Adopted Levels, Gammas

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	N. Nica	NDS 195,1 (2024)	19-Sep-2023

Q(β^-)=294 *3*; S(n)=6916 *4*; S(p)=5274 *3*; Q(α)=1005 *3* 2021Wa16
S(2n)=15801 *15*, S(2p)=12782 *3* (2021Wa16).

^{162}Ho Levels

The $K^\pi=5^+$ band reported by 1972WaYO with levels at 286, 398, 527, and 673 keV is not included here.
Measured Coulomb displacement energies: 1983Ja03.
Model calculations that may be of interest include configuration assignments 1966So02, 1982Si02, and 1992Kv01; moments and radii 1993Pa04; and level energies 1995Li40.
For discussions of the systematic features of signature inversion in the (π $h_{11/2}$)(ν $i_{13/2}$) bands in this mass region, see, e. g., 2001Ri19 and 2003Ya19.
Data for the 106 level and the lower-lying ones are from the ^{162}Ho IT decay data set. Values for the levels above this are from the in-beam studies.

Cross Reference (XREF) Flags

A ^{160}Gd(^{7}Li,5nγ)
B ^{162}Ho IT decay (67.0 min)
C ^{162}Dy(d,2nγ),(p,nγ),

E(level)[†]	J$^\pi$[‡]	$T_{1/2}$	XREF	Comments
0[#]	1^+	15.0 min *10*	ABC	%ε+%β^+=100 μ=2.32 *3*; Q=0.71 *3* XREF: A(0.0). J$^\pi$: J from atomic-beam magnetic resonance measurement (1969Ek01,1988NeZZ) and π from allowed ε decay (log *ft*=5.0 and 4.9, respectively) to the 0^+ g.s. and the first 2^+ level in ^{162}Dy. Configuration=(π 7/2[523])-(ν 5/2[523]) from expected Nilsson states for the odd particles and supported by calculated (1988Ra41) μ=2.60 and Q=0.65. $T_{1/2}$: average of 15.0 min *10* (1965St08) and 15 min *1* (1973Ba21). Others: 11.8 min *10* (1961Jo10), 12 min *2* (1969Ak01), and 15 min (1969Ek01). μ: from 1988NeZW as quoted in 1988Ra41. Q: from 1988NeZW as quoted in 1988Ra41. For ^{162}Ho-^{160}Ho, $\Delta\langle r^2\rangle\approx0.20$ fm^2 (taken from plot of 1989Al27 by evaluator). In an evaluation of nuclear rms charge radii, 2013An02 report $\langle r^2\rangle^{1/2}$=5.182 fm *31*.
38.34[@] *2*	2^+	1.2 ns *2*	ABC	J$^\pi$: from M1 γ to 1^+ level and expected structure of 1^+ band. $T_{1/2}$: from 1978Sc10 by γ-ce coincidences following ^{162}Ho IT decay (67 min): also 1977AnZG by same authors.
96.07[#] *2*	3^+		ABC	J$^\pi$: from M1 γ to 2^+ level and expected structure of 1^+ band.
105.87[&] *6*	6^-	67.0 min *7*	ABC	%ε+%β^+=37; %IT=63 μ=+3.60 *4*; Q=4.0 *7* E(level): from ^{162}Ho IT decay. J$^\pi$: J from atomic-beam magnetic resonance measurement (1969Ek01) and π from allowed ε decay (log *ft*=4.77) to 5^- level in ^{162}Dy. Configuration=(π 7/2[523])+(ν 5/2[642]) with an admixture of configuration=(π 7/2[523])+(ν 3/2[651]) from expected Nilsson states for the odd particles and supported by calculated μ=3.3 (1988Ra41). $T_{1/2}$: weighted average of 68 min *2* (1964Ma10), 65 min *5* (1965GrZZ), 67 min *2* (1969Ak01), 66 min *3* (1969Ho17), 63.5 min *19* (1971Wo09), and 68 min *1*

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Adopted Levels, Gammas (continued)

^{162}Ho Levels (continued)

E(level)[†]	J$^{\pi}$[‡]	T$_{1/2}$	XREF	Comments
				(1973Ba21). Others: 1957Mi67, 68 min (1961Jo10), 65 min *5* (1965GrZZ), 68 min (1969Ek01), and 72 min (1973St22). %ε+%β^+,%IT: from evaluator's analysis based on Ice(L)(38.34)/Ice(K)(184.99) ratio measured by 1961Jo10, with 38.34γ in ^{162}Ho IT decay (67 min) scheme and 184.99γ in ^{162}Ho ε decay (67.0 min) scheme, giving %IT=63 and %ε=37. See ^{162}Ho IT decay (67.0 min) dataset for details. μ: from the compilation by 2014StZZ and based on the measurement of 1989Al27, where the value is 3.59 *4*: other: 3.60 *9* from 1988NeZW, 1988Ra41. Q: from the compilation by 2016St14 and based on the measurement of 1989Al27; others: 1988NeZW, 1988Ra41. For the 6$^-$ isomer (67 min), 1989Al27 give for ^{162}Ho-^{160}Ho, $\Delta<r^2>$=0.156 fm^2 *7* and for ^{165}Ho-^{162}Ho, $\Delta<r^2>$=0.207 fm^2 *7*.
171.7[@]	4$^+$		A C	J$^{\pi}$: from γ to 3$^+$ level and expected structure of 1$^+$ band.
176.5[a]	7$^-$		A C	
179.8[c]	1$^-$	8.7 ns *2*	A C	E(level): the 179 γ has been placed from a level at 179 keV as suggested by 1978Sc10, rather than from a level at 286 keV with J^{π}=5$^+$ as given by 1972WaYO and others. J$^{\pi}$: J^{π} and configuration proposed by 1978Sc10; this would be the other coupling of the two orbitals in the 6$^-$, 106 state. T$_{1/2}$: from $\gamma\gamma$(t) in ^{162}Dy(p,nγ) (1978Sc10). Other: 9 ns (1973GoYV). Additional information 1.
184.8[d]	(6$^+$)		A	
266.8[&]	8$^-$		A C	
270.0[#]	5$^+$		A C	J$^{\pi}$: γ to 4$^+$ level and expected band structure.
301.2[e]	(7$^+$)		A	
377.4[a]	9$^-$		A C	
385.9[@]	6$^+$		A C	J$^{\pi}$: γ's to 4$^+$ and 5$^+$ levels and expected band structure.
389.7[b]	(6$^-$)		A	
437.1[d]	(8$^+$)		A	
476.0[c]	(7$^-$)		A	
507.8[&]	10$^-$		A C	
521.5[#]	7$^+$		A	
563.0[b]	(8$^-$)		A	
592.3[e]	(9$^+$)		A	
658.2[a]	11$^-$		A C	
672.8[@]	8$^+$		A	
687.4[c]	(9$^-$)		A	
765.8[d]	(10$^+$)		A	
811.2[b]	(10$^-$)		A	
828.2[&]	12$^-$		A C	
846.4[#]	9$^+$		A	
940.1[e]	(11$^+$)		A	
978.6[c]	(11$^-$)		A	
1018.2[a]	13$^-$		A C	
1030.8[@]	10$^+$		A	
1144.0[b]	(12$^-$)		A	
1146.7[d]	(12$^+$)		A	
1225.8[&]	14$^-$		A C	
1244.2[#]	11$^+$		A	

