Coulomb excitation

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

Additional information 1.

2012Mo23 compiled for XUNDL database by B. Singh (McMaster).

2014Sm02 compiled for XUNDL database by A. M. Hurst (LBNL).

There have been numerous Coulomb excitation measurements. Those giving electric moments are: 1960Ad01, 1960El07, 1961Go09, 1963Gr04, 1964Al25, 1964Ho25, 1965Yo04, 1966Se06, 1968Ke04, 1969Fr11, 1971St24, 1972Sa42, 1973Be40, 1973Eb01, 1974Br31, 1974Sh12, 1974Wo01, 1976Co08, 1977Fi01, 1977Wo03, and 1979Ki14; magnetic moments: 1958Go72, 1967Wo06, 1968Be42, 1969Wh04, 1970Be36, 1971Ku09, 1972Ku10, 1974Ar23, and 1975Ro24; lifetime studies: 1959Bi10, 1967Wo06, 1968Ri09, 1972Di06, 1977Ke06, 1980Jo08, and 1999Kr10; levels: 1992Mo20 and 1999As05; and other studies: 1962Af01, 1964De07, 1966El07, 1968Br03, 1968Ve01, and 1970Da28.

A number of the studies listed here report measurements of μ and Q values for several ^{154}Sm levels. These data are not listed here, but are summarized in the Adopted Levels data set for the respective level.

Experimental methods:

1958Ch36: Natural Sm target, p beam with E≤3.7 MeV. Eγ(82) measured with curved-crystal spectrometer.

1958Go72: p beam with E(p)=2.1 MeV. Measured perturbed $\gamma(\theta)$ with NaI detectors to determine g-factor.

1959Bi10: Natural Sm target, pulsed p beam with E(p)=2.8 MeV. γ measured with plastic scintillator. Report $T_{1/2}$(82).

1960Ad01: Natural Sm target, ^{16}O beam with E(^{16}O)=36, 39 MeV. γ measured with NaI detector, two states observed.

1960El07: p and d beams with E=4.5 MeV. Magnetic spectrograph. Report B(E2)(82).

1961Go09: p beam. Measured thick target yields, report B(E2)(82).

1962Af01: Measured yields.

1963Gr04: Enriched target, ^{16}O beam with E(^{16}O)=14-50 MeV. ce measured in magnetic spectrometer, report E for 4^+ level.

1964Al25: Enriched target, ^{14}N beam with E(^{14}N)=37 MeV. Report B(E2)($2+\rightarrow4^+$).

1964De07: Enriched target, ^{16}O beam with E(^{16}O)≤44 MeV. Scattered ^{16}O counted in solid-state counter and γ in NaI detector. Measured level population probabilities.

1964Ho25: ^{14}N beam with E(^{14}N)=11.0 MeV. γ measured with NaI detector, report B(E2)(82).

1965Yo04: Natural and enriched (99.07%) targets, ^{16}O beam with E(16O)=43.5 MeV. γ measured with NaI and particles with Si(Au) detectors, report B(E2)(1180,1440).

1966El07: Enriched target, d beam with E(d)=12 MeV. Magnetic spectrometer, report relative population of states.

1966Se06: Enriched (> 99%) target, ^{16}O beam with E(^{16}O)≤65 MeV. γ measured with NaI detectors in singles, $\gamma\gamma$, and γ-particle coincidence modes, report B(E3)(1012).

1967Wo06: Enriched (> 96%) target, pulsed p beam. Measured $T_{1/2}$ and g factor from precession of γ angular distribution.

1968Be42: Enriched target, ^{16}O beam with E(^{16}O)=36 MeV. Recoil-into-gas technique used to deduce g-factor(82).

1968Br03: Recoil nuclei implanted in polarized magnetic environment and measured precession of γ angular distribution.

1968Ke04: Additional analysis of data used in 1965Yo04. Report B(E3)(1012).

1968Ri09: Pulsed proton beam, E(p)=3.5 MeV. γ measured with NaI, report $T_{1/2}$(82).

1968Ve01: (d,d′) with E(d)=12.1 MeV and (α,α′) with E(α)=16.1 MeV. Measured level energies and $\gamma(\theta)$.

1969Fr11: ^{16}O beam with E(^{16}O)=48-60 MeV and ^{32}S beam with E(^{32}S)=86.7-110 MeV. γ measured with Ge detector in coincidence with the scattered projectiles, report B(E2)(82).

1969Wh04: Mossbauer measurement. Report magnetic moment.

1970Be36: Reevaluation of g-factor of 1968Be42.

1970Da28: Enriched (99.88%) target, ^{16}O beam with E(^{16}O)=33 MeV. Measured ce′s in magnetic spectrometer, report multipolarity of γ(82,185).

1971Ku09: ^{16}O beam with E(^{16}O)=52 MeV. Measured perturbed $\gamma(\theta)$, report g-factors of 4^+ and 6^+ states.

1971St24: Natural Sm target, α beam with E(α)=10-12 MeV. Report E4 matrix element.

1972Di06: ^{40}Ar beam with E(^{40}Ar)=146 MeV. γ measured with Ge detector. $T_{1/2}(4^+,6^+,8^+)$ measured by recoil-distance Doppler-shift method.

1972Ku10: ^{16}O beam with E(^{16}O)=35 MeV. Measured perturbed $\gamma(\theta)$. Report g-factor(4^+,6^+).

