(HI,xnγ) 1983It01

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	S. -c. Wu	NDS 108, 1057 (2007)	1-Mar-2007

1975No09: ^{207}Pb(^{12}C,3nγ), ^{208}Pb(^{12}C,4nγ), E=60-90 MeV; measured Iγ, Iα, excit, $\gamma(\theta$,t), ce(θ,t).
1982Ch25: ^{206}Pb(^{13}C,3nγ), E(^{12}C)=67-83 MeV; ^{208}Pb(^{12}C,4nγ), E(^{13}C)=75-85 MeV; measured Iγ, excit, γ(t), $\gamma\gamma$.
1983It01: ^{208}Pb(^{12}C,4nγ),(^{13}C,5nγ), E=65-95 MeV; measured Iγ, Ice, $\gamma\gamma$, γ(t), $\gamma(\theta)$, γ(lin pol).
1983Lo01: ^{208}Pb(^{13}C,5nγ), E=75-95 MeV; measured Iγ, $\gamma(\theta)$, $\alpha\gamma$, γ(t).
1991Dr08,1992ByZY: ^{208}Pb(^{12}C,4nγ), ^{208}Pb(^{13}C,5nγ); E=78,80 MeV; measured γ, γ(t).

^{216}Ra Levels

The level scheme is that of 1983It01 based on Iγ, excitation functions, $\gamma\gamma$, and γ(t). This scheme differs from that of 1983Lo01 for levels above 3293 and in the order of the 344.2 and 613.3γ's connecting the 2335 and 3293 levels. γ(t) data of 1982Ch25 establish that the 613γ precedes the 344γ. See 1983It01 for a discussion of the level scheme differences.

α decay from excited levels (1975No09)

E(level)	Eα	$\Gamma\alpha/\Gamma$	HF
1164	10491	0.0023	
1508	10823	0.0058	
1711	11028	0.0088	2250
	9551	0.0098	2.8
2026	11345	0.0012	

E(level)†	J$^\pi$‡	T$_{1/2}$#	Comments
0	0$^+$		
688.20 *20*	2$^+$		
1164.1 *3*	4$^+$		
1507.6@ *3*	6$^+$	<0.2 ns	
1711.1@ *4*	8$^+$	1.42 ns *20*	T$_{1/2}$: weighted average of 1.7 ns *7* (1982Ch25), 1.4 ns *2* (1991Dr08).
2026.0 *4*	10$^+$	0.6 ns *1*	T$_{1/2}$: from 1992ByZY (value replaces that quoted in 1991Dr08). g-factor=+0.1 *2* (1990Sc29).
2335.2 *4*	11$^-$		
2679.4 *4*	13$^-$	0.96 ns *20*	g-factor=−0.1 *2* (1990Sc29). T$_{1/2}$: weighted average of 0.90 ns *21* (1991Dr08), 1.6 ns *7* (1982Ch25).
3292.7 *5*	14$^+$		
3412.7? *5*			
3491.6 *5*	16$^+$		
3580.7?			
3582.1 *5*	16$^+$		
3712.1 *5*	18$^+$		
3763.5 *5*	19$^-$	5.34 ns *15*	g-factor=0.51 *3* (1985Ad09), 0.49 *5* (1990Sc29). T$_{1/2}$: weighted average of 5.27 ns *14* (1991Dr08), 5.3 ns *3* (1985Ad09), 6.0 ns *4* (1983It01); others: 8.1 ns *2* (1983Lo16), 6.9 ns *2* (1982Ch25), 7.0 ns *7* (1975No09). Note that 1975No09 and 1983Lo16 assign this half-life to the 8$^+$ 1711 level, while 1982Ch25 assign it to an unspecified isomer feeding the 14$^+$ 3290-keV level.
4320.4 *6*	20$^-$		
4719.0 *6*	21$^-$		
4977.0 *7*	23$^-$		
5170.5 *7*	(25$^-$)	6.6 ns *3*	g-factor=0.63 *6* (1985Ad09), 0.7 *2* (1990Sc29). T$_{1/2}$: from 557γ(t): 6.6 ns *3* (1985Ad09), 6.7 ns *6* (1983It01). The 399, 258 and 194γ's are

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(HI,xnγ) 1983It01 (continued)

^{216}Ra Levels (continued)