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Adopted Levels, Gammas (continued)

^{162}Ho Levels (continued)

E(level)[†]	Jπ[‡]	XREF	Comments
1355.0[e]	(13+)	A	
1358.6[c]	(13−)	A	
1456.2[a]	15−	A C	
1457.2[@]	12+	A	
1566.7[b]	(14−)	A	
1598.7?[d]	(14+)	A	
1697.6[&]	16−	A	
1709.1[#]	13+	A	
1827.6[c]	(15−)	A	
1834.5[e]	(15+)	A	
1948.4[@]	14+	A	
1970.5[a]	17−	A	
2078.2[b]	(16−)	A	
2234.6?[#]	15+	A	
2241.2[&]	18−	A	
2380.4[c]	(17−)	A	
2559.2[a]	19−	A	
2672.5[b]	(18−)	A	
2852.7[&]	20−	A	
3006.0[c]	(19−)	A	
3216.7[a]	21−	A	
3529.1[&]	22−	A	
3938.9[a]	23−	A	
4265.0[&]	24−	A	
4717.0[a]	25−	A	
5053.0[&]	26−	A	
5537.0[a]	27−	A	
5882.0[&]	28−	A	
0+x[g]	(5+)	A	Additional information 2.
101.0+x[f]	(6+)	A	
219.4+x[g]	(7+)	A	
365.2+x[f]	(8+)	A	
521.0+x[g]	(9+)	A	
709.6+x[f]	(10+)	A	
899.5+x[g]	(11+)	A	
1129.3+x[f]	(12+)	A	
0+y[i]	(9+)	A	Additional information 3.
217.2+y[h]	(10+)	A	
454.7+y[i]	(11+)	A	
710.3+y[h]	(12+)	A	
984.0+y[i]	(13+)	A	
1272.6+y[h]	(14+)	A	
1581.5+y[i]	(15+)	A	

[†] Level energies computed from a least-squares fit to the listed Eγ values. For γ′s for which no ΔEγ values are given, an uncertainty of 1 keV was assumed in the fitting. For those levels for which the connecting γ′s have no listed uncertainties, no

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Adopted Levels, Gammas (continued)

^{162}Ho Levels (continued)

uncertainty is given.

‡ Values for those levels seen in the in-beam studies are based on the observed pattern of the deexciting γ′s and the expected rotational band structure. Specific arguments are not given for individual cases.

Band(A): $K^\pi=1^+$ g.s. band, α=1 branch. Configuration=(π 7/2[523])-(ν 5/2[523]). A=9.65; B=−0.0055; A_2=+0.0183, computed from the 1^+ through 4^+ levels. Note that these parameters underpredict the 5^+ and 6^+ level energies by ≈5 keV.

@ Band(a): $K^\pi=1^+$ g.s. band, α=0 branch. Configuration=(π 7/2[523])-(ν 5/2[523]). See the comment of the α=1 branch.

& Band(B): $K^\pi=6^-$ band dominant configuration=(π 7/2[523])+(ν 5/2[642]), α=0 branch, with an admixture of (π 7/2[523])+(ν 3/2[651]).

a Band(b): $K^\pi=6^-$ band dominant configuration=(π 7/2[523])+(ν 5/2[642]), α=1 branch, with an admixture of (π 7/2[523])+(ν 3/2[651]).

b Band(C): $K^\pi=1^-$ band, α=0 branch. Configuration=(π 7/2[523])-(ν 5/2[642]).

c Band(c): $K^\pi=1^-$ band, α=1 branch. Configuration=(π 7/2[523])-(ν 5/2[642]).

d Band(D): $K^\pi=6^+$ band, α=0 branch. Configuration=(π 7/2[523])+(ν 5/2[523]).

e Band(d): $K^\pi=6^+$ band, α=1 branch. Configuration=(π 7/2[523])+(ν 5/2[523]).

f Band(E): $K^\pi=5^+$ band, α=0 branch. Configuration=(π 7/2[523])+(ν 3/2[521]).

g Band(e): $K^\pi=5^+$ band, α=1 branch. Configuration=(π 7/2[523])+(ν 3/2[521]).

h Band(F): $K^\pi=9^+$ band, α=0 branch. Configuration=(π 7/2[523])+(ν 11/2[505]).

i Band(f): $K^\pi=9^+$ band, α=1 branch. Configuration=(π 7/2[523])+(ν 11/2[505]).

