Adopted Levels, Gammas

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	C. W. Reich	NDS 112,2497 (2011)	1-Jun-2011

Q(β^-)=593.7 *14*; S(n)=7696.6 *6*; S(p)=6808.9 *11*; Q(α)=−427 *5* 2012Wa38

Note: Current evaluation has used the following Q record $ 593.0 *13* 7696.6 *6* 6808.6 *10* −426 *5* 2009AuZZ.

Values are essentially the same as those of 2003Au03.

S(p): other: 6815.9 *17*, as measured by 1975Bu02.

Additional information 1.

The data adopted here are from the ^{161}Gd β^- decay and the ^{160}Gd(^{3}He,d), ^{160}Gd(α,t), and ^{162}Dy(t,α) reactions.

For calculations of the wave functions for some of these levels, see 1972So12 or 1973Ga29 and 1970WeZS. For a discussion of the band assignments, see 1975Ni03.

The contributions of Nilsson states and vibrations to the various bandheads have been calculated by 1970WeZS, 1971SoZW, 1972So12, 1973Ga29, and 1983So01. The last four articles have some authors in common and similar results. These contributions are greater than 90% for the 3/2$^+$[411], 5/2$^+$[413], and 5/2$^-$[532] bandheads. For spins of 7/2 and greater, the 7/2$^-$[523] and 5/2$^-$[532] bands are mixed, with the main contributions being 63% to 73% in the 7/2$^-$ levels and less at 9/2$^-$. For the 1/2$^+$[411] bandhead, the various calculations give a 54% to 73% contribution from the Nilsson state and 24% to 35% contribution from a vibrational state based on the 3/2$^+$[411] ground state. For the 5/2$^+$[402] band, the calculations give a 65% contribution from the Nilsson state and 11% and 12% from two vibrational states. 1970WeZS also give the calculated contributions for the first one or two rotational states in these bands.

^{161}Tb Levels

Additional information 2.

Cross Reference (XREF) Flags

A	^{160}Gd(p,p) IAR
B	^{161}Gd β^- decay
C	^{160}Gd(^{3}He,d),^{160}Gd(α,t)
D	^{162}Dy(t,α)

E(level)[†]	J$^\pi$[‡#]	T$_{1/2}$	XREF	Comments
0.0[@]	3/2$^+$	6.89 d *2*	BCD	%β^-=100 μ=2.2 *1*; Q=+1.2 *6* J$^\pi$: J measured by atomic-beam, magnetic resonance (1964Bu09). Calculated μ (1989Be04) consistent with 3/2[411]. Hence, π=+. T$_{1/2}$: weighted average of: 6.75 d *10* (1949Bu01); 7.2 d *2* (1950He18); 6.8 d *1* (1952Co33); 7.2 d *5* (1955Ba90); 6.9 d *1* (1956Bi55); 6.88 d *10* (1963Ho15); 7.3 d *6* (1964Fu11); 6.90 d *2* (1971Ba28); 6.91 d *5* (1985An25); and 6.8985 d *5* (1989Ab22, from the same group as 1985An25). Because of the large reduced-χ^2 value implied using the listed uncertainties, the following choices were adopted in computing this average: the quoted uncertainty in the 1971Ba28 value (0.02 d) was increased to 0.04 d; the value, 7.20 d *7*, of 1958Ba44 was not included; and the quoted uncertainty (0.0005 d) in the value from 1989Ab22 was increased to 0.05 d. (Note that even doubling the uncertainties in the last two T$_{1/2}$ values included in the average does not materially alter the adopted value.) Other half-lives, without uncertainties, are given by 1955Fo18, 1956Co58, 1956Sm10, and 1972WyZZ. μ,Q: from 1989Ra17 evaluation and based on $\gamma(\theta$,t) data for ^{161}Tb β^- decay (1983Ri15) of oriented nuclei. The same values are listed in the compilation by 2005St24.
56.289[@] *9*	5/2$^+$		BCD	

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Adopted Levels, Gammas (continued)

^{161}Tb Levels (continued)

