^{94}Zr(^{7}Li,3nγ) 1987Bi21

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Jun Chen, Balraj Singh	NDS 164, 1 (2020)	15-Feb-2020

1987Bi21 (also 1987Bi23): E=23-31 MeV ^{7}Li beams were produced from the 16-MV XTU Tandem Accelerator of Laboratori Nazionali di Legnaro. Target was a 618 μg/cm^2 self-supporting ^{94}Zr (91.2% enriched) metal foil. γ-rays were detected with three coaxial HPGe detectors (FWHM≈2 keV at 1.33 MeV) and conversion electrons were detected with the "SPEL" spectrometer consisting of a magnetic (solenoid) transport system and a thick Si(Li) detector (FWHM=2.4 keV at 520 keV). Measured Eγ, Iγ, E(ce), I(ce), γ(excitation function), $\gamma\gamma$-coin, γ anisotropies (θ=0°,90°). Deduced levels, J, π, conversion coefficients, γ-ray multipolarities, mixing ratios. Comparisons with structure calculations using 2-quasi-particle plus rotor model.

All data are from 1987Bi21.

^{98}Tc Levels

E(level)†	J$^\pi$‡	E(level)†	J$^\pi$‡	E(level)†	J$^\pi$‡	E(level)†	J$^\pi$‡
0.0@	6+	1018.5 *3*		1582.43# *18*	10−	2677.4# *3*	13−
21.82@ *21*	5+	1090.65# *14*	8−	1851.38# *19*	11−	2810.6 *6*	
106.43@ *6*	7+	1102.84@ *17*	9+	1920.4? *4*		3055.2@ *7*	
346.93 *12*	(6)	1166.33# *16*	9−	1995.5@ *5*	(11+)	3129.5# *4*	(14−)
441.02@ *6*	7+	1207.82 *16*		2303.8# *3*	12−		
670.23 *23*		1254.3 *3*		2367.8? *5*			
764.34@ *14*	8+	1549.74 *17*		2481.8 *6*			

† From a least-squares fit to γ-ray energies.

‡ As given by 1987Bi21, based on γ-ray excitation functions and γ-ray multipolarities deduced from γ anisotropies and ce data.

Band(A): $\pi g_{9/2}\otimes\nu h_{11/2}$.

@ Seq.(B): $\pi g_{9/2}\otimes\nu(d_{5/2},g_{7/2})$.

γ(^{98}Tc)

γ anisotropy ratio R=Iγ(90°)/Iγ(0°)>1.1 corresponds to ΔJ=1, dipole, and <0.9 to ΔJ=2, quadrupole (1987Bi21).