γ(^{162}Ho)

Additional information 4.

E_i(level)	J_i^π	E_γ †‡	I_γ #	E_f	J_f^π	Mult.	α @	Comments
38.34	2^+	38.34 *2*	100	0	1^+	M1	6.88	B(M1)(W.u.)=0.041 *+9−6* α(L)=5.37 *8*; α(M)=1.187 *17* α(N)=0.275 *4*; α(O)=0.0400 *6*; α(P)=0.00223 *4*
96.07	3^+	57.74 *2*	100 *8*	38.34	2^+	M1	12.63	α(K)=10.57 *15*; α(L)=1.611 *23*; α(M)=0.356 *5* α(N)=0.0826 *12*; α(O)=0.01199 *17*; α(P)=0.000670 *10*
		96.06 *3*	1.8 *2*	0	1^+	E2	3.28	α(K)=1.210 *17*; α(L)=1.591 *23*; α(M)=0.384 *6* α(N)=0.0865 *13*; α(O)=0.01026 *15*; α(P)=5.01×10^{-5} *7*
105.87	6^-	9.80 *5*	100	96.07	3^+	E3		B(E3)(W.u.)=1.41×10^4 *5* exceeds RUL=100. The computed B(E3)(W.u.) value is regarded as approximate only, since the α value cannot be reliably calculated. See the comment in the ^{162}Ho IT decay data set. The value listed there, 4.77×10^7 *7*, was used in the B(E3)(W.u.) calculation.
171.7	4^+	75.6	100	96.07	3^+	[M1,E2]	7.1 *13*	α(K)=3.4 *15*; α(L)=2.8 *21*; α(M)=0.67 *51* α(N)=0.15 *12*; α(O)=0.018 *13*; α(P)=2.0×10^{-4} *11*
176.5	7^-	70.5	100	105.87	6^-	[M1,E2]	9.1 *20*	α(K)=4.1 *20*; α(L)=3.9 *30*; α(M)=0.92 *73* α(N)=0.21 *17*; α(O)=0.025 *19*; α(P)=2.4×10^{-4} *14*
179.8	1^-	141.5	24	38.34	2^+	[E1]	0.1256	B(E1)(W.u.)=1.66×10^{-6} *+40−36* α(K)=0.1053 *15*; α(L)=0.01589 *23*; α(M)=0.00350 *5* α(N)=0.000800 *12*; α(O)=0.0001101 *16*; α(P)=5.04×10^{-6} *7* I_γ: value computed from partial γ half-lives given by 1978Sc10; based on private communication from authors of 1972WaYO.
		179.8	100	0	1^+	[E1]	0.0665	B(E1)(W.u.)=3.37×10^{-6} *+20−22* α(K)=0.0560 *8*; α(L)=0.00827 *12*; α(M)=0.00182 *3* α(N)=0.000417 *6*; α(O)=5.80×10^{-5} *9*; α(P)=2.76×10^{-6} *4*

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Adopted Levels, Gammas (continued)

$\gamma(^{162}Ho)$ (continued)

E_i(level)	J_i^π	E_γ †‡	I_γ #	E_f	J_f^π	Comments
184.8	(6^+)	79.1		105.87	6^-	
266.8	8^-	90.4		176.5	7^-	
		160.5		105.87	6^-	
270.0	5^+	98.2	100	171.7	4^+	
301.2	(7^+)	116.5		184.8	(6^+)	
		124.7		176.5	7^-	
377.4	9^-	110.5		266.8	8^-	
		201.0		176.5	7^-	
385.9	6^+	115.9		270.0	5^+	
		214.3		171.7	4^+	
437.1	(8^+)	136.0		301.2	(7^+)	
		170.0		266.8	8^-	
		252.5		184.8	(6^+)	
		260.5		176.5	7^-	
476.0	(7^-)	86.5		389.7	(6^-)	
507.8	10^-	130.5	100	377.4	9^-	
		240.9	29	266.8	8^-	
521.5	7^+	131.5		389.7	(6^-)	
		135.5		385.9	6^+	
		251.4		270.0	5^+	
563.0	(8^-)	87.2		476.0	(7^-)	
		173.5		389.7	(6^-)	
592.3	(9^+)	155.5		437.1	(8^+)	
		215.0		377.4	9^-	
		291.1		301.2	(7^+)	
658.2	11^-	150.5	100	507.8	10^-	
		280.7	32	377.4	9^-	
672.8	8^+	110.0		563.0	(8^-)	
		151.0		521.5	7^+	
		196.7		476.0	(7^-)	
		287.0		385.9	6^+	
687.4	(9^-)	124.5		563.0	(8^-)	
		211.5		476.0	(7^-)	
765.8	(10^+)	173.5		592.3	(9^+)	
		328.5		437.1	(8^+)	
811.2	(10^-)	124.0		687.4	(9^-)	
		248.0		563.0	(8^-)	
828.2	12^-	170.0	100	658.2	11^-	
		320.4	64	507.8	10^-	
846.4	9^+	159.0		687.4	(9^-)	
		173.5		672.8	8^+	
		324.7		521.5	7^+	
940.1	(11^+)	174.0		765.8	(10^+)	
		348.0		592.3	(9^+)	
978.6	(11^-)	167.4		811.2	(10^-)	
		291.3		687.4	(9^-)	
1018.2	13^-	189.9	96	828.2	12^-	
		360.0	100	658.2	11^-	
1030.8	10^+	184.5		846.4	9^+	
		219.7		811.2	(10^-)	
		358.2		672.8	8^+	
1144.0	(12^-)	165.3		978.6	(11^-)	
		332.7		811.2	(10^-)	
1146.7	(12^+)	206.5		940.1	(11^+)	
		381.0		765.8	(10^+)	

