(HI,xnγ) 1994Th01,1993Th05,1978Sa13

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Jean Blachot	ENSDF	1-Jul-2008

^{100}Mo(^{12}C,4n), E= 54 MeV, 1994Th01.
^{96}Zr(^{16}O,4nγ), E=74,75 MeV, 1993Th05 (1993Th05 and 1994Th01 are same group).
Coincident gamma-ray events were collected with the NORDBALL multi-detector array consisting of up to 20 Compton-suppressed Ge detectors. The Ge detectors are situated in four rings at angles of θ=37°, 79°, 101° and 143° relative to the beam direction, with five detector positions in each ring, and with a distance of 19 cm from target to detector. Two experiments were performed, namely a thin target experiment and a backed target experiment. In the thin target experiment a stack of two self-supporting ^{96}Zr foils (85% enrichment), each with a thickness of 0.92 mg/cm^2 was used. The beam energy was 74 MeV with a beam current of 4 pnA. All 20 Compton-suppressed Ge detectors were used, and about 280 million gamma-gamma-coincidences were collected. The backed target experiment used a 0.74 mg/cm ^{2} thick ^{96}Zr foil (85% enrichment) with a 6.2 mg/cm ^{2} thick ^{197}Au backing. The beam energy was 75 MeV with a beam current of 3.5 pnA. Nineteen Compton-suppressed Ge detectors were used and 440 million gamma-gamma-coincidences were collected. NORDBALL is also equipped with a BaF2 inner ball, allowing for measurements of the sum-energy and the gamma-ray multiplicity. In the two experiments 10 and 39 BaF2-detectors were used, respectively.
^{96}Zr(^{16}O,4nγ), E= 56 MeV, 1978Sa13.
Authors measured γ excitation functions, γ angular distributions, $\gamma\gamma$-coincidences and γ-linear polarizations. The $\gamma\gamma$-coincidence measurements were used to sort the members of unresolved multiplets. δ for the γ-transitions were determined from the $\gamma(\theta)$ measurements. Multipolarities of the transitions were determined from the linear polarization measurements. In addition, the $\gamma\gamma$-coincidence measurements were used to deduce δ and multipolarity for transitions that are part of an unresolved multiplet. The evaluators consider results from this technique to be less certain than those from the $\gamma(\theta)$ or γ-linear polarization measurements. The γ-linear polarization measurements are discussed in detail in 1978St01.
Other (HI,xnγ) measurements: ^{96}Zr(^{16}O,4nγ) (1971CoZS), ^{104}Pd(α,2nγ) and ^{106}Pd(α,4nγ) (1969HaZU).

^{108}Cd Levels

E(level)	J$^\pi$[†]	T$_{1/2}$[‡]	Comments
0	0$^+$		
632.92[e] *5*	2$^+$	7.0 ps *6*	
1508.39[e] *7*	4$^+$	<3.5 ps	
2239.41[h] *20*	4$^+$		
2541.27[e] *9*	6$^+$		
2545.32 *22*	(4$^+$)		
2565.10 *15*	5$^+$	0.2[#] ns *1*	
2601.55 *9*	5$^-$		
2706.94 *9*	5$^-$		
2807.91 *16*	6$^+$		
2975.30[a] *10*	6$^-$	0.15[#] ns *10*	
2994.29[h] *18*	(6$^+$)		
3057.46[&] *9*	7$^-$	31 ps *24*	T$_{1/2}$: other: 100 ps *50* (1985An27).
3110.41 *12*	8$^+$	0.3[#] ns *1*	
3189.9 *4*	(6,7,8)$^+$		
3223.73[a] *10*	8$^-$	0.49 ns *14*	T$_{1/2}$: other: 0.2 ns *1* (1985An27).
3248.54 *14*	7$^-$		
3474.40[@] *13*	8$^-$		
3485.11[&] *10*	9$^-$	47.1 ps *21*	T$_{1/2}$: other: <100 ps (1985An27).
3683.22[e] *11*	8$^+$		
3737.43[b] *10*	9$^-$	6.2 ps *7*	T$_{1/2}$: other: 200 ps *100* (1985An27).
3860.90[h] *14*	8$^+$		
3872.18[a] *13*	10$^-$	5.75 ps *21*	
4152.64[e] *11*	10$^+$	35.4 ps *21*	

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(HI,xnγ) 1994Th01,1993Th05,1978Sa13 (continued)

^{108}Cd Levels (continued)

E(level)	Jπ†	T1/2‡	E(level)	Jπ†
4188.11[&] *11*	11−	3.60 ps *14*	7383.4[g] *3*	(16)
4196.38[@] *19*	10−	5.5 ps *14*	7386.0[@] *3*	16−
4568.57[b] *16*	11−	1.66 ps *21*	7528.9[c] *4*	(16−)
4618.2 *10*	(9,10+)		7564.2[e] *4*	18+
4708.75[e] *13*	12+	10.1 ps *3*	7725.3[&] *5*	17−
4755.70[f] *22*	10+		7740.7[c] *4*	17−
4826.04[a] *19*	12−	1.11 ps *7*	7862.2[d] *11*	(16)
5124.96[@] *20*	12−	2.1 ps *3*	7913.3[f] *4*	(18+)
5179.88[&] *17*	13−	0.69 ps *7*	8102.2[c] *4*	18−
5502.58[e] *14*	14+	1.52 ps *7*	8185.5[d] *11*	(17)
5574.20[b] *21*	13−		8283.9[@] *4*	18−
5588.9[c] *11*	11−		8534.9[g] *5*	(18)
5591.78[f] *18*	12+		8544.2[d] *11*	(18)
5639.44[c] *16*	12−		8584.7[c] *5*	19−
5760.56[c] *19*	13−		8671.0[&] *5*	19−
5837.50[g] *25*	(12)		8824.5[e] *5*	(20+)
5982.4[a] *3*	14−		8965.0[d] *11*	(19)
6076.61[c] *23*	14−	<2 ps	9174.9[c] *5*	(20−)
6124.32[f] *18*	14+		9326.0[@] *5*	(20−)
6251.53[@] *25*	14−		9757.3[&] *6*	(21−)
6404.1[&] *4*	15−		9879.4[c] *6*	(21−)
6458.88[e] *25*	16+	<1.4 ps	9894.3[g] *6*	(20)
6487.99[g] *22*	(14)		10293.6[e] *6*	(22+)
6598.5[c] *3*	15−	<2 ps	10532.7[@] *6*	(22−)
6891.04[f] *23*	16+		11018.5[&] *7*	(23−)
7212.7[a] *5*	(16−)		11906.7[@] *7*	(24−)
7213.9[c] *4*	(15−)		11914.8[e] *7*	(24+)
7275.3[c] *4*	16−		12489.2[&] *8*	(25−)