1972Sa42: α beam with E(α)=10.5-12 MeV. α measured in Si(Au) detector and magnetic spectrometer. Report B(E2)(82) and E4 matrix element.

1973Be40: Enriched target, α beam with E(α)=11.0-21.0 MeV. α measured in magnetic spectrometer. Report E2 and E4 matrix elements.

Coulomb excitation (continued)

1973Eb01: Enriched (99%) target, α beam with E(α)=12 MeV, ^{16}O beam with E(^{16}O)=24-30 MeV, and ^{32}S beam with E(^{32}S)=35-40 MeV. γ measured using a Ge detector. Report E4 matrix element.
1974Br31: Enriched (99.8%) target, α beam with E(α)=11-20 MeV. α measured with Si(Au) detectors. Report E2 and E4 matrix elements.
1974Sh12: α beam with E(α)=8-17 MeV. α measured in Si(Au) detector. Report B(E2)(82) and E4 matrix element.
1974Wo01: Enriched target, α beam with E(α)=12 MeV. α measured in Si(Au) detector. Report E2 and E4 matrix elements.
1975Le22: α beam with E(α)=12-19 MeV. α measured in magnetic spectrometer. See 1973Be40 for same results.
1975Ro24: ^{16}O beam with E(^{16}O)=40 MeV. Measured $\gamma\gamma(\theta)$.
1977Fi01: Enriched (98.69%) target, α beam with E(α)=11.23-12.00 MeV. α measured in Si(Au) detector. Report E2 and E4 matrix elements.
1977Ke06: Enriched target, ^{56}Fe and ^{84}Kr beams with E=4.14 MeV/nucleon. γ measured with Ge detector. $T_{1/2}(8^+,10^+,12^+)$ determined by Doppler-broadened lineshape method.
1977Wo03: Enriched target, α beam with E(α)=11.5-12 MeV. Si(Au) detector. Report B(E2)(82).
1979Ki14: Enriched (94%) target, p beam with E(p)=35 MeV. Measured p′ measured in magnetic spectrometer. Report E2 and E4 moments.
1980Jo08: ^{40}Ar beam with E(^{40}Ar)=146,153 MeV. γ′s measured with Ge(Li) detector. $T_{1/2}(4^+,6^+,8^+,10^+)$ determined by Doppler-shift recoil-distance method.
1992Mo20: ^{58}Ni beam with E(^{58}Ni)=220 MeV. γ′s measured with array of 20 Ge detectors and recoil ^{58}Ni with 5 Si detectors. Measured coincidences and $\gamma(\theta)$, report 5 bands with J^π to 16^+, 13^-, 6^+, 14^+, and 7^+. Report only level energies, no Eγ or Iγ.
1999As05: ^{176}Yb and ^{208}Pb beams, measured γ′s with GAMMASPHERE array of 55 Compton-suppressed Ge detectors. Report levels in ground-state band up to 22^+.
1999Kr10: ^{16}O beam with E(^{16}O)=65 MeV. Measured γ′s in YRAST Ball array of 3 Clover detectors, 19 Compton-shielded Ge detectors and particles with 8 photoelectric cells. Measured $T_{1/2}$ by Doppler-shifted Attenuation Method (DSAM) for 3 levels.
2000KuZT: ^{90}Zr beam, E(^{90}Zr)=380 MeV. Enriched target, γ′s detected in the GEMINI Ge-detector array. Show only two gated γ-ray spectra. Present only γ′s within the g.s. band. g.s. band mentioned only up to the 16^+ member.
2001MoZT: ^{90}Zr beam, E(^{90}Zr)=340 MeV. Discuss relative population in Coul. ex. of the members of the first two excited $K^\pi=0^+$ bands. Many of the same authors as 2000KuZT.
2009WiZU: ^{154}Sm(^{16}O,^{16}O′), E=55, 60, 65 MeV; measured conversion electrons Ee, Ie after Coulomb excitation; deduced monopole strength, β-band.
2012Mo23: E=570 MeV ^{154}Sm beam from Atlas accelerator at ANL on 0.63 mg/cm^2 ^{12}C target. Gamma rays detected by Gammasphere array of 99 HPGe detectors. Measured Eγ, Iγ, $\gamma\gamma$, $\gamma(\theta)$. Deduced E2 matrix elements from analysis of relative Coul. ex. yields with a multiple Coulomb excitation code based on Winther-de Boer theory. Matrix elements were constrained by the experimental branching ratios and multipole mixing ratios. Known B(E2) values for g.s. band transitions and known static quadrupole moments for the first 2^+ and 4^+ states were included in the analysis. Relative sign of E2 matrix elements were derived from Alaga rule. Comparison with X(5) and CBS model calculations.
2014Sm02: E=65 MeV ^{16}O beam on 1.5 mg/cm^2 thick 99% enriched ^{154}Sm target. Measured γ rays and ce due to Coulomb excitation of ^{154}Sm using Silicon And GErmanium (SAGE) spectrometer at the University of Jyväskylä composed of 34 High-Purity Germanium (HPGe) detectors (24 clovers and 10 EUROGAM Phase I detectors) from the JUROGAMII array coupled to a 1-mm thick 90-segment single-sided annular silicon strip detector. Data collected for 65 h using with average beam current of 20 pnA. Measured γ-γ and γ-ce coincidences. Deduced levels, E_γ, K-conversion coefficient and multipolarities. Electric monopole transition strengths determined and compared to Bohr and Mottelson β-vibrational model, the Interacting Boson Model (IBA), and two-state mixing calculations. Low values for measured monopole strength inconsistent with a β-vibrational mode.

