^{130}Te(^{12}C,4nγ) 2009Bh04

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Jun Chen	NDS 146, 1 (2017)	30-Sep-2017

2009Bh04: E=65 MeV ^{12}C beam was produced from the 15UD Pelletron at Inter University Accelerator Centre (IUAC), New Delhi. Target was 99.9% enriched ^{130}Te of 2.2 mg/cm^2 thickness on a 2.0 mg/cm^2 Au backing. γ rays were detected with five Clover HPGe detectors. Measured Eγ, Iγ, $\gamma\gamma$, $\gamma\gamma(\theta)$(DCO), γ(lin pol). Deduced levels, J, π, band structures, γ-ray multipolarities. Comparisons with shell-model and total Routhian surface (TRS) calculations.

2013Al03,2012Al25: E=56 MeV ^{12}C beam was produced from the Tandem van de Graaff accelerator at the National Institute for Physics and Nuclear Engineering, Bucharest, Romania. Target was 1 mg/cm^2 enriched ^{130}Te foil on a 20 mg/cm^2 Pb backing. γ rays were detected with an array of eight LaBr$_3$(Ce) scintillator detectors (FWHM=30 keV at Eγ=1.33 MeV) and eight HPGe detectors (FWHM=2.2-2.8 keV). Measured Eγ, Iγ, $\gamma\gamma$-coin, $\gamma\gamma\gamma$-coin, $\gamma\gamma$(t). Deduced levels, half-lives, transition strengths. Systematics of neighboring nuclei. Comparisons with shell-model calculations.

1980Me11: E=60 MeV. Measured $\gamma(\theta$,H,t). Deduced g-factor and half-life for the 10$^+$ isomer.

^{138}Ce Levels

E(level)[†]	J$^\pi$[‡]	T$_{1/2}$[#]	Comments
0.0[&]	0$^+$		
788.60[&] *10*	2$^+$		
1826.21[&] *14*	4$^+$	<50 ps	
2129.11[&] *16*	7$^-$		
2136.71 *17*	4$^+$		
2217.11 *16*	5$^-$	450 ps *30*	
2293.81[&] *15*	6$^+$	880 ps *19*	T$_{1/2}$: weighted average of 920 ps *25* and 860 ps *60* (2013Al03).
2732.51 *19*	(6$^+$)		
2764.4 *3*	(6$^-$)		
3108.81[&] *16*	8$^+$	<50 ps	
3331.41 *22*	8$^-$		
3430.01 *22*	(8$^+$)		
3507.11[c] *19*	9$^-$		
3539.01[&] *18*	10$^+$	81 ns *2*	g=−0.176 *10* (1980Me11) T$_{1/2}$: from γ(t) in 1980Me11. g-factor is measured using TDPAD (1980Me11).
3545.61 *22*	(9$^-$)		
3942.31[&] *20*	11$^+$	140 ps *11*	
4139.1 *3*	(10$^-$)		
4203.8 *3*	(10$^-$)		
4359.91[&] *22*	12$^+$		
4401.7[c] *3*	10$^-$		
4781.42 *25*	(12$^+$)		
4842.92 *25*	13$^-$		
4974.62 *23*	13$^+$		
5071.1 *4*	(11$^-$)		
5089.22 *24*	12$^-$		
5214.22[&] *23*	13$^-$		
5312.32[&] *24*	14$^+$	80 ps *9*	
5387.5[c] *4*	11$^-$		
5411.42[a] *25*	14$^-$		
5566.32[&] *25*	15$^+$		
5714.3 *3*	(14$^-$)		
5726.6[b] *3*	14$^+$		

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^{130}Te(^{12}C,4nγ) 2009Bh04 (continued)

^{138}Ce Levels (continued)