† Values are from γ multipolarities.
‡ From Doppler-shift recoil-distance method in (HI,xnγ) (1994Th01), except where noted otherwise.
# From centroid shift measurement (1985An27).
@ Band(A): band 1.
& Band(B): band 2.
a Band(C): band 3.
b Band(D): band 4.
c Band(E): band 5.
d Band(F): band 6.
e Band(G): band 7.
f Band(H): band 8.
g Band(I): band 9.
h Band(J): band 10.

(HI,xnγ) 1994Th01,1993Th05,1978Sa13 (continued)

γ(^{108}Cd)

Eγ[†]	Iγ[†]	Ei(level)	J^π_i	Ef	J^π_f	Mult.[‡]	δ	Comments
116.4		3110.41	8+	2994.29	(6+)			
121.2 *10*	43 *2*	5760.56	13−	5639.44	12−	D		
161.66[#@] *20*	11.0[&] *15*	2706.94	5−	2545.32	(4+)			
166.25[#] *5*	280 *14*	3223.73	8−	3057.46	7−	M1+E2	+0.185 *15*	B(M1)(W.u.)=0.0069 *21*; B(E2)(W.u.)=7.2 *24*
177.6 *10*	1.8 *3*	3860.90	8+	3683.22	8+	D		
186.4 *10*	3.0 *4*	5760.56	13−	5574.20	13−	D		
191.4 *10*	9 *5*	3248.54	7−	3057.46	7−	D+Q		
211.7 *10*	11 *1*	7740.7	17−	7528.9	(16−)	D		
225.87[#] *7*	14 *1*	3474.40	8−	3248.54	7−	D+Q	−0.14 *11*	
242.84[#] *7*	[d]	2807.91	6+	2565.10	5+	D+Q	−0.04 *6*	
248.49[#@] *8*	105 *6*	3223.73	8−	2975.30	6−			
261.49[#] *17*	169 *9*	3485.11	9−	3223.73	8−	M1+E2		δ: 0.06 *3* or ≥20.
268.39[#@] *20*	32 *2*	2975.30	6−	2706.94	5−	D+Q		δ: 0.40 *13* or 4.2 *18*.
280.3 *10*	15 *1*	4152.64	10+	3872.18	10−	D+Q		
291.9 *10*	52 *5*	4152.64	10+	3860.90	8+	Q		
302.79[#] *25*	5.3[a] *10*	3110.41	8+	2807.91	6+			
316.0 *10*	74 *5*	6076.61	14−	5760.56	13−	D		
323.3 *10*	<21	8185.5	(17)	7862.2	(16)	D		
325.5[#] *4*	[c]	2565.10	5+	2239.41	4+			
350.52[#] *5*	174 *9*	3057.46	7−	2706.94	5−	E2		B(E2)(W.u.)=3.E+1 *3*
358.7 *10*	<27	8544.2	(18)	8185.5	(17)	D		
361.5 *10*	32 *2*	8102.2	18−	7740.7	17−	D		
373.77[#] *5*	93 *5*	2975.30	6−	2601.55	5−	M1+E2	+0.56 *6*	B(M1)(W.u.)=0.0015 *10*; B(E2)(W.u.)=2.8 *20*
414.97[#@] *20*	155 *10*	4152.64	10+	3737.43	9−	E1		B(E1)(W.u.)=3.5×10^{-5} *4* δ: + 0.02 *7*.
416.96[#] *10*	42 *3*	3474.40	8−	3057.46	7−	D+Q		δ: - 0.31 *16* or - 2.6 *10*.
420.8 *10*	<15	8965.0	(19)	8544.2	(18)			
427.64[#] *5*	125 *6*	3485.11	9−	3057.46	7−	E2		B(E2)(W.u.)=11.7 *9*
433.7[#] *4*	9.0 *13*	2975.30	6−	2541.27	6+	Q		
455.89[#] *5*	286 *14*	3057.46	7−	2601.55	5−	E2		B(E2)(W.u.)=14 *12*
458.9 *10*	20 *4*	4196.38	10−	3737.43	9−	E2,M1		
459.4 *2*		5639.44	12−	5179.88	13−	D+Q		
465.5 *10*	18 *1*	7740.7	17−	7275.3	16−	D		
469.42[#] *5*	165 *10*	4152.64	10+	3683.22	8+	E2		B(E2)(W.u.)=7.3 *7*
482.5 *10*	26 *5*	8584.7	19−	8102.2	18−	D		
498.5[#] *3*	15 *2*	3474.40	8−	2975.30	6−	Q		
514.2[#] *5*	101 *8*	3737.43	9−	3223.73	8−			
514.4 *2*		5639.44	12−	5124.96	12−			
516.15[#] *7*	144 *8*	3057.46	7−	2541.27	6+	E1		B(E1)(W.u.)=1.7×10^{-5} *13* δ: δ(M2/E1)=+ 0.004 *12*.
521.9 *10*	62 *4*	6598.5	15−	6076.61	14−	M1		B(M1)(W.u.)>0.077
526.9 *10*	11 *1*	7740.7	17−	7213.9	(15−)	Q		
532.7 *10*	32 *2*	6124.32	14+	5591.78	12+	Q		
556.08[#] *7*	466 *23*	4708.75	12+	4152.64	10+	E2		B(E2)(W.u.)=34.5 *11*
[x]563.34[#] *25*								
569.31[#@] *10*	70 *4*	3110.41	8+	2541.27	6+	E2		B(E2)(W.u.)=1.0 *4*
573.1 *10*	15 *1*	3683.22	8+	3110.41	8+	D		
590.2 *10*	<5	9174.9	(20−)	8584.7	19−			

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(HI,xnγ) 1994Th01,1993Th05,1978Sa13 (continued)

γ(^{108}Cd) (continued)