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Adopted Levels, Gammas (continued)

$\gamma(^{162}Ho)$ (continued)

E_i(level)	J_i^π	E_γ[†‡]	I_γ[#]	E_f	J_f^π
1225.8	14^-	207.5	100	1018.2	13^-
		397.7	93	828.2	12^-
1244.2	11^+	213.5		1030.8	10^+
		397.5		846.4	9^+
1355.0	(13^+)	208.4		1146.7	(12^+)
		414.7		940.1	(11^+)
1358.6	(13^-)	214.5		1144.0	(12^-)
		380.1		978.6	(11^-)
1456.2	15^-	230.3	100	1225.8	14^-
		438.0	54	1018.2	13^-
1457.2	12^+	213.0		1244.2	11^+
		426.7		1030.8	10^+
1566.7	(14^-)	208.2		1358.6	(13^-)
		422.7		1144.0	(12^-)
1598.7?	(14^+)	452.0[&]		1146.7	(12^+)
1697.6	16^-	241.2		1456.2	15^-
		472.0		1225.8	14^-
1709.1	13^+	252.0		1457.2	12^+
		464.5		1244.2	11^+
1827.6	(15^-)	261.0		1566.7	(14^-)
		469.0		1358.6	(13^-)
1834.5	(15^+)	479.5		1355.0	(13^+)
1948.4	14^+	239.0		1709.1	13^+
		491.5		1457.2	12^+
1970.5	17^-	273.0		1697.6	16^-
		514.4		1456.2	15^-
2078.2	(16^-)	250.5		1827.6	(15^-)
		511.5		1566.7	(14^-)
2234.6?	15^+	525.5[&]		1709.1	13^+
2241.2	18^-	270.5		1970.5	17^-
		543.5		1697.6	16^-
2380.4	(17^-)	302.0		2078.2	(16^-)
		552.9		1827.6	(15^-)
2559.2	19^-	317.5		2241.2	18^-
		589.0		1970.5	17^-
2672.5	(18^-)	292.0		2380.4	(17^-)
		594.5		2078.2	(16^-)
2852.7	20^-	293.5		2559.2	19^-
		611.5		2241.2	18^-
3006.0	(19^-)	333.5		2672.5	(18^-)
		625.5		2380.4	(17^-)
3216.7	21^-	364.0		2852.7	20^-
		657.5		2559.2	19^-
3529.1	22^-	312.5		3216.7	21^-
		676.5		2852.7	20^-
3938.9	23^-	410.0		3529.1	22^-
		722.0		3216.7	21^-
4265.0	24^-	326		3938.9	23^-
		736		3529.1	22^-
4717.0	25^-	452		4265.0	24^-
		778		3938.9	23^-
5053.0	26^-	336		4717.0	25^-
		788		4265.0	24^-
5537.0	27^-	484		5053.0	26^-
		820		4717.0	25^-
5882.0	28^-	345		5537.0	27^-
		829		5053.0	26^-
101.0+x	(6^+)	100.9		0+x	(5^+)
219.4+x	(7^+)	118.5		101.0+x	(6^+)
		219.5		0+x	(5^+)
365.2+x	(8^+)	146.0		219.4+x	(7^+)
		264.1		101.0+x	(6^+)
521.0+x	(9^+)	155.6		365.2+x	(8^+)
		301.5		219.4+x	(7^+)
709.6+x	(10^+)	188.7		521.0+x	(9^+)
		344.6		365.2+x	(8^+)
899.5+x	(11^+)	189.8		709.6+x	(10^+)
		378.3		521.0+x	(9^+)
1129.3+x	(12^+)	229.5		899.5+x	(11^+)
		420.0		709.6+x	(10^+)
217.2+y	(10^+)	217.4		0+y	(9^+)
454.7+y	(11^+)	237.5		217.2+y	(10^+)
		454.5		0+y	(9^+)
710.3+y	(12^+)	255.6		454.7+y	(11^+)
		493.2		217.2+y	(10^+)
984.0+y	(13^+)	273.5		710.3+y	(12^+)
		529.2		454.7+y	(11^+)
1272.6+y	(14^+)	288.5		984.0+y	(13^+)
		562.5		710.3+y	(12^+)
1581.5+y	(15^+)	309.0		1272.6+y	(14^+)
		597.5		984.0+y	(13^+)

[†] The γ's associated with the 5^+ band of 1972WaYO are not included here because the 179γ proposed to depopulate the bandhead at 286 keV has been shown to depopulate a level at 179 keV.

[‡] Values for the γ's between levels in the in-beam studies quoted to tenths of a keV are from the light ion-induced reactions. 2004Es01 report Eγ values to only the nearest keV.

[#] Values for the γ's between levels in the in-beam studies are from the light-ion induced reactions. 2004Es01 and 2005Li63 do not report Iγ values.