^{154}Sm Levels

E(level)[†]	J$^\pi$[‡]	$T_{1/2}$[#]	Comments
0.0[c]	0^+	stable	
81.99[c] *2*	2^+	3.02 ns *4*	B(E2)↑=4.32 *2*; μ=+0.78 *4* $T_{1/2}$: Weighted average of 3.03 ns *5* (1967Wo06) and 3.00 ns *6* (1968Ri09). Other: 2.74 ns *24* (1959Bi10). B(E2)↑: Weighted average of 4.30 *3* (1972Sa42), 4.26 *6* (1973Be40), 4.39 *9* (1974Br31), 4.37 *6* (average of two values in 1974Sh12), 4.266 *41* (average of three values in in 1974Wo01), 4.40 *9* (1976Co08), 4.490 *63* (1977Fi01, but with the uncertainty increased by a factor of 3),

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Coulomb excitation (continued)

^{154}Sm Levels (continued)

E(level)[†]	J$^{\pi}$[‡]	T$_{1/2}$[#]	Comments
			and 4.34 *6* (average of two values in 1979Po04). For a weighted average of the published values, the reduced χ^2=6.6 and the value of 1977Fi01 is 5σ high; therefore, the uncertainty of this value was increased. With the uncertainty assigned by the evaluator, the reduced χ^2=1.80. Several of these values were derived from reported E2 matrix elements. B(E2)↑: Other B(E2) values: 4.61 *20* (1960El07), 4.1 *4* (1961Go09), 4.38 *30* and 4.53 *35* (1963Gr04), 5.1 *4* (1964Ho25), 4.2 *6* (1968Ve01), 4.268 *33* (1973GrXL, see 1974Sh12), 4.26 *6* (1975Le22, same value as in 1973Be40), 4.45 *39* (1977HoZF, preliminary result), 4.24 *12* (1979Ki14). μ: From 1989Ra17 evaluation and 2005St24 compilation and based on data of 1969Wh04. Others: +0.53 *12* (1958Go72, as revised in 1976Fu06), 0.58 *6* (1967Wo06, as revised in 1978LeZA), 0.37 *8* (1968Be42), 0.63 *5* (1970Be36), and 0.76 *8* (1974Ar23).
266.67[c] *8*	4$^+$	172 ps *4*	B(E4)↑= 0.305 *18*; μ=+1.35 *15* T$_{1/2}$: Weighted average of 173 ps *5* (1972Di06) and 169 ps *10* (1980Jo08). B(E2)↑: B(E2,2+→4$^+$)↑=2.5 *4*; weighted average of 2.32 *46* (1964Al25) and 2.7 *6* (1968Ve01). This value corresponds to a lifetime of 149 ps *24* for the 4$^+$ level, which compares well to the directly measured value of 172 ps *4*. B(E4)↑: Computed from the square of the E4 matrix element 0.552 *16*, which is the weighted average of +0.67 *8* (1971St24), 0.43 *8* (1972Sa42), +0.58 *14* (1973Be40), +0.50 *+9−12* (1973Eb01), 0.54 *12* (1974Br31), 0.56 *7* (average of two values in 1974Sh12), 0.53 *9* (average of three values in 1974Wo01), 0.63 *5* (1977Fi01), 0.54 *2* (1979Ki14). Others: 0.65 *5* (1973GrXL, see 1974Sh12); 0.58 *14* (1975Le22, see 1973Be40); and B(E4)=0.221 *10* (1976Co08, from inelastic electron scattering). μ: From 1972Ku10, given as g=0.337 *36*. Value is also given in the evaluation of 1989Ra17 and the evaluation of 2005St24.
543.9[c] *5*	6$^+$	22.7 ps *6*	μ=+1.90 *28* T$_{1/2}$: Weighted average of 23.3 ps *7* (1972Di06) and 22.7 ps *6* (average of two values in 1980Jo08). Other: 23.8 ps (2001KuZU, preliminary result). μ: From 1972Ku10, given as g=0.317 *46*. Value is also given in the evaluation of 1989Ra17 and the compilation of 2005St24.
902.8[c] *7*	8$^+$	5.93 ps *25*	T$_{1/2}$: Weighted average of 6.2 ps *6* (1972Di06), 6.0 ps *4* (1977Ke06), and 5.8 ps *4* (1980Jo08). Other: 6.8 ps (2001KuZU, preliminary result).
921.6[&d]	1$^-$		
1012.6[d]	3$^-$		B(E3)↑=0.10 *2* E(level): value shown on the level scheme of 1992Mo20. B(E3)↑: Weighted average of 0.11 *3* (1968Ke04) and 0.09 *2* (1968Ve01). Other: 1966Se06.
1099.9[&e]	0$^+$	0.90 ps *21*	T$_{1/2}$: From 1999Kr10.
1177.9[&e]	2$^+$	>2.4 ps	B(E2)↑=0.023 *5* T$_{1/2}$: From 1999Kr10. Other: 1.4 ps *3* computed from B(E2) value, but 1999Kr10 argue that this value is not correct. B(E2)↑: Weighted average of 0.030 *7* (1965Yo04) and 0.020 *5* (1968Ve01).
1180.9[&d]	5$^-$		
1333.0[c] *9*	10$^+$	2.45 ps *12*	T$_{1/2}$: Weighted average of 2.52 ps *16* (1977Ke06) and 2.37 ps *18* (1980Jo08). Other: 2.45 ps (2001KuZU, preliminary result).
1338[&e]	4$^+$		
1371?[@&]	(4$^+$)		E(level): Existence of this level is not confirmed in (n,n′γ). IT is not included in the Adopted Levels.
1431[&d]	7$^-$		
1440.4[f]	2$^+$	0.42 ps *3*	B(E2)↑=0.069 *10* T$_{1/2}$: From 1999Kr10. Other: 0.28 ps *4* computed from B(E2) value. B(E2)↑: From 1968Ve01; note conflict with T$_{1/2}$ measurement.
1475[@&]	(6$^+$)		
1539.9[&f]	3$^+$		

