Coulomb excitation

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	N. Nica	NDS 200,2 (2025)	22-Aug-2022

Additional information 1.

The B(EL) values given here are from 1970RiZY, 1977Ro08, 1977Ro26, 1977Sc33, 1977Wo02, 1977Wo03 and 1993Su16; and the lifetimes are from 1972Ru07, 1975Wa15, 1977Si18 and 2004To09. Other Coulomb-excitation measurements include 1960El07, 1964Al25, 1965Yo04, and 1970Be36.

Experimental methods:

1960El07: Coulomb excitation with p and d, with E=4.5 for p and d. p′ and d′ measured in magnetic spectrometer.

1964Al25: excitation with ^{14}N, E=37 MeV; γ measured.

1965Yo04: excitation with ^{16}O, E=43.5 MeV; γ measured with NaI detector and scattered ^{16}O with Si(Au) detectors.

1970Be36: ^{16}O, E ≈ 36 MeV; measured $\gamma(\theta,H)$ with recoil-into-gas technique for g factor.

1970RiZY: α, E(α)=15 MeV. α' measured in magnetic spectrometer, and (^{16}O,^{16}O′), E(^{16}O)=30-56 MeV. Report B(E2) to 2^+ of β- and γ-vibrational bands.

1972Ru07: ^{35}Cl, E=100 MeV; measured lifetimes by Doppler-shift, recoil-distance method for 4^+, 0^+, and 6^+ levels.

1975Wa15: ^{35}Cl, E=130-135 MeV; measured lifetimes by Doppler-broadened lineshape method for 6^+, 8^+ and 10^+ levels.

1977Ro08: α, E(α)=11-17 MeV; α' measured in magnetic spectrometer; report B(E2) for three 2^+ levels.

1977Ro26: same as 1977Ro08; report M(E2) for first 2^+ level.

1977Sc33: α, E(α)=11.8 MeV; α' measured with Si(Au) detector; report M(E2) and M(E4) for first 2^+ and 4^+ levels.

1977Si18: same as 1975Wa15; same results as 1975Wa15.

1977Wo02: α, E(α)=11.8 MeV; α' measured with Si(Au) detector. Report M(E2) and M(E4) for first 2^+ and 4^+ levels.

1977Wo03: same as 1977Wo02; report B(E2) to 2^+ of β- and γ-vibrational bands, B(E2) from first 2^+ to second 0^+, and B(E3) to 3^- level.

1993Su16: ^{58}Ni, E=228 MeV, ^{48}Ti, E=178 MeV, and ^{32}S, E=118 MeV; γ's measured using 20 Compton-suppressed Ge detectors of the Nordball system in coincidence with backscattered particles which were detected in 5 position-sensitive Si detectors and one annular Si detector.

2004To09: ^{32}S, E(^{32}S)=110 MeV. Enriched (98%) target. γ's detected in the Euroball detector placed at 0° with respect to the beam axis together with four additional high-efficiency Ge detectors at a backward angle of 144°. Backscattered particles were detected by photodiode cells. Measured lifetimes of 6 levels using the the recoil-distance Doppler-shift method.

^{154}Gd Levels

E(level)	J^π[‡]	$T_{1/2}$[#]	Comments
0.0[@]	0^+	stable	
123.1[@]	2^+	1.183 ns *12*	B(E2)↑=3.86 *3*; g=0.427 *14* $T_{1/2}$: Computed from the listed B(E2)↑ and the measured α value (1.197 *14*) from ^{154}Eu β^- decay. This agrees well with the 1.184 ns *5* value, measured in ^{154}Eu β^- decay. B(E2)↑: Weighted average of 3.85 *8* (1977Ro08 and 1977Ro26), 3.90 *6* (1977Sc33), and 3.83 *4* (1977Wo02). The latter two were quoted as E2 matrix elements. Others: 3.4 *3* (1960El07); 3.36 (1993Su16). μ: From 1970Be36. Other: 0.45 *5* (1970Be36).
371.2[@]	4^+	45.6 ps *8*	B(E4)↑=0.33 *6* $T_{1/2}$: Weighted average of 46.0 ps *15* (1972Ru07) and 45.4 *10* (2004To09). B(E4)↑: Weighted average of the square of the E4 matrix elements 0.53 *7* (1977Sc33) and 0.64 *+6−7* (1977Wo02). B(E2)↑: B(E2,$2^+ \rightarrow 4^+$)=1.43 (1964Al25). From this B(E2)↑ value, one computes a half-life for the 371-keV level of 68 ps.
680[&]	0^+	4.56 ps *27*	$T_{1/2}$: Weighted average of 4.0 ps *6* (1972Ru07) and 4.7 *3* (2004To09). B(E2)↑: B(E2) for transition from 2^+ of ground-state band to 0^+ of β-vibrational band deduced to be 0.043 *+13−14* (1977Wo03).
718.2[@]	6^+	8.26 ps *25*	$T_{1/2}$: Weighted average of 7.8 ps *4* (1972Ru07) and 8.40 *22* (2004To09).
815[&]	2^+	6.4 ps *7*	B(E2)↑=0.020 *3*