E(level)[†]	J^{π}[‡]	E(level)[†]	J^{π}[‡]	E(level)[†]	J^{π}[‡]	E(level)[†]	J^{π}[‡]
5731.0[a] *3*	15^-	6536.3[@] *3*	15^-	7185.2 *3*	(16^-)	8322.2 *4*	(20^+)
5871.2[b] *3*	15^+	6597.5 *5*		7211.2[@] *3*	18^-	8350.2[@] *4*	20^-
5955.2 *4*		6606.3[b] *4*	17^+	7225.1 *3*	(16^-)	8709.5[@] *4*	21^-
6014.3[&] *3*	16^+	6685.4[@] *3*	16^-	7392.3[b] *5*	(18^+)	8873.4[&] *4*	22^+
6134.6 *3*	(14^+)	6738.3 *4*	(16^-)	7427.5 *4*		8921.0 *4*	
6328.5[c] *4*	(12^-)	6841.6[&] *3*	17^+	7532.3 *3*	(17^-)	8957.8[@] *4*	22^-
6363.4[a] *4*	16^-	6859.6 *5*		7682.8 *4*	19^+	8978.2 *4*	
6408.5 *4*	(15^-)	6888.9[@] *3*	17^-	7685.7[@] *4*	19^-	9430.8[&] *5*	(23^+)
6450.9 *4*		7074.0[a] *4*	(17^-)	7744.1 *4*	(18^-)	9511.3 *4*	
6451.2[b] *4*	16^+	7104.6[&] *3*	18^+	7803.1[&] *4*	20^+		

[†] From a least-squares fit to γ-ray energies.
[‡] From 2009Bh04, based on deduced γ-ray multipolarities.
[#] From $\gamma\gamma$(t) with centroid-shift method (2013Al03), unless otherwise stated.
[@] Band(A): Band based on 15^-. Possible magnetic-rotational band with proposed configuration= $\pi g_{7/2}\otimes\pi h_{11/2}\otimes\nu h_{11/2}^{-2}$.
[&] Band(B): Yrast sequence. Configurations: $[\pi(g_{7/2}^6 d_{5/2}^2)\otimes\nu h_{11/2}^{-2} + \pi(g_{7/2}^5 d_{5/2}^3)\otimes\nu h_{11/2}^{-2}]$ for positive-parity states and $[\pi(g_{7/2}^6 d_{5/2}^1 h_{11/2}^1)\otimes\nu h_{11/2}^{-2}] + [\pi(g_{7/2}^5 d_{5/2}^2 h_{11/2}^1)\otimes\nu h_{11/2}^{-2}] + [\pi(g_{7/2}^5 d_{5/2}^3)\otimes\nu(s_{1/2}^{-1} h_{11/2}^{-1}]$ for negative-parity states. Above 6 MeV excitation, configuration= $\pi h_{11/2}^2\otimes\nu h_{11/2}^{-2}$.
[a] Band(C): Band based on 14^-. Possible configuration=$\pi(g_{7/2}d_{5/2})\otimes\ \nu(h_{11/2}^{-1}d_{3/2}^{-1})$.
[b] Band(D): Band based on 14^+.
[c] Band(E): Band based on 9^-. Possible configuration=$\nu h_{11/2}\otimes\nu d_{3/2}$ or $\nu h_{11/2}\otimes\nu s_{1/2}$.

γ(^{138}Ce)

DCO ratio is ($I_{\gamma1}$ at 138°, gated with γ_2 at 81°)/ ($I_{\gamma1}$ at 81°, gated with γ_2 at 138°). The gating transition is ΔJ=1, dipole, unless otherwise stated. Expected DCO ratios are: ≈1 for pure dipole transitions and ≈1.5 for pure quadrupole transitions when gated on ΔJ=1, dipole; and DCO ≈0.6 for pure dipole and ≈1.0 for pure quadrupole when gated on quadrupole transitions (2009Bh04).

POL=(a(Eγ)$N_{perpendicular}-N_{parallel}$)/ (a(E$\gamma$)$N_{perpendicular}+N_{parallel}$); where a(E$\gamma$)is a correction factor is equal to $N_{parallel}$(unpolarized source)/$N_{perpendicular}$ (unpolarized source). N are the number of photons of a given energy. A positive value of Pol indicates transition is electric whereas a negative value for magnetic transition (2009Bh04).

E_γ[†]	I_γ[#]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[@]	Comments
31.9 *2*	0.10 *2*	3539.01	10^+	3507.11	9^-	(E1)	
76.7 *1*	17.5 *18*	2293.81	6^+	2217.11	5^-	E1	
80.4 *2*		2217.11	5^-	2136.71	4^+	E1	
98.1 *1*	15.9 *16*	5312.32	14^+	5214.22	13^-	E1	
99.1 *2*	0.30 *5*	5411.42	14^-	5312.32	14^+	E1	
109.0 *2*	0.10 *2*	3539.01	10^+	3430.01	(8^+)	(E2)	
120.3 *2*	2.4 *4*	7803.1	20^+	7682.8	19^+	M1+E2	DCO=1.43 *2*, POL=−0.10 *9*.
125.0 *2*	6.6 *10*	5214.22	13^-	5089.22	12^-	M1+E2	DCO=1.42 *7*, POL=−0.13 *6*.
144.6 *2*	0.8 *1*	5871.2	15^+	5726.6	14^+	M1	DCO=1.05 *4*.
146.6 *2*	1.0 *2*	6597.5		6450.9			
149.1 *2*	1.2 *2*	6685.4	16^-	6536.3	15^-	M1	DCO=0.93 *13*.
155.1 *2*	2.9 *4*	6606.3	17^+	6451.2	16^+	M1	DCO=1.17 *12*, POL=−0.23 *12*.
157.1[‡] *2*	11.0 *11*	2293.81	6^+	2136.71	4^+	E2	DCO=1.54 *12*.
164.7 *1*	40.4 *20*	2293.81	6^+	2129.11	7^-	E1	

