Adopted Levels, Gammas

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	C. W. Reich	NDS 113, 2537 (2012)	1-Mar-2012

Q(β^-)=438 *4*; S(n)=6912 *10*; S(p)=5310 *4*; Q(α)=373 *4* 2017Wa10
Q(ε)=2444 *4*; S(2n)=1.608×10^4 *10*; S(2p)=12931 *4* 2017Wa10
Additional information 1.
Additional information 2.

Data are from 24-h and 5-h IT decays (1970To11, 1957Mi01, and 1955Ha52) for three levels below 100 keV; from single-particle transfer (1974ElZW) for five levels below 300 keV; and from the ^{150}Nd(^{11}B,5nγ) reaction (1982Be46).

Other studies of possible interest:

Coulomb displacement energies for ^{156}Gd – ^{156}Tb: 1983Ja03.

Model calculations of μ and Q: 1978Ko15.

A survey of the features of the nuclear structure of the low-lying states of the odd-odd deformed nuclides is given by 1998Ja07.

A survey of the properties of K=0 bands in strongly deformed nuclides is given by 1988Fr16.

Numerous discussions of signature inversion in the ($\nu i_{13/2}$)($\pi h_{11/2}$) band in ^{156}Tb as well as in a number of other odd-odd nuclides have been published. See, e.g., 1992Ja03, 1994Yo02, 1994Yo03, 1995Li40, 1996Go19, 1997Zh13, 2001Zh16, 2001Ri19, 2003Ya19.

^{156}Tb Levels

Cross Reference (XREF) Flags

A	^{150}Nd(^{11}B,5nγ),^{124}Sn(^{36}S,p3nγ)
B	^{155}Gd(^{3}He,d),(α,t)
C	^{156}Tb IT decay (5.3 h)
D	^{156}Tb IT decay (24.4 h)

E(level)[†]	J$^\pi$[‡]	$T_{1/2}$	XREF	Comments
0.0[@]	3$^-$	5.35 d *10*	ABCD	%ε+%β^+=100 μ=1.41 *18*; Q=+2.3 *8* J$^\pi$: J from atomic-beam magnetic resonance (1970Ad09). π from log *ft*=5.85 for ε decay to 4$^-$ level at 2044 in ^{156}Gd and expected g.s. configuration. $T_{1/2}$: From 1959He44, ε decay. Others: 5.9 d (1949Bu01), 5.2 d (1955Ha52), 5.6 d (1957Mi67), and 5.0 and 4.7 d (1973St22). μ: From 1989Ra17 evaluation and based on data of 1962Lo01. Others: 1.68 *21* and 1.92 *26* from the 1989Ra17 evaluation and based on data of 1983Be03 and 1979Ri17, respectively. See, also, the compilation by 2005St24. Q: From 1989Ra17 evaluation and based on data of 1983Be03. Others: +3.0 *9* and +1.40 *45* from the 1989Ra17 evaluation and based on the data of 1979Ri17 and 1962Lo01, respectively. See, also, the compilation by 2005St24. %β^-: γ radiations following the β^- decay to ^{156}Dy have not been reported, so the β^- branching is taken to be zero in the determination of the %ε+%β^+ value. Only decay to the 2$^+$ and 4$^+$ members of the ground-state band would be allowed by the Q(β^-) value. The lack of observed ε decay to the 2$^+$ and 4$^+$ members of ground-state band in ^{156}Gd lends support to this conclusion. Additional information 3.
49.630[&] *10*	4$^+$	49 ns *7*	A D	J$^\pi$: E1 γ to 3$^-$ g.s. indicates J$^\pi$=2$^+$,3$^+$,4$^+$. Excitation function (1970To11, IT decay) indicates J>J(g.s.). $T_{1/2}$: From 1982Be46, ^{150}Nd(^{11}B,5nγ).
49.630+x[d]	(7$^-$)	24.4 h *10*	D	%IT=100 E(level): Level postulated by 1970To11 to explain 24.4-h half-life, since $T_{1/2}$ of 49 level is known to be short. J$^\pi$: Value inferred from comparison of the spins of the g.s. and the 2 isomers with

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Adopted Levels, Gammas (continued)

^{156}Tb Levels (continued)

