(HI,xnγ) 1984Ha35,1986HeZR

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	N. Nica	NDS 160, 1 (2019)	21-Oct-2019

Additional information 1.

The data are taken primarily from 1984Ha35 and 1986HeZR.

1986HeZR: ^{124}Sn(^{35}Cl,4n), ^{122}Sn(^{37}Cl,4n), E(Cl) not given. Measured excitation function, Eγ, $\gamma(\theta)$, $\gamma\gamma$, $T_{1/2}$. Observe members of the h11/2-based band through the 61/2$^-$ level, together with two new side bands and a noncollective level structure. Eγ, level energies, J^π and band assignments only are given.

1984Ha35: ^{141}Pr(^{18}O,4nγ), E(^{18}O)=85 MeV. Measured Eγ, Iγ and $\gamma\gamma$ using an array of 4 Compton-suppressed Ge(Li) detectors with an additional "ball" of 14 BGO crystals in a 4π geometry, $\gamma(\theta)$. These authors observe members of the h11/2-related band up through the 47/2$^-$ state.

1979Fo11: ^{145}Nd(^{14}N,4nγ), E(^{14}N)=72 MeV. Measured Eγ, Iγ, $\gamma\gamma$, γ(t), $\gamma(\theta)$. These authors report levels at 1787.3, 2129.5, 2464.7 and 2918.7 keV whose spins, judging by their proposed γ-decay patterns, are in the range from ≈21/2 to 31/2. These levels are apparently not populated in the other in-beam studies and are not considered further here.

1978De27: ^{150}Sm(^{10}B,5nγ), E(^{10}B)=60-70 MeV. Measured Eγ, Iγ, $\gamma(\theta)$, $\gamma\gamma$, E(ce), Ice(K). The ce data are not presented in this paper. These authors observe the members of the h11/2-based band up through the the 35/2$^-$ state, except for the 33/2$^-$ member. Their data on the band structure of this band are in essential agreement with those of 1984Ha35 and are not given separately here.

1997Me24, from the ^{124}Sn(^{35}Cl,4n) reaction with E(^{35}Cl)=145 MeV, use a mini-orange detector at 0° to measure K-conversion coefficients for several well-established ΔJ=1 transitions. These data support the previously established multipolarities.

^{155}Ho Levels

E(level)[†@]	J$^\pi$[‡]	$T_{1/2}$	Comments
0.0	5/2$^+$[#]		
110.3[c]	7/2$^+$[#]		
142.0[bd]	11/2$^-$[#]	0.88[&] ms *8*	
230.3	9/2$^-$		
344.8[ac]	(9/2$^+$)		
518.8[d]	15/2$^-$		
538.1[e]	13/2$^-$		
582.8?[ac]	(11/2$^+$)		E(level): level not confirmed by 2015Re03 in ^{124}Sn(^{37}Cl,6nγ) dataset.
1001.5[e]	17/2$^-$		
1017.9[d]	19/2$^-$		
1561.3[e]	21/2$^-$		
1605.5[d]	23/2$^-$		
1647.2?			
2129.8[f]	23/2		
2189.5[e]	25/2$^-$		
2265.6[d]	27/2$^-$		
2464.9[f]	27/2		
2644.3[h]	(27/2)		
2730.9[h]	(29/2)		
2858.9[e]	29/2$^-$		
2918.2[f]	31/2		
2978.3[d]	31/2$^-$		
3065.7[h]	31/2		
3263.3[g]	33/2		
3399.9[e]	33/2$^-$		
3490.6[f]	35/2		

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(HI,xnγ) 1984Ha35,1986HeZR (continued)

^{155}Ho Levels (continued)