E_γ	I_γ[†]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	δ[@]	α[&]	Comments
71.9[‡] 5		1090.65	8^-	1018.5					E_γ,I_γ: weak γ ray.
75.6 4	46 10	1166.33	9^-	1090.65	8^-	(D)			I_γ: other: 38 10 at 0°. R=1.2 4.
106.46 6	100 15	106.43	7^+	0.0	6^+	D			I_γ: other: 57 5 at 0°. R=1.75 30.
[x]229									In coin with 996γ.
240.5 1	9.6 4	346.93	(6)	106.43	7^+	D			I_γ: other: 7.6 4 at 0°. R=1.26 9.
268.9 1	21.0 9	1851.38	11^-	1582.43	10^-	M1(+E2)	<1.2	0.025 6	α(K)exp=0.0207 46 α(K)=0.022 5; α(L)=0.0027 7; α(M)=0.00049 13 α(N)=7.6×10^{-5} 19; α(O)=4.6×10^{-6} 8 I_γ: other: 16.4 5 at 0°. R=1.28 7.
323.3[b] 2	≈4[b]	670.23		346.93	(6)				
323.3[b] 2	34[b] 1	764.34	8^+	441.02	7^+	M1(+E2)	<0.9	0.0140 17	α(K)exp=0.0117 19 α(K)=0.0122 15; α(L)=0.00147 22; α(M)=0.00027 4 α(N)=4.2×10^{-5} 6; α(O)=2.7×10^{-6} 3 I_γ: total Iγ=38.1 12, about 10% is estimated to deexcite 670 level.
325.8 7	16.0 8	1090.65	8^-	764.34	8^+	E1		0.00468	α(K)exp=0.0046 18 α(K)=0.00412 7; α(L)=0.000468 7; α(M)=8.44×10^{-5} 13 α(N)=1.336×10^{-5} 21; α(O)=8.68×10^{-7} 13 δ(M2/E1)<0.25 from α(K)exp.
328.8 3	2.7 8	2810.6		2481.8					
334.6 1	5.3 6	441.02	7^+	106.43	7^+	D			I_γ: other: 4.6 4 at 0°. R=1.15 17.
341.9 1	9.1 6	1549.74		1207.82		D			I_γ: other: 5.7 5 at 0°. R=1.60 18.
373.5 1	6.2 5	2677.4	13^-	2303.8	12^-	M1(+E2)	<0.8	0.0093 8	α(K)exp=0.0071 16 α(K)=0.0082 7; α(L)=0.00097 10; α(M)=0.000175 18 α(N)=2.8×10^{-5} 3; α(O)=1.80×10^{-6} 12 I_γ: other: 4.0 6 at 0°. R=1.55 26.
402.00 8	14.4 6	1166.33	9^-	764.34	8^+	E1		0.00271	α(K)exp=0.0020 3 α(K)=0.00238 4; α(L)=0.000270 4; α(M)=4.87×10^{-5} 7 α(N)=7.72×10^{-6} 11; α(O)=5.06×10^{-7} 7 I_γ: other: 9.1 13 at 0°. R=1.58 24. δ(M2/E1)<0.08 from α(K)exp.

γ(^{98}Tc) (continued)

E_γ	I_γ [†]	E_i(level)	J_i^π	E_f	J_f^π	Mult. [#]	δ [@]	α [&]	Comments
416.05 8	27.5 11	1582.43	10$^-$	1166.33	9$^-$	M1(+E2)	<0.6	0.0069 3	α(K)exp=0.0056 6 α(K)=0.0060 3; α(L)=0.00070 4; α(M)=0.000128 8 α(N)=2.03×10^{-5} 11; α(O)=1.34×10^{-6} 5
[x]418									In coin with 240γ.
419.2 2	3.8 6	441.02	7$^+$	21.82	5$^+$	E2		0.00860	α(K)exp=0.0103 19 α(K)=0.00748 11; α(L)=0.000929 13; α(M)=0.0001687 24 α(N)=2.64×10^{-5} 4; α(O)=1.577×10^{-6} 23
440.99 6	62.1 18	441.02	7$^+$	0.0	6$^+$	M1(+E2)	<0.4	0.00585 14	α(K)exp=0.0047 4 α(K)=0.00513 12; α(L)=0.000593 17; α(M)=0.000107 3 α(N)=1.71×10^{-5} 5; α(O)=1.140×10^{-6} 23 I_γ: other: 45.3 13 at 0°. R=1.37 6.
447.0 2	2.2 8	1549.74		1102.84	9$^+$				
452.0[‡] 3	3.5[‡] 20	3129.5	(14$^-$)	2677.4	13$^-$				
452.5[‡] 2	14.0[‡] 20	2303.8	12$^-$	1851.38	11$^-$	M1(+E2)	<1.4	0.0059 5	α(K)exp=0.0048 7 α(K)=0.0051 4; α(L)=0.00060 7; α(M)=0.000109 12 α(N)=1.73×10^{-5} 17; α(O)=1.12×10^{-6} 7
584.1 2	1.3 7	1254.3		670.23					
649.6 2	9.4 6	1090.65	8$^-$	441.02	7$^+$	E1		8.62×10^{-4}	α(K)exp<0.0011 α(K)=0.000759 11; α(L)=8.52×10^{-5} 12; α(M)=1.537×10^{-5} 22 α(N)=2.44×10^{-6} 4; α(O)=1.633×10^{-7} 23 I_γ: other: 5.6 9 at 0°. R=1.68 29. δ(M2/E1)<0.27 from α(K)exp.
657.9[‡] 2	14.5 9	764.34	8$^+$	106.43	7$^+$	M1,E2		0.00228 6	α(K)exp=0.0017 3 α(K)=0.00200 5; α(L)=0.000232 10; α(M)=4.19×10^{-5} 18 α(N)=6.66×10^{-6} 25; α(O)=4.38×10^{-7} 7 I_γ: contribution from 658.3γ (in ^{97}Mo) is estimated as 7.5 15 at 90°. Other: 7.8 10 for the doublet at 0°. Mult.: either M1 or E2 is possible from α(K)exp. 1987Bi21 assigned M1(+E2).
[x]671.6 5	4.0 6								In coin with 240γ and 323γ.
685.3 2	15.6 8	1851.38	11$^-$	1166.33	9$^-$	(E2)		0.00209	α(K)exp=0.0018 2 α(K)=0.00183 3; α(L)=0.000215 3; α(M)=3.90×10^{-5} 6 α(N)=6.16×10^{-6} 9; α(O)=3.95×10^{-7} 6 I_γ: other: 24.8 13 at 0°. R=0.62 5. Mult.: α(K)exp gives M1 or E2; $\gamma(\theta)$ consistent with ΔJ=2, quadrupole, however dipole mixing cannot be ruled out. 1987Bi21 assigned E2.
721.2 5	7.4 8	2303.8	12$^-$	1582.43	10$^-$				
754.1[c] 4	9.4 13	1920.4?		1166.33	9$^-$				