E(level)[†]	J^{π}[‡]	$T_{1/2}$	XREF	Comments
				those in ^{154}Tb, in particular with that of the low-lying 7^- state there. From excitation-function data, 1970To11 conclude that the spin of the 24.4-h isomer is greater than that of the ^{156}Tb g.s. (3^-) and that of the 5.3-h isomer is less than that of the ^{156}Tb g.s. %IT: Value assumed by evaluator since β^- and ε decays have not been reported. No β^- decay is expected, since there are no high-spin levels in the daughter below the Q(β^-) energy.
87[@]	4^-[#]		B	
88.4[e]	(0^+)	5.3 h *2*	C	%IT<100; %ε+%β^+>0 J^{π}: E3 γ to the g.s. ($J^{\pi}=3^-$). Excitation function (1970To11, IT decay) indicates J(88)<J(g.s.). $T_{1/2}$: Unweighted average of 5.0 h *1* (1950Wi13), 5.5 h (1955Ha52), and 5.4 h *6* (1970To11), all from IT decay. %IT: Value unknown, but known to decay both by IT and β^+ decay. 1950Wi13 report Eβ+≈1400, which agrees with Q value of 2444 *4*, but their limit of Iβ^+<25% is not useful since the theoretical Iε/Iβ^+>7 already requires Iβ^+<13%. 1970Ag02 report Eβ+=2640.0 *5* which is much too high, so their value of Iβ^+=0.024% *8* may also be in error.
100[f]	1^-[#]		B	
109.7[a]	5^+		A	J^{π}: D γ to 4^+ level and expected band structure.
156[f]	2^-[#]		B	
183.5[&]	6^+		A	J^{π}: D γ to 5^+ level and expected band structure.
188[f]	3^-[#]		B	
222			B	
245			B	
281.9[a]	7^+		A	J^{π}: From D γ to 6^+ level and expected band structure.
290[f]	4^-[#]		B	
313			B	
378.9[b]	$6^{(-)}$		AB	
393.6[&]	8^+		A	
405			B	
442.0[c]	$7^{(-)}$		A	
483			B	
530.6[a]	9^+		A	
546.6[b]	$8^{(-)}$		A	
550			B	
590			B	
615			B	
638			B	
646.8[c]	$9^{(-)}$		A	
686.2[&]	10^+		A	
695			B	
754			B	
790			B	
800.0[b]	$10^{(-)}$		A	
858.2[a]	11^+		A	
954.5[c]	$11^{(-)}$		A	
1060.4[&]	12^+		A	
1146.9[b]	$12^{(-)}$		A	
1263.3[a]	13^+		A	
1366.8[c]	$13^{(-)}$		A	

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Adopted Levels, Gammas (continued)

^{156}Tb Levels (continued)

E(level)†	Jπ‡	XREF	E(level)†	Jπ‡	XREF	E(level)†	Jπ‡	XREF	E(level)†	Jπ‡	XREF
1510.6&	14^+	A	2609.9&	18^+	A	4049b	$22^{(-)}$	A	9159b	(34^-)	A
1584.3b	$14^{(-)}$	A	2694.2b	$18^{(-)}$	A	4255?a	(23^+)	A	10160b	(36^-)	A
1741.4a	15^+	A	2890.5a	19^+	A	4556c	$23^{(-)}$	A	11204b	(38^-)	A
1873.9c	$15^{(-)}$	A	3114.5c	$19^{(-)}$	A	4794b	$24^{(-)}$	A	12293b	(40^-)	A
2029.6&	16^+	A	3243.7&	20^+	A	5579b	(26^-)	A	13435b	(42^-)	A
2103.2b	$16^{(-)}$	A	3345.7b	$20^{(-)}$	A	6407b	(28^-)	A	14638b	(44^-)	A
2285.9a	17^+	A	3548.4a	21^+	A	7280b	(30^-)	A	15907b	(46^-)	A
2461.5c	$17^{(-)}$	A	3815c	$21^{(-)}$	A	8198b	(32^-)	A			

† From unweighted least-squares fit to γ energies.

‡ Specific arguments are given for the levels below 300 keV. Above this energy, the assignments are entirely from the heavy-ion data set. These depend on the γ multipolarities and the band-structure considerations customarily employed in such studies.