E(level)[†]	J$^{\pi}$[‡]	Comments
		also delayed with this half-life. Other: 1983Lo16, 1983Lo01 report 10 ns *3* which they assign to a level at 5868 keV.
5471.3 *8*	(26$^-$)	
5832.5 *8*	(27$^-$)	
6266.1 *9*	(28$^-$)	

[†] From a least-squares fit to the Eγ.
[‡] From 1983It01 based on excit, γ(θ) and γ multipolarity arguments.
[#] From 1991Dr08, unless otherwise noted.
[@] Combined g-factor=+0.1 *3* for 6$^+$ and 8$^+$ levels, deduced from 475.0 and 688.2 γ′s (1990Sc29).

γ(^{216}Ra)

1982Ch25 give Iγ for the γ′s with 7 ns≤$T_{1/2}$≤35 ns. They show that the I(γ+ce) for the cascade transitions from the 3293 level are equal within the uncertainties.

E_{γ}[†]	I_{γ}[‡]	E_i(level)	J^{π}_i	E_f	J^{π}_f	Mult.	α[f]	I$_{(\gamma+ce)}$	Comments
51.4 *1*	17.8 *11*	3763.5	19$^-$	3712.1	18$^+$	E1	0.650		α(L)=0.492 *8*; α(M)=0.1202 *18*; α(N+..)=0.0386 *6* α(N)=0.0310 *5*; α(O)=0.00657 *10*; α(P)=0.000956 *15*; α(Q)=3.81×10^{-5} *6* Mult.: from intensity balance. For any multipolarity other than E1, I(γ+ce)(51γ) would be greater than I(γ+ce)(688γ). Note that δ(M2/E1)<0.07 from the requirement I(γ+ce)(51γ)<I(γ+ce)(688γ). From RUL, δ<0.002.
^{x}110.8 *2*								6.9 *7*	
120.1[g] *2*	2.4 *5*	3412.7?		3292.7	14$^+$	D[e]			I$_{\gamma}$: from I(γ+ce) with α(E1)=0.313.
130.4 *5*	2.0 *5*	3712.1	18$^+$	3582.1	16$^+$	[E2]	3.10 *7*		α(K)=0.302 *5*; α(L)=2.06 *5*; α(M)=0.559 *13*; α(N+..)=0.184 *5* α(N)=0.148 *4*; α(O)=0.0315 *7*; α(P)=0.00459 *11*; α(Q)=2.38×10^{-5} *5*
132[#g]		3712.1	18$^+$	3580.7?					
^{x}145.0[@] *10*									
^{x}145.8[@] *10*									
^{x}156.6[@] *10*									
168[#g]		3580.7?		3412.7?					
193.5 *2*	≈3.0[&]	5170.5	(25$^-$)	4977.0	23$^-$	[E2]	0.660		α(K)=0.1722 *25*; α(L)=0.359 *6*; α(M)=0.0969 *15*; α(N+..)=0.0319 *5* α(N)=0.0256 *4*; α(O)=0.00548 *8*; α(P)=0.000811 *12*; α(Q)=8.10×10^{-6} *12*
198.9 *1*	9.2 *11*	3491.6	16$^+$	3292.7	14$^+$	E2[c]	0.597		α(K)=0.1634 *23*; α(L)=0.319 *5*; α(M)=0.0861 *13*; α(N+..)=0.0283 *4* α(N)=0.0227 *4*; α(O)=0.00487 *7*; α(P)=0.000722 *11*; α(Q)=7.56×10^{-6} *11*
203.5 *1*	51 *3*	1711.1	8$^+$	1507.6	6$^+$	E2[a]	0.549		α(K)=0.1564 *22*; α(L)=0.289 *4*;

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(HI,xnγ) 1983It01 (continued)

γ(^{216}Ra) (continued)