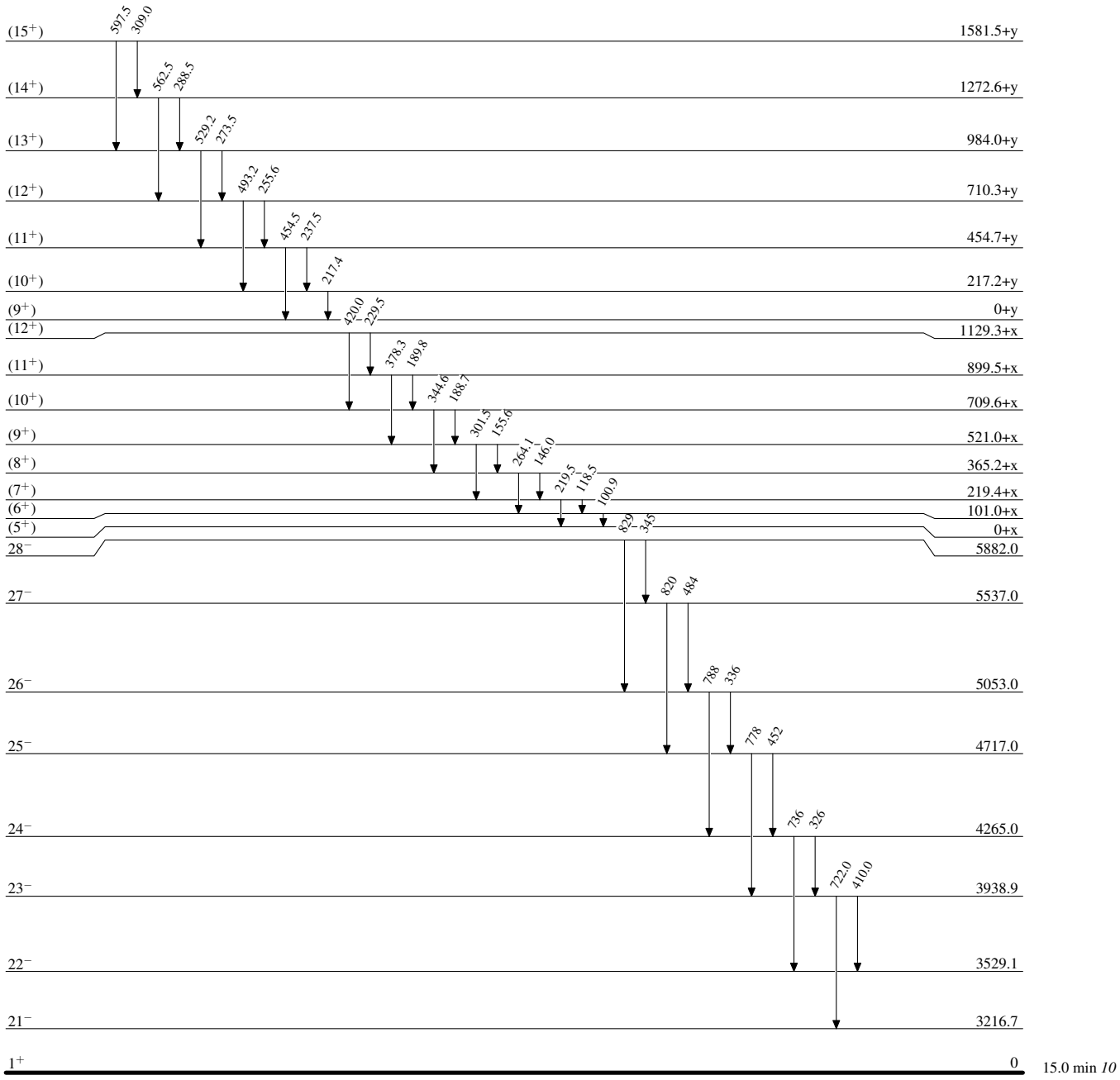
[@] Additional information 5.