\# From comparison of the measured (^{3}He,d) and (α,t) cross sections with those predicted for the members of the band having the proposed configuration, together with the expected energy spacings (1974ElZW).

@ Band(A): $K^\pi=3^-$ Band, conf=π3/2[411]+ν3/2[521].

& Band(B): $K^\pi=4^+$ Band, (π3/2[411])($\nu i_{13/2}$), α=0. At the lower spins, the most likely two-quasiparticle conf is π3/2[411]+ν5/2[642].

a Band(C): $K^\pi=4^+$ Band, (π3/2[411])($\nu i_{13/2}$), α=1. At the lower spins, the most likely two-quasiparticle conf is π3/2[411]+ν5/2[642].

b Band(D): Probable ($\nu i_{13/2}$)($\pi h_{11/2}$) band, α=0. At the lower spins, the most likely conf assignment is π5/2[532]+ν3/2 [651], with $K^\pi=4^-$.

c Band(E): Probable ($\nu i_{13/2}$)($\pi h_{11/2}$) band, α=1. At the lower spins, the most likely conf assignment is π5/2[532]+ν3/2 [651], with $K^\pi=4^-$.

d Band(F): $K^\pi=7^-$ Bandhead, conf=π3/2[411]+ν11/2[505].

e Band(G): $K^\pi=0^+$ Bandhead, conf=π3/2[411]-ν3/2[402].

f Band(H): $K^\pi=0^-$ Band, conf=π3/2[411]-ν3/2[521].

γ(^{156}Tb)

Unplaced γ's are not included here; see the heavy-ion-induced reaction data set.

E_i(level)	J_i^π	E_γ	I_γ	E_f	J_f^π	Mult.†	α‡	Comments
49.630	4^+	49.630 *10*	100	0.0	3^-	E1	0.357	B(E1)(W.u.)=2.9×10^{-5} *4* Mult.: From L-subshell ratios in ^{156}Tb IT decay (24.4 h). δ: M2 mixing is<0.6% (1970To11), ^{156}Tb IT decay (24.4 h).
88.4	(0^+)	88.4	100	0.0	3^-	E3	86.2	For %IT=100, B(E3)(W.u.)=1.20×10^{-5} *11*. This is an upper limit, since any non-zero $\varepsilon+\beta^+$ branch will lower this value. Mult.: Assignment based on K/L2/L3/M/N data from ^{156}Tb IT decay (5.3 h).
109.7	5^+	59.97	100	49.630	4^+	D		
183.5	6^+	73.95	100	109.7	5^+	D		
		133.94	31	49.630	4^+			
281.9	7^+	98.50	100	183.5	6^+	D		

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Adopted Levels, Gammas (continued)

$\gamma(^{156}Tb)$ (continued)