$^{98}_{43}$Tc$_{55}$-3

$\gamma(^{98}Tc)$ (continued)

E_γ	I_γ[†]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	α[&]	Comments
766.6 *2*	16.0 *11*	1207.82		441.02	7^+			
785.4[c] *4*	7.1 *12*	2367.8?		1582.43	10^-			
825.8[a‡c] *4*	39.3[a] *14*	2677.4	13^-	1851.38	11^-			
825.8[a‡] *4*	39.3[a] *14*	3129.5	(14^-)	2303.8	12^-			
892.7 *4*	11.2 *8*	1995.5	(11^+)	1102.84	9^+	(Q)		I_γ: other: 12.1 *17* at 0°. R=0.92 *15*.
912.0 *3*	5.5 *10*	1018.5		106.43	7^+			
932.1 *5*	4.6 *5*	2481.8		1549.74				
[x]949.6 *3*	7.6 *11*							In coin with 106γ.
984.3 *2*	28.5 *11*	1090.65	8^-	106.43	7^+	E1	3.65×10^{-4}	α(K)exp=0.00026 *7* α(K)=0.000322 *5*; α(L)=3.58×10^{-5} *5*; α(M)=6.46×10^{-6} *9* α(N)=1.029×10^{-6} *15*; α(O)=6.95×10^{-8} *10* I_γ: other: 19.0 *22* at 0°. R=1.50 *18*. δ(M2/E1)<0.15 from α(K)exp.
996.5 *2*	22.9 *9*	1102.84	9^+	106.43	7^+	(E2)	8.34×10^{-4}	α(K)exp=0.00083 *18* α(K)=0.000732 *11*; α(L)=8.38×10^{-5} *12*; α(M)=1.516×10^{-5} *22* α(N)=2.41×10^{-6} *4*; α(O)=1.594×10^{-7} *23* I_γ: other: 34.9 *15* at 0°. R=0.65 *4*. Mult.: α(K)exp gives E2 or M1; γ(θ) consistent with ΔJ=2, quadrupole, however M1 admixture cannot be ruled out. 1987Bi21 assigned E2.
[x]1014.5 *3*	11.0 *10*							In coin with 106γ.
1059.6 *5*	4.6 *5*	3055.2		1995.5	(11^+)			
1101.6 *3*	6.9 *10*	1207.82		106.43	7^+			

† Quoted values are relative intensities measured at 90°. Values at 0° are given under comments.