$E_γ$[†]	$I_γ$[†]	E_i(level)	$J^π_i$	E_f	$J^π_f$	Mult.[‡]	δ	Comments
615.4 *10*	28 *3*	7213.9	(15⁻)	6598.5	15⁻	D,Q		
621.6 *10*	12 *1*	6124.32	14⁺	5502.58	14⁺	D+Q		
632.92[#] *5*	1000 *50*	632.92	2⁺	0	0⁺	E2		B(E2)(W.u.)=26.1 *23*
648.44[#] *10*	158 *8*	3872.18	10⁻	3223.73	8⁻	E2		B(E2)(W.u.)=28.1 *11*
648.6[#] *4*		3189.9	(6,7,8)⁺	2541.27	6⁺	E2		
650.6 *10*	59 *4*	6487.99	(14)	5837.50	(12)	Q		
667.49[#] *10*	129 *10*	4152.64	10⁺	3485.11	9⁻	E1		B(E1)(W.u.)=7.1×10⁻⁶ *8* δ: + 0.09 *14*.
676.9 *10*	32 *2*	7275.3	16⁻	6598.5	15⁻	D		
679.91[#] *5*	101 *8*	3737.43	9⁻	3057.46	7⁻	E2		B(E2)(W.u.)=10.3 *16*
696.5 *10*	11.5 *12*	4568.57	11⁻	3872.18	10⁻	M1,E2		
703.00[#] *5*	182 *10*	4188.11	11⁻	3485.11	9⁻	E2		B(E2)(W.u.)=30.0 *12*
704.5 *2*		9879.4	(21⁻)	9174.9	(20⁻)			
707.9 *10*	34 *2*	3248.54	7⁻	2541.27	6⁺	D		
721.7 *10*	44 *4*	4196.38	10⁻	3474.40	8⁻	E2		B(E2)(W.u.)=12 *4*
730.83[#] *25*	10.7[b] *15*	2239.41	4⁺	1508.39	4⁺			
748.1 *10*	5 *1*	5574.20	13⁻	4826.04	12⁻	D+Q		
750.6 *10*	13 *3*	3860.90	8⁺	3110.41	8⁺	D		
754.7[#] *3*	3 *1*	2994.29	(6⁺)	2239.41	4⁺	Q		
766.7 *10*	44 *3*	6891.04	16⁺	6124.32	14⁺	Q		
793.80[#] *7*	350 *18*	5502.58	14⁺	4708.75	12⁺	E2		B(E2)(W.u.)=38.7 *18*
831.0 *10*	46 *3*	4568.57	11⁻	3737.43	9⁻	E2		B(E2)(W.u.)=23 *4*
836.0 *10*	16 *2*	5591.78	12⁺	4755.70	10⁺	Q		
866.7 *10*	12 *1*	3860.90	8⁺	2994.29	(6⁺)	Q		
875.46[#] *5*	1000	1508.39	4⁺	632.92	2⁺	E2		B(E2)(W.u.)>10
883.0 *10*	12 *1*	5591.78	12⁺	4708.75	12⁺	D		
ˣ886.02[#] *20*								
895.4 *10*	62 *4*	7383.4	(16)	6487.99	(14)	Q		
897.9 *10*	45 *3*	8283.9	18⁻	7386.0	16⁻	Q		
928.5 *10*	55 *3*	5124.96	12⁻	4196.38	10⁻	E2		B(E2)(W.u.)=12.8 *19*
930.2 *10*	10.0 *12*	7528.9	(16⁻)	6598.5	15⁻	D,Q		
934.4 *10*	9 *1*	5760.56	13⁻	4826.04	12⁻	D,Q		
945.7 *10*	36 *2*	8671.0	19⁻	7725.3	17⁻	Q		
953.64[#@] *25*	107 *6*	4826.04	12⁻	3872.18	10⁻	(E2)		B(E2)(W.u.)=21.2 *14*
956.3 *2*	216 *11*	6458.88	16⁺	5502.58	14⁺	E2		B(E2)(W.u.)>17
ˣ963.26[#] *25*								$E_γ$: placed by 1978Sa13 feeding the 5503 level. This transition has Eγ=956.3 in 1993Th05.
970.7 *10*	17 *1*	5588.9	11⁻	4618.2	(9,10⁺)	D		
985.3 *10*	22 *2*	6487.99	(14)	5502.58	14⁺	D		
991.66[#@] *15*	116 *6*	5179.88	13⁻	4188.11	11⁻	(E2)		B(E2)(W.u.)=28 *3*
1005.8 *10*	28 *2*	5574.20	13⁻	4568.57	11⁻	Q		
1022.2 *10*	21 *2*	7913.3	(18⁺)	6891.04	16⁺			
1032.85[#] *7*	422 *21*	2541.27	6⁺	1508.39	4⁺	E2		
1038.0[#] *10*		2545.32	(4⁺)	1508.39	4⁺			
1042.1 *10*	<20	9326.0	(20⁻)	8283.9	18⁻	Q		
1043.2 *10*	2 *1*	4152.64	10⁺	3110.41	8⁺	E2		B(E2)(W.u.)=0.0016 *9*
1056.83[#] *15*	[c]	2565.10	5⁺	1508.39	4⁺	D+(Q)	+0.08 *8*	
1070.7 *10*	14.0 *14*	5639.44	12⁻	4568.57	11⁻	D+Q		
1072.6 *10*	22 *2*	4755.70	10⁺	3683.22	8⁺	Q		
1086.3 *10*	<15	9757.3	(21⁻)	8671.0	19⁻	Q		

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(HI,xnγ) 1994Th01,1993Th05,1978Sa13 (continued)

$\gamma(^{108}Cd)$ (continued)

