=−0.07 *3*.
353.0		1725.9	7(−)	1372.9	5(−)			
367.2		2476.6	10(−)	2109.3	8(−)			
383.4		2109.3	8(−)	1725.9	7(−)			
400.4	80.3	1043.1	8⁺	642.8	6⁺	E2[a]	0.0346	A2=+0.28 *2*, A4=−0.08 *2*.
401.8		2878.5	12(−)	2476.6	10(−)			
405.1	2.1	3094.4	13⁻	2689.1	11⁻			
426.6		1799.5	6(−)	1372.9	5(−)			
445.8		3324.4	14(−)	2878.5	12(−)			
448.6	3.1	2931.9	13⁻	2483.5	11⁻	Q		A2=+0.26 *4*, A4=−0.09 *4*.
462.2	67.8	1505.2	10⁺	1043.1	8⁺	E2[a]	0.0236	A2=+0.29 *2*, A4=−0.09 *2*.
483.2	2.9	3577.6	15⁻	3094.4	13⁻	(Q)		A2=+0.26 *5*, A4=−0.03 *6*.

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(HI,xnγ) 1989IrZZ,1981Li15,1977Bo14 (continued)

γ(^{170}Hf) (continued)

E_γ[†]	I_γ[‡]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	α[c]	Comments
497.9	3.2	3429.7	15^-	2931.9	13^-	Q		A_2=+0.35 *6*, A_4=−0.18 *7*.
509.7		3834.1	$16^{(-)}$	3324.4	$14^{(-)}$			
510.9		2016.1	12^+	1505.2	10^+	E2[a]	0.0183	I_γ: not determined; contaminated by 511-keV annihilation peak. A_2=+0.15 *2*, A_4=−0.07 *2*.
535.4	3.2	3965.0	17^-	3429.7	15^-	Q		A_2=+0.27 *8*, A_4=−0.15 *8*.
545.6	1.1	4123.2	17^-	3577.6	15^-	(Q)		A_2=+0.32 *15*, A_4=−0.03 *15*.
550.7	31.5	2567.0	14^+	2016.1	12^+	E2[a]	0.01524	A_2=+0.28 *1*, A_4=−0.10 *2*.
560.3		4394.4	$18^{(-)}$	3834.1	$16^{(-)}$			
561.0		4093.5	18^+	3532.4	16^+			E_γ: other: 561 in 1982BaZH.
564.0	2.2	4529.0	19^-	3965.0	17^-	Q		A_2=+0.30 *8*, A_4=−0.09 *8*.
584.4	21.0	3151.3	16^+	2567.0	14^+	E2[a]	0.01321	A_2=+0.24 *2*, A_4=−0.08 *3*.
591.7		4714.9	(19^-)	4123.2	17^-			
596.9	2.5[@]	5125.9	21^-	4529.0	19^-			
597.6		4364.1	(19)	3766.5	18^+			
599.9		4994.3	$20^{(-)}$	4394.4	$18^{(-)}$			
615.2	10.3	3766.5	18^+	3151.3	16^+	E2[a]	0.01170	A_2=+0.21 *4*, A_4=−0.04 *4*.
622.3		4986.4	(21)	4364.1	(19)			
628.2		5343.1	(21^-)	4714.9	(19^-)			
643.8		5638.1	$22^{(-)}$	4994.3	$20^{(-)}$			
643.8	1.5	5769.7	23^-	5125.9	21^-	(Q)		A_2=+0.21 *24*, A_4=+0.01 *26*.
654.5	4.0	4421.0	20^+	3766.5	18^+	E2[a]	0.01014	A_2=+0.25 *5*, A_4=−0.14 *5*.
657.5		4751.0	20^+	4093.5	18^+	(E2)[b]	0.01004	E_γ: other: 659 in 1981Li15.
667.5		5653.9	(23)	4986.4	(21)			
671.7		6014.8	(23^-)	5343.1	(21^-)			
701.1		6339.2	$24^{(-)}$	5638.1	$22^{(-)}$			
706.6	0.7[@]	6476.3	25^-	5769.7	23^-	(E2)		α(K)exp=0.014 *6* Mult.: M1,E2 from α(K)exp; 1981Li15 assign E2 based on band structure.
709.3	2.2	5130.3	22^+	4421.0	20^+	E2[&]		α(K)exp=0.010 *2*
716.4		6370.3	(25)	5653.9	(23)			
729.6		6744.4	(25^-)	6014.8	(23^-)			
762.4		4529.0	19^-	3766.5	18^+			
767.3		7106.5	(26^-)	6339.2	$24^{(-)}$			
770.4		7140.7	(27)	6370.3	(25)			
772.3	1.2[@]	5902.6	24^+	5130.3	22^+			
775.3		7251.6	$27^{(-)}$	6476.3	25^-			
798.1		7542.5	(27^-)	6744.4	(25^-)			
813.7	1.2	3965.0	17^-	3151.3	16^+	D		A_2=−0.36 *16*, A_4=+0.11 *20*.
826.9		7967.6	(29)	7140.7	(27)			
835.8	0.7[@]	6738.4	26^+	5902.6	24^+			E_γ: other: 836.6 in 1981Li15.
838.1		7944.6	(28^-)	7106.5	(26^-)			
847.3		8098.9	$29^{(-)}$	7251.6	$27^{(-)}$			
862.6	2.3	3429.7	15^-	2567.0	14^+	E1[&]		α(K)exp=0.0019 *7* A_2=−0.15 *7*, A_4=−0.02 *8*.
868.0		8410.5	(29^-)	7542.5	(27^-)			
886.3		8853.9	(31)	7967.6	(29)			
897.1		7635.5	(28^+)	6738.4	26^+			E_γ: value given as 879.1 in 1989IrZZ and 1999Li42 clearly contains a typographical error; level energy difference is 897.1. a 786γ, tentatively placed from 28^+ band member by 1981Li15, was not confirmed by 1989IrZZ.
906.9		8851.5	(30^-)	7944.6	(28^-)			