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Coulomb excitation (continued)

^{154}Sm Levels (continued)

E(level)[†]	J$^{\pi}$[‡]	T$_{1/2}$[#]	Comments
1577[&e]	6$^+$		
1584[b]	3$^-$		
1665.1[&f]	4$^+$		
1706[b]	3$^+$		
1741[@&]	(8$^+$)		
1760[&d]	9$^-$		
1805[af]	5$^+$		
1815[b]	2$^+$,3		
1825.9[c] *10*	12$^+$	1.39 ps *9*	T$_{1/2}$: From 1980Jo08.
1974[&f]	(6$^+$)		
2069[@&]	(10$^+$)		
2154.3[af]	7$^+$		
2163[&d]	11$^-$		
2373.0[c]	14$^+$		
2439[@&]	(12$^+$)		
2636[&d]	13$^-$		
2793?[@&]	(14$^+$)		
2968.2[c]	16$^+$		
3609.3[c]	18$^+$		
4295.7[c]	20$^+$		
5027.9[c]	22$^+$		

[†] From γ energies, unless otherwise noted.
[‡] From adopted values.
[#] From Coulomb-excitation studies only; see Adopted Levels for values from other measurements.
[@] Proposed as a member of a band by 1992Mo20, but the existence of the suggested bandhead (at 1371 keV) is questionable and the band characteristics are not otherwise discussed.
[&] From 1992Mo20.
[a] Level shown by 1992Mo20, but no γ transitions indicated.
[b] From 2012Mo23.
[c] Band(A): K$^{\pi}$=0$^+$ ground-state band.
[d] Band(B): K^{π}=0$^-$ octupole-vibrational band.
[e] Band(C): First excited K$^{\pi}$=0$^+$ band. According to 2014Sm02 low values for measured monopole strength are inconsistent with β-vibrational mode. However 2009WiZU state that the large monopole strength for the 0$^+$ -> 0$^+$ transition confirms the interpretation of the first excited 0$^+$ state as collective β-vibrational excitation of the g.s.
[f] Band(D): γ-vibrational band.

Coulomb excitation (continued)

$\gamma(^{154}Sm)$

E_γ [†]	I_γ [‡]	E_i(level)	J_i^π	E_f	J_f^π	Mult. [#]	α [d]	Comments
81.99 [@] *2*		81.99	2^+	0.0	0^+	E2	4.86	
184.68 [&] *8*		266.67	4^+	81.99	2^+	E2	0.273	
277.2 *5*	310 *20*	543.9	6^+	266.67	4^+			
358.9 *5*	14.4 *8*	902.8	8^+	543.9	6^+			
375 [c]	4.6 *3*	1815	2^+,3	1440.4	2^+			
403 [ae]		2163	11^-	1760	9^-			
430.2 *5*		1333.0	10^+	902.8	8^+			
473 [ae]		2636	13^-	2163	11^-			
492.9 *5*		1825.9	12^+	1333.0	10^+			
528 [a]		1431	7^-	902.8	8^+			
547.1 [b]		2373.0	14^+	1825.9	12^+			
595.2 [b]		2968.2	16^+	2373.0	14^+			
637.0 [a]		1180.9	5^-	543.9	6^+			
641.1 [b]		3609.3	18^+	2968.2	16^+			
674 [a]		1577	6^+	902.8	8^+			
686.4 [b]		4295.7	20^+	3609.3	18^+			
732.2 [b]		5027.9	22^+	4295.7	20^+			
745.9 [a]		1012.6	3^-	266.67	4^+			
794 [a]	3.4 *3*	1338	4^+	543.9	6^+	E2		B(E2)(W.u.)=0.66 *21* (2012Mo23) Mult.: Adopted value. Relative sign of E2 matrix element=+ (2012Mo23).
810 [a]		2636	13^-	1825.9	12^+			
830 [a]		2163	11^-	1333.0	10^+			
839.7 [a]		921.6	1^-	81.99	2^+			
857 [a]		1760	9^-	902.8	8^+			
887 [a]		1431	7^-	543.9	6^+			
911.2 [a]	62.7 *16*	1177.9	2^+	266.67	4^+	E2		α(K)exp=0.0034 *16* (2014Sm02) B(E2)(W.u.)=1.32 *15* (2012Mo23) Relative sign of E2 matrix element=+ (2012Mo23). Additional information 2. Mult.: Adopted value.
914.2 [a]		1180.9	5^-	266.67	4^+			
921.6 [a]		921.6	1^-	0.0	0^+			
930.7 [a]		1012.6	3^-	81.99	2^+			
931 [a]		1475	(6^+)	543.9	6^+			
967 [ae]		2793?	(14^+)	1825.9	12^+			
1018.0 [a]	91.1 *15*	1099.9	0^+	81.99	2^+	E2	0.00240 *4*	B(E2)(W.u.)=11.2 *21* (2012Mo23)