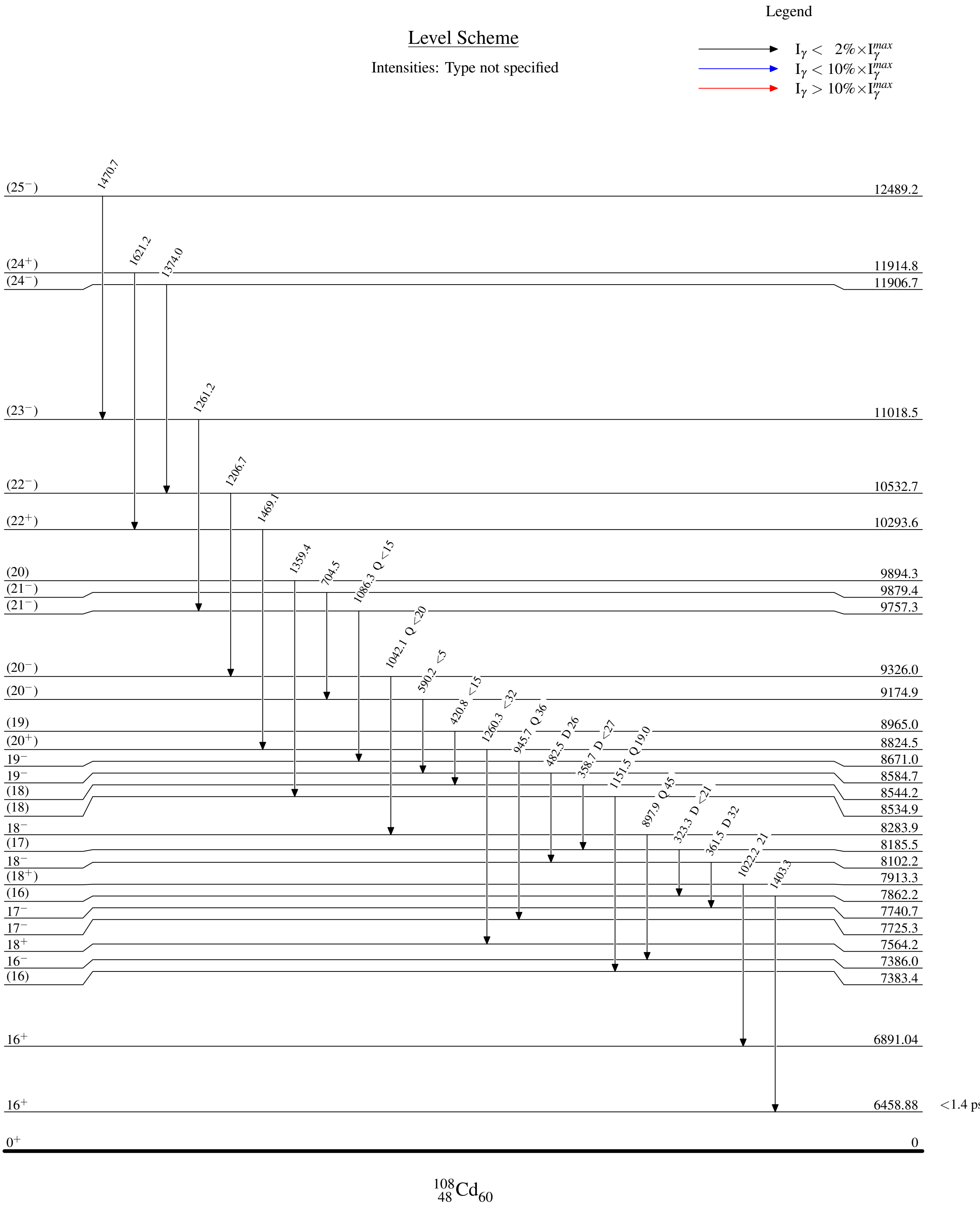
E_γ [†]	I_γ [†]	E_i(level)	J_i^π	E_f	J_f^π	Mult. [‡]	δ
1093.13[#] *7*	371 *19*	2601.55	5⁻	1508.39	4⁺	E1+M2	−0.038 *18*
1105.3 *10*	81 *5*	7564.2	18⁺	6458.88	16⁺	Q	
1126.6 *10*	17 *2*	6251.53	14⁻	5124.96	12⁻	Q	
1129.0 *10*	43 *3*	5837.50	(12)	4708.75	12⁺	D+Q	
1134.5 *10*	18 *2*	7386.0	16⁻	6251.53	14⁻	Q	
1141.85[#] *10*	167 *9*	3683.22	8⁺	2541.27	6⁺	E2	
1151.5 *10*	19.0 *12*	8534.9	(18)	7383.4	(16)	Q	
1156.3 *10*	46 *3*	5982.4	14⁻	4826.04	12⁻	Q	
1191.9 *3*	3 *1*	5760.56	13⁻	4568.57	11⁻	Q	
1198.54[#] *7*	190 *10*	2706.94	5⁻	1508.39	4⁺	E1+M2	−0.050 *16*
1206.7 *3*		10532.7	(22⁻)	9326.0	(20⁻)		
1224.2 *10*	73 *4*	6404.1	15⁻	5179.88	13⁻	Q	
1230.3 *3*		7212.7	(16⁻)	5982.4	14⁻		
1250.6 *10*	10 *1*	6076.61	14⁻	4826.04	12⁻	Q	
1260.3 *10*	<32	8824.5	(20⁺)	7564.2	18⁺		
1261.2 *3*		11018.5	(23⁻)	9757.3	(21⁻)		
1299.5[#] *10*	[d]	2807.91	6⁺	1508.39	4⁺		
1309.3 *10*	11 *2*	7386.0	16⁻	6076.61	14⁻	Q	
1319.7 *10*	<9	3860.90	8⁺	2541.27	6⁺		
1321.2 *10*	40 *3*	7725.3	17⁻	6404.1	15⁻	Q	
1359.4 *3*		9894.3	(20)	8534.9	(18)		
1374.0 *3*		11906.7	(24⁻)	10532.7	(22⁻)		
1388.5 *10*	7 *1*	6891.04	16⁺	5502.58	14⁺	Q	
1403.3		7862.2	(16)	6458.88	16⁺		
1403.6 *10*	<8	7386.0	16⁻	5982.4	14⁻		
1415.5 *10*	13 *1*	6124.32	14⁺	4708.75	12⁺	Q	
1425.5 *10*	10 *1*	6251.53	14⁻	4826.04	12⁻	Q	
1439.7 *10*	7 *1*	5591.78	12⁺	4152.64	10⁺	Q	
1451.9 *10*	7 *1*	5639.44	12⁻	4188.11	11⁻	D+Q	
1469.1 *3*		10293.6	(22⁺)	8824.5	(20⁺)		
1470.7 *3*		12489.2	(25⁻)	11018.5	(23⁻)		
1486.3 *10*	17 *1*	2994.29	(6⁺)	1508.39	4⁺	Q	
1507.8[#] *10*	19.0 *11*	4618.2	(9,10⁺)	3110.41	8⁺	Q	
1606.0[#@] *15*	10.0 *13*	2239.41	4⁺	632.92	2⁺		
1621.2 *3*		11914.8	(24⁺)	10293.6	(22⁺)		
1767.6 *10*	3 *1*	5639.44	12⁻	3872.18	10⁻	Q	