E(level)[†]	J^{π}[‡#]	$T_{1/2}$	XREF	Comments
133.681[@] *11*	7/2$^+$		BCD	
230.72[@] *7*	9/2$^+$		BCD	XREF: C(236)D(233).
314.914[&] *11*	5/2$^+$		BCD	J^{π}: M1+E2 γ's to 3/2$^+$ and 7/2$^+$ levels.
394.364[&] *17*	7/2$^+$		BCD	
417.228[a] *13*	7/2$^-$	0.88 ns *2*	BCD	J^{π}: E1 γ's to 5/2$^+$ and 7/2$^+$ levels, and log *ft*=4.86 in β^- decay. This log *ft* value indicates that the β- transition is allowed-unhindered. In this mass region, such a transition connects the neutron and proton Nilsson orbitals 5/2[523] and 7/2[523], respectively. This establishes the J^{π} assignments for both levels and also provides the conf assignments for them. $T_{1/2}$: weighted average of 0.87 ns *5* (1964Lo09), 0.84 ns *4* (1965Ma24) and 0.90 ns *3* (1969Be54) from ^{161}Gd β^- decay.
480.130[b] *12*	5/2$^-$	<0.1 ns	B d	XREF: d(486). J^{π}: E1 γ to 5/2$^+$ level and γ's to 3/2$^+$, 7/2$^+$, and 7/2$^-$. $T_{1/2}$: from ^{161}Gd β^- decay (1967Ma33). Other: <0.2 ns from ^{161}Gd β^- decay (1965Ma24).
488.78[a] *3*	9/2$^-$		BCd	XREF: d(486).
499[&]	9/2$^+$		CD	
520[c] *3*	1/2$^+$		CD	
558[c] *3*	3/2$^+$		CD	
584[a] *3*	11/2$^-$		Cd	
585.776[b] *15*	7/2$^-$	<0.2 ns	B d	J^{π}: J from $\gamma\gamma(\theta)$ (1974OkZW) and π from band assignment. $T_{1/2}$: from ^{161}Gd β^- decay (1965Ma24).
602[c] *3*	5/2$^+$		CD	
638 *4*			C	
698[c] *3*	7/2$^+$		Cd	XREF: d(699).
707.19[b] *25*	9/2$^-$		B d	XREF: d(699). J^{π}: from band structure deduced in (t,α).
743 *3*			C	
772 *5*			C	
847[b] *3*	11/2$^-$		CD	
920[d] *3*	1/2$^-$		CD	
950[d] *3*	5/2$^-$		CD	
980[f]	1/2$^+$		D	
997[g] *3*			CD	J^{π}: Proposed doublet, from (t,α), consisting of 7/2$^+$,7/2[404] and 3/2$^+$,1/2[411].
1020[d] *3*	3/2$^-$		C	
1064[d] *3*	9/2$^-$		C	
1080[f] *3*	(5/2$^+$)		CD	J^{π}: In (t,α), a 1078 level is assigned as a doublet consisting of 9/2$^-$,1/2[541] and 5/2$^+$,1/2[411]. Note that here the 9/2$^-$ state is placed at 1064 keV.
1111 *3*			CD	
1130 *3*			CD	
1141 *4*			C	
1149.88 *7*	(3/2$^+$)		B	J^{π}: Proposed in β^- decay as the bandhead of a β vibration built on the g.s. (J^{π}=3/2$^+$).
1178[d] *3*	7/2$^-$		CD	
1209.72 *9*			BCD	
1232 *3*			CD	
1252.37[e] *6*	5/2$^+$		BCD	
1281 *2*			D	J^{π}: assigned, in (t,α), as a doublet of the 3/2$^+$ and 5/2$^+$ members of the 1/2[420] band.
1302 *3*			C	
1333			D	

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Adopted Levels, Gammas (continued)

^{161}Tb Levels (continued)

E(level)†	Jπ‡#	L	XREF	Comments
1349.66 *5*			BCD	
1386 *3*			CD	
1404.68 *12*			BC	
1420.62 *7*			BC	
1433 *3*			C	
1436 *2*			D	J^π: assigned, in (t,α), as a doublet of the $7/2^+$ and $9/2^+$ members of the 1/2[420] band.
1460.54 *10*			B	
1477.63 *11*			B	
1498 *3*			C	
1524			D	
1533.80 *9*			BC	
1537.43 *8*			B	
1552.17 *12*			B D	
1558.18 *11*			BC	
1601.02 *7*			BC	
1623.11 *7*			B	
1655.81 *7*			B D	
1680 *3*			C	
1718 *8*			C	
1756 *3*			C	
1778.19 *12*			BC	XREF: C(1782).
1810.75 *12*			BC	
1825.2 *3*			B D	
1845			D	
1853.6 *3*			BC	
1856.95 *22*			B	
1900[d]	$11/2^-$		D	
1946			D	
1979			D	
17040	$(5/2^-)$		A	J^π: If level is the isobaric analog of the ^{161}Gd g.s.
17113	$(7/2^-)$		A	J^π: If level is the isobaric analog of the 72 level in ^{161}Gd.
17353	$(3/2^-)$	1	A	J^π: If level is the isobaric analog of the 314 level in ^{161}Gd.
17369	$(1/2^-)$	1	A	J^π: If level is the isobaric analog of the 355 level in ^{161}Gd.
17478	$(5/2^-)$	3	A	J^π: If level is the isobaric analog of the 438 level in ^{161}Gd.
17569	$(7/2^-)$		A	J^π: If level is the isobaric analog of the 529 level in ^{161}Gd.
17874	$(1/2^-,3/2^-)$	1	A	J^π: If level is the isobaric analog of the 834 level in ^{161}Gd.
17929	$(7/2^-)$	3	A	J^π: If level is the isobaric analog of the 889 level in ^{161}Gd.