E_i(level)	J^π_i	E_γ	I_γ	E_f	J^π_f	Mult.[†]
281.9	7^+	172.10[@]	≤96[@]	109.7	5^+	
378.9	$6^{(-)}$	269.26	100	109.7	5^+	D
393.6	8^+	111.62	100	281.9	7^+	D
		210.14	90	183.5	6^+	Q
442.0	$7^{(-)}$	63.0	79	378.9	$6^{(-)}$	D
		258.48	100	183.5	6^+	D
530.6	9^+	137.02	94	393.6	8^+	D
		248.6	100	281.9	7^+	Q
546.6	$8^{(-)}$	104.61	100	442.0	$7^{(-)}$	D
646.8	$9^{(-)}$	100.21	100	546.6	$8^{(-)}$	D
		204.80	40	442.0	$7^{(-)}$	Q
686.2	10^+	155.64	81	530.6	9^+	D
		292.74	100	393.6	8^+	Q
800.0	$10^{(-)}$	153.22	100	646.8	$9^{(-)}$	D
		253.51	60	546.6	$8^{(-)}$	Q
858.2	11^+	172.10[@]	≤91[@]	686.2	10^+	
		327.39	100	530.6	9^+	Q
954.5	$11^{(-)}$	154.40	100	800.0	$10^{(-)}$	D
		307.65	100	646.8	$9^{(-)}$	Q
1060.4	12^+	202.27	55	858.2	11^+	
		374.2	100	686.2	10^+	Q
1146.9	$12^{(-)}$	192.50	71	954.5	$11^{(-)}$	D
		347.06	100	800.0	$10^{(-)}$	
1263.3	13^+	203.00	35	1060.4	12^+	
		405.1	100	858.2	11^+	Q
1366.8	$13^{(-)}$	219.88	37	1146.9	$12^{(-)}$	D
		412.1	100	954.5	$11^{(-)}$	Q
1510.6	14^+	247.3	22	1263.3	13^+	
		450.3	100	1060.4	12^+	Q
1584.3	$14^{(-)}$	217.46	26	1366.8	$13^{(-)}$	D
		437.5	100	1146.9	$12^{(-)}$	
1741.4	15^+	230.8	25	1510.6	14^+	
		478.0	100	1263.3	13^+	Q
1873.9	$15^{(-)}$	289.74	23	1584.3	$14^{(-)}$	D
		507.0	100	1366.8	$13^{(-)}$	Q
2029.6	16^+	≈288	8	1741.4	15^+	
		519.0[#]	<100	1510.6	14^+	
2103.2	$16^{(-)}$	229.15	≤83	1873.9	$15^{(-)}$	D
		519.0[#]	<100	1584.3	$14^{(-)}$	
2285.9	17^+	256	32	2029.6	16^+	
		544.7	100	1741.4	15^+	Q
2461.5	$17^{(-)}$	358.4	54	2103.2	$16^{(-)}$	
		587.6	100	1873.9	$15^{(-)}$	Q
2609.9	18^+	580.3	100	2029.6	16^+	Q
2694.2	$18^{(-)}$	232.6	≥15	2461.5	$17^{(-)}$	D
		591.0	100	2103.2	$16^{(-)}$	Q
2890.5	19^+	604.6	100	2285.9	17^+	
3114.5	$19^{(-)}$	420.2	30	2694.2	$18^{(-)}$	
		653.1	100	2461.5	$17^{(-)}$	
3243.7	20^+	633.8	100	2609.9	18^+	Q
3345.7	$20^{(-)}$	651.5	100	2694.2	$18^{(-)}$	
3548.4	21^+	657.9	100	2890.5	19^+	

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Adopted Levels, Gammas (continued)

$\gamma(^{156}Tb)$ (continued)

E_i(level)	J_i^π	E_γ	I_γ	E_f	J_f^π	E_i(level)	J_i^π	E_γ	I_γ	E_f	J_f^π
3815	$21^{(-)}$	700	100	3114.5	$19^{(-)}$	8198	(32^-)	918	100	7280	(30^-)
4049	$22^{(-)}$	703	100	3345.7	$20^{(-)}$	9159	(34^-)	961	100	8198	(32^-)
4255?	(23^+)	707[&]	100	3548.4	21^+	10160	(36^-)	1001	100	9159	(34^-)
4556	$23^{(-)}$	741	100	3815	$21^{(-)}$	11204	(38^-)	1044	100	10160	(36^-)
4794	$24^{(-)}$	745	100	4049	$22^{(-)}$	12293	(40^-)	1089	100	11204	(38^-)
5579	(26^-)	785	100	4794	$24^{(-)}$	13435	(42^-)	1142	100	12293	(40^-)
6407	(28^-)	828	100	5579	(26^-)	14638	(44^-)	1203	100	13435	(42^-)
7280	(30^-)	873	100	6407	(28^-)	15907	(46^-)	1269	100	14638	(44^-)

† Specific multipolarities are from ce studies of the isomeric decays (1970To11,1957Mi67,1957Mi01) and D or Q assignments are from $\gamma(\theta)$ in the heavy-ion study, as interpreted by the evaluator.

‡ 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.

Multiply placed.