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^{130}Te(^{12}C,4nγ) 2009Bh04 (continued)

γ(^{138}Ce) (continued)

E_γ[†]	I_γ[#]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[@]	Comments
175.7 2	4.6 7	3507.11	9⁻	3331.41	8⁻	M1	DCO=1.2 3.
197.2 2	11.8 12	5411.42	14⁻	5214.22	13⁻	M1	DCO=1.10 4, POL=−0.16 9.
203.5 2	7.6 11	6888.9	17⁻	6685.4	16⁻	M1	DCO=1.07 6, POL=−0.15 8.
211.8 2	2.8 4	7744.1	(18⁻)	7532.3	(17⁻)	(M1+E2)	DCO=1.3 3.
248.3 2	1.2 2	8957.8	22⁻	8709.5	21⁻	M1	DCO=1.08 15.
254.0[‡] 1	56 3	5566.32	15⁺	5312.32	14⁺	M1+E2	DCO=0.84 1, POL=−0.06 3.
262.1 2	1.0 2	6859.6		6597.5			
263.0 2	14.5 15	7104.6	18⁺	6841.6	17⁺	M1	DCO=1.13 5, POL=−0.10 6.
302.9 1	95 5	2129.11	7⁻	1826.21	4⁺	E3	
307.2 2	0.20 3	7532.3	(17⁻)	7225.1	(16⁻)	(M1)	
319.6 2	10.9 11	5731.0	15⁻	5411.42	14⁻	M1	DCO=1.00 4, POL=−0.15 5.
322.3 1	17.8 18	7211.2	18⁻	6888.9	17⁻	M1	DCO=1.10 6, POL=−0.13 4.
337.7 2	14.4 14	5312.32	14⁺	4974.62	13⁺	M1	DCO=1.06 3, POL=−0.08 6.
347.1 2	0.5 1	7532.3	(17⁻)	7185.2	(16⁻)	(M1)	DCO=0.7 4.
359.3[‡] 2	2.2 3	8709.5	21⁻	8350.2	20⁻	M1	DCO=0.72 25, POL=−0.19 11.
369.6 2	1.1 2	7211.2	18⁻	6841.6	17⁺	(E1)	
388.9 2	3.2 5	5955.2		5566.32	15⁺		
390.9 1	63 3	2217.11	5⁻	1826.21	4⁺	E1	DCO=1.30 12, POL=+0.04 4.
396.7 2	3.9 6	3942.31	11⁺	3545.61	(9⁻)	(M2)	DCO=2.1 4.
398.3 2	1.3 2	3507.11	9⁻	3108.81	8⁺	E1	
403.3 1	130 7	3942.31	11⁺	3539.01	10⁺	M1+E2	DCO=1.10 1, POL=+0.02 2.
417.6[‡] 1	110 6	4359.91	12⁺	3942.31	11⁺	M1	DCO=0.74 2, POL=−0.04 2.
430.2[‡] 1	123 6	3539.01	10⁺	3108.81	8⁺	E2	DCO=1.08 3, POL=+0.03 2. A_2=+0.16 4 (1980Me11).