† From least-squares fit to γ energies for ^{161}Gd decay and otherwise from reactions.

‡ J^π and band assignments are from agreement of calculated cross sections for (^{3}He,d), (α,t), and (t,α) reactions with measured cross sections and intensity patterns and level spacings within bands. Other J^π arguments are noted explicitly.

See levels from ^{161}Gd β^- decay for possible band assignment for β-vibrational bandheads at 1149 and 1349 keV and 3/2[541] band at 1477 keV.

@ Band(A): 3/2[411] band. A=11.47 keV, B=−17 eV.

& Band(B): 5/2[413] band. A=11.35 keV.

a Band(C): 7/2[523] band. A=7.95 keV.

b Band(D): 5/2[532] band. A=17.54 keV.

c Band(E): $K^\pi=1/2^+$ band. A=11.2 keV, a=+0.19. The assigned configuration is the 1/2[411] Nilsson orbital mixed with the K−2 γ-vibrations based on the 3/2[411] g.s. and on the 5/2[413] state at 314 keV.

d Band(F): 1/2[541] band. A=9.5 keV, a=+2.4.

e Band(G): 5/2[402] bandhead.

f Band(H): fragment of 1/2[411].

g Band(I): 7/2[404] bandhead.

Adopted Levels, Gammas (continued)