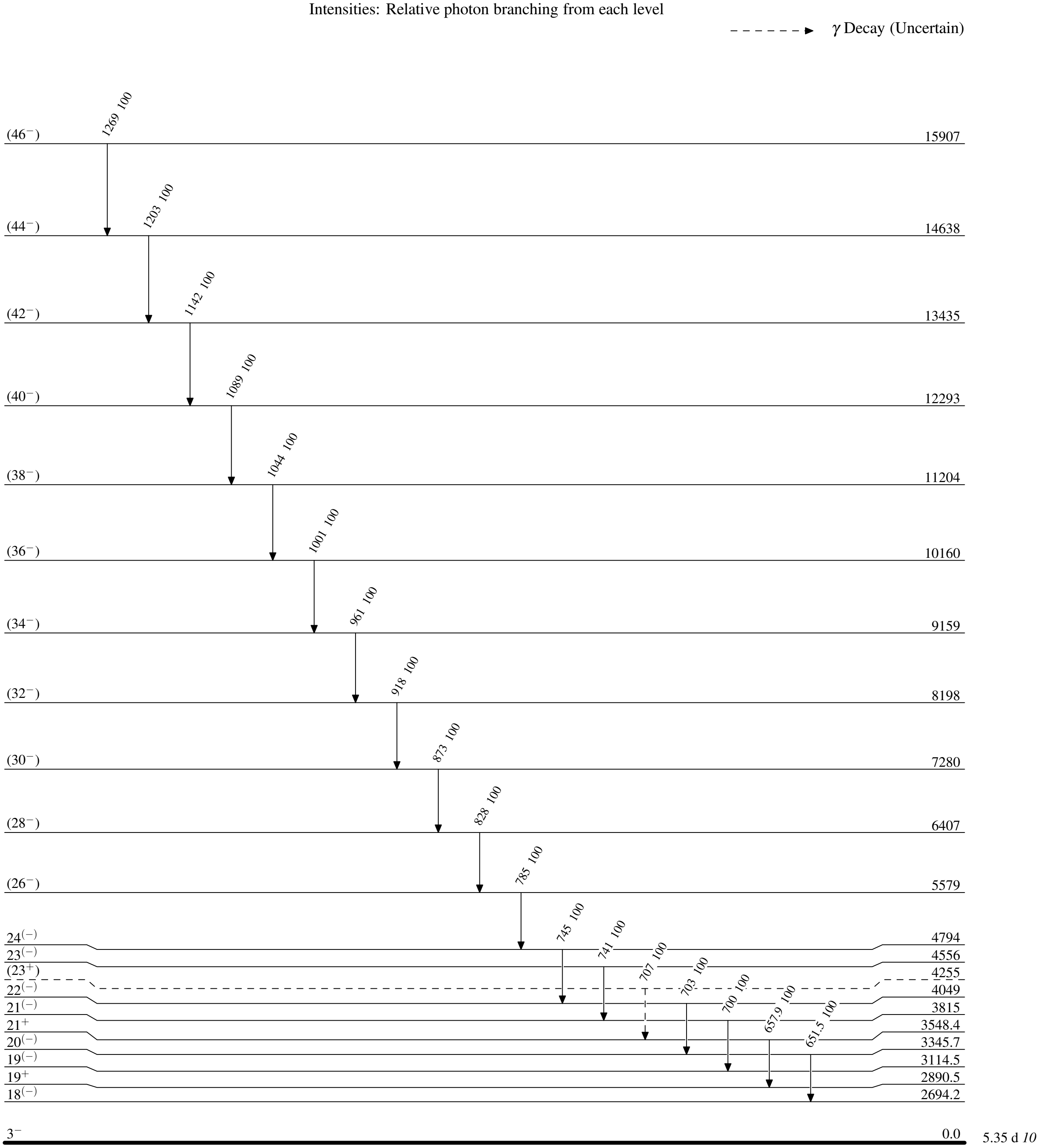
@ Multiply placed with undivided intensity.

& Placement of transition in the level scheme is uncertain.

