Coulomb excitation

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	N. Nica	NDS 176, 1 (2021)	1-May-2021

Additional information 1.
^{160}Gd(x,x′), (x,x′γ).
1958Ch36: x=p, E=1.8 MeV, curved crystal, Eγ only.
1959Bi10: x=p, E=2.8 MeV.
1960El07: x=p,d, E=4.5 MeV.
1961Go09: x=p, E=1.8, 3.18 MeV, thick target $\sigma(\gamma)$.
1962Af01: x=^{14}N, E=50 MeV.
1963Gr04: x=^{16}O, E=14-50 MeV. Measured Ice.
1964De07: x=^{16}O, E=18-44 MeV.
1965Yo04: x=^{16}O, E=43.5 MeV.
1967Wo06: x=p, $\gamma(\theta$,H,t).
1968Ri09: x=p, E=3.5 MeV.
1969Av01: x=^{16}O, E=30 MeV, delayed coincidence (^{16}O′-γ).
1970Be36: x=^{16}O, E ≈ 36 MeV, recoil into gas.
1970Ru04: x=^{35}Cl, E=64 MeV.
1971Sp06: x=α, E=4-4.5 MeV.
1972Er04: x=α, E=11-13 MeV.
1974Ba81: x=α, E=11-12.5 MeV, $\sigma(\alpha')/\sigma(\alpha)$.
1974Sh12: x=α, E=11.50-12.25 MeV.
1977Ro08: x=α, E=11-17 MeV, $\sigma(\alpha,\theta)$.
1977Ro26: x=α, E=11.5-14 MeV.
1981Mc06: x=α, E=13.5 MeV, Eγ,Iγ,$\gamma(\theta)$.
1983Ha24: x=^{34}S,^{63}Cu; E(^{34}S)=various energies from 58 to 130 MeV, E(^{63}Cu)=230 MeV; natural Gd targets; large-volume (≈85 cm^3) Ge(Li) detectors; measured I$\gamma(\theta$, H); deduced g-factors for g.s.-band levels up to J=10.
1991St01: x=^{58}Ni, E=160 MeV; natural Gd target attached to a Pb-backed Fe foil using a layer of In. Measured simultaneously transient-field precessions for levels in ground-state bands of ^{156}Gd, ^{158}Gd and ^{160}Gd. Deduced g-factors of first 4$^+$ and 6$^+$ states in ^{160}Gd.
1993Su16: x=^{58}Ni; E(^{58}Ni)=225 MeV; Gd target, thickness=0.935 mg/cm^2, chemical form and isotopic enrichment not given; γ rays detected using 20 BGO Compton-suppressed Ge detectors of the "Nordball" system in coincidence with back-scattered ^{58}Ni ions, which were detected in five position-sensitive Si detectors and one annular-type Si detector. Each position-sensitive detector covered a scattering angle from 101.1° to 144.0°, and the annular detector counted the ions scattered into an angular range from 163.9° to 176.4°. γ-ray energies were corrected for Doppler shift using the position information. Measured Eγ, $\gamma\gamma$ coin, particle-$\gamma\gamma$ coin. Iγ not given. Members of the g.s. band (up to J=16), the γ-vib band (up to J=12), and the K^π=0$^-$ octupole band (up to J=11) were reported.
Others: 1980Ha52, 1970Ru04.
For calculated values of the charge deformation parameters β_2 and β_4 see 1974Sh12 and 1972Er04.

^{160}Gd Levels

E(level)[†]	J$^\pi$[‡]	T$_{1/2}$	Comments
0.0[#]	0$^+$		
75.26[#] *1*	2$^+$	2.72 ns *1*	B(E2)↑=5.19 *4*; g=+0.364 *17* E(level): from energy of deexciting γ (1958Ch36). T$_{1/2}$: weighted average of: 2.72 ns *1* (1971Sp06) delayed coincidence; 2.69 ns *6* (1969Av01) delayed coincidence; 2.68 ns *6* (1968Ri09) pulsed beam; and 2.72 ns *6* (1967Wo06) pulsed beam. Other: 2.52 ns *14* (1959Bi10) delayed coincidence. Assuming B(E2)=5.19 *4* and α=7.33 *10*, one computes T$_{1/2}$=2.71 ns *4*. B(E2)↑: weighted average of: 5.15 *6* (1977Ro08), 5.23 *7* (1974Sh12), 5.24 *9* (1972Er04). Others:

Continued on next page (footnotes at end of table)

Coulomb excitation (continued)

^{160}Gd Levels (continued)