$^{154}_{62}Sm_{92}$-5

Coulomb excitation (continued)

$\gamma(^{154}Sm)$ (continued)

E_γ[†]	I_γ[‡]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	δ	$I_{(\gamma+ce)}$	Comments
									Relative sign of E2 matrix element=+ (2012Mo23). Mult.: Adopted value.
1033[a]		1577	6^+	543.9	6^+				
1071[a]	13.1 *9*	1338	4^+	266.67	4^+	E0+M1+E2	>50		α(K)exp=0.0079 *+87−73* (2014Sm02,2022Ki03) B(E2)(W.u.)=0.57 *18* (2012Mo23) Additional information 4. $\rho^2(E0)_{exp}$=0.0082 *+120−82* (2014Sm02) 2022Ki03 evaluation results: $\rho^2(E0)_{exp}$=0.012 *9*, q^2_K=4.9 *34*, X(E0/E2)=0.8 *5*, α(K)exp=0.0079 *+87−73*, δ>50, $T_{1/2}$=43 ps *+10−16* (original reference not found). Mult.,δ: Adopted value. Relative sign of E2 matrix element=− (2012Mo23).
1096.0[a]	87.0 *16*	1177.9	2^+	81.99	2^+	E0+M1+E2	−30 *21*		α(K)exp≤0.0067 *6* (2014Sm02,2022Ki03) B(E2)(W.u.)=0.72 *9* (2012Mo23) Additional information 3. $\rho^2(E0)_{exp}$≤0.0094 *15* (2014Sm02) using α(K)=0.00257 *4* for 911γ (theory from BrIcc code), and α(K)exp≤0.0067 *6* for 1096γ from current experiment. Other value: <0.0063 (2009WiZU). 2022Ki03 evaluation results: $\rho^2(E0)_{exp}$≤0.009, q^2_K≤3.1, X(E0/E2)≤0.45, α(K)exp≤0.0067 *6* , δ=−30 *21*, $T_{1/2}$≥2.4 ps. B(E2)(W.u.)=0.72 *9* is for δ=−30 *21*. The other calculated value, B(E2)(W.u.)=0.15 *2* for δ=−0.48 *2*, is rejected by 2012Mo23 from Alaga Rule. Relative sign of E2 matrix element=− (2012Mo23). Mult.: Adopted value. δ: from $\gamma(\theta)$ data (2012Mo23). The other solution of δ=−0.48 *2* is rejected by 2012Mo23 on the basis of comparison of experimental and predicted (by Alaga rule) B(E2) ratios.
1099.3[e]		1099.9	0^+	0.0	0^+	E0		0.50 *18*	Conversion electrons corresponding to 1099γ found in spectrum measured only by 2009WiZU. $\rho^2(E0)_{exp}$=0.096 42 (2009WiZU) 2022Ki03 evaluation results for E0, 1099.3 transition and E2, 1017.2γ: $\rho^2(E0)_{exp}$≠0.110 *40*, q^2_K=2.3 *8*, X(E0/E2)=0.31 *10* for $T_{1/2}$=0.90 ps *21*. $I_{(\gamma+ce)}$: From I(1018γ)=91.1 *15* and α(K)=0.00203 *3* one can get the corresponding relative intensity of the K-shell conversion electrons Ice(K)(1018γ)=0.185 *4*; this multiplied by q^2_K = Ice(K)(1099γ)/Ice(K)(1018γ) = 2.3 *8* gives Ice(K)(1099γ)=0.43 *15*. Using the ratio of the electronic factors $\Omega_K(E0)/\Omega_{Tot}(E0)$ = 0.85 *6* calculated by the code BrIcc, one finally gets Ice(K)(1099γ)=0.50 *18*.
1104[ae]		1371?	(4^+)	266.67	4^+				
1106[a]		2439	(12^+)	1333.0	10^+				
1121.3[a]		1665.1	4^+	543.9	6^+				

$^{154}_{62}Sm_{92}$-6

Coulomb excitation (continued)

γ(^{154}Sm) (continued)