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(HI,xnγ) 1989IrZZ,1981Li15,1977Bo14 (continued)

γ(^{170}Hf) (continued)

E_γ[†]	I_γ[‡]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	Comments
915.6	3.0	2931.9	13^-	2016.1	12^+	E1[&]	α(K)exp=0.0010 *4* A_2=−0.39 *7*, A_4=+0.17 *8*.
917.6		9016.5	(31^-)	8098.9	$29^{(-)}$		
933.3		9343.8	(31^-)	8410.5	(29^-)		
942.5		4093.5	18^+	3151.3	16^+	(E2)[b]	E_γ: other: 941 in 1981Li15.
945.5		9799.4	(33)	8853.9	(31)		
954.4		8589.9	(30^+)	7635.5	(28^+)		E_γ: an 805γ, tentatively placed from 30^+ band member in 1981Li15, was not confirmed by 1989IrZZ.
965.2		3532.4	16^+	2567.0	14^+		E_γ: other: 965 in 1982BaZH.
978.6	3.1	2483.5	11^-	1505.2	10^+	E1[&]	α(K)exp=0.0014 *4* A_2=−0.20 *5*, A_4=+0.07 *6*.
984.4		4751.0	20^+	3766.5	18^+	(E2)[b]	E_γ: other: 984 in 1981Li15.
985.4		10001.9	(33^-)	9016.5	(31^-)		
986[d]		4138?	+	3151.3	16^+	(E2)	Coin with γ cascade from 16^+ member of g.s. band.
1008.1		9598.1	(32^+)	8589.9	(30^+)		
1050.8		1372.9	$5^{(-)}$	322.0	4^+		
1055.5		10653.6	(34^+)	9598.1	(32^+)		
1078.5	0.7	3094.4	13^-	2016.1	12^+	D	A_2=−0.29 *19*, A_4=0.00 *22*.
1083.0		1725.9	$7^{(-)}$	642.8	6^+		
1131		1773.8	(6^+)	642.8	6^+	(M1)	Coin with 320.8γ (6^+ to 4^+, g.s. band). γ(θ) isotropic; α(K)exp consistent with mult=M1 (1981Li15). Placement from 1979Dr08.
1183.8	2.2	2689.1	11^-	1505.2	10^+	E1[&]	α(K)exp<0.0015 A_2=−0.49 *10*, A_4=−0.02 *11*.