E(level)[†@]	Jπ[‡]	E(level)[†@]	Jπ[‡]	E(level)[†@]	Jπ[‡]	E(level)[†@]	Jπ[‡]
3651.6[d]	35/2⁻	4493.6[e]	41/2⁻	5712.1[f]	47/2	7294.0[i]	(57/2)
3658.8[h]	(35/2)	4602.5[h]	(41/2)	5933.0[e]	49/2⁻	7680.9[e]	57/2⁻
3839.5[g]	37/2	4838.0[d]	43/2⁻	6059.2[g]	49/2	8041.4?[d]	59/2⁻
3906.1[e]	37/2⁻	4876.9[f]	43/2	6169.7[i]	(49/2)	8224.7[i]	(61/2)
4121.4[f]	39/2	5167.0[e]	45/2⁻	6342.2[d]	51/2⁻	8243.1	(59/2)
4211.5[d]	39/2⁻	5215.8[g]	45/2	6774.5[e]	53/2⁻	8488.1	(61/2)
4278.9[h]	(39/2)	5394.0[i]	45/2	6845.5[i]	(53/2)	8516.1[e]	61/2⁻
4490.6[g]	41/2	5547.0[d]	47/2⁻	7195.1[d]	55/2⁻		

[†] The γ deexciting the 11/2⁻ level has not been seen in the in-beam studies. From their failure to observe this transition in a specially designed γγ-coincidence experiment, as well as its associated conversion electrons in a mini-orange electron spectrometer, 1984Ha35 conclude that Eγ<40. The energy of this transition (Eγ=31.7) and, hence, that of the 11/2⁻ level are taken from the ^{155}Er ε decay data. Since the level energies reported by 1986HeZR are all tied to that of this 11/2⁻ level, they have been increased by 142.0, the value of this level energy.

[‡] Unless otherwise indicated, the listed values are those reported by 1986HeZR. Where this study and that of 1984Ha35 overlap, the two sets of J^π values agree. The values reported by 1984Ha35 are based largely on angular-distribution measurements and general considerations of rotational-band structure to identify stretched E2 transitions and mixed M1+E2 transitions. Such data are not presented by 1986HeZR. However, they are based on similar considerations, and the evaluator considers them to be of a validity generally comparable with those from most in-beam-based studies. They have been adopted in this evaluation.

[#] From adopted values.

[@] With the exception of the h11/2-related bands and the 7/2[404] band, the grouping of levels into "bands" is essentially that shown by 1986HeZR. Where no configuration assignments are given, there appears to be considerable ambiguity or uncertainty in this process. In addition, it is likely that the configurational makeup of the states changes, and involves both collective and noncollective excitations, as one moves up in spin within the various "bands" or groupings of levels.

[&] From 1979Fo11, γ(t), Kα_1 x ray(t).

[a] From 1979Fo11.

[b] The level energy and that of its deexciting γ, as shown by 1986HeZR, are not consistent. The evaluator has assumed that the level energy is given incorrectly.

[c] Band(A): Possible 7/2⁺ band. Configuration=(π 7/2(404)).

[d] Band(B): h11/2-based band, signature=−1/2.

[e] Band(C): h11/2-based band, signature=+1/2.

[f] Band(D): Side band, signature=−1/2. Configuration=((ν,$i_{13/2}$; α=+1/2)(ν,$f_{7/2}$; α=+1/2)(π,$h_{11/2}$; α=+1/2)) is probable, as proposed by 1986HeZR, based on cranked shell-model calculations.

[g] Band(E): Side band, signature=+1/2. Configuration=((ν,$i_{13/2}$; α=+1/2)(ν,$f_{7/2}$; α=+1/2)(π,$h_{11/2}$; α=−1/2)) is probable, as proposed by 1986HeZR, based on cranked shell-model calculations.

[h] Band(F): Possible band.

[i] Band(G): Possible band.

γ(^{155}Ho)

E_γ[†‡]	I_γ[#]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[&]	Comments
(16.3[@])	0.45[@] 14	1017.9	19/2⁻	1001.5	17/2⁻	M1(+E2)	
(19.3[@])	0.10[@] 2	538.1	13/2⁻	518.8	15/2⁻		
(31.7 1)		142.0	11/2⁻	110.3	7/2⁺	M2	E_γ,Mult.: from 1980Bu25.
(44.0[@])	1.3[@] 4	1605.5	23/2⁻	1561.3	21/2⁻	M1(+E2)	

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(HI,xnγ) 1984Ha35,1986HeZR (continued)

γ(^{155}Ho) (continued)