$\gamma(^{161}Tb)$

E_i(level)	J_i^π	E_γ[†]	I_γ	E_f	J_f^π	Mult.[‡]	δ[#]	α[@]	Comments
56.289	5/2+	56.290 *12*	100	0.0	3/2+	M1		16 *3*	
133.681	7/2+	77.393 *10*	100 *9*	56.289	5/2+	M1+E2	0.12 *1*	4.63	
		133.68 *2*	15 *2*	0.0	3/2+			0.915	
230.72	9/2+	97.04 *7*	100	133.681	7/2+			2.7 *3*	
314.914	5/2+	181.232 *12*	3.3 *1*	133.681	7/2+	M1+E2	≈−0.87	0.371 *25*	
		258.62 *3*	4.3 *2*	56.289	5/2+	M1+E2	−0.6 +*3*−*2*		
		314.92 *2*	100 *4*	0.0	3/2+	M1+E2	+0.29 *6*		
394.364	7/2+	79.41 *4*	3.5 *6*	314.914	5/2+			5.2 *10*	
		338.07 *2*	100 *6*	56.289	5/2+	M1+E2	+0.08 *3*		
		394.34 *6*	13 *1*	0.0	3/2+				
417.228	7/2−	102.315 *10*	23.1 *13*	314.914	5/2+	E1		0.283	B(E1)(W.u.)=4.0×10^{-5} *3*
		283.55 *3*	9.9 *4*	133.681	7/2+	E1		0.0191	B(E1)(W.u.)=8.0×10^{-7} *4*
		360.94 *2*	100. *2*	56.289	5/2+	E1		0.01051	B(E1)(W.u.)=3.91×10^{-6} *14*
		417.0 *4*	0.51 *7*	0.0	3/2+	[M2]		0.1524	B(M2)(W.u.)=0.34 *5*
480.130	5/2−	62.910 *25*	2.2 *7*	417.228	7/2−	[M1+E2]		12 *4*	
		85.79 *7*	5.6 *11*	394.364	7/2+	[E1]		0.453	B(E1)(W.u.)>8.2×10^{-5}
		165.213 *15*	96. *7*	314.914	5/2+	E1		0.0780	B(E1)(W.u.)>0.00020
		423.86 *7*	6.7 *11*	56.289	5/2+	[E1]		0.00718	B(E1)(W.u.)>8.1×10^{-7}
		480.12 *2*	100. *6*	0.0	3/2+	[E1]		0.00539	B(E1)(W.u.)>8.4×10^{-6}
488.78	9/2−	71.57 *3*	100	417.228	7/2−			7.6 *18*	
585.776	7/2−	97.04 *7*	≤11.4	488.78	9/2−			2.7 *3*	
		105.64 *2*	58 *8*	480.130	5/2−			2.00 *13*	
		168.47 *7*	6.5 *9*	417.228	7/2−			0.46 *5*	
		191.38 *3*	50.4 *24*	394.364	7/2+			0.0528	
		270.87 *5*	69 *3*	314.914	5/2+			0.0214	
		452.2 *2*	4.7 *8*	133.681	7/2+				
		529.50 *2*	100 *6*	56.289	5/2+				
707.19	9/2−	121.7 *3*	100	585.776	7/2−			1.265 *24*	
1149.88	(3/2+)	835.0 *3*	≤9.2	314.914	5/2+				
		1093.52 *9*	53. *3*	56.289	5/2+				
		1149.94 *9*	100. *5*	0.0	3/2+				
1209.72		1153.43 *12*	83 *11*	56.289	5/2+				
		1209.72 *11*	100 *8*	0.0	3/2+				
1252.37	5/2+	772.18 *10*	39 *3*	480.130	5/2−				
		835.0[&] *3*	≤12	417.228	7/2−				
		857.93 *11*	22.8 *22*	394.364	7/2+				
		937.53 *9*	100 *5*	314.914	5/2+				
		1252.42 *12*	19.7 *13*	0.0	3/2+				
1349.66		955.35 *8*	28.8 *15*	394.364	7/2+				
		1034.72 *8*	100 *3*	314.914	5/2+				
		1349.60 *9*	18.6 *11*	0.0	3/2+				
1404.68		818.9 *3*	<47	585.776	7/2−				
		924.55 *12*	100 *11*	480.130	5/2−				