Adopted Levels, Gammas

Level Scheme

Intensities: Relative photon branching from each level

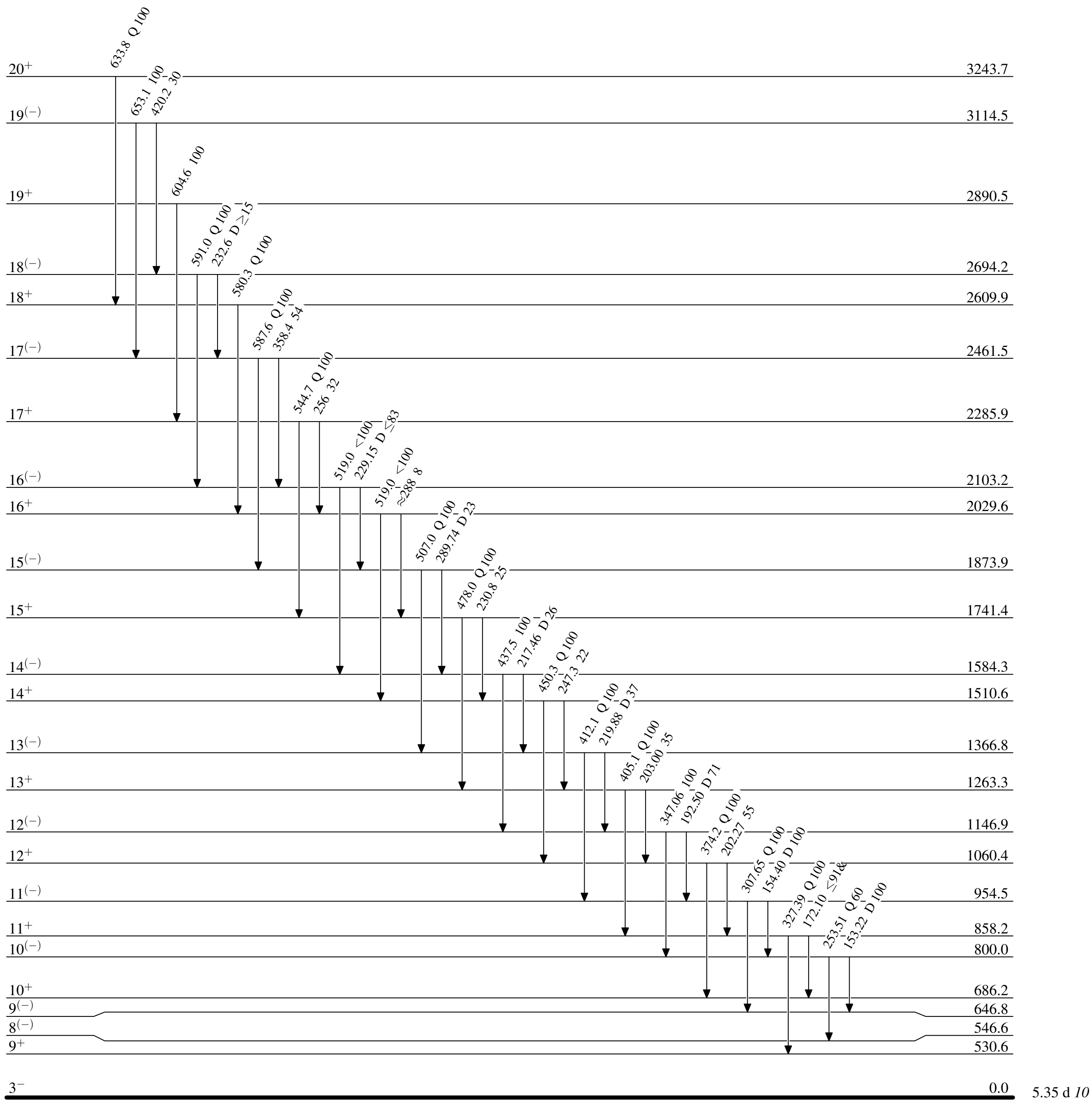


$^{156}_{65}Tb_{91}$

Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level
& Multiply placed: undivided intensity given