E_γ [†‡]	I_γ [#]	E_i(level)	J_i^π	E_f	J_f^π	Mult. [&]	δ [&]	Comments
(76.0[@])	1.9[@] *7*	2265.6	27/2⁻	2189.5	25/2⁻	M1(+E2)		
110.3		110.3	7/2⁺	0.0	5/2⁺	M1		Mult.: from I(Kα_1 x ray)/Iγ(110γ) in the delayed γ spectrum, 1979Fo11 measure α(K)exp=1.87 *20*, consistent with the value (adopted α(K)=1.98 for E_g=110.12) for a pure M1 transition.
(119.2[@])	3.9[@] *11*	2978.3	31/2⁻	2858.9	29/2⁻	M1(+E2)		
[x]163.2						D		
187.3		2918.2	31/2	2730.9	(29/2)			
227[a]		3490.6	35/2	3263.3	33/2			
227.0		5394.0	45/2	5167.0	45/2⁻			
234.5 *2*		344.8	(9/2⁺)	110.3	7/2⁺			From 1979Fo11.
238.0[a] *2*		582.8?	(11/2⁺)	344.8	(9/2⁺)			E_γ: From 1979Fo11; not found by 2015Re03 in ^{124}Sn(^{37}Cl,6nγ).
245.0		8488.1	(61/2)	8243.1	(59/2)			
251.5	16	3651.6	35/2⁻	3399.9	33/2⁻	M1+E2	+0.07 *4*	
254.4	21	3906.1	37/2⁻	3651.6	35/2⁻	M1+E2	−0.04 *7*	
266.0		2730.9	(29/2)	2464.9	27/2			
273.9		2918.2	31/2	2644.3	(27/2)			
275.3		2464.9	27/2	2189.5	25/2⁻			
282.0		4121.4	39/2	3839.5	37/2			
282.0	57	4493.6	41/2⁻	4211.5	39/2⁻			
305.4	18	4211.5	39/2⁻	3906.1	37/2⁻			
307.8	43	538.1	13/2⁻	230.3	9/2⁻	E2		
323.6		4602.5	(41/2)	4278.9	(39/2)			
329.0		5167.0	45/2⁻	4838.0	43/2⁻			
335.2		2464.9	27/2	2129.8	23/2			
339		5215.8	45/2	4876.9	43/2			
344.4		4838.0	43/2⁻	4493.6	41/2⁻			I_γ: Iγ(626γ)/Iγ(344γ)=1.0 *2* (1984Ha35).
345.0		3263.3	33/2	2918.2	31/2			
347		6059.2	49/2	5712.1	47/2			
349.0		3839.5	37/2	3490.6	35/2			
361[a]		8041.4?	59/2⁻	7680.9	57/2⁻			
369.3		4490.6	41/2	4121.4	39/2			
376.8		518.8	15/2⁻	142.0	11/2⁻			
380.0		5547.0	47/2⁻	5167.0	45/2⁻			
385.9		5933.0	49/2⁻	5547.0	47/2⁻			
396.1	97	538.1	13/2⁻	142.0	11/2⁻	M1+E2	+1.5 *+8−5*	
409		6342.2	51/2⁻	5933.0	49/2⁻			
[x]418.8						Q		
421[a]		7195.1	55/2⁻	6774.5	53/2⁻			
421.5		3065.7	31/2	2644.3	(27/2)			
421.5	22	3399.9	33/2⁻	2978.3	31/2⁻	M1+E2	+0.065 *24*	
432[a]		6774.5	53/2⁻	6342.2	51/2⁻			
448.4		7294.0	(57/2)	6845.5	(53/2)			
453.2		2918.2	31/2	2464.9	27/2			
455.0		2644.3	(27/2)	2189.5	25/2⁻			
458[a]		6169.7	(49/2)	5712.1	47/2			
463.5	107	1001.5	17/2⁻	538.1	13/2⁻	E2		
465.1		2730.9	(29/2)	2265.6	27/2⁻			
472.5 *2*		582.8?	(11/2⁺)	110.3	7/2⁺			E_γ: From 1979Fo11; replaced at another level by 2015Re03 in ^{124}Sn(^{37}Cl,6nγ) dataset.
475[a]		8516.1	61/2⁻	8041.4?	59/2⁻			

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(HI,xnγ) 1984Ha35,1986HeZR (continued)

γ(^{155}Ho) (continued)