† From 1993Th05, unless otherwise noted. Uncertainties in Eγ are stated to range from 0.2 to 1.0. Iγ are also given by 1978Sa13.
‡ From 1994Th01 (DCO) and 1978Sa13 γ(θ), γ(polarization) and α(K)exp.
# From 1978Sa13.
@ Doublet.
& From Iγ/Iγ(1199γ)=0.058 *7* (1978Sa13).
a From Iγ/Iγ(569γ)=0.076 *13* (1978Sa13).
b From Iγ/Iγ(1606γ)=1.07 *5* in adopted γ′s.
c Iγ(325.5γ)/Iγ(1056.83γ)=0.53 *9* (1978Sa13).
d Iγ(1299.5γ)/Iγ(242.84γ)=0.45 *13* (1978Sa13).
x γ ray not placed in level scheme.

(HI,xnγ) 1994Th01,1993Th05,1978Sa13

Level Scheme

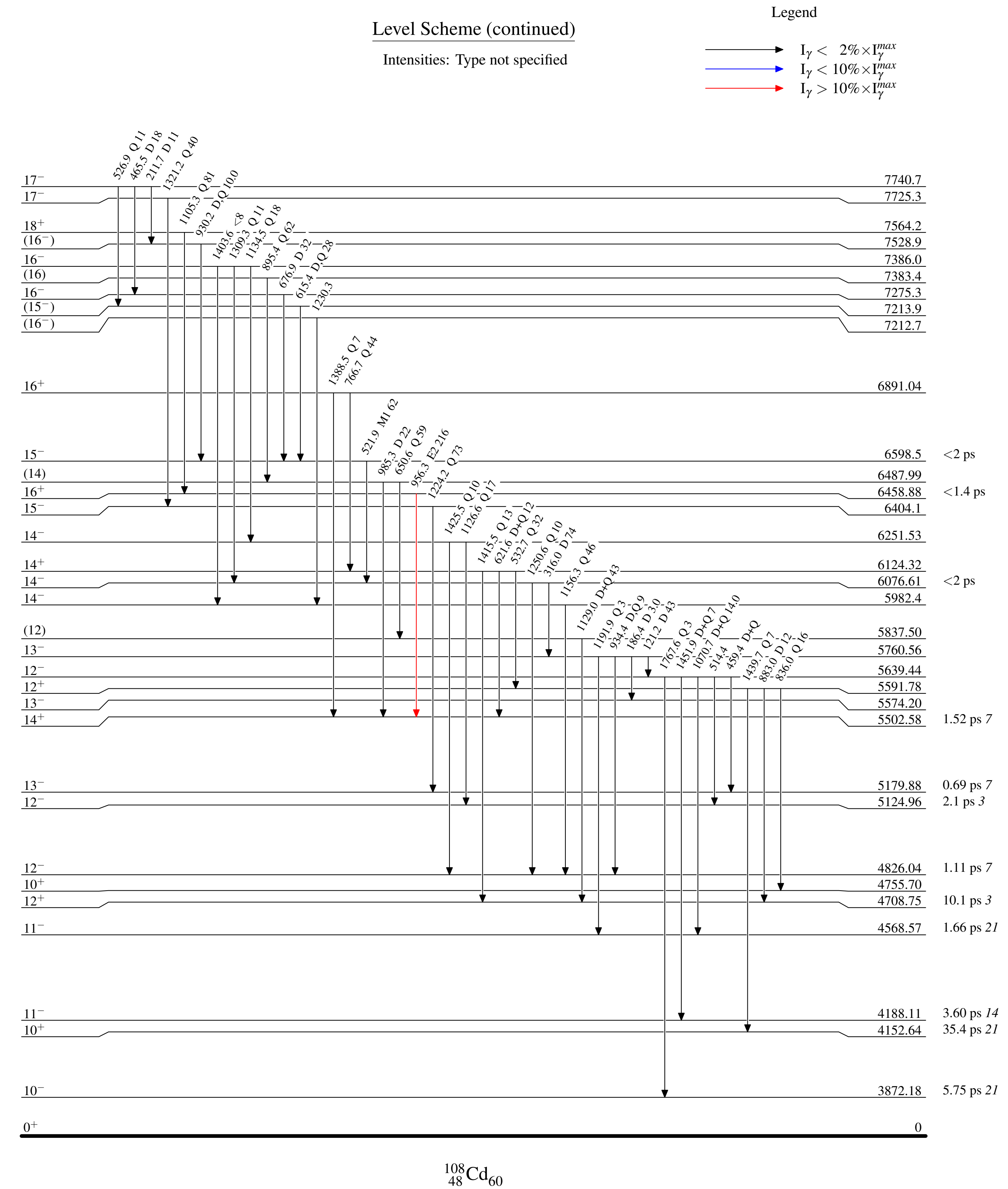
Intensities: Type not specified



(HI,xnγ) 1994Th01,1993Th05,1978Sa13

Level Scheme (continued)