E_γ[†]	I_γ[‡]	E_i(level)	J^π_i	E_f	J^π_f	Mult.	α[f]	Comments
								α(M)=0.0780 *11*; α(N+..)=0.0257 *4* α(N)=0.0206 *3*; α(O)=0.00442 *7*; α(P)=0.000656 *10*; α(Q)=7.13×10^{-6} *10*
[x]217.3[@] *10*								
220.4 *2*	8.6 *11*	3712.1	18$^+$	3491.6	16$^+$	E2[c]	0.415	α(K)=0.1336 *19*; α(L)=0.207 *3*; α(M)=0.0557 *8*; α(N+..)=0.0183 *3* α(N)=0.01471 *22*; α(O)=0.00316 *5*; α(P)=0.000470 *7*; α(Q)=5.85×10^{-6} *9*
258.0 *2*	5.0 *9*	4977.0	23$^-$	4719.0	21$^-$	E2[c]	0.244	α(K)=0.0969 *14*; α(L)=0.1086 *16*; α(M)=0.0290 *5*; α(N+..)=0.00958 *14* α(N)=0.00767 *11*; α(O)=0.001652 *24*; α(P)=0.000249 *4*; α(Q)=4.00×10^{-6} *6*
289.5 *2*	7.4 *8*	3582.1	16$^+$	3292.7	14$^+$	E2[c]	0.1696	α(K)=0.0763 *11*; α(L)=0.0689 *10*; α(M)=0.0183 *3*; α(N+..)=0.00605 *9* α(N)=0.00484 *7*; α(O)=0.001045 *15*; α(P)=0.0001587 *23*; α(Q)=3.06×10^{-6} *5*
300.8 *3*	6.0 *18*	5471.3	(26$^-$)	5170.5	(25$^-$)	(D+Q)[d]		I_γ: from I(γ+ce) with α(M1+E2)=0.45 *30*.
[x]304.0[@] *10*								
309.2 *1*	65 *3*	2335.2	11$^-$	2026.0	10$^+$	E1[a]	0.0329	α(K)=0.0265 *4*; α(L)=0.00482 *7*; α(M)=0.001149 *17*; α(N+..)=0.000380 *6* α(N)=0.000301 *5*; α(O)=6.73×10^{-5} *10*; α(P)=1.123×10^{-5} *16*; α(Q)=7.32×10^{-7} *11*
314.9 *1*	66 *3*	2026.0	10$^+$	1711.1	8$^+$	E2[a]	0.1316	α(K)=0.0641 *9*; α(L)=0.0499 *7*; α(M)=0.01322 *19*; α(N+..)=0.00437 *7* α(N)=0.00349 *5*; α(O)=0.000756 *11*; α(P)=0.0001154 *17*; α(Q)=2.52×10^{-6} *4*
[x]328.5[@] *10*								
343.5 *1*	81 *4*	1507.6	6$^+$	1164.1	4$^+$	E2[a]	0.1023	α(K)=0.0536 *8*; α(L)=0.0361 *5*; α(M)=0.00951 *14*; α(N+..)=0.00314 *5* α(N)=0.00251 *4*; α(O)=0.000545 *8*; α(P)=8.39×10^{-5} *12*; α(Q)=2.07×10^{-6} *3*
344.2 *1*	46 *3*	2679.4	13$^-$	2335.2	11$^-$	E2[a]	0.1017	α(K)=0.0533 *8*; α(L)=0.0358 *5*; α(M)=0.00944 *14*; α(N+..)=0.00312 *5* α(N)=0.00249 *4*; α(O)=0.000541 *8*; α(P)=8.33×10^{-5} *12*; α(Q)=2.07×10^{-6} *3*
361.2 *2*	5.4 *13*	5832.5	(27$^-$)	5471.3	(26$^-$)	(D+Q)[d]		I_γ: from I(γ+ce) with α(M1+E2)=0.27 *18*.
398.6 *2*	8.7 *14*	4719.0	21$^-$	4320.4	20$^-$	M1+E2[b]	0.20 *13*	α(K)=0.15 *12*; α(L)=0.035 *14*; α(M)=0.008 *3*; α(N+..)=0.0028 *10* α(N)=0.0022 *8*; α(O)=0.00050 *19*; α(P)=8.E−5 *4*; α(Q)=5.E−6 *4*
433.6 *5*	3.8 *12*	6266.1	(28$^-$)	5832.5	(27$^-$)	(D+Q)[d]		I_γ: from I(γ+ce) with α(M1+E2)=0.17 *11*.
475.9 *2*	92 *5*	1164.1	4$^+$	688.20	2$^+$	E2[a]	0.0435	α(K)=0.0278 *4*; α(L)=0.01173 *17*; α(M)=0.00302 *5*; α(N+..)=0.001002 *14* α(N)=0.000798 *12*; α(O)=0.0001751 *25*; α(P)=2.77×10^{-5} *4*; α(Q)=1.025×10^{-6} *15*
[x]545.1[@] *10*								
556.9 *3*	10.4 *11*	4320.4	20$^-$	3763.5	19$^-$	M1+E2[b]	0.08 *6*	α(K)=0.06 *5*; α(L)=0.013 *7*; α(M)=0.0032 *14*; α(N+..)=0.0011 *5* α(N)=0.0009 *4*; α(O)=0.00019 *9*; α(P)=3.3×10^{-5} *16*; α(Q)=2.3×10^{-6} *16*
[x]583.4[@] *10*								
613.3 *2*	47.4 *20*	3292.7	14$^+$	2679.4	13$^-$	E1[a]	0.00787	α(K)=0.00645 *9*; α(L)=0.001085 *16*; α(M)=0.000256 *4*; α(N+..)=8.51×10^{-5} *12*