1420.62		835.0[&] *3*	32 *7*	585.776	7/2−				
		1026.25 *10*	100 *7*	394.364	7/2+				
		1105.84 *13*	48 *4*	314.914	5/2+				
		1364.19 *13*	42 *5*	56.289	5/2+				
1460.54		972.3 *8*	<22	488.78	9/2−				
		1066.22 *12*	100 *10*	394.364	7/2+				
		1145.50 *18*	62 *14*	314.914	5/2+				
1477.63		1344.2 *4*	<45	133.681	7/2+				
		1421.37 *15*	100 *8*	56.289	5/2+				
		1477.55 *15*	<164	0.0	3/2+				
1533.80		947.75 *24*	30 *3*	585.776	7/2−				

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Adopted Levels, Gammas (continued)

$\gamma(^{161}Tb)$ (continued)

E_i(level)	J^π_i	E_γ [†]	I_γ	E_f	J^π_f
1533.80		1053.7 *3*	<31	480.130	5/2$^-$
		1400.13 *12*	100 *7*	133.681	7/2$^+$
		1477.55 *15*	<83	56.289	5/2$^+$
		1533.87 *15*	79 *6*	0.0	3/2$^+$
1537.43		951.10 *22*	28. *3*	585.776	7/2$^-$
		1048.75 *12*	95. *10*	488.78	9/2$^-$
		1143.15 *12*	100. *10*	394.364	7/2$^+$
		1480.9 *3*	20.0 *25*	56.289	5/2$^+$
1552.17		1063.4 *2*	100 *16*	488.78	9/2$^-$
		1135.2 *4*	52 *11*	417.228	7/2$^-$
		1495.82 *16*	<122	56.289	5/2$^+$
1558.18		1424.3 *2*	67 *5*	133.681	7/2$^+$
		1501.8 *2*	59 *5*	56.289	5/2$^+$
		1558.33 *15*	100 *8*	0.0	3/2$^+$
1601.02		1015.10 *14*	29 *5*	585.776	7/2$^-$
		1112.20 *15*	43 *12*	488.78	9/2$^-$
		1120.92 *10*	100 *7*	480.130	5/2$^-$
		1286.4 *4*	9.3 *17*	314.914	5/2$^+$
		1544.80 *14*	27.6 *19*	56.289	5/2$^+$
1623.11		1228.72 *14*	37 *3*	394.364	7/2$^+$
		1308.27 *10*	100 *7*	314.914	5/2$^+$
		1489.42 *15*	47 *3*	133.681	7/2$^+$
1623.11		1567.0 *6*	<5.1	56.289	5/2$^+$
		1622.95 *15*	<77	0.0	3/2$^+$
1655.81		1175.82 *11*	100. *10*	480.130	5/2$^-$
		1261.11 *11*	98. *5*	394.364	7/2$^+$
		1341.10 *12*	83. *8*	314.914	5/2$^+$
1778.19		1071.5 *4*	<40	707.19	9/2$^-$
		1192.42 *15*	100. *15*	585.776	7/2$^-$
		1297.9 *2*	71. *12*	480.130	5/2$^-$
		1547.5 *5*	<29	230.72	9/2$^+$
1810.75		1224.93 *20*	100 *18*	585.776	7/2$^-$
		1495.82 *16*	<159	314.914	5/2$^+$
		1677.3 *4*	50 *9*	133.681	7/2$^+$
1825.2		1430.7 *6*	<55	394.364	7/2$^+$
		1691.7 *4*	100. *17*	133.681	7/2$^+$
		1768.6 *5*	<90	56.289	5/2$^+$
1853.6		1373.2 *5*	<137	480.130	5/2$^-$
		1459.5 *5*	<133	394.364	7/2$^+$
		1538.7 *5*	100 *25*	314.914	5/2$^+$
		1622.95 *15*	<946	230.72	9/2$^+$
1856.95		1271.8 *5*	<58	585.776	7/2$^-$
		1376.7 *3*	100. *15*	480.130	5/2$^-$
		1439.5 *4*	85. *12*	417.228	7/2$^-$