E(level)[†]	J^{π}[‡]	$T_{1/2}$	Comments
			1960El07, 1961Go09, 1963Gr04. From 1974Sh12, one obtains B(E2)=5.25 *7* or 5.21 *7*, depending on how the quantal corrections are applied. The value listed here is the average of these two. g: From the compilation of 1995St11. Others: +0.323 *15* (1970Be36); and +0.303 *26* (1967Wo06). The + sign is that assigned by the evaluator.
248.3[#]	4^+		g=+0.38 *5* g: value normalized to g(2^+)=+0.387 *4* for ^{156}Gd (1991St01). The + sign is assigned by the evaluator. reduced matrix element M(E4; 0^+ to 4^+)=0.33 *5*. Weighted average of 0.35 *+9−7* (1977Ro26), 0.28 *+8−9* (1974Sh12), 0.36 *10* (1972Er04). Values determined from measured excitation probabilities.
514.4[#]	6^+		g=+0.38 *5* g: value normalized to g(2^+)=+0.387 *4* for ^{156}Gd (1991St01). The + sign is assigned by the evaluator.
867.3[#]	8^+		
988.2[@]	2^+	1.40 ps *6*	B(E2)↑=0.098 *4* B(E2)↑: weighted average of: 0.088 *4* (1981Mc06), 0.101 *3* (1977Ro08), 0.104 *4* (1974Ba81), 0.093 *15* (1965Yo04). $T_{1/2}$: from B(E2).
1058[@]	3^+		
1149[@]	4^+		
1224.8[&]	1^-		
1289.7[&]	3^-	0.051 ps *14*	B(E3)↑=0.120 *6* $T_{1/2}$: from 1981Mc06, Doppler-broadened lineshape. B(E3)↑: weighted average of 0.118 *7* (1981Mc06) and 0.127 *14* (1977Ro08).
1300[#]	10^+		g(10^+)/g(2^+)=0.93 *13* (1983Ha24).
1391[@]	6^+		
1426[&]	5^-		
1642[&]	(7^-)		
1716[@]	(8^+)		
1805.5[#]	12^+		
1940[&]	(9^-)		
2117[@]	(10^+)		
2312[&]	(11^-)		
2376.5[#]	14^+		
2581[@]	(12^+)		
3007.3[#]	16^+		

[†] For those levels assigned to one of the three bands listed here, the values are from 1993Su16, unless noted otherwise. These level energies and those of the associated γ rays are given only on the level scheme shown by 1993Su16. Since these latter values are quoted to the nearest keV only, the level-energy differences and the respective γ-ray energies do not always agree exactly.

[‡] From adopted values.

[#] Member of the ground-state band.

[@] Member of the γ-vibrational band.

[&] Member of the $K^{\pi}=0^-$ octupole band.

Coulomb excitation (continued)

$\gamma(^{160}Gd)$

E_γ [†]	E_i(level)	J_i^π	E_f	J_f^π	Mult.	δ	Comments
75.26 *1*	75.26	2^+	0.0	0^+			E_γ: from 1958Ch36 curved crystal.
173	248.3	4^+	75.26	2^+			
266	514.4	6^+	248.3	4^+			
325	1716	(8^+)	1391	6^+			
353	867.3	8^+	514.4	6^+			
401	2117	(10^+)	1716	(8^+)			
433	1300	10^+	867.3	8^+			
464	2581	(12^+)	2117	(10^+)			
506	1805.5	12^+	1300	10^+			
507[#]	2312	(11^-)	1805.5	12^+			
571	2376.5	14^+	1805.5	12^+			
631	3007.3	16^+	2376.5	14^+			
640	1940	(9^-)	1300	10^+			
740.0[‡]	988.2	2^+	248.3	4^+	E2		E_γ: γ not shown in the level scheme of 1993Su16. Mult.: from $\gamma(\theta)$ (1981Mc08) and RUL.
775	1642	(7^-)	867.3	8^+			
776	2581	(12^+)	1805.5	12^+			
810	1058	3^+	248.3	4^+			
817	2117	(10^+)	1300	10^+			
849	1716	(8^+)	867.3	8^+			
877	1391	6^+	514.4	6^+			
899.8[‡]	1149	4^+	248.3	4^+			
912	1426	5^-	514.4	6^+			
912.9[‡]	988.2	2^+	75.26	2^+	E2+(M1)	≥100	Mult.: from $\gamma(\theta)$ (1981Mc06) and RUL. δ: from $\gamma(\theta)$ (1981Mc06).
983	1058	3^+	75.26	2^+			
988.2[‡]	988.2	2^+	0.0	0^+	E2		Mult.: from $\gamma(\theta)$ (1981Mc08) and RUL.
1012	2312	(11^-)	1300	10^+			
1041.1[‡]	1289.7	3^-	248.3	4^+			
1073	1940	(9^-)	867.3	8^+			
1074	1149	4^+	75.26	2^+			
1128	1642	(7^-)	514.4	6^+			
1143	1391	6^+	248.3	4^+			
1150	1224.8	1^-	75.26	2^+			
1178	1426	5^-	248.3	4^+			
1202	1716	(8^+)	514.4	6^+			
1214.0[‡]	1289.7	3^-	75.26	2^+	(E1)		Mult.: from $\gamma(\theta)$ (1981Mc08), mult=D. Mult=M1 is ruled out since the transition involves a change in parity.
1225	1224.8	1^-	0.0	0^+			
1250	2117	(10^+)	867.3	8^+			
1281	2581	(12^+)	1300	10^+			