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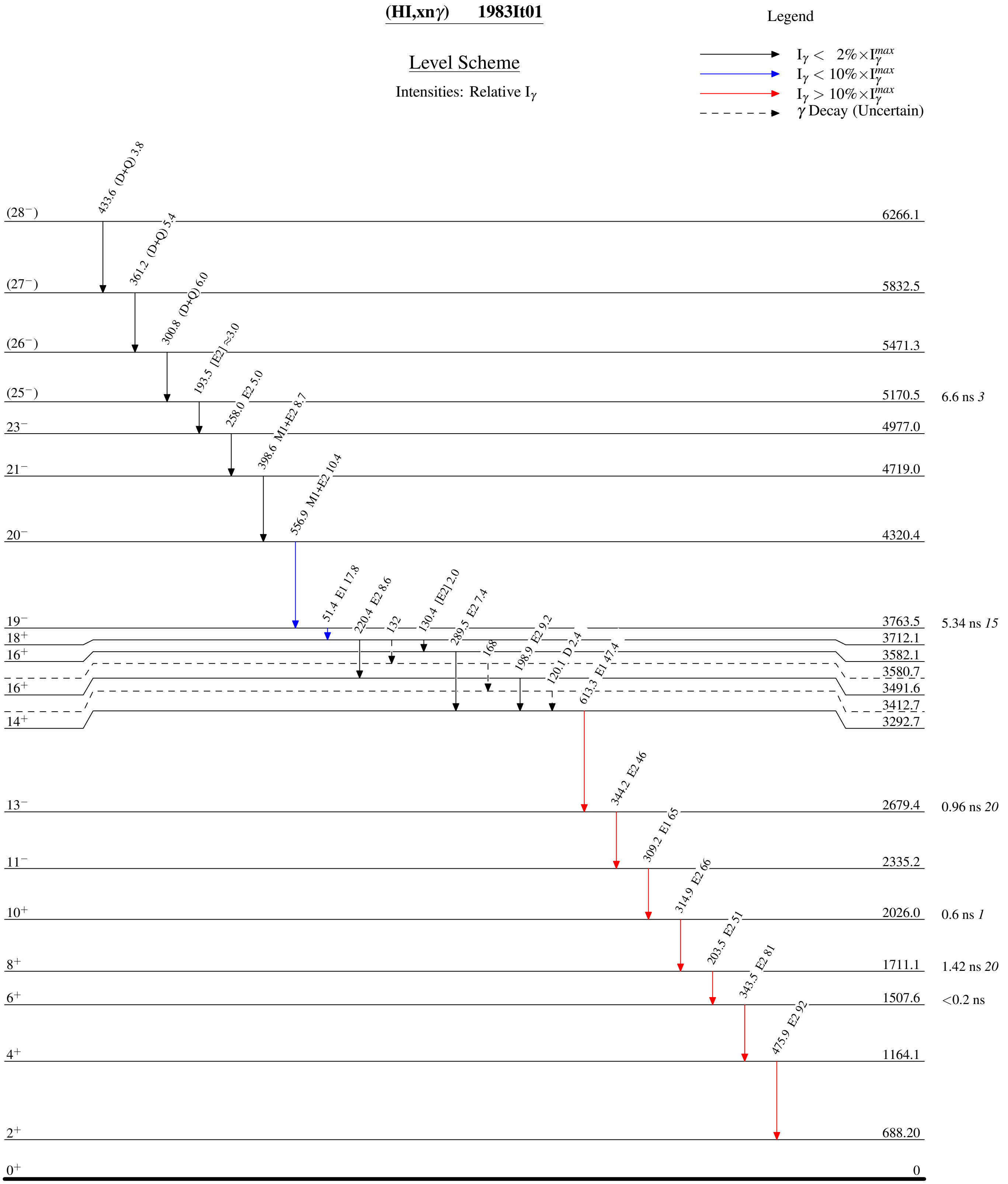
(HI,xnγ) 1983It01 (continued)