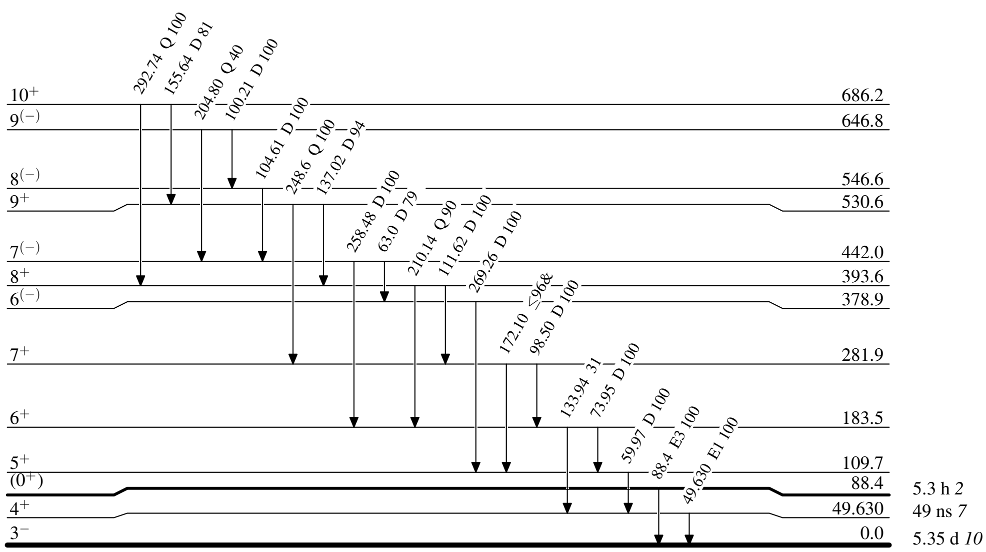


$^{156}_{65}Tb_{91}$

Adopted Levels, Gammas

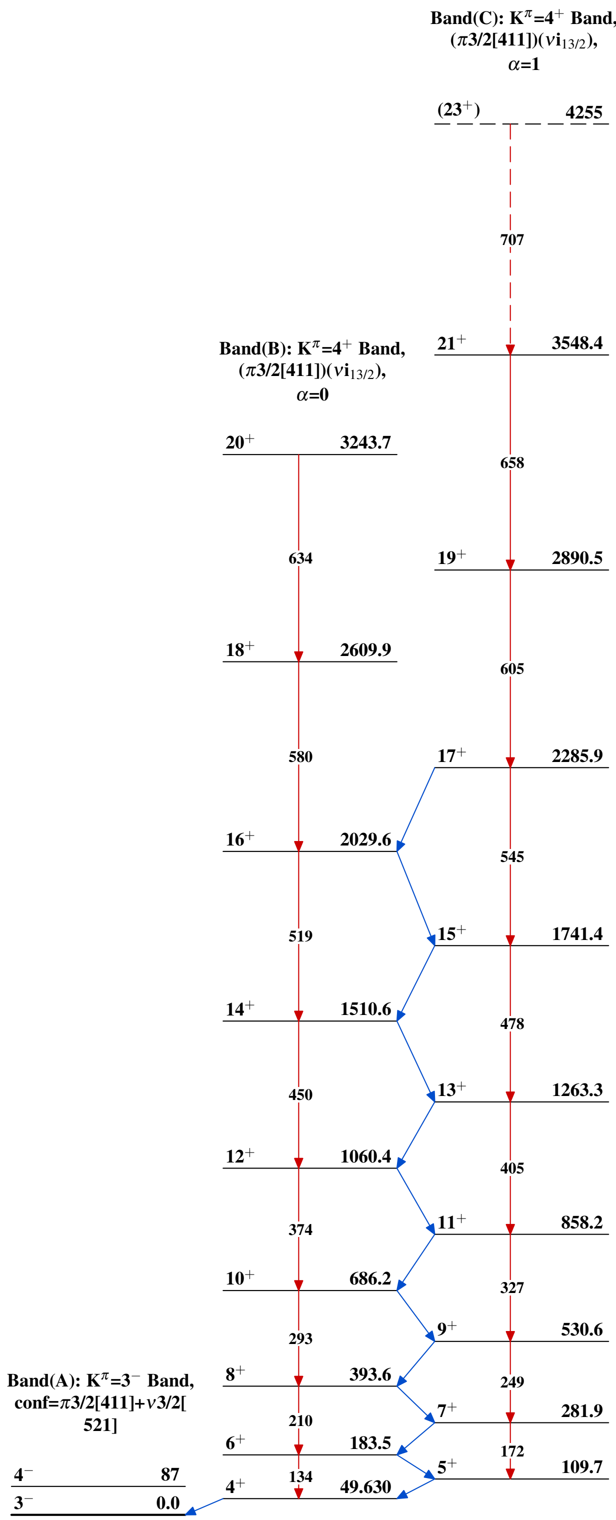
Level Scheme (continued)