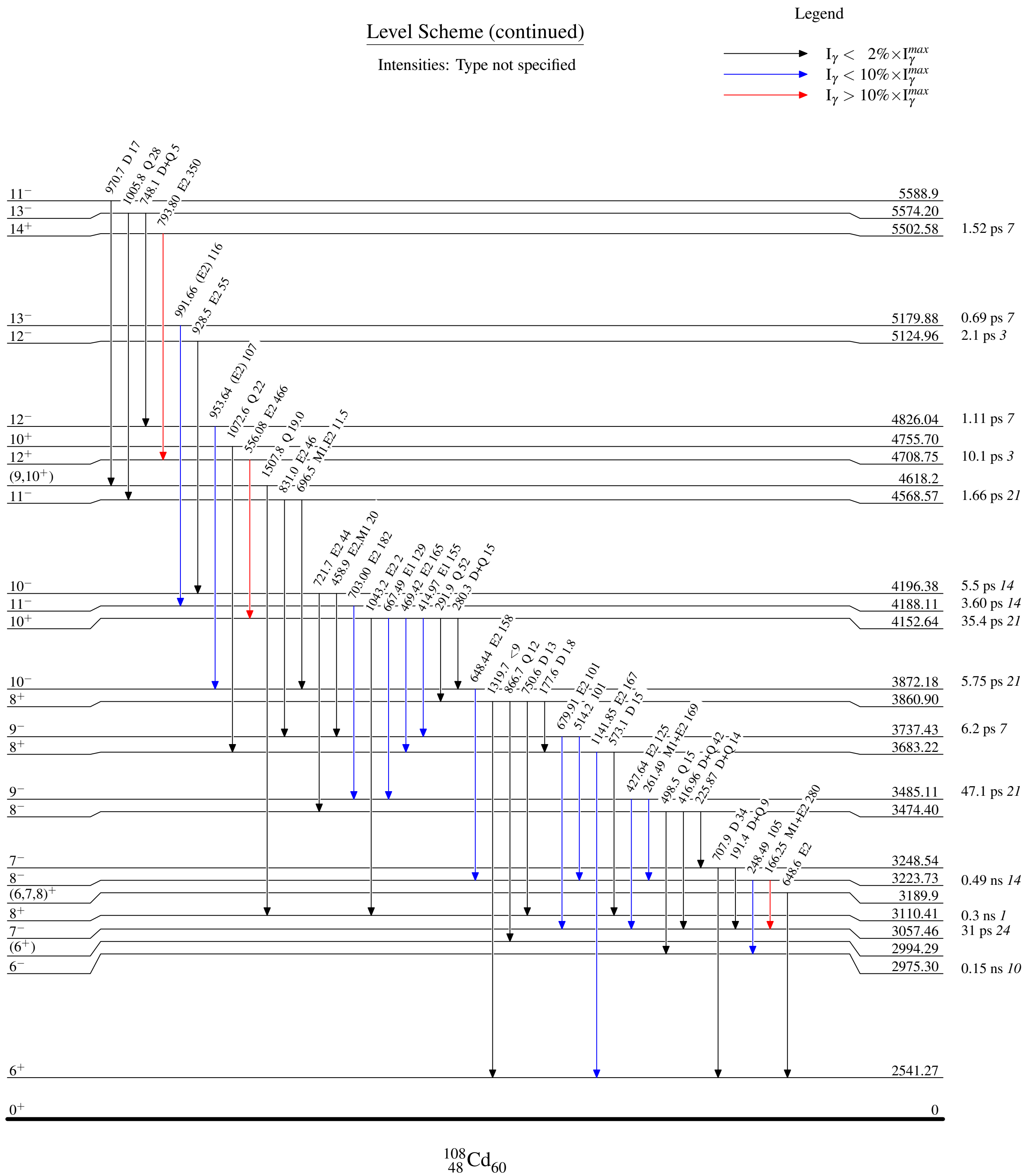
Intensities: Type not specified



(HI,xnγ) 1994Th01,1993Th05,1978Sa13

Level Scheme (continued)