432.8 2	2.8 4	5214.22	13⁻	4781.42	(12⁺)	(E1)	DCO=1.2 3.
438.7 2	1.3 2	2732.51	(6⁺)	2293.81	6⁺	M1	
448.0[‡] 1	38.2 19	6014.3	16⁺	5566.32	15⁺	M1	DCO=0.69 2, POL=−0.04 3.
467.6[‡] 1	23.0 12	2293.81	6⁺	1826.21	4⁺	E2	DCO=1.03 3, POL=+0.08 5.
469.4 2	1.8 3	5312.32	14⁺	4842.92	13⁻	E1	
474.5[‡] 2	8.5 13	7685.7	19⁻	7211.2	18⁻	M1	DCO=0.64 7, POL=−0.06 5.
483.0[‡] 2	10.4 10	4842.92	13⁻	4359.91	12⁺	E1	DCO=0.70 5, POL=+0.07 6.
495.7 2	2.0 3	6450.9		5955.2			
500.1 2	0.7 1	5714.3	(14⁻)	5214.22	13⁻	(M1)	DCO=0.85 4.
547.3 2	1.6 2	2764.4	(6⁻)	2217.11	5⁻	(M1)	
550.8 2	0.6 1	6685.4	16⁻	6134.6	(14⁺)	(M2)	
557.4 2	1.5 2	9430.8	(23⁺)	8873.4	22⁺	(M1)	DCO=1.1 5.
568.5 2	0.6 1	5411.42	14⁻	4842.92	13⁻	M1	DCO=1.7 6, POL=−0.3 3.
570.8 2	0.10 2	8921.0		8350.2	20⁻		
578.2[‡] 2	7.7 12	7682.8	19⁺	7104.6	18⁺	M1	DCO=0.7 1, POL=−0.16 7.
580.0[‡] 2	3.8 6	6451.2	16⁺	5871.2	15⁺	M1	DCO=0.62 10, POL=−0.09 5.
585.9 2	2.1 3	7427.5		6841.6	17⁺		
614.7 1	26.1 13	4974.62	13⁺	4359.91	12⁺	M1	DCO=0.96 2, POL=−0.07 3.
628.0 2	0.8 1	8978.2		8350.2	20⁻		
632.0[‡] 2	1.8 3	4139.1	(10⁻)	3507.11	9⁻	(M1)	DCO=0.35 5, POL=−0.08 10.
632.4[‡] 2	3.3 5	6363.4	16⁻	5731.0	15⁻	M1	DCO=0.56 20, POL=−0.21 11.
639.4 2	1.4 2	8322.2	(20⁺)	7682.8	19⁺	(M1)	DCO=1.0 3.
658.2 2	0.9 1	4203.8	(10⁻)	3545.61	(9⁻)	(M1)	
664.5 2	4.1 6	8350.2	20⁻	7685.7	19⁻	M1	DCO=0.91 5, POL=−0.09 10.
671.1 2	0.40 6	6685.4	16⁻	6014.3	16⁺	E1+M2	Mult.: DCO=1.7 4,ΔJ=0.
697.5 2	2.3 3	3430.01	(8⁺)	2732.51	(6⁺)	(E2)	
698.5 2	2.3 3	7803.1	20⁺	7104.6	18⁺	E2	
710.6 2	0.7 1	7074.0	(17⁻)	6363.4	16⁻	(M1)	
729.3 2	0.20 3	5089.22	12⁻	4359.91	12⁺	E1	DCO=1.1 4.