[†] See ^{161}Gd β^- decay for unplaced γ's.

[‡] From ^{161}Gd β^- decay (1976Hn01,1959Sc29). From K x ray/γ and L_1/M ratios for 56γ (1959Sc29,1976Hn01) and α(K)exp for all other γ's with the γ and ce data scaled to the theoretical M1 value for the 56-keV γ.

[#] From $\gamma\gamma(\theta)$ in ^{161}Gd β^- decay (1974OkZW).

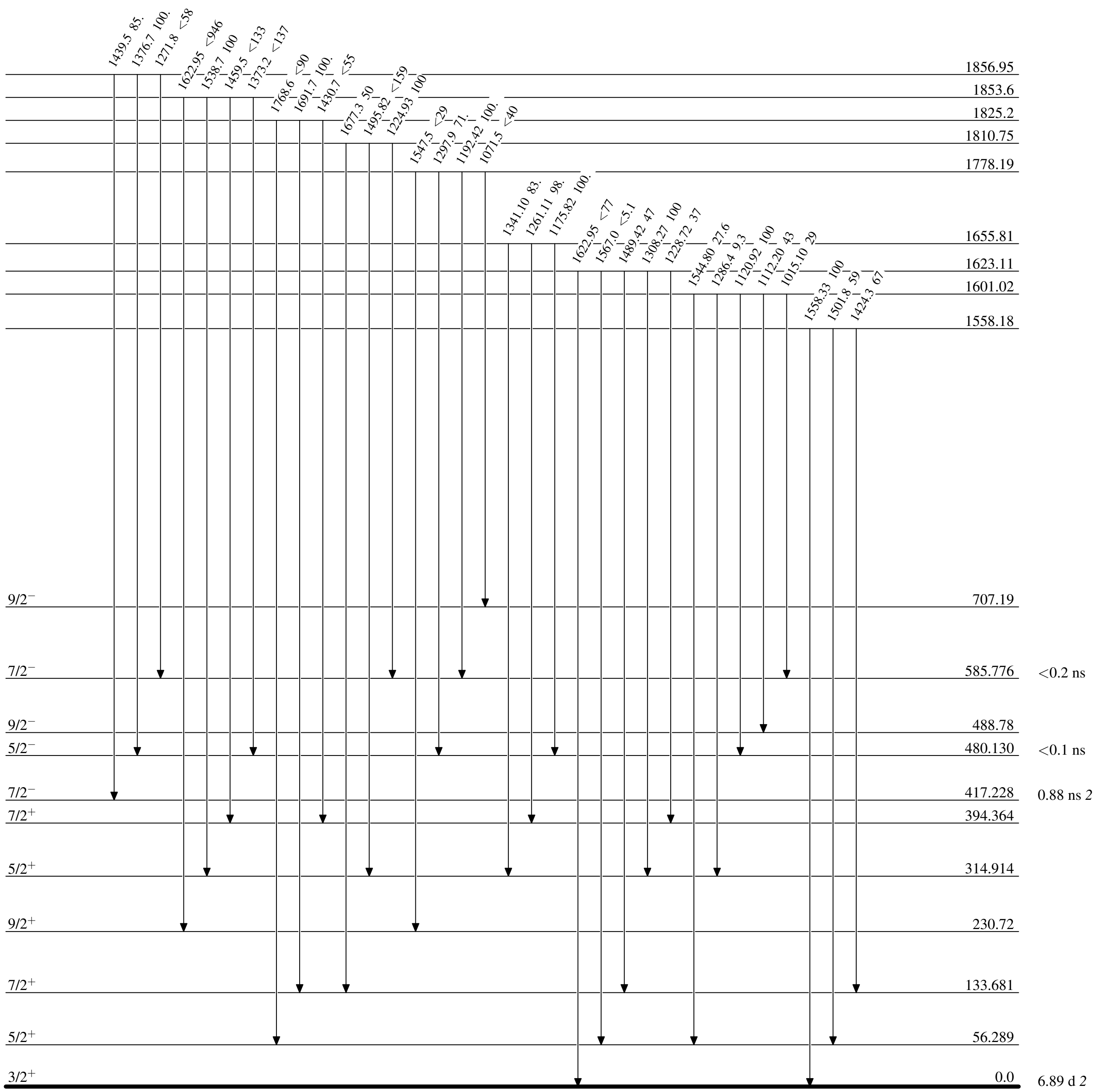
[@] Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