‡ From γγ-coin.

\# From 1987Bi21 based on measured α(K)exp and/or γ anisotropies. Quoted values of α(K)exp are not corrected for angular distribution effect, which would increase the reported values by about 10-20% for pure E1 and by 5-8% for pure M1 and would almost have no effect on pure E2 (1987Bi21).

@ Deduced by evaluators from α(K) exp in 1987Bi21.

& 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.

a Multiply placed with undivided intensity.

b Multiply placed with intensity suitably divided.

c Placement of transition in the level scheme is uncertain.

x γ ray not placed in level scheme.

$^{94}Zr(^{7}Li,3n\gamma)$ 1987Bi21

Level Scheme

Intensities: Relative I_γ

& Multiply placed: undivided intensity given

@ Multiply placed: intensity suitably divided

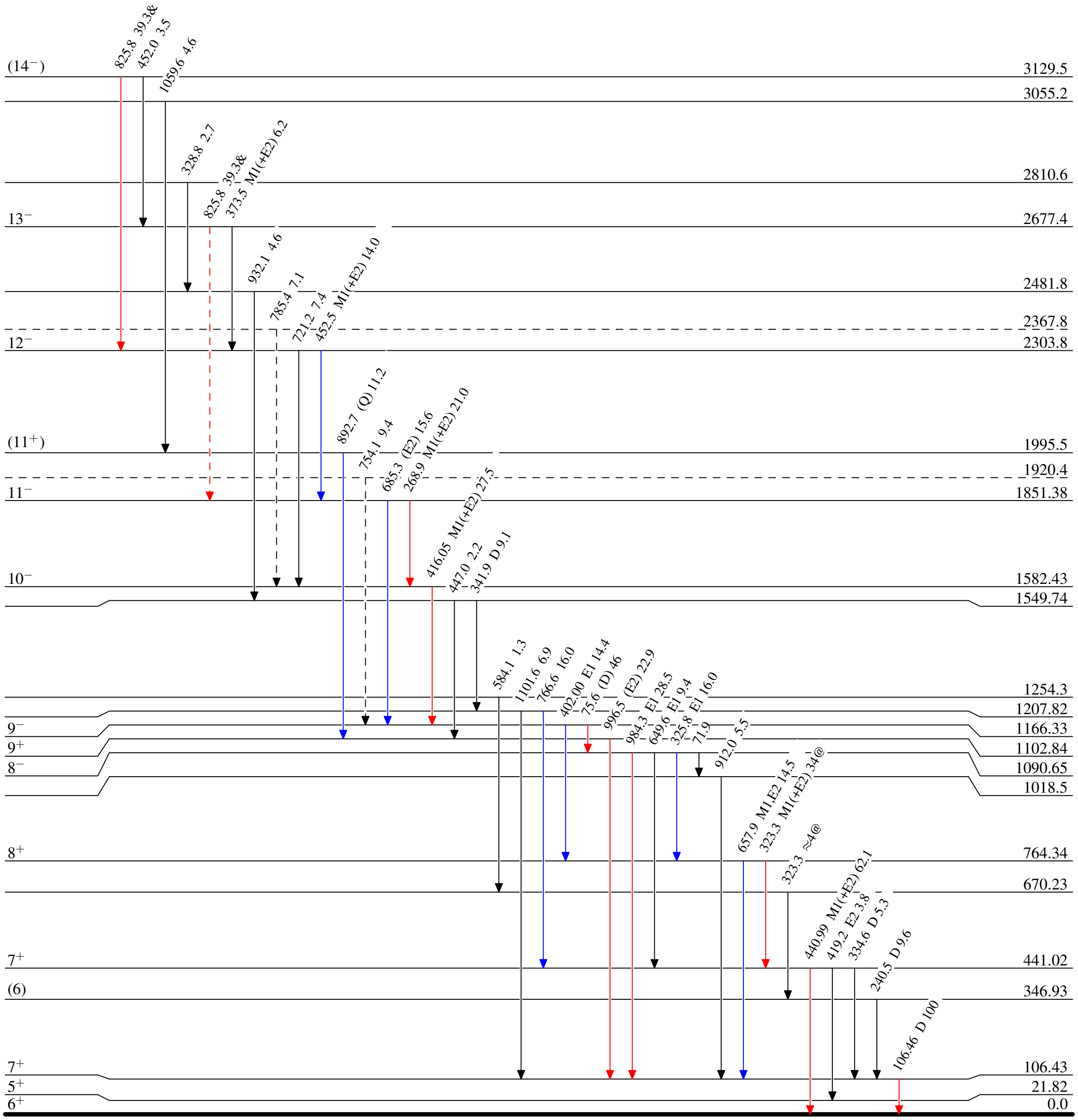
Legend

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

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

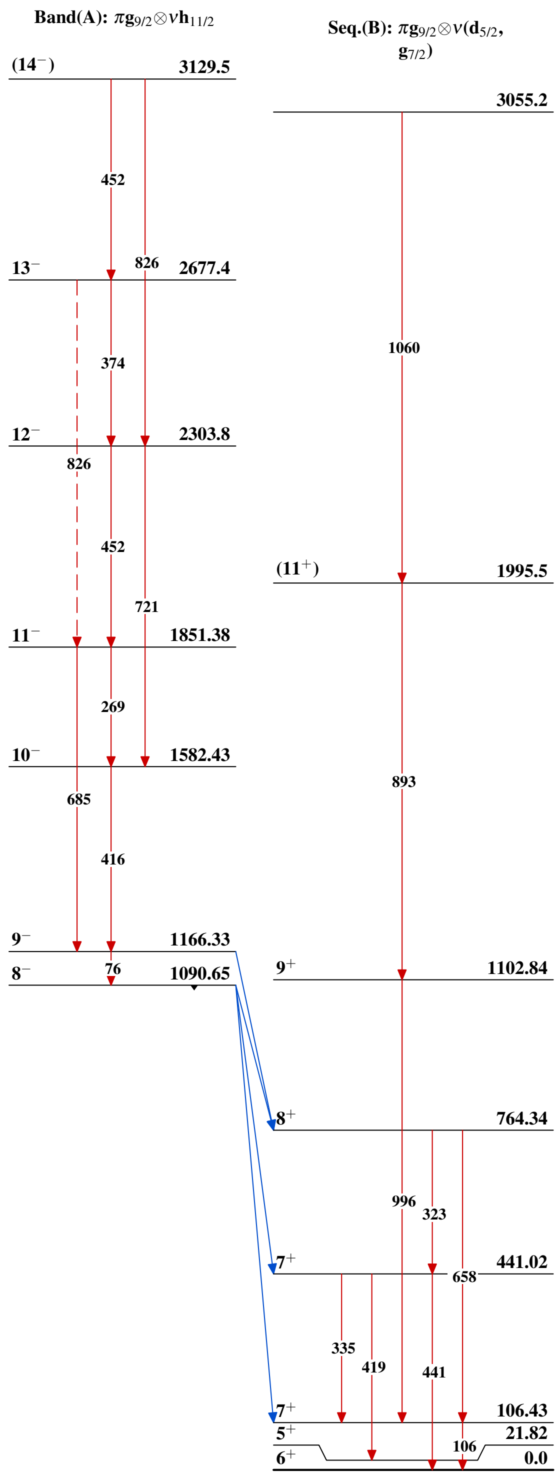
$I_\gamma > 10\% \times I_\gamma^{max}$

γ Decay (Uncertain)



$^{98}_{43}Tc_{55}$

$^{94}Zr(^{7}Li,3n\gamma)$ 1987Bi21



$^{98}_{43}Tc_{55}$