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

Adopted Levels, Gammas

Level Scheme

Intensities: Relative photon branching from each level



$^{162}_{67}Ho_{95}$

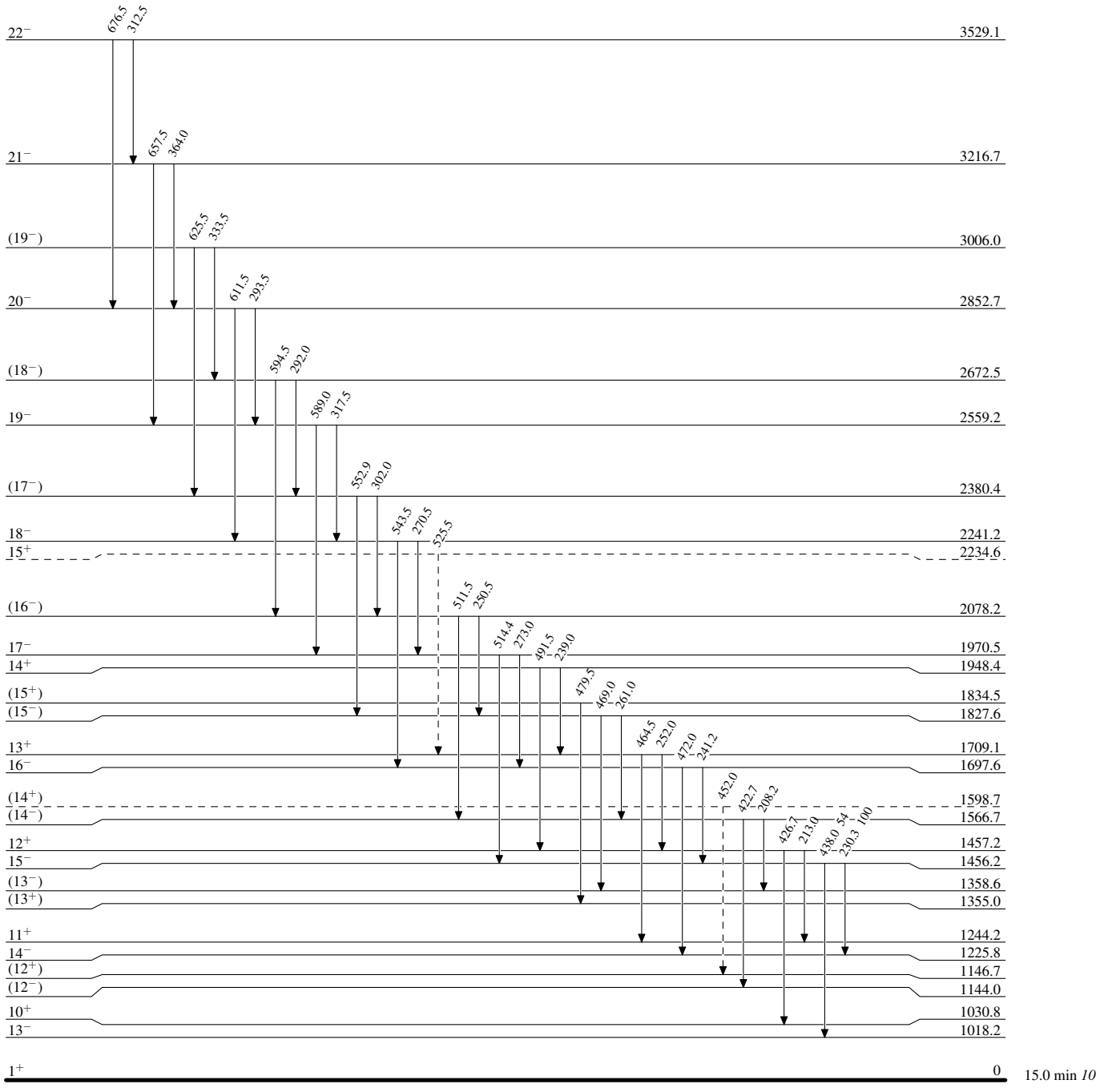
Adopted Levels, Gammas

Legend

Level Scheme (continued)

Intensities: Relative photon branching from each level

γ Decay (Uncertain)