E_γ [†‡]	I_γ [#]	E_i(level)	J_i^π	E_f	J_f^π	Mult. [&]	δ [&]	Comments
481[a]		4602.5	(41/2)	4121.4	39/2			
482.7	107	1001.5	17/2⁻	518.8	15/2⁻	M1+E2	+1.2 +5−3	
482.7		2129.8	23/2	1647.2?				
499.0	454	1017.9	19/2⁻	518.8	15/2⁻	E2		
506.3	20	3906.1	37/2⁻	3399.9	33/2⁻			
514.6		2644.3	(27/2)	2129.8	23/2			
517		5394.0	45/2	4876.9	43/2			
541.0	16	3399.9	33/2⁻	2858.9	29/2⁻	E2		
543.4	93	1561.3	21/2⁻	1017.9	19/2⁻	M1+E2	+0.59 10	
559.8	154	1561.3	21/2⁻	1001.5	17/2⁻	E2		
559.8	27	4211.5	39/2⁻	3651.6	35/2⁻			
568.5		2129.8	23/2	1561.3	21/2⁻			
572.5		3490.6	35/2	2918.2	31/2			
576.2		3839.5	37/2	3263.3	33/2			
583.9	106	2189.5	25/2⁻	1605.5	23/2⁻	M1+E2	+0.42 6	
587.6	252	1605.5	23/2⁻	1017.9	19/2⁻	E2		
587.6[a]	71	4493.6	41/2⁻	3906.1	37/2⁻			
593.1	12	2858.9	29/2⁻	2265.6	27/2⁻			
593.1		3658.8	(35/2)	3065.7	31/2			
600.6		3065.7	31/2	2464.9	27/2			
[x]613.7						Q		
620.2		4278.9	(39/2)	3658.8	(35/2)			
626.6		4838.0	43/2⁻	4211.5	39/2⁻			I_γ: Iγ(626γ)/Iγ(344γ)=1.0 2 (1984Ha35).
628.3	125	2189.5	25/2⁻	1561.3	21/2⁻	E2		
630.8		4121.4	39/2	3490.6	35/2			
[x]638.2						D		
645.7		1647.2?		1001.5	17/2⁻			
651.0		4490.6	41/2	3839.5	37/2			
660.1	130	2265.6	27/2⁻	1605.5	23/2⁻	E2		
669.5	35	2858.9	29/2⁻	2189.5	25/2⁻	E2		
673.4	64	3651.6	35/2⁻	2978.3	31/2⁻	E2		
673.4		5167.0	45/2⁻	4493.6	41/2⁻			
675.8		6845.5	(53/2)	6169.7	(49/2)			
709.0		5547.0	47/2⁻	4838.0	43/2⁻			
712.8	81	2978.3	31/2⁻	2265.6	27/2⁻	E2		
725.1		5215.8	45/2	4490.6	41/2			
755.5		4876.9	43/2	4121.4	39/2			
766.0		5933.0	49/2⁻	5167.0	45/2⁻			
775.7		6169.7	(49/2)	5394.0	45/2			
786.4		6845.5	(53/2)	6059.2	49/2			
791.5		5394.0	45/2	4602.5	(41/2)			
795.4		6342.2	51/2⁻	5547.0	47/2⁻			
[x]801.6						Q		
835.2		5712.1	47/2	4876.9	43/2			
835.2		8516.1	61/2⁻	7680.9	57/2⁻			
841.5		6774.5	53/2⁻	5933.0	49/2⁻			
843.4		6059.2	49/2	5215.8	45/2			
846.1[a]		8041.4?	59/2⁻	7195.1	55/2⁻			
852.9		7195.1	55/2⁻	6342.2	51/2⁻			
[x]879.2						Q		
903.4		5394.0	45/2	4490.6	41/2			
906.4		7680.9	57/2⁻	6774.5	53/2⁻			
[x]923.1						D		
930.7		8224.7	(61/2)	7294.0	(57/2)			
949.3		8243.1	(59/2)	7294.0	(57/2)			

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(HI,xnγ) 1984Ha35,1986HeZR (continued)

γ(^{155}Ho) (continued)

† Unless otherwise noted, the listed γ-ray energies are those reported by 1986HeZR.