Continued on next page (footnotes at end of table)

Coulomb excitation (continued)

^{154}Gd Levels (continued)

E(level)	J^{π}‡	$T_{1/2}$#	Comments
			$T_{1/2}$: From 2004To09. From the B(E2)↑ value, $T_{1/2}$=6.9 ps *10* is computed. B(E2)↑: Weighted average of 0.024 *4* (1970RiZY), 0.015 *4* (1977Ro08), and 0.020 *+3–4* (1977Wo03). Others: 0.12 *8* (1965Yo04); 0.111 (1993Su16). Note that this value is not the one that is adopted.
996[a]	2^+	0.89 ps *3*	B(E2)↑=0.147 *5* $T_{1/2}$: Computed from B(E2)↑ value. B(E2)↑: Weighted average of 0.157 *11* (1970RiZY), 0.143 *11* (1977Ro08), and 0.145 *+7–6* (1977Wo03). Others: 0.13 *5* (1965Yo04); 0.058 (1993Su16).
1047[&]	4^+	7.6 ps *4*	E(level): Nominal value, 2004To09 are the only ones to report this level in Coul. ex., but do not list its energy. $T_{1/2}$: From 2004To09.
1145[@]	8^+	2.57 ps *10*	$T_{1/2}$: Weighted average of 2.56 ps *14* (1975Wa15 and 1977Si18) and 2.58 *14* (2004To09).
1241.3[†b]	1^-		B(E1)↑=0.00243 B(E1)↑: From 1993Su16.
1251.6[†b]	3^-		B(E3)↑=0.21 *5* B(E3)↑: From 1977Wo03. Other: 0.041 (1993Su16).
1617.1[†]	3^-		B(E3)↑=0.030 B(E3)↑: From 1993Su16. E(level): 3^- member of the $K^{\pi}=1^-$ octupole band.
1638[@]	10^+	1.11 ps *14*	$T_{1/2}$: From 1975Wa15 and 1977Si18.

† Nominal value from Adopted Levels; authors do not give this level energy.
‡ From Adopted Levels.
# Values given here are from Coulomb-excitation experiments only; see Adopted Levels for summary of all measurements.
@ Band(A): $K^{\pi}=0^+$ ground-state band.
& Band(B): $K^{\pi}=0^+$ probable β-vibrational band.
a Band(C): $K^{\pi}=2^+$ γ-vibrational band.
b Band(D): $K^{\pi}=0^-$ octupole band.