[†] From 1989IrZZ, unless noted otherwise; data for transitions reported in 1981Li15 and/or 1999Li42 are identical. ΔE not stated by authors; Eγ for transitions from the first three excited states are within 0.1 keV of value reported in ^{170}Ta ε decay.

[‡] Relative photon intensities from ^{158}Gd(^{16}O,4nγ), E=80 MeV (1981Li15), normalized so I(212.2γ)=100.

[#] Based on γ(θ), except as noted.

[@] From coincidence spectrum.

[&] From measured α(K)exp (1981Li15).

[a] Q from γ(θ); not M2 from RUL.

[b] Unenumerated γ(θ) and α(K)exp data favor mult=E2, but do not preclude some M1 admixture (1981Li15).

[c] 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.

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

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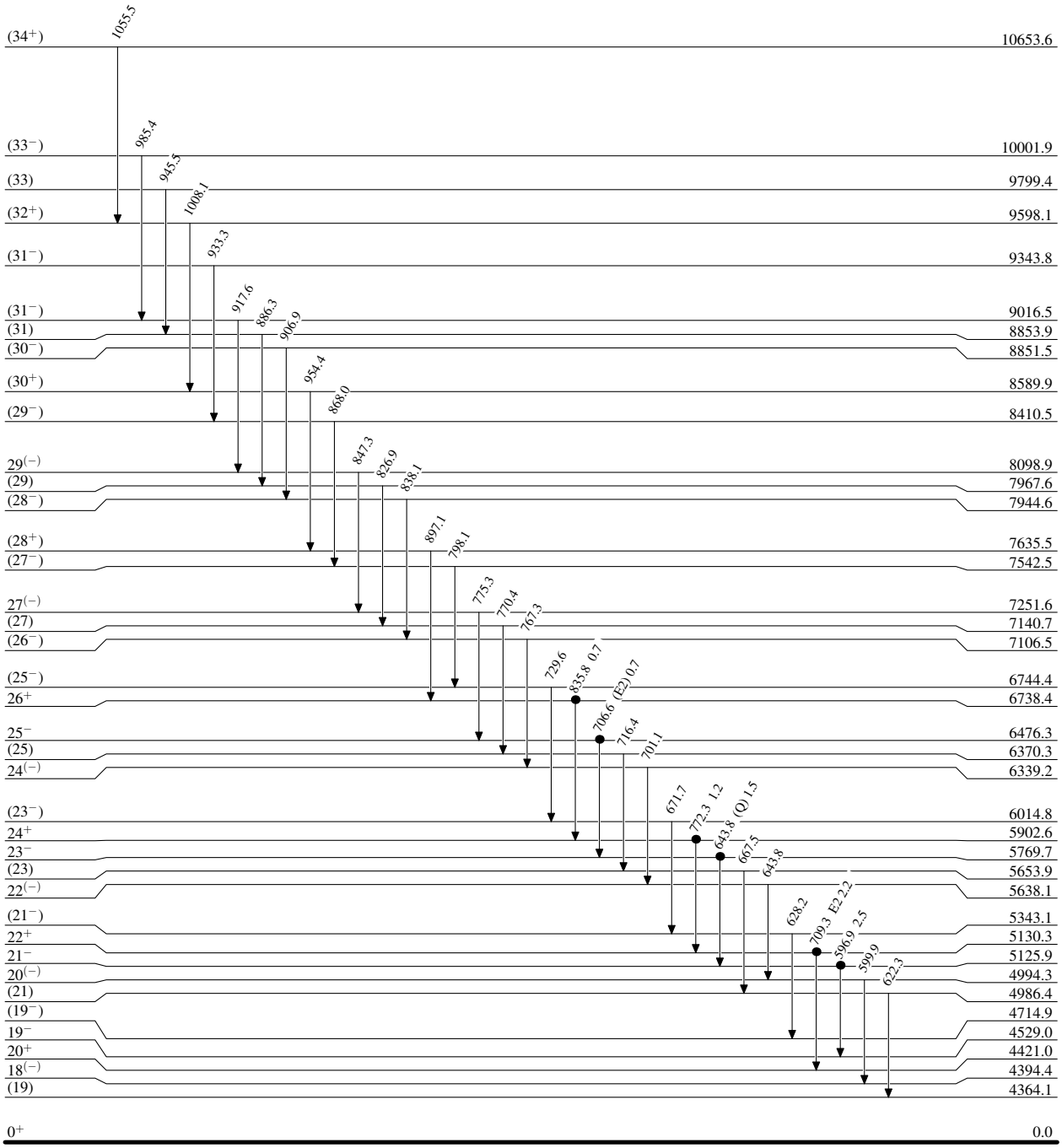
Level Scheme