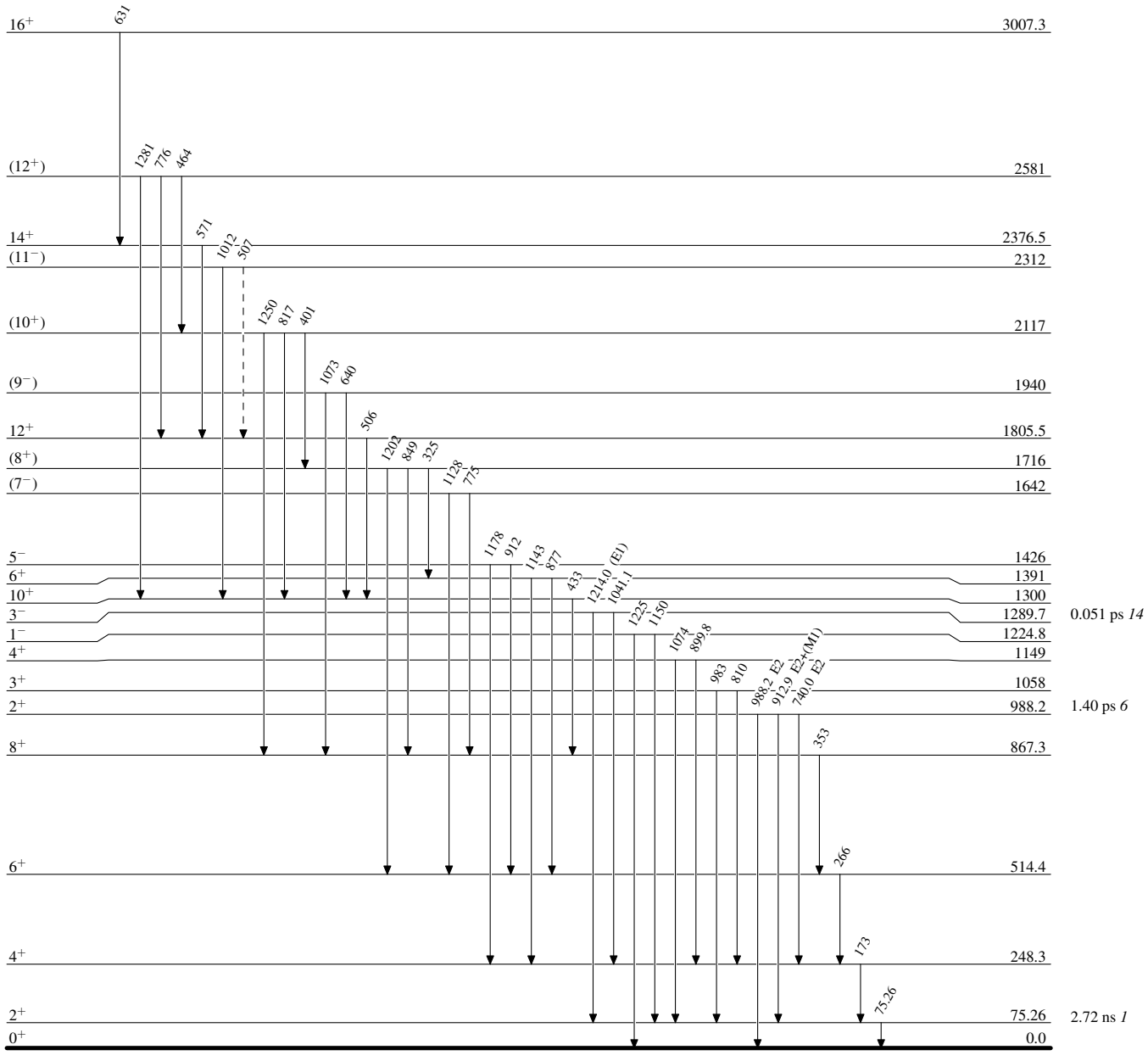
[†] From 1993Su16, unless noted otherwise.
[‡] From 1981Mc06.
[#] Placement of transition in the level scheme is uncertain.

Coulomb excitation

Legend

Level Scheme

γ Decay (Uncertain)



$^{160}_{64}Gd_{96}$