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

Adopted Levels, Gammas

Level Scheme

Intensities: Relative photon branching from each level

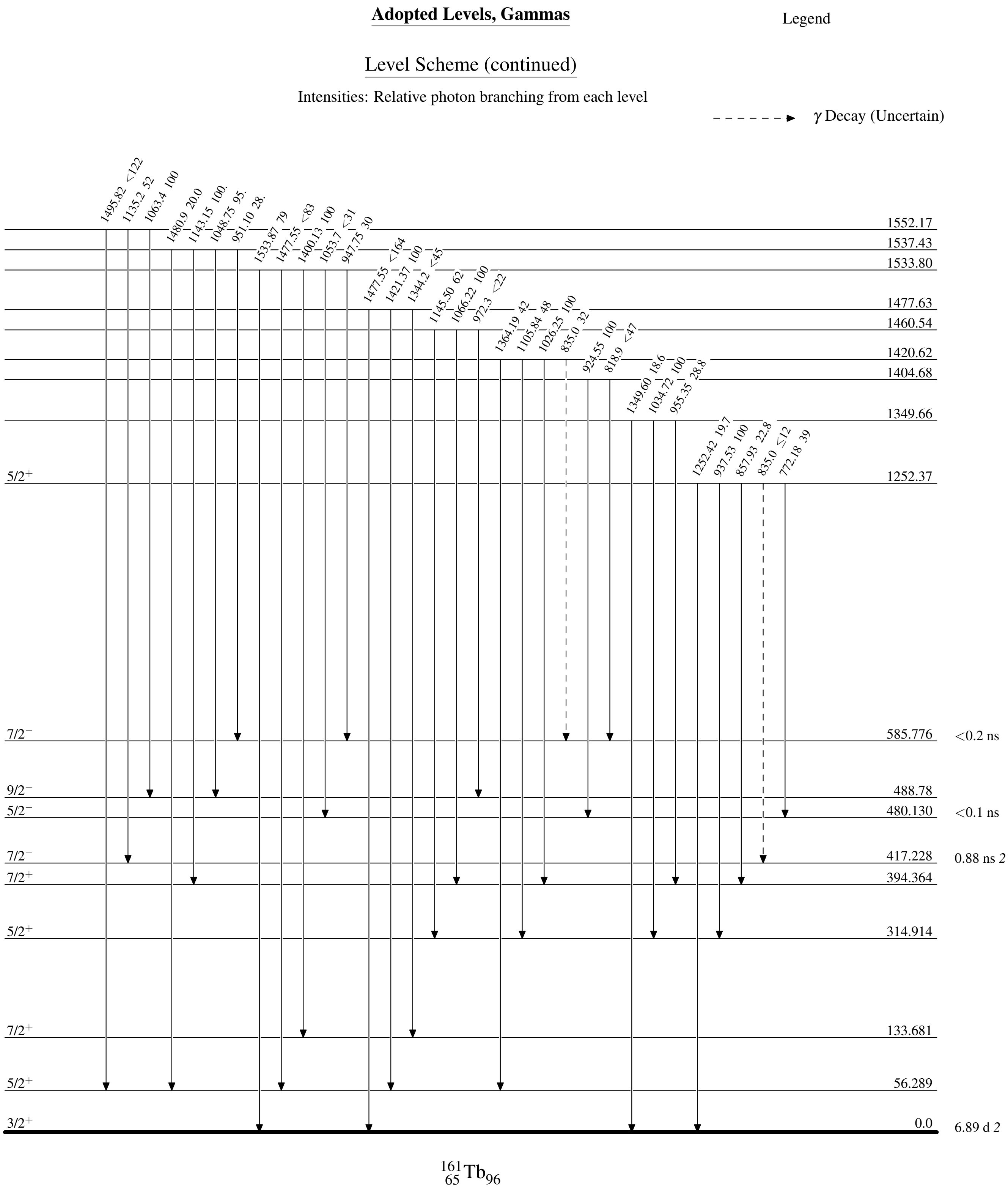


$^{161}_{65}Tb_{96}$

Adopted Levels, Gammas

Level Scheme (continued)

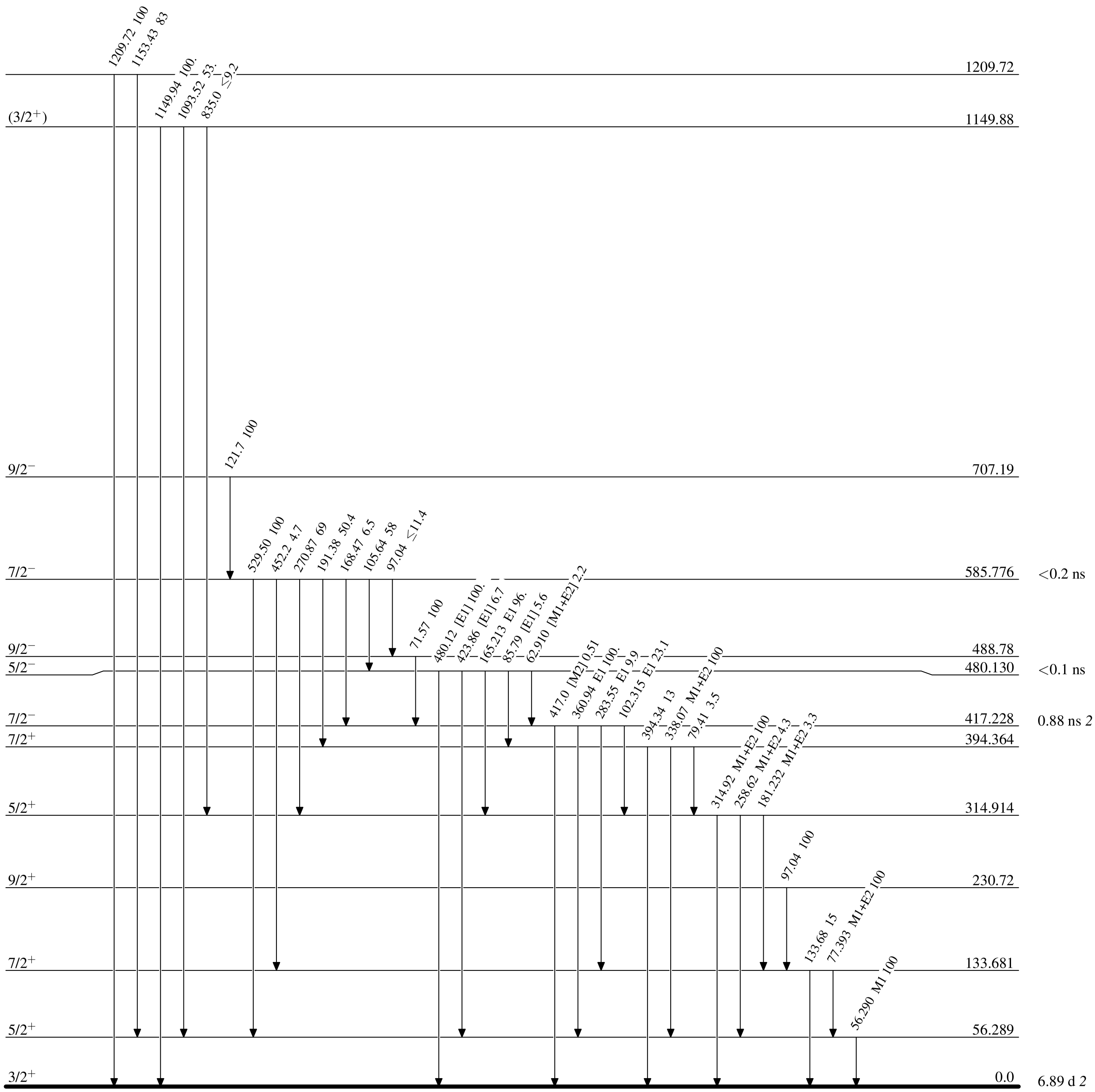
Intensities: Relative photon branching from each level