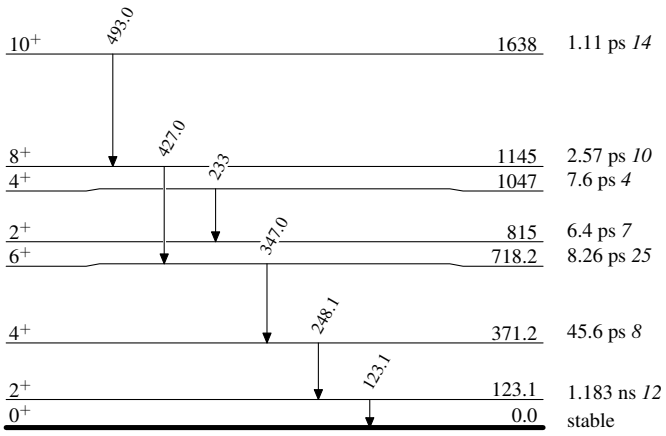
$\gamma(^{154}Gd)$

E_{γ}†	E_i(level)	J_i^{π}	E_f	J_f^{π}	Comments
123.1	123.1	2^+	0.0	0^+	
233	1047	4^+	815	2^+	E_{γ}: Nominal value, listed by 2004To09.
248.1	371.2	4^+	123.1	2^+	
347.0	718.2	6^+	371.2	4^+	
427.0	1145	8^+	718.2	6^+	
493.0	1638	10^+	1145	8^+	

† From 1977Si18.

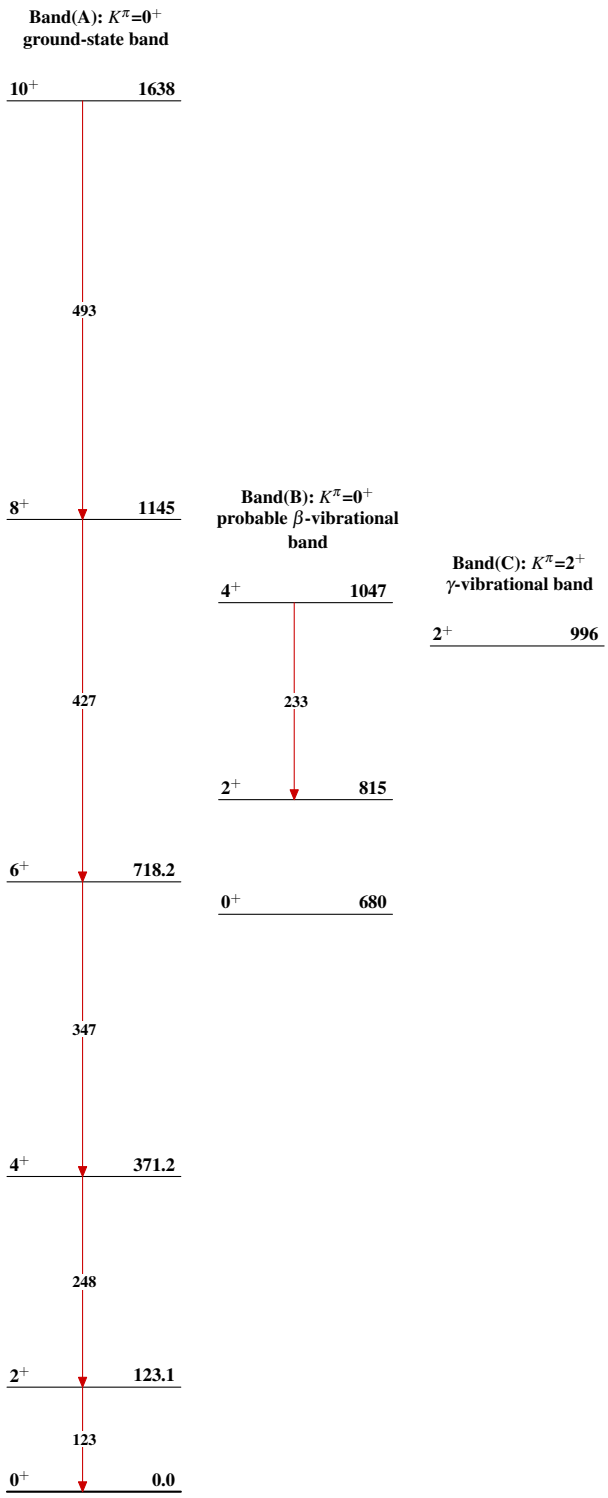
Coulomb excitation

Level Scheme



$^{154}_{64}Gd_{90}$

Coulomb excitation



$^{154}_{64}Gd_{90}$

Coulomb excitation (continued)

Band(D): $K^{\pi}=0^{-}$ octupole band

3^{-} 1251.6

1^{-} 1241.3

$^{154}_{64}Gd_{90}$