‡ Of the gammas listed as unplaced (by 1986HeZR), three (the 613.7, 638.2 and 879.2) are grouped into a band. The remaining γ's are shown as deexciting this band. This "band", and these deexciting gammas, could not be placed in the level scheme by 1986HeZR because of spreading of the intensity into a large number of weak transitions.

From the angular-distribution coefficients, A_0, of the respective angular distributions, as reported by 1984Ha35, unless noted otherwise.

@ Transition not observed by 1984Ha35. The listed Iγ value was deduced by these authors from the measured intensities of other γ rays in coincidence spectra gated by gammas appropriately located in the level scheme.

& From 1984Ha35, $\gamma(\theta)$, unless otherwise noted. Quadrupole transitions are assumed to be E2 rather than M2. The positive signs have been entered by the evaluator since 1984Ha35 do not list them.

a Placement of transition in the level scheme is uncertain.

x γ ray not placed in level scheme.

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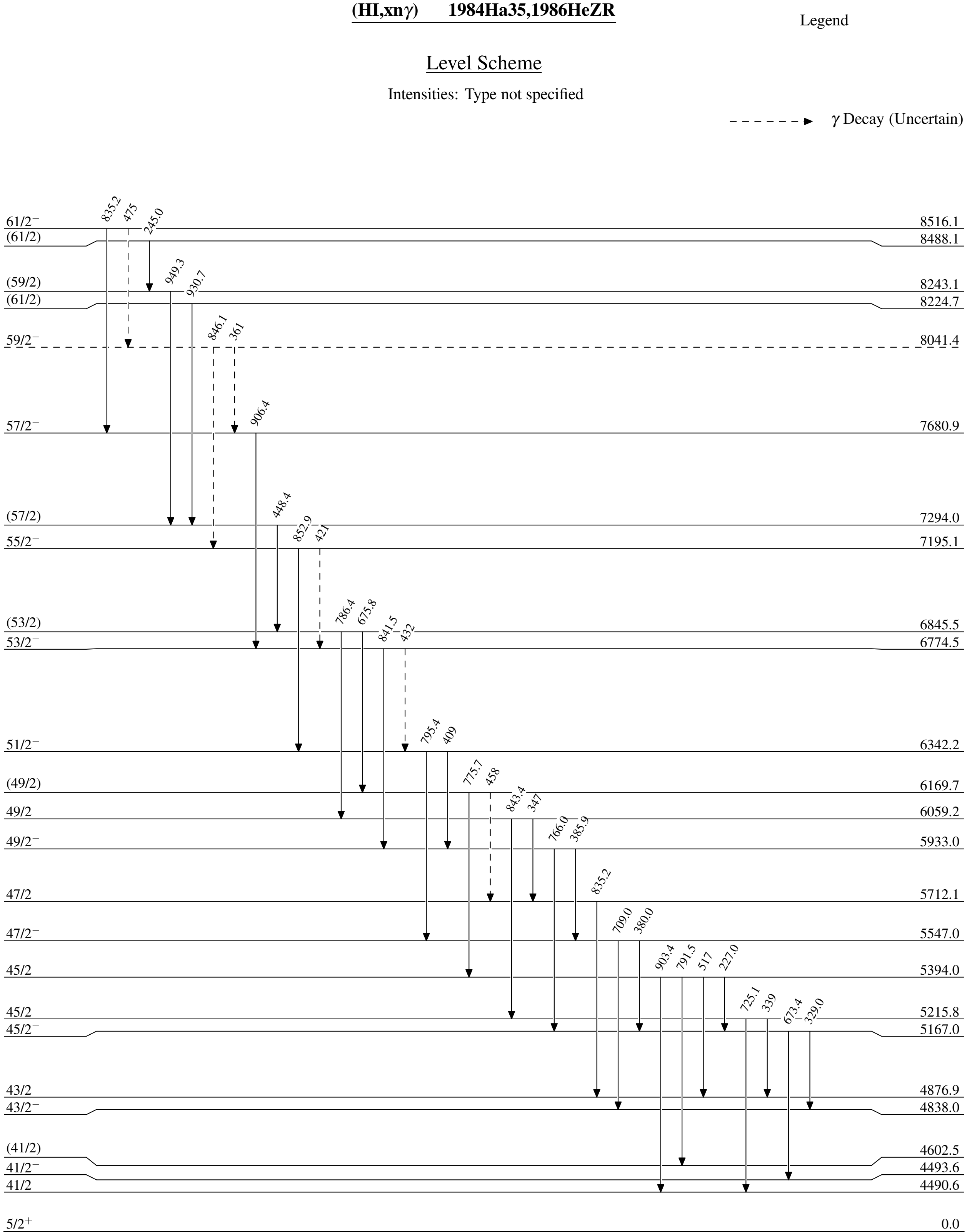
Level Scheme