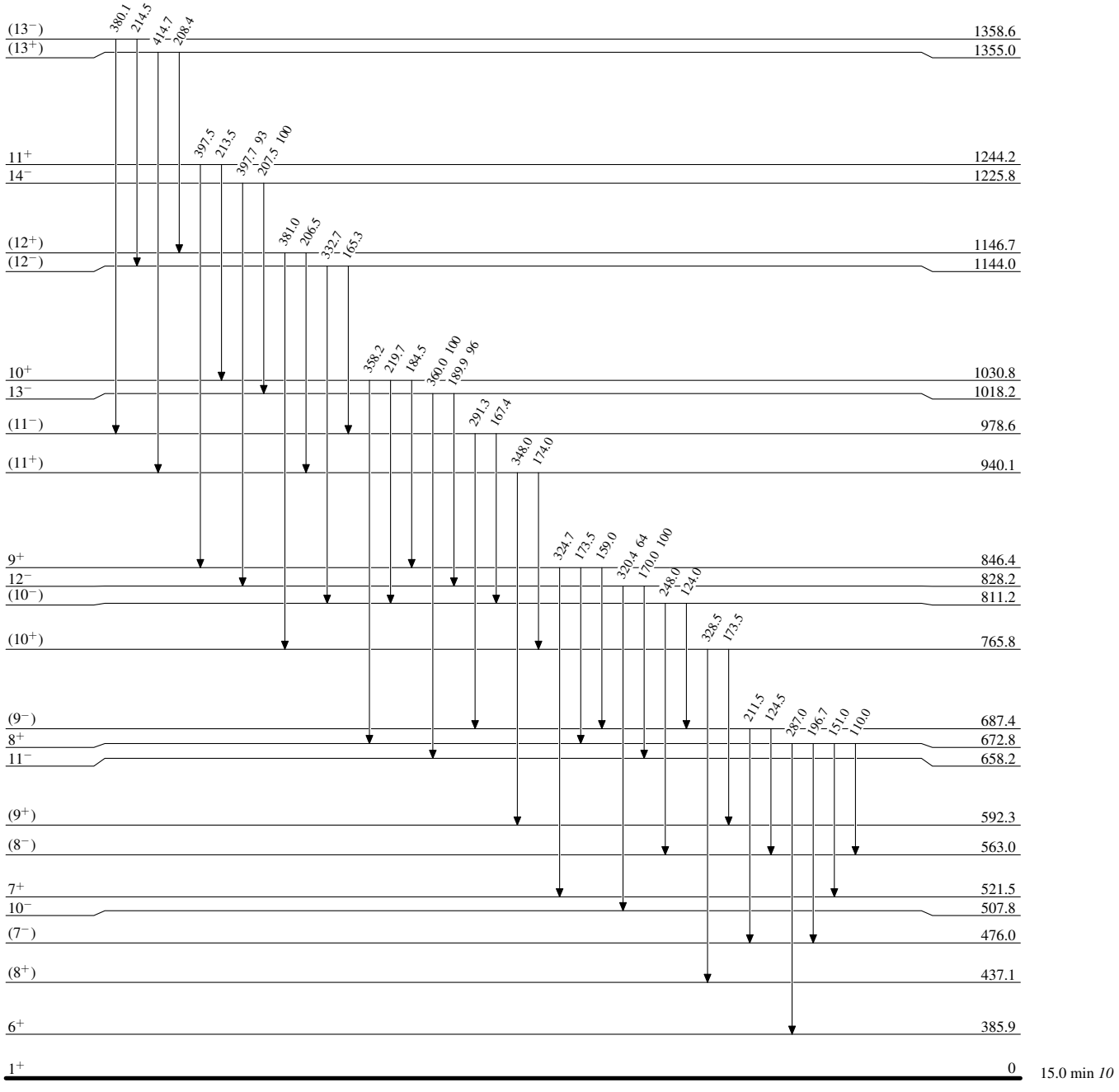


$^{162}_{67}Ho_{95}$

Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level

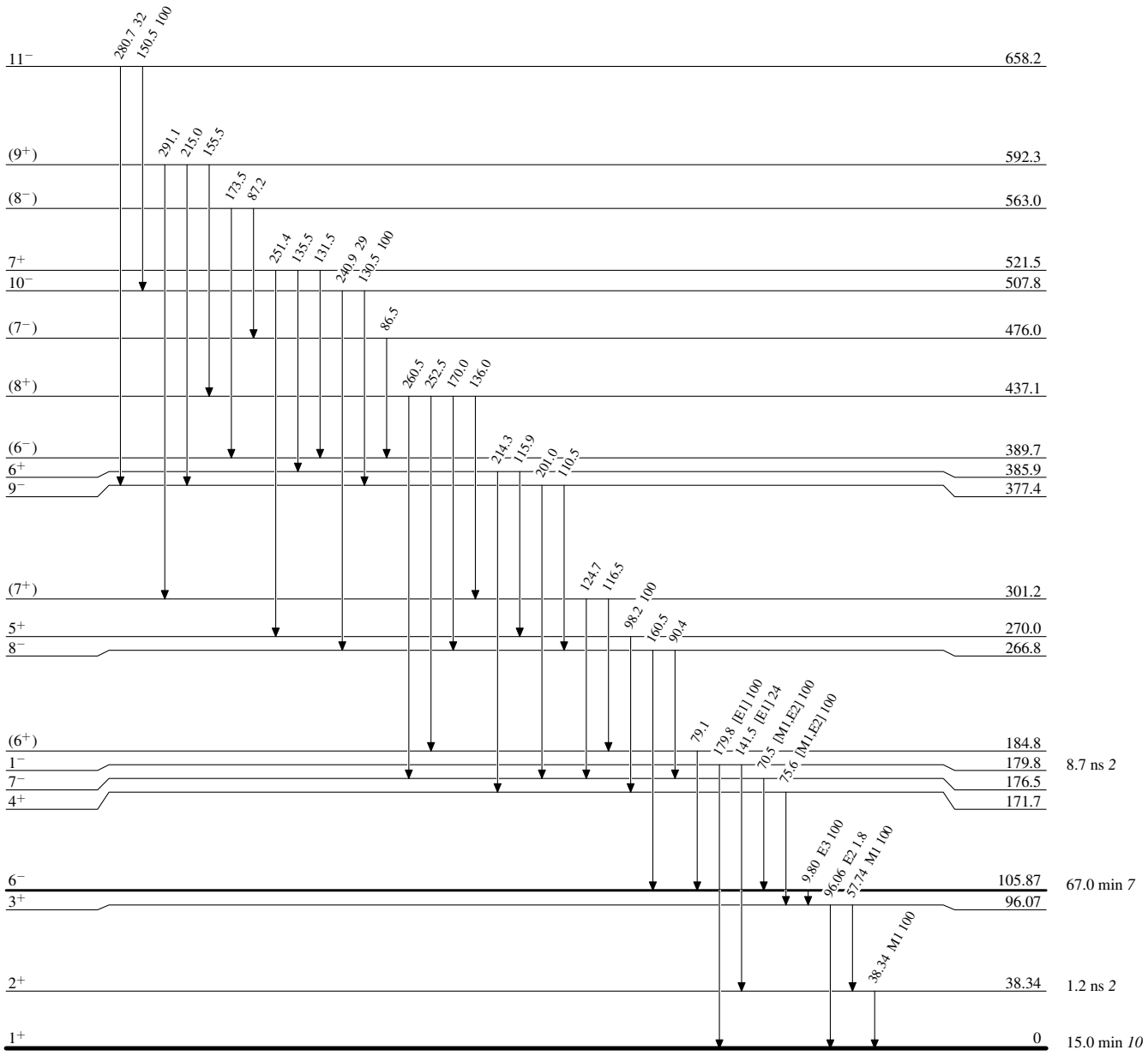


$^{162}_{67}Ho_{95}$

Adopted Levels, Gammas

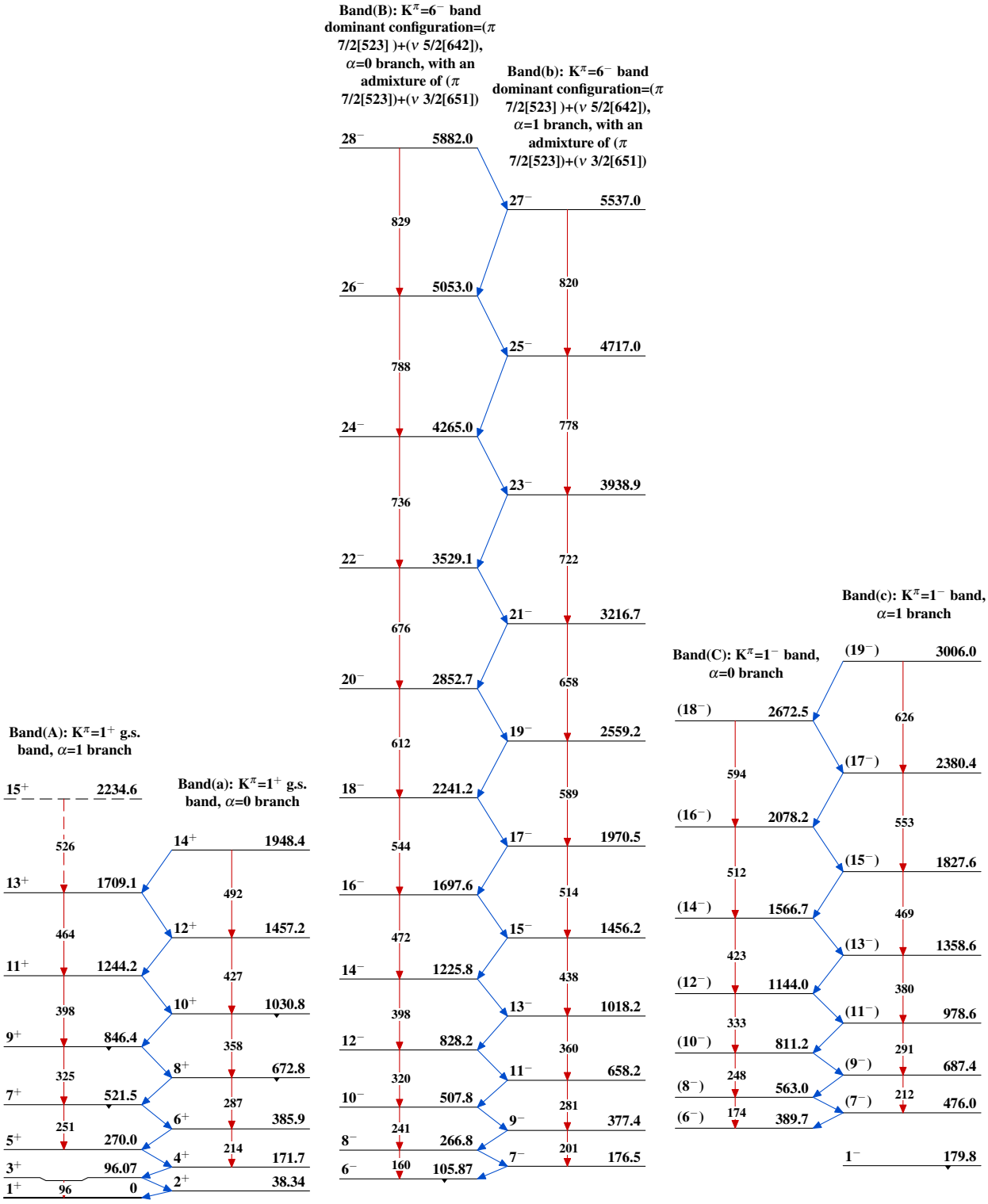
Level Scheme (continued)