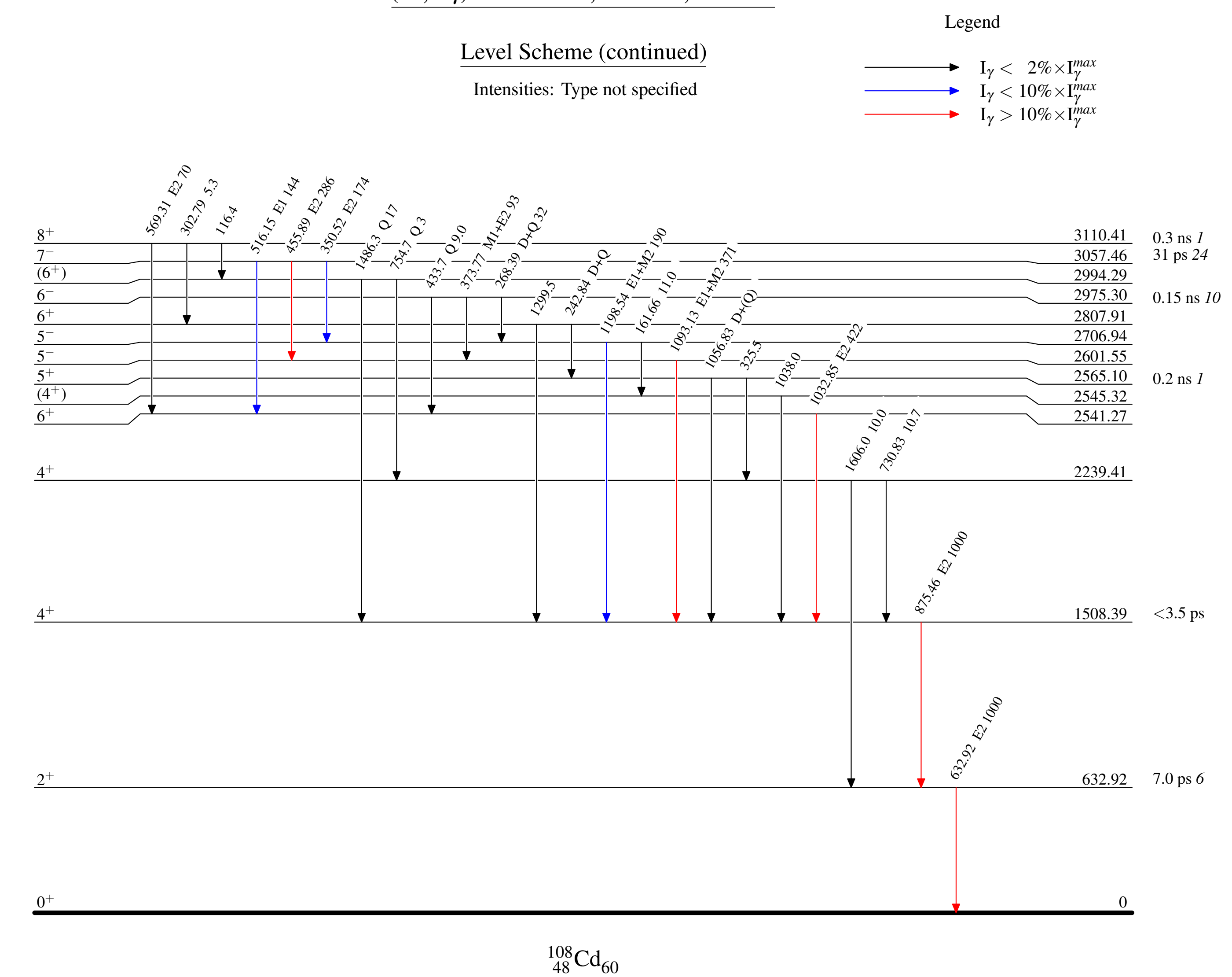
Intensities: Type not specified

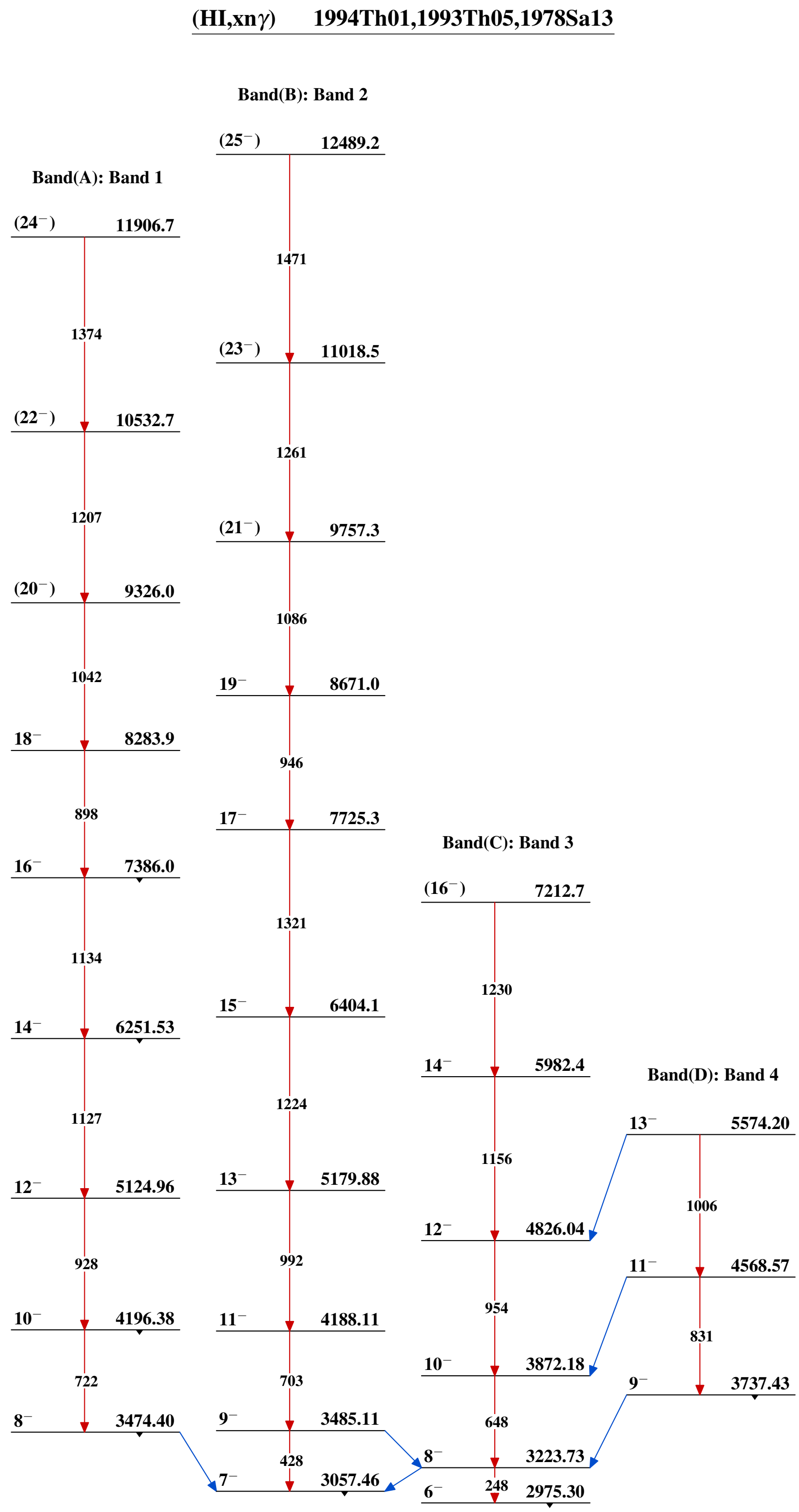


(HI,xnγ) 1994Th01,1993Th05,1978Sa13

Level Scheme (continued)