Intensities: Relative Iγ from ^{158}Gd(^{16}O,4nγ) E=80 MeV

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

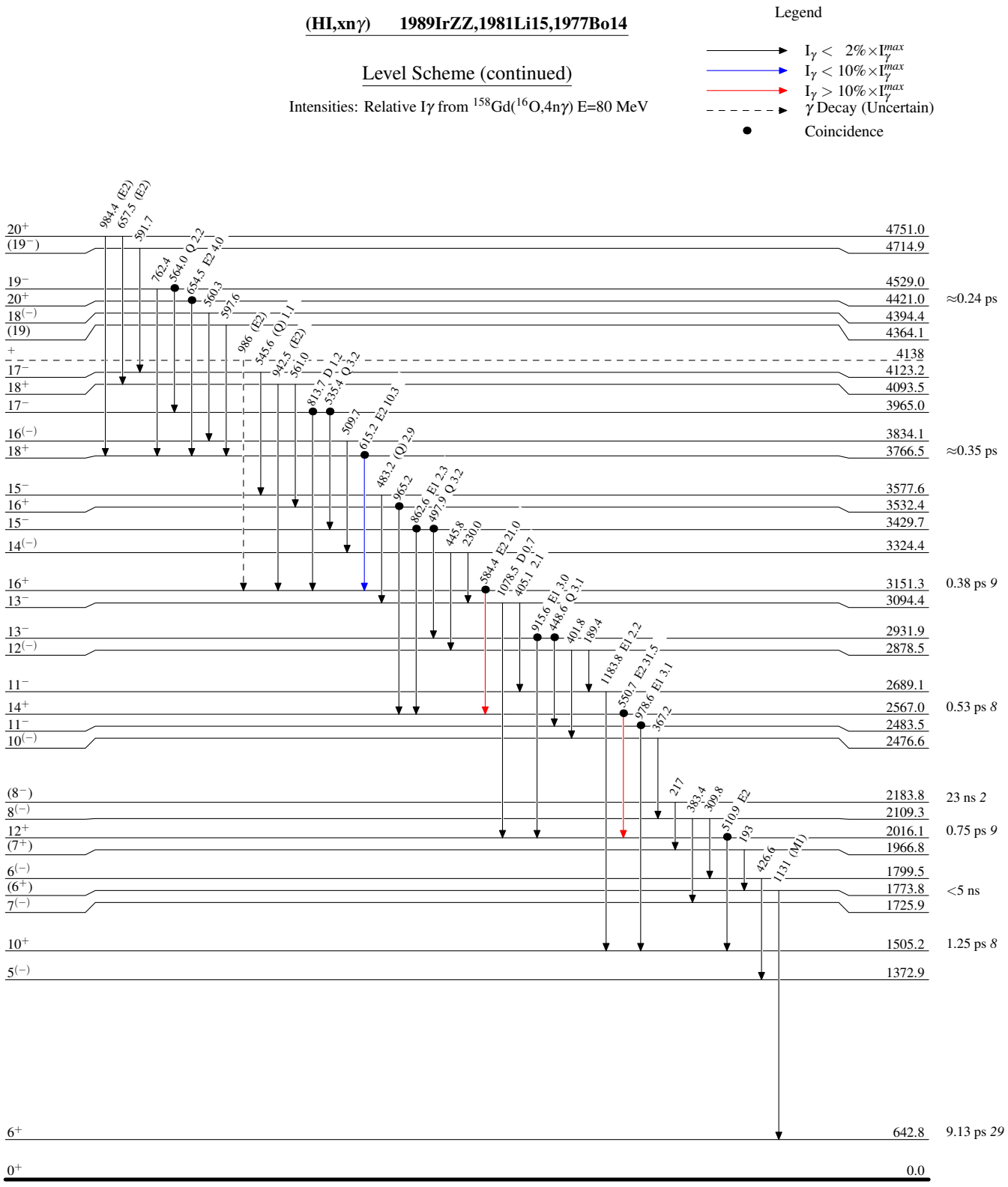


$^{170}_{72}Hf_{98}$

(HI,xnγ) 1989IrZZ,1981Li15,1977Bo14

Level Scheme (continued)

Intensities: Relative Iγ from ^{158}Gd(^{16}O,4nγ) E=80 MeV



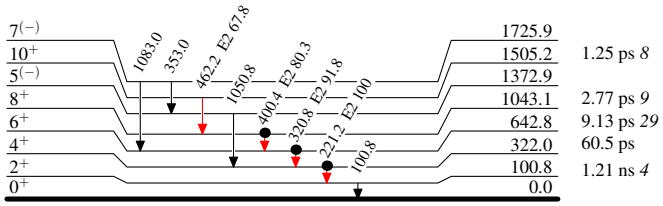
$^{170}_{72}Hf_{98}$

(HI,xnγ) 1989IrZZ,1981Li15,1977Bo14

Level Scheme (continued)