Intensities: Relative photon branching from each level

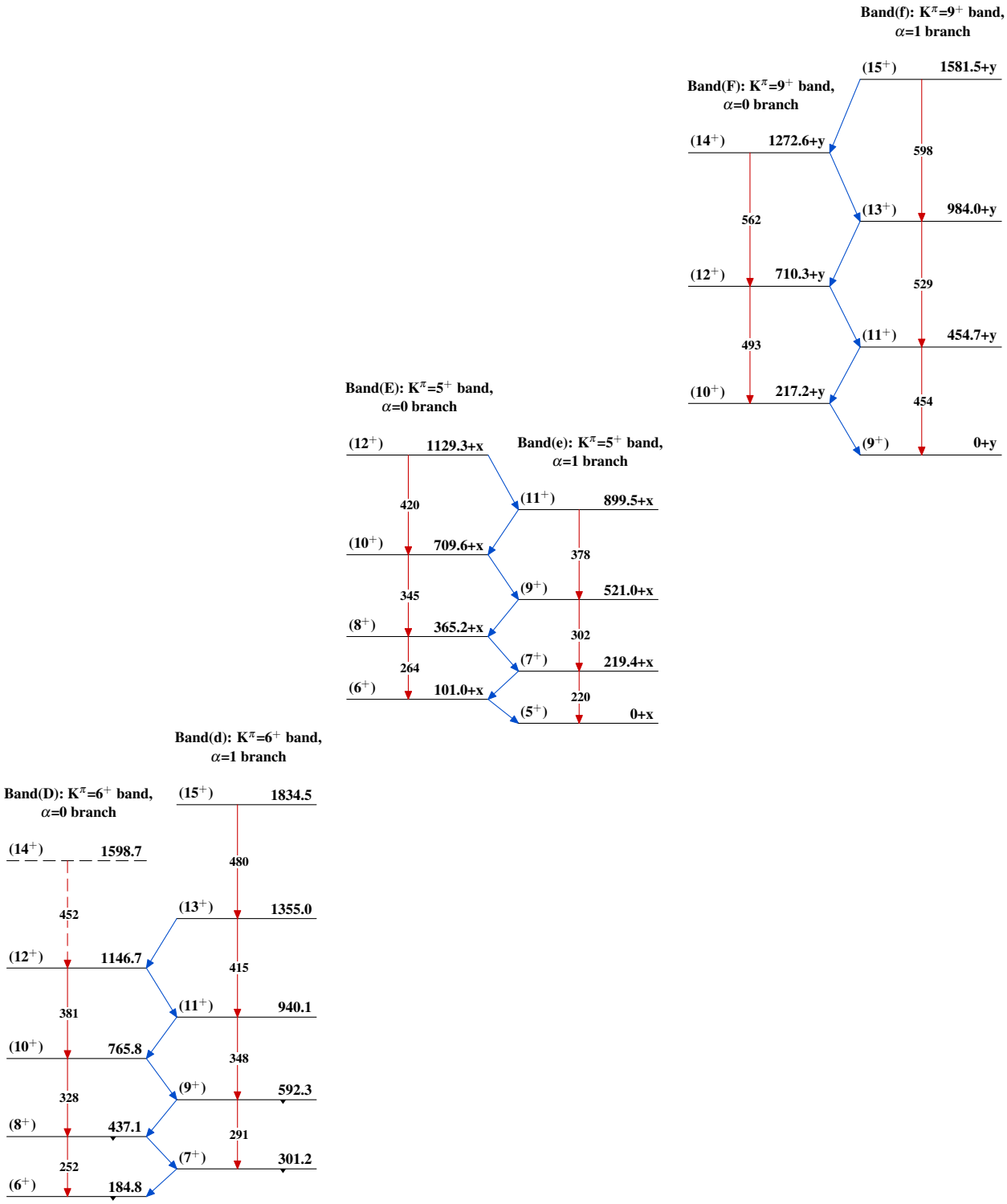


$^{162}_{67}Ho_{95}$

Adopted Levels, Gammas



Adopted Levels, Gammas (continued)



$^{162}_{67}Ho_{95}$