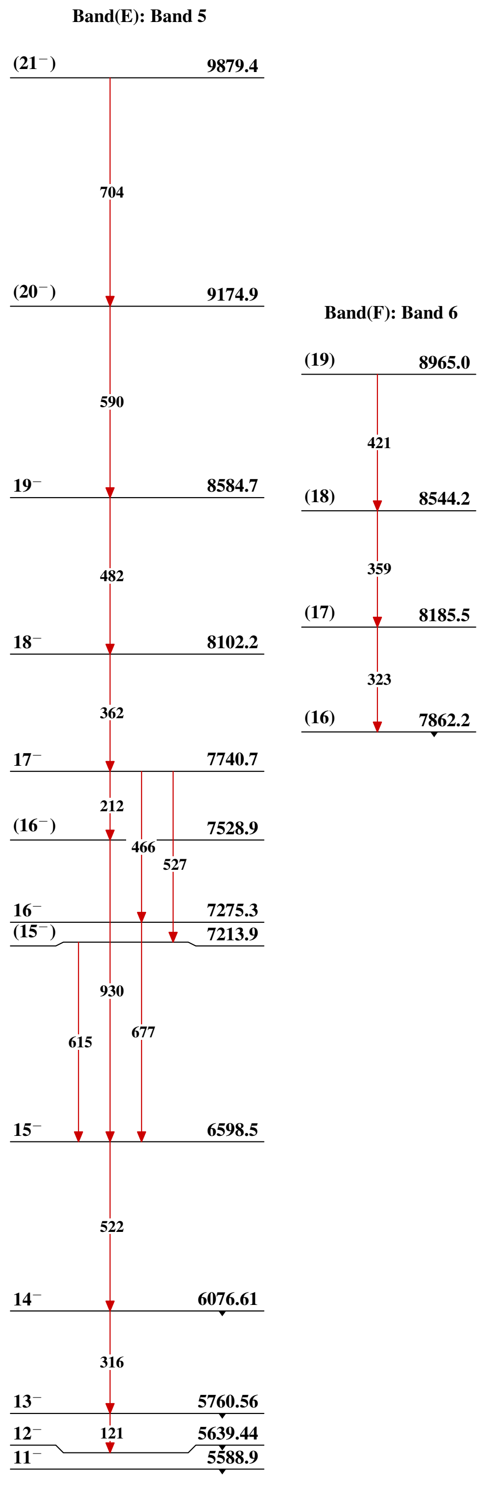
Intensities: Type not specified




(HI,xnγ) 1994Th01,1993Th05,1978Sa13
Band(A): Band 1
(24⁻) 11906.7
1374
(22⁻) 10532.7
1207
(20⁻) 9326.0
1042
18⁻ 8283.9
898
16⁻ 7386.0
1134
14⁻ 6251.53
1127
12⁻ 5124.96
928
10⁻ 4196.38
722
8⁻ 3474.40
Band(B): Band 2
(25⁻) 12489.2
1471
(23⁻) 11018.5
1261
(21⁻) 9757.3
1086
19⁻ 8671.0
946
17⁻ 7725.3
1321
15⁻ 6404.1
1224
13⁻ 5179.88
992
11⁻ 4188.11
703
9⁻ 3485.11
428
7⁻ 3057.46
Band(C): Band 3
(16⁻) 7212.7
1230
14⁻ 5982.4
1156
12⁻ 4826.04
954
10⁻ 3872.18
648
8⁻ 3223.73
248
6⁻ 2975.30
Band(D): Band 4
13⁻ 5574.20
1006
11⁻ 4568.57
831
9⁻ 3737.43

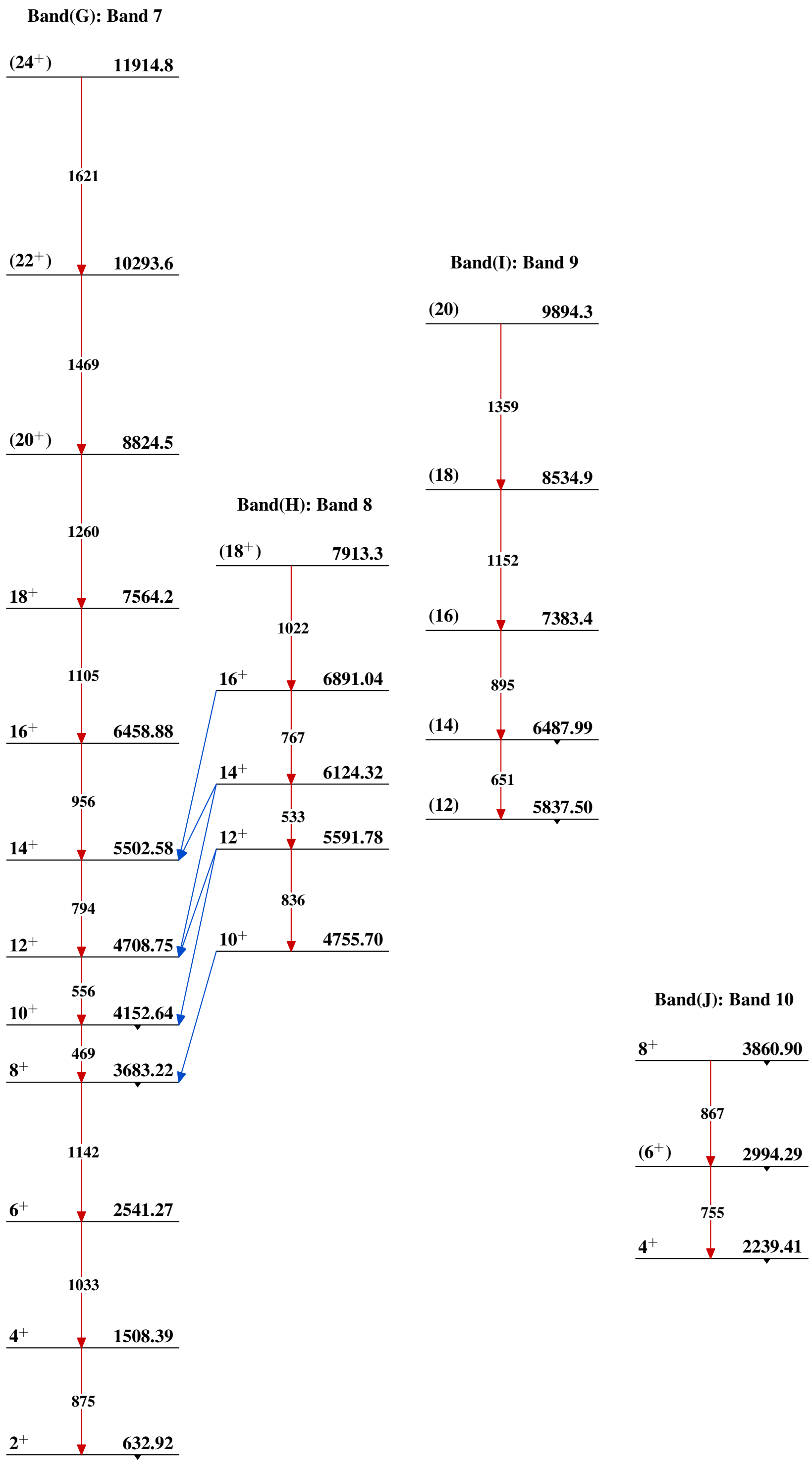
$^{108}_{48}Cd_{60}$

(HI,xnγ) 1994Th01,1993Th05,1978Sa13 (continued)



$^{108}_{48}Cd_{60}$

(HI,xnγ) 1994Th01,1993Th05,1978Sa13 (continued)



$^{108}_{48}Cd_{60}$