Intensities: Relative photon branching from each level
& Multiply placed: undivided intensity given



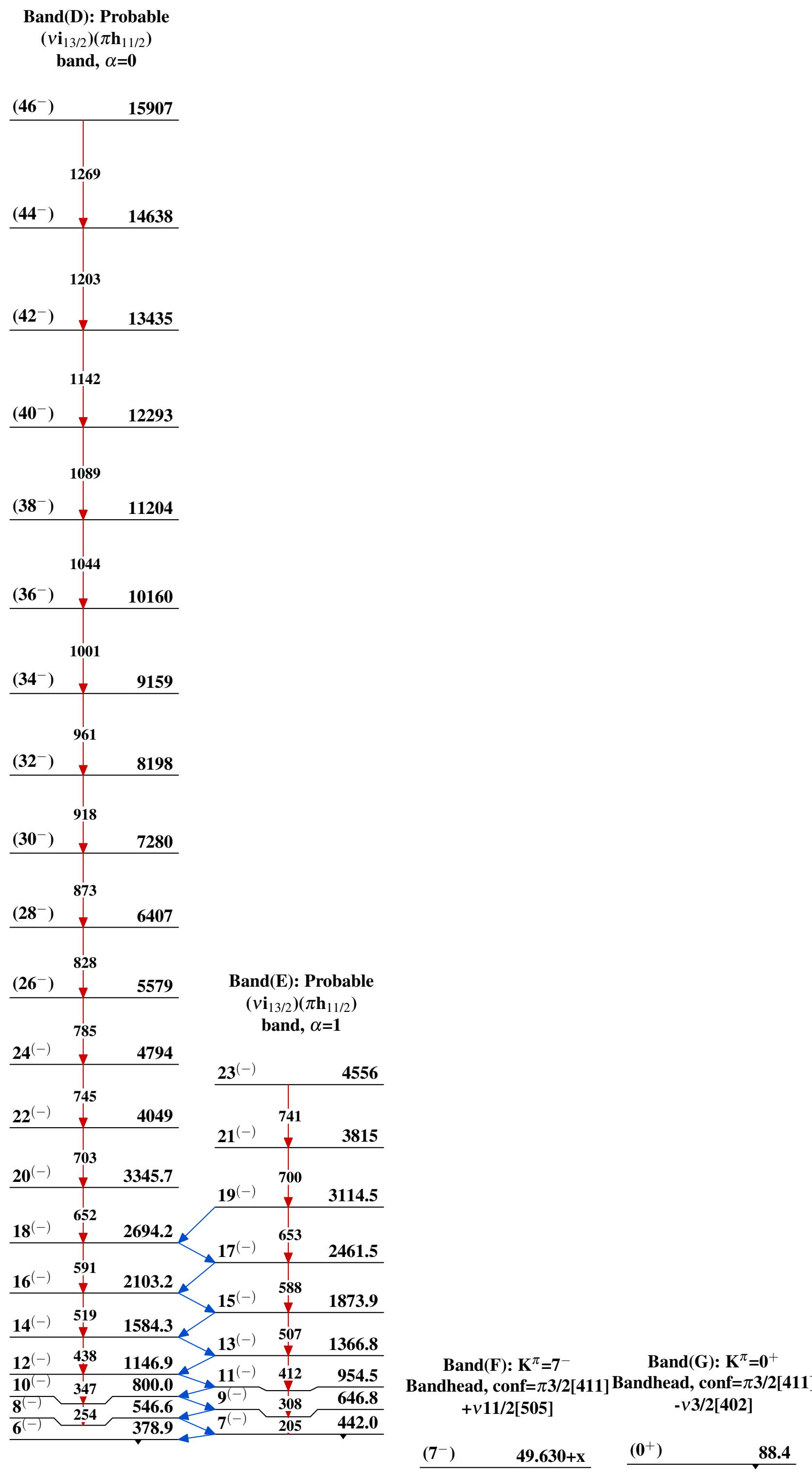
$^{156}_{65}Tb_{91}$

Adopted Levels, Gammas



$^{156}_{65}Tb_{91}$

Adopted Levels, Gammas (continued)



$^{156}_{65}Tb_{91}$

Adopted Levels, Gammas (continued)