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^{130}Te(^{12}C,4nγ) 2009Bh04 (continued)

γ(^{138}Ce) (continued)

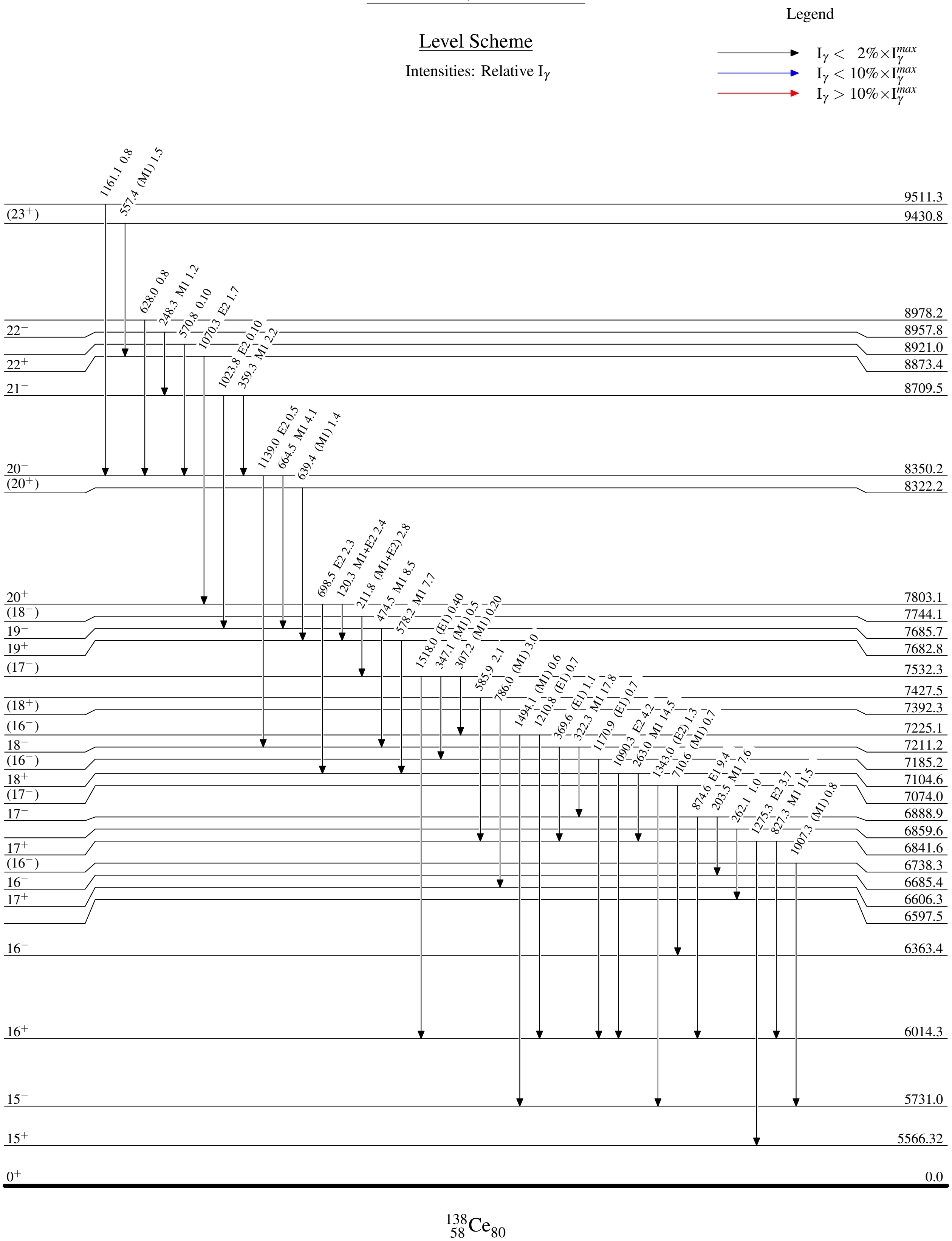
E_γ[†]	I_γ[#]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[@]	Comments
786.0 *2*	3.0 *5*	7392.3	(18$^+$)	6606.3	17$^+$	(M1)	
788.6[‡] *1*	195 *10*	788.60	2$^+$	0.0	0$^+$	E2	DCO=1.03 *2*, POL=+0.04 *3*.
815.0[‡] *1*	91 *5*	3108.81	8$^+$	2293.81	6$^+$	E2	DCO=0.92 *1*, POL=+0.03 *2*. A_2=+0.19 *6* (1980Me11).
827.3[‡] *2*	11.5 *12*	6841.6	17$^+$	6014.3	16$^+$	M1	DCO=0.65 *2*, POL=−0.06 *4*.
839.1[‡] *2*	4.7 *7*	4781.42	(12$^+$)	3942.31	11$^+$	(M1+E2)	DCO=0.78 *15*.
854.3 *1*	61 *3*	5214.22	13$^-$	4359.91	12$^+$	E1	DCO=0.98 *2*, POL=+0.04 *3*.
874.6[‡] *2*	9.4 *14*	6888.9	17$^-$	6014.3	16$^+$	E1	DCO=0.64 *9*, POL=+0.09 *6*.
894.6 *2*	3.3 *5*	4401.7	10$^-$	3507.11	9$^-$	M1	DCO=0.97 *9*, POL=−0.10 *12*.
896.6 *2*	12.9 *13*	5871.2	15$^+$	4974.62	13$^+$	E2	DCO=1.71 *8*, POL=+0.09 *7*.
906.3[‡] *2*	2.5 *4*	2732.51	(6$^+$)	1826.21	4$^+$	E2	DCO=0.94 *15*.
932.0[‡] *2*	0.6 *1*	5071.1	(11$^-$)	4139.1	(10$^-$)	(M1)	DCO=0.69 *19*.
941.0[‡] *2*	0.30 *5*	6328.5	(12$^-$)	5387.5	11$^-$	(M1)	DCO=0.55 *24*.
970.0 *2*	0.40 *6*	6536.3	15$^-$	5566.32	15$^+$	E1	
979.7 *1*	33.6 *17*	3108.81	8$^+$	2129.11	7$^-$	E1	DCO=1.15 *2*, POL=+0.03 *3*.
985.8 *2*	1.1 *2*	5387.5	11$^-$	4401.7	10$^-$	M1	DCO=0.97 *14*, POL=−0.11 *13*.
997.1 *2*	1.3 *2*	6408.5	(15$^-$)	5411.42	14$^-$	(M1)	
1007.3 *2*	0.8 *1*	6738.3	(16$^-$)	5731.0	15$^-$	(M1)	
1023.8 *2*	0.10 *2*	8709.5	21$^-$	7685.7	19$^-$	E2	
1037.6[‡] *1*	183 *9*	1826.21	4$^+$	788.60	2$^+$	E2	DCO=0.96 *2*, POL=+0.05 *4*.
1070.3 *2*	1.7 *3*	8873.4	22$^+$	7803.1	20$^+$	E2	DCO=1.5 *3*, POL=+0.4 *3*.