E_γ[†]	I_γ[‡]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	δ	Comments
1166[a]		2069	(10$^+$)	902.8	8$^+$			
1173.7[a]	13.9 *10*	1440.4	2$^+$	266.67	4$^+$	E2		B(E2)(W.u.)=0.36 *5* (2012Mo23) Relative sign of E2 matrix element=+ (2012Mo23). Mult.: Adopted value.
1177.9[a]	55.7 *16*	1177.9	2$^+$	0.0	0$^+$	E2		B(E2)(W.u.)=0.32 *4* (2012Mo23) Relative sign of E2 matrix element=+ (2012Mo23). Mult.: Adopted value.
1197[a]		1741	(8$^+$)	543.9	6$^+$			
1208[a]		1475	(6$^+$)	266.67	4$^+$			
1256[a]	16.4 *6*	1338	4$^+$	81.99	2$^+$	E2		B(E2)(W.u.)=0.32 *11* (2012Mo23) Relative sign of E2 matrix element=+ (2012Mo23). Mult.: Adopted value.
1273.2[a]		1539.9	3$^+$	266.67	4$^+$			
1289[ae]		1371?	(4$^+$)	81.99	2$^+$			
1310[a]		1577	6$^+$	266.67	4$^+$			
1317[c]		1584	3$^-$	266.67	4$^+$			
1358.5[a]	258.2 *61*	1440.4	2$^+$	81.99	2$^+$	M1+E2	−19 *10*	B(E2)(W.u.)=3.2 *3* (2012Mo23) A_2=−0.073 *16*; A_4=+0.005 *18* B(E2)(W.u.)=3.2 *3* is for δ=−19 *10*. The other calculated value, B(E2)(W.u.)=0.65 *6* for δ=−0.51 *7*, is rejected by 2012Mo23 from Alaga Rule. Relative sign of E2 matrix element=+ (2012Mo23). Mult.: Adopted value. δ: from γ(θ) data. Other solution of δ=−0.51 *7* is rejected on the basis of comparison of experimental and predicted (by Alaga rule) B(E2) ratios.
1398.4[a]		1665.1	4$^+$	266.67	4$^+$			
1430[a]		1974	(6$^+$)	543.9	6$^+$			
1440[c]	4.2 *4*	1706	3$^+$	266.67	4$^+$			
1440.4[a]	207.6 *53*	1440.4	2$^+$	0.0	0$^+$	E2		B(E2)(W.u.)=1.9 *2* (2012Mo23) A_2=+0.229 *18*; A_4=−0.029 *21* Relative sign of E2 matrix element=+ (2012Mo23). Mult.: Adopted value.
1458.0[a]		1539.9	3$^+$	81.99	2$^+$			
1502[c]		1584	3$^-$	81.99	2$^+$			
1583.2[a]		1665.1	4$^+$	81.99	2$^+$			
1707[a]		1974	(6$^+$)	266.67	4$^+$			

[†] From unweighted average of data of 1972Di06, 1977Ke06, and 1980Jo08, unless otherwise noted. Uncertainty assumed to be 0.5 keV, as quoted by 1977Ke06.
[‡] Relative intensities from 2012Mo23.
[#] From conversion-electron study (1970Da28) unless otherwise specified.

$^{154}_{62}Sm_{92}$-7

Coulomb excitation (continued)

$\gamma(^{154}Sm)$ (continued)

@ From 1958Ch36.
& From ^{154}Pm β^- decay.
a Deduced from level energies of 1992Mo20.
b From 1999As05.
c From 2012Mo23.
d Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with "Frozen Orbitals" approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.
e Placement of transition in the level scheme is uncertain.