Intensities: Relative Iγ from ^{158}Gd(^{16}O,4nγ) E=80 MeV

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



$^{170}_{72}Hf_{98}$

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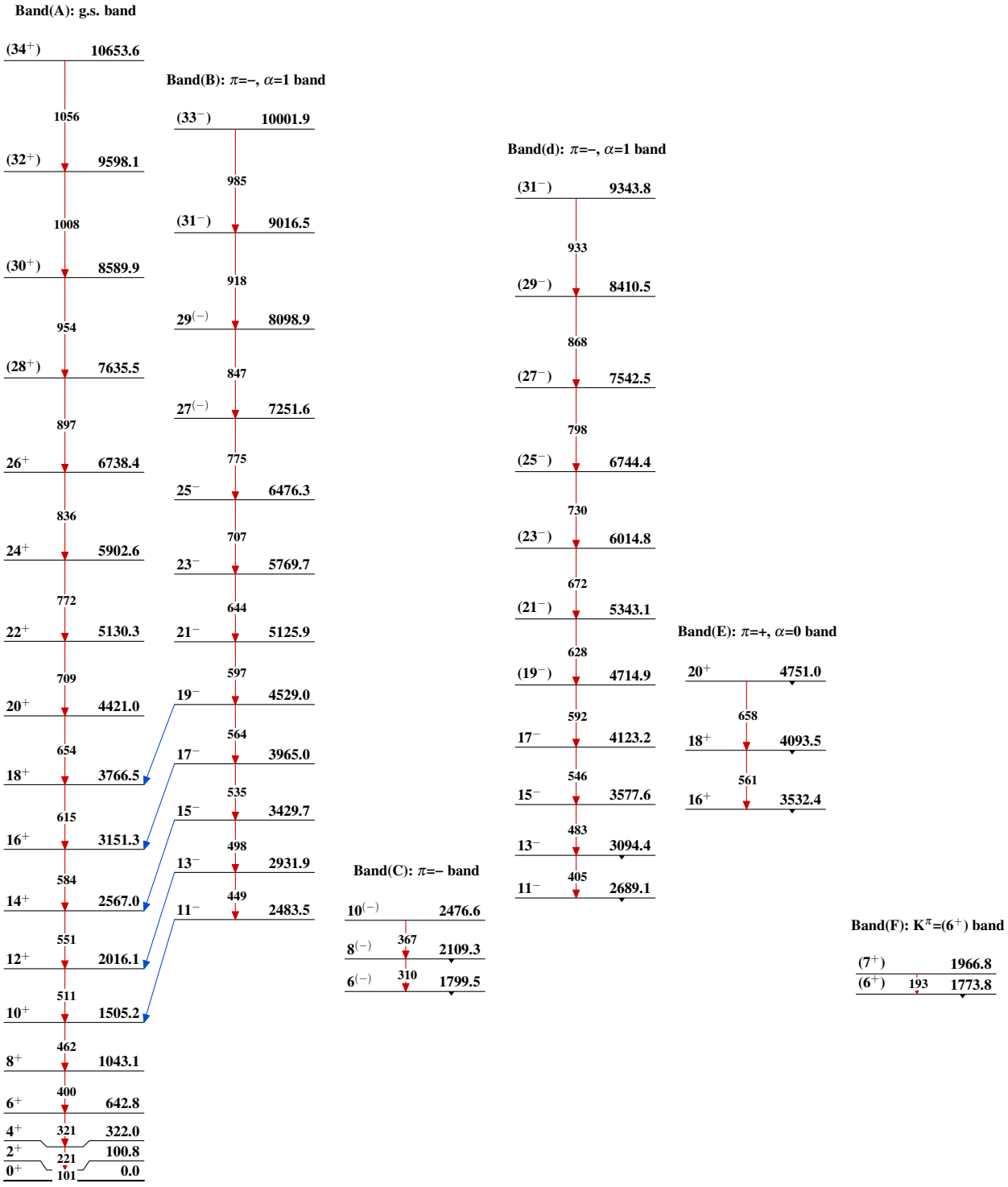
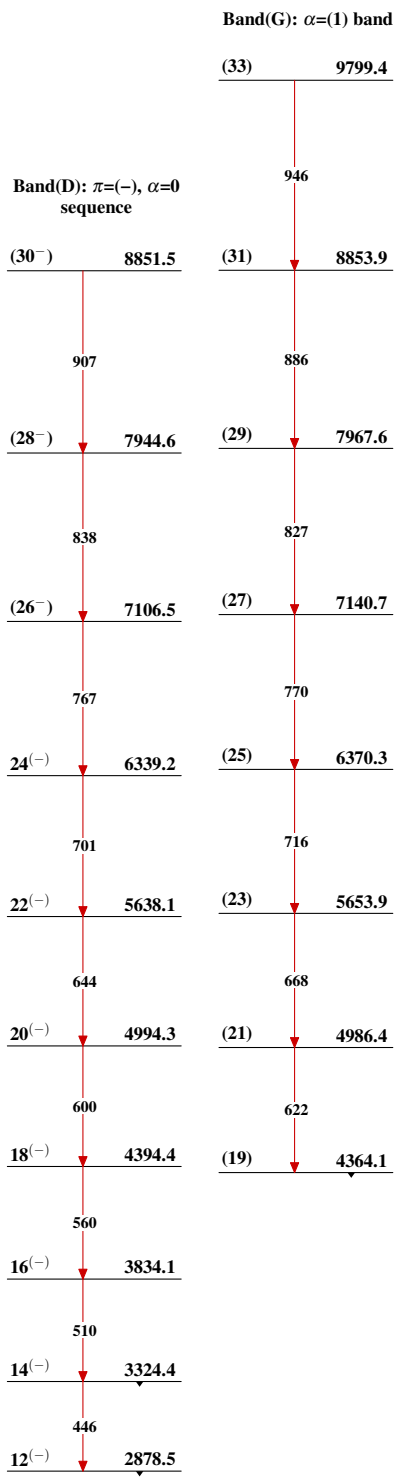


$^{170}_{72}Hf_{98}$

(HI,xnγ) 1989IrZZ,1981Li15,1977Bo14 (continued)



$^{170}_{72}Hf_{98}$