Intensities: Type not specified

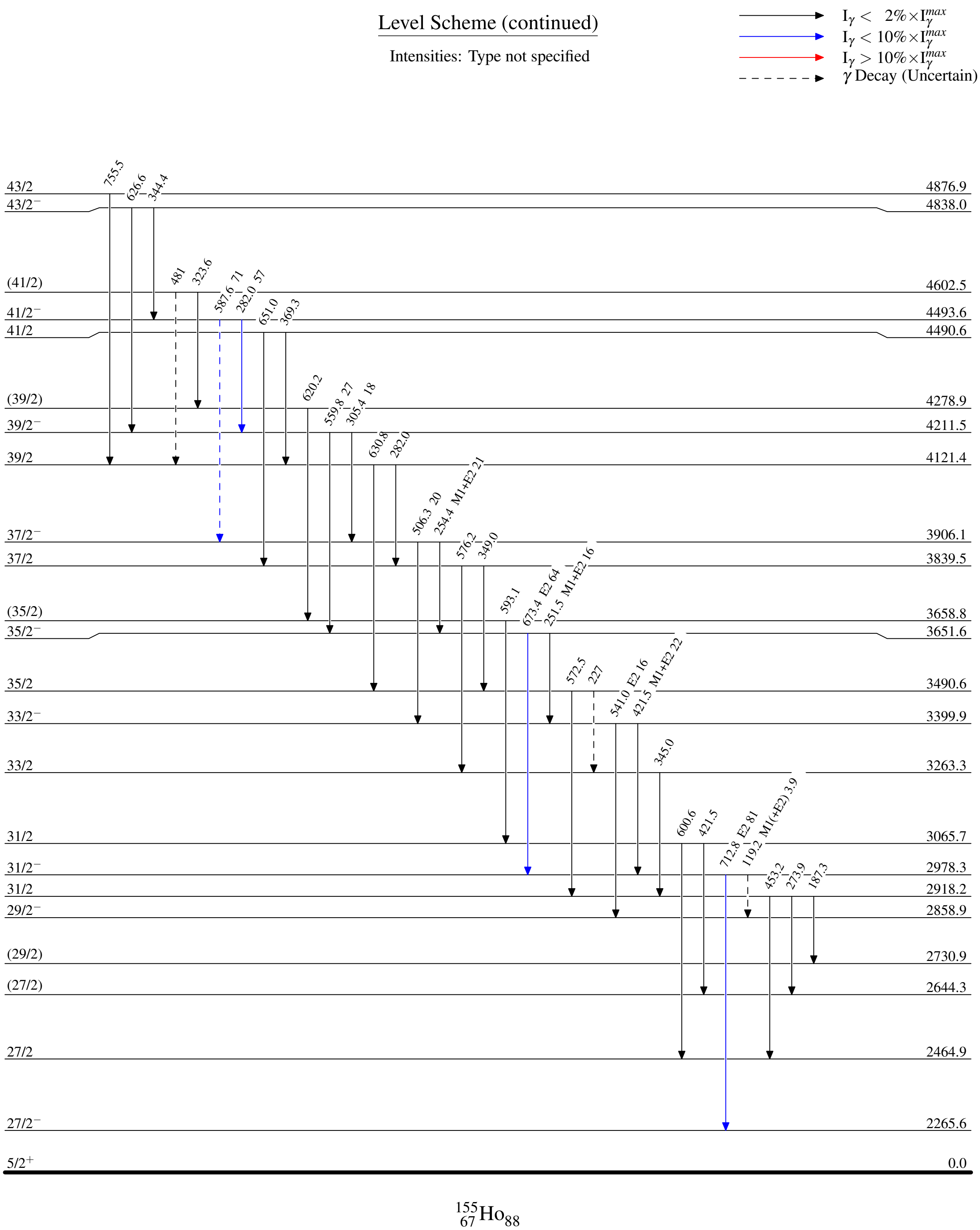


$^{155}_{67}Ho_{88}$

(HI,xnγ) 1984Ha35,1986HeZR

Level Scheme (continued)