$^{154}_{62}Sm_{92}$-8

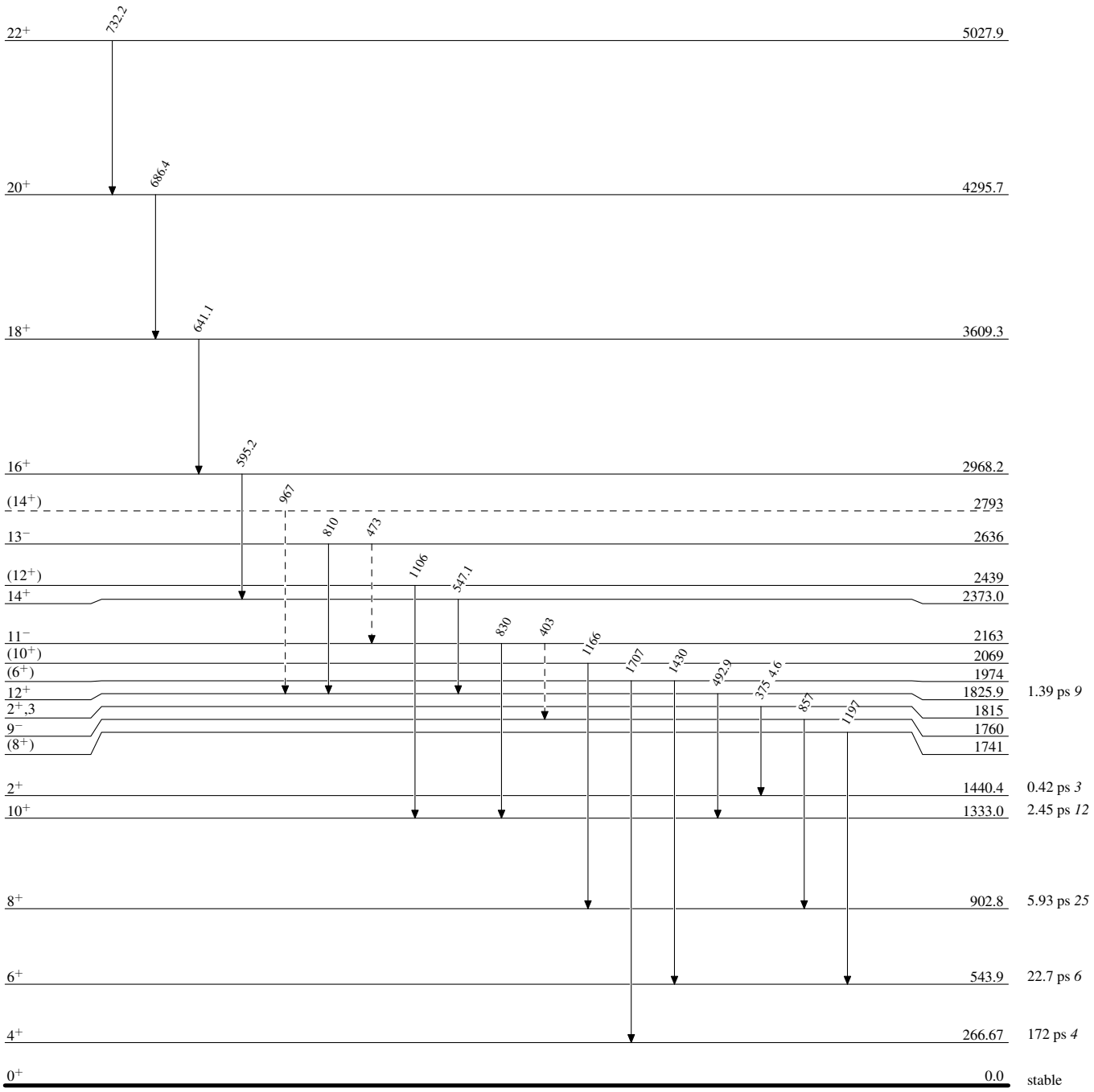
Coulomb excitation

Level Scheme

Intensities: Relative I_γ

Legend

$I_\gamma < 2\% \times I_\gamma^{max}$
$I_\gamma < 10\% \times I_\gamma^{max}$
$I_\gamma > 10\% \times I_\gamma^{max}$
γ Decay (Uncertain)



$^{154}_{62}Sm_{92}$

Coulomb excitation

Level Scheme (continued)

Intensities: Relative I_γ

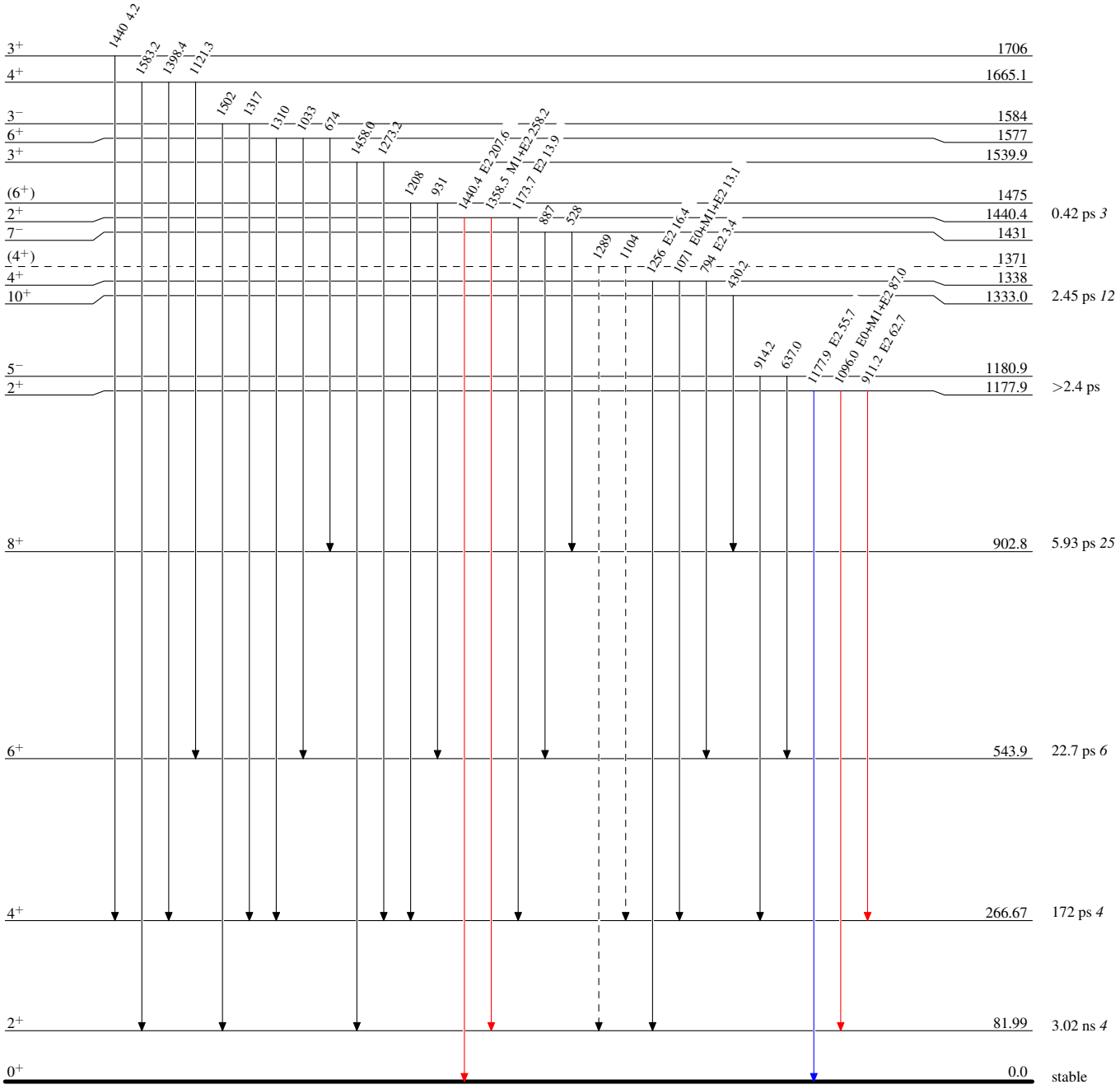
Legend

$I_\gamma < 2\% \times I_\gamma^{max}$

$I_\gamma < 10\% \times I_\gamma^{max}$

$I_\gamma > 10\% \times I_\gamma^{max}$

γ Decay (Uncertain)