Adopted Levels, Gammas

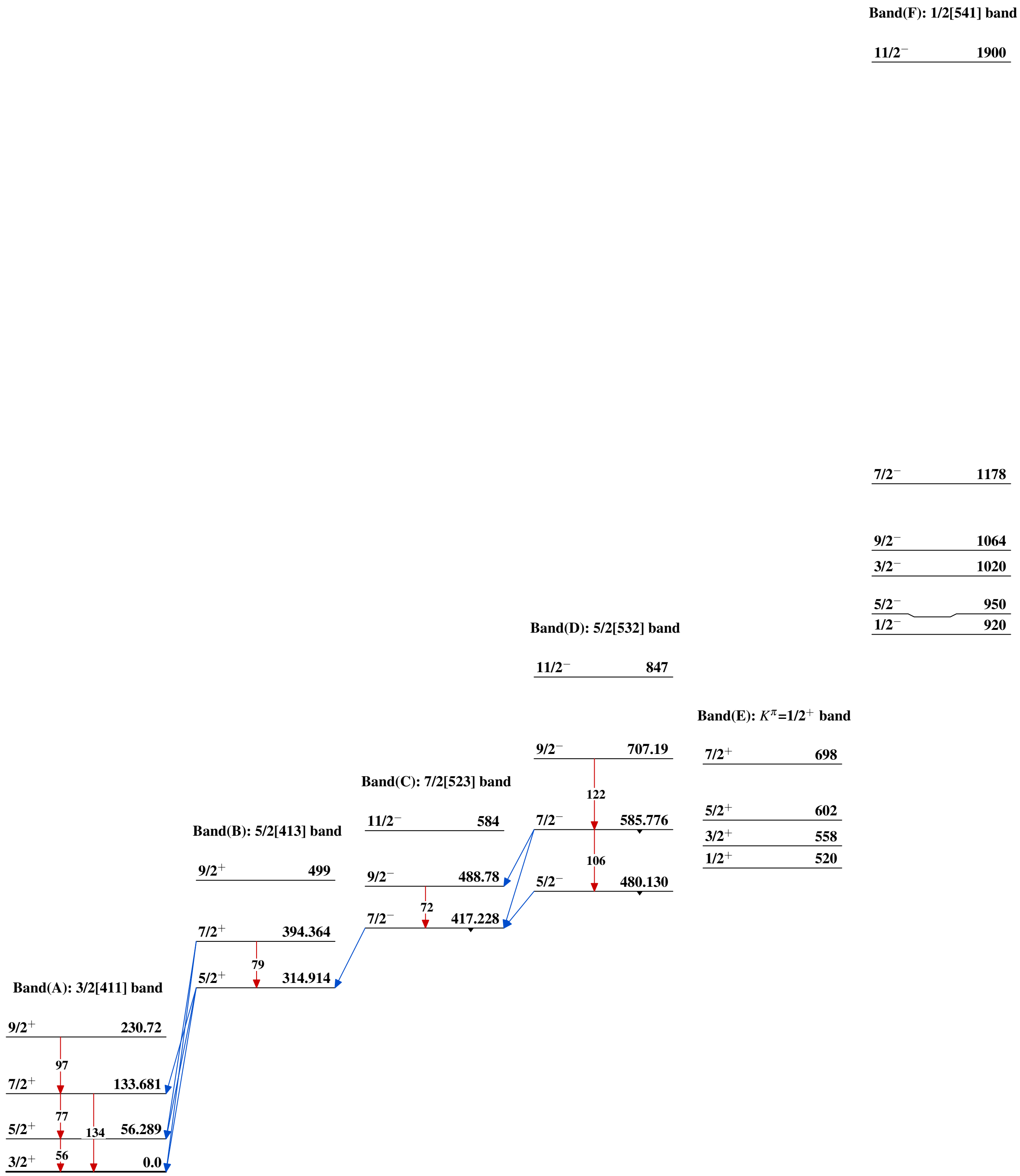
Level Scheme (continued)

Intensities: Relative photon branching from each level



${}^{161}_{65}Tb_{96}$

Adopted Levels, Gammas



$^{161}_{65}Tb_{96}$

Adopted Levels, Gammas (continued)

$^{161}_{65}Tb_{96}$