1090.3 *2*	4.2 *6*	7104.6	18$^+$	6014.3	16$^+$	E2	DCO=1.50 *14*, POL=+0.26 *24*.
1119.1[‡] *2*	9.3 *14*	6685.4	16$^-$	5566.32	15$^+$	E1	DCO=0.70 *9*, POL=+0.09 *6*.
1139.0 *2*	0.5 *1*	8350.2	20$^-$	7211.2	18$^-$	E2	
1146.9[‡] *2*	13.1 *13*	5089.22	12$^-$	3942.31	11$^+$	E1	DCO=0.71 *4*, POL=+0.08 *6*.
1161.1 *2*	0.8 *1*	9511.3		8350.2	20$^-$		
1170.9 *2*	0.7 *1*	7185.2	(16$^-$)	6014.3	16$^+$	(E1)	DCO=0.70 *18*, POL=+0.17 *20*.
1202.3 *2*	6.2 *9*	3331.41	8$^-$	2129.11	7$^-$	M1	DCO=0.84 *23*, POL=−0.2 *3*.
1210.8 *2*	0.7 *1*	7225.1	(16$^-$)	6014.3	16$^+$	(E1)	DCO=1.0 *3*.
1224.0 *2*	1.0 *2*	6536.3	15$^-$	5312.32	14$^+$	E1+M2	Mult.: DCO=1.8 *8*, ΔJ=0.
1275.3[‡] *2*	3.7 *6*	6841.6	17$^+$	5566.32	15$^+$	E2	DCO=0.99 *3*.
1291.7 *2*	1.4 *2*	6134.6	(14$^+$)	4842.92	13$^-$	(E1)	DCO=1.14 *5*, POL=+0.22 *17*.
1343.0 *2*	1.3 *2*	7074.0	(17$^-$)	5731.0	15$^-$	(E2)	
1348.1[‡] *2*	12.3 *12*	2136.71	4$^+$	788.60	2$^+$	E2	DCO=0.94 *3*, POL=+0.08 *6*.
1366.7 *2*	1.8 *3*	5726.6	14$^+$	4359.91	12$^+$	E2	DCO=1.18 *20*.
1378.0 *2*	7.5 *11*	3507.11	9$^-$	2129.11	7$^-$	E2	DCO=1.56 *18*, POL=+0.11 *9*.
1409.9 *2*	0.9 *1*	3539.01	10$^+$	2129.11	7$^-$	E3	
1416.5 *2*	6.8 *10*	3545.61	(9$^-$)	2129.11	7$^-$	(E2)	DCO=1.78 *23*.
1494.1 *2*	0.6 *1*	7225.1	(16$^-$)	5731.0	15$^-$	(M1)	
1518.0 *2*	0.40 *6*	7532.3	(17$^-$)	6014.3	16$^+$	(E1)	DCO=1.2 *4*.

† Uncertainty=0.1 keV for Iγ≥20 and 0.2 keV for Iγ<20, based on a general statement by 2009Bh04.
‡ DCO value for gate on ΔJ=2, quadrupole transition.
# Typical uncertainty is 5% for Iγ>20, 10% for 10≤Iγ≤20 and 15% for Iγ<10 (2009Bh04).
@ From 2009Bh04 based on γγ(DCO) and γ(lin pol).

^{130}Te(^{12}C,4nγ) 2009Bh04

Level Scheme

Intensities: Relative I_γ



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