$^{154}_{62}Sm_{92}$

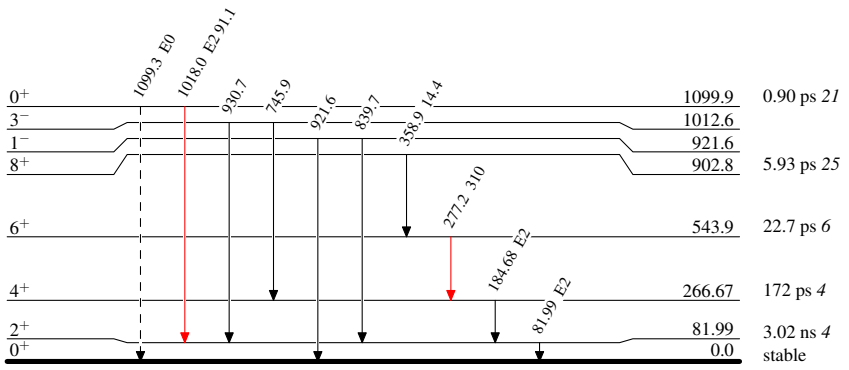
Coulomb excitation

Level Scheme (continued)

Intensities: Relative I_γ

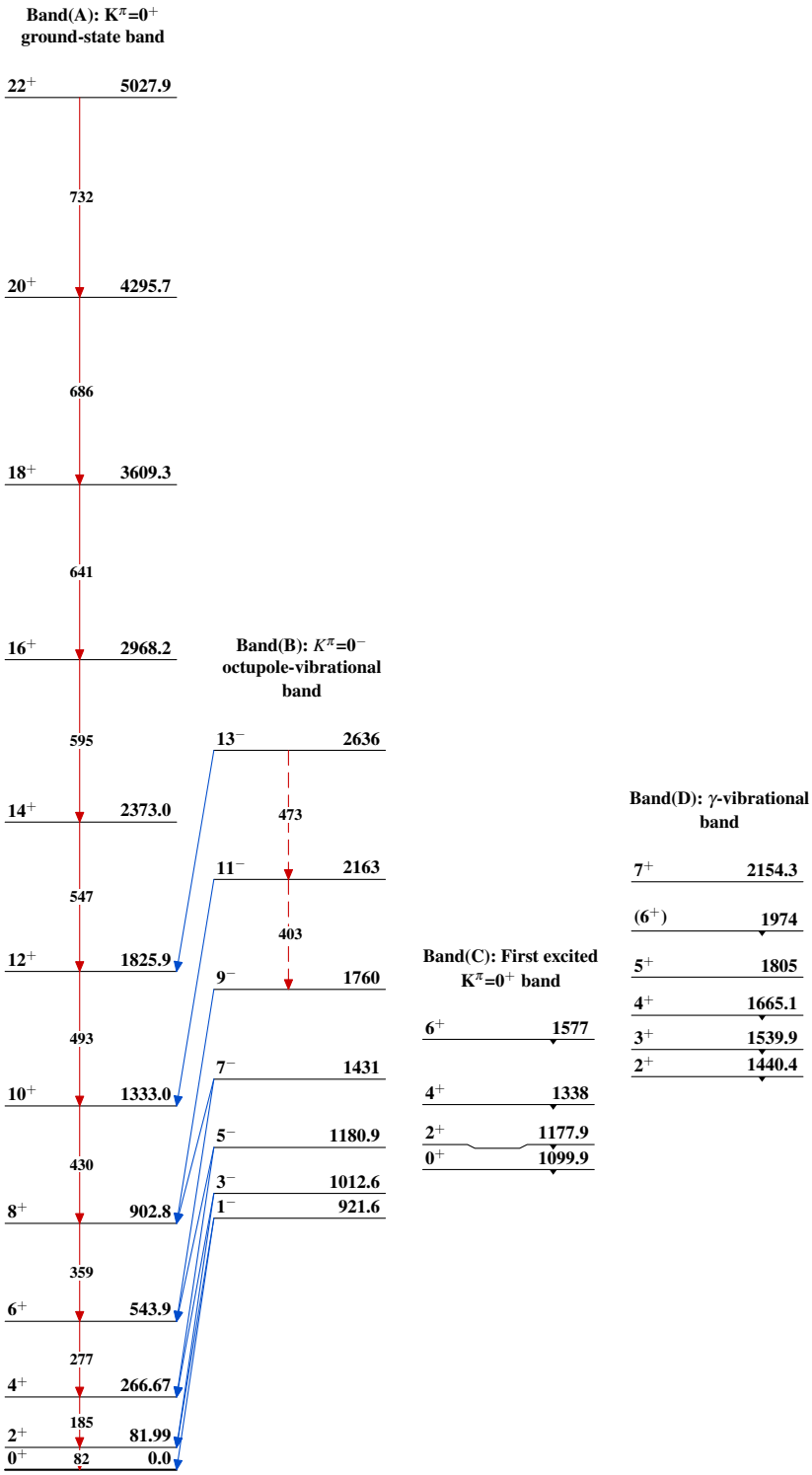
Legend

$I_\gamma < 2\% \times I_\gamma^{max}$
$I_\gamma < 10\% \times I_\gamma^{max}$
$I_\gamma > 10\% \times I_\gamma^{max}$
γ Decay (Uncertain)



$^{154}_{62}Sm_{92}$

Coulomb excitation



$^{154}_{62}Sm_{92}$