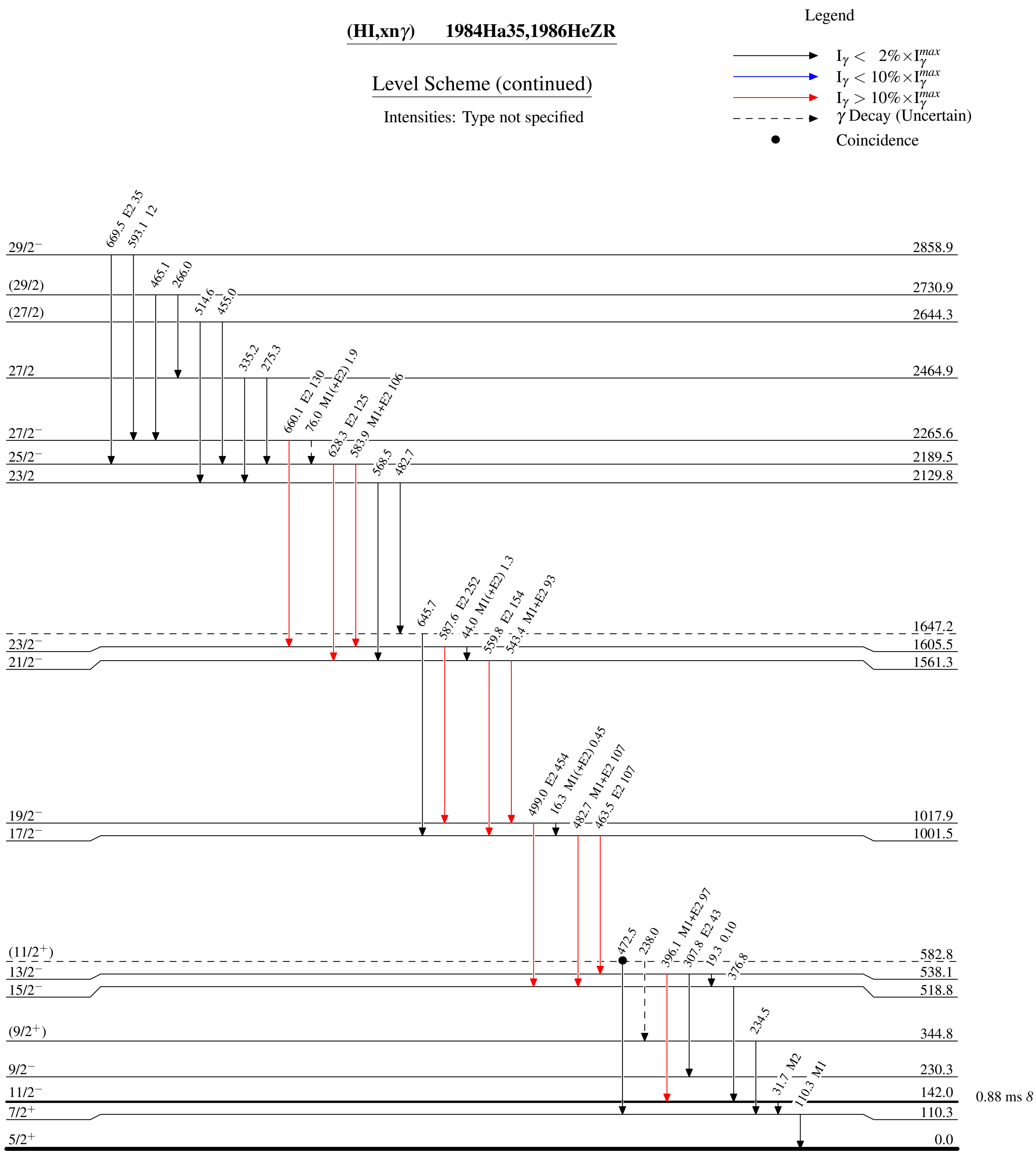
Intensities: Type not specified



(HI,xnγ) 1984Ha35,1986HeZR

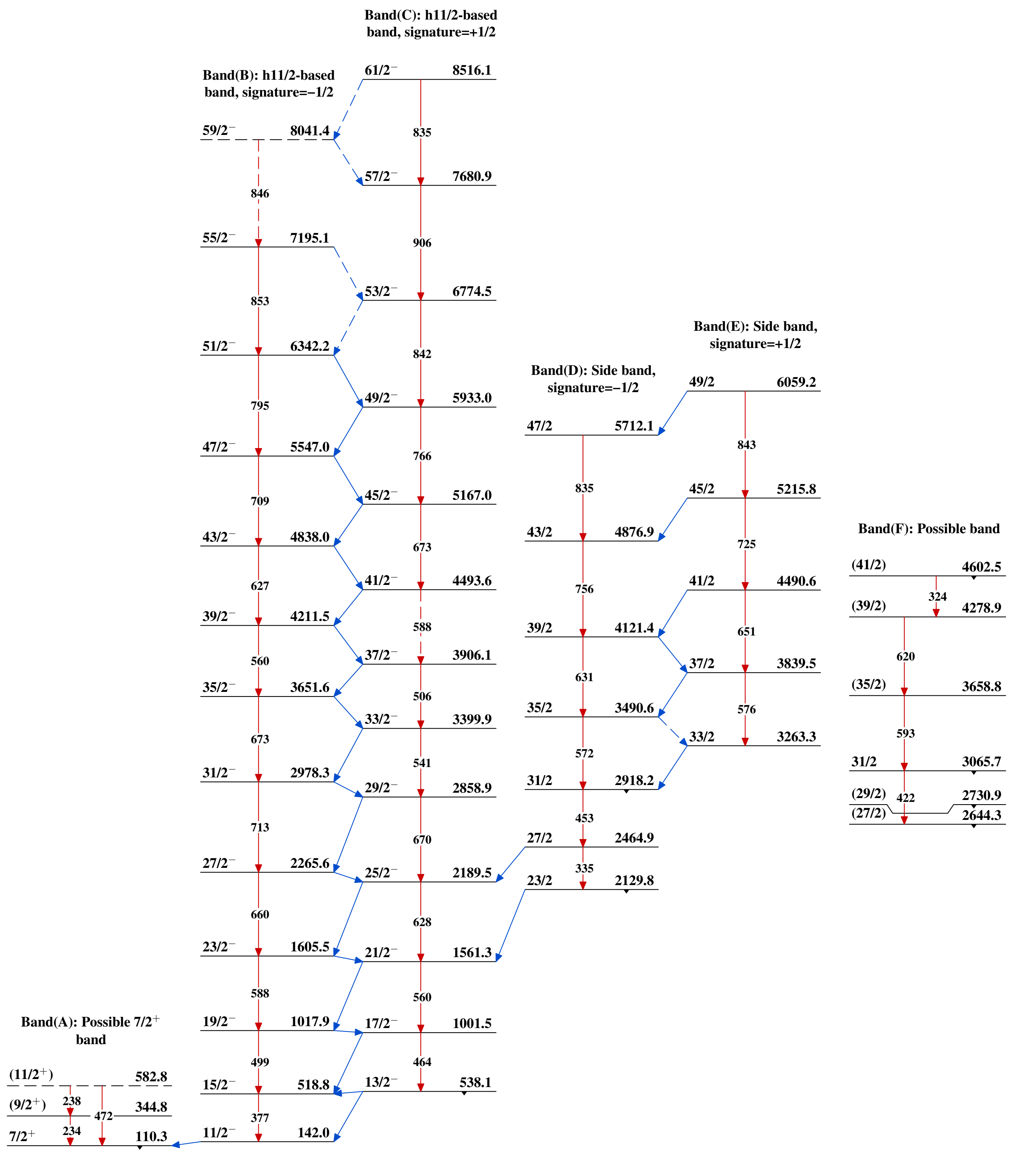
Level Scheme (continued)

Intensities: Type not specified



$^{155}_{67}Ho_{88}$

(HI,xnγ) 1984Ha35,1986HeZR



$^{155}_{67}Ho_{88}$

(HI,xnγ) 1984Ha35,1986HeZR (continued)