γ(^{216}Ra) (continued)

E_γ[†]	I_γ[‡]	E_i(level)	J^π_i	E_f	J^π_f	Mult.	α[f]	Comments
								α(N)=6.71×10^{-5} *10*; α(O)=1.517×10^{-5} *22*; α(P)=2.59×10^{-6} *4*; α(Q)=1.88×10^{-7} *3*
688.2 *2*	98 *5*	688.20	2$^+$	0	0$^+$	E2[a]	0.0190	α(K)=0.01374 *20*; α(L)=0.00394 *6*; α(M)=0.000986 *14*; α(N+..)=0.000328 *5* α(N)=0.000260 *4*; α(O)=5.78×10^{-5} *9*; α(P)=9.46×10^{-6} *14*; α(Q)=4.84×10^{-7} *7*

[†] From 1983It01.
[‡] From 1983It01, E(^{12}C)=80 MeV. The evaluator has calculated Iγ from the I(γ+ce) given by 1983It01 using α for the multipolarity assumed by the authors. 1983It01 do not give the α they used to calculate I(γ+ce) given in their table 1.
[#] Not in γ table of 1983It01, but shown in their level scheme. No Iγ available.
[@] From 1982Ch25. The γ is above the J=14 *3292*.7-keV level in level scheme; for coin data see 1982Ch25.
[&] Iγ taken at θ=55°.
[a] From γ(θ) and γ(lin pol) measurements of 1983It01.
[b] From α(K)exp of 1983It01. Values are from relative Iγ and Ice normalized so that α(K)exp yields E2 theory values for the ΔJ=2 cascade gammas below the 14$^+$ level.
[c] Transition is stretched quadrupole from γ(θ). From placement in level scheme, $T_{1/2}$<7 ns so mult=M2 is ruled out.
[d] 1983It01 suggest mult=M1+E2 on the basis of γ(θ).
[e] 1983It01 suggest mult=E1 on the basis of γ(θ).
[f] 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.
[g] Placement of transition in the level scheme is uncertain.
[x] γ ray not placed in level scheme.


(HI,xnγ) 1983It01
Level Scheme
Intensities: Relative Iγ
Legend
Iγ < 2%×Iγ^max
Iγ < 10%×Iγ^max
Iγ > 10%×Iγ^max
γ Decay (Uncertain)
(28⁻) 6266.1
433.6 (D+Q) 3.8
(27⁻) 5832.5
361.2 (D+Q) 5.4
(26⁻) 5471.3
300.8 (D+Q) 6.0
(25⁻) 5170.5 6.6 ns 3
193.5 [E2] ≈3.0
23⁻ 4977.0
258.0 E2 5.0
21⁻ 4719.0
398.6 M1+E2 8.7
20⁻ 4320.4
556.9 M1+E2 10.4
19⁻ 3763.5 5.34 ns 15
18⁺ 3712.1
16⁺ 3582.1
3580.7
16⁺ 3491.6
3412.7
14⁺ 3292.7
51.4 E1 17.8
220.4 E2 8.6
132
130.4 [E2] 2.0
289.5 E2 7.4
168
198.9 E2 9.2
120.1 D 2.4
613.3 E1 47.4
13⁻ 2679.4 0.96 ns 20
344.2 E2 46
11⁻ 2335.2
309.2 E1 65
10⁺ 2026.0 0.6 ns 1
314.9 E2 66
8⁺ 1711.1 1.42 ns 20
203.5 E2 51
6⁺ 1507.6 <0.2 ns
343.5 E2 81
4⁺ 1164.1
475.9 E2 92
2⁺ 688.20
0⁺ 0

$^{216}_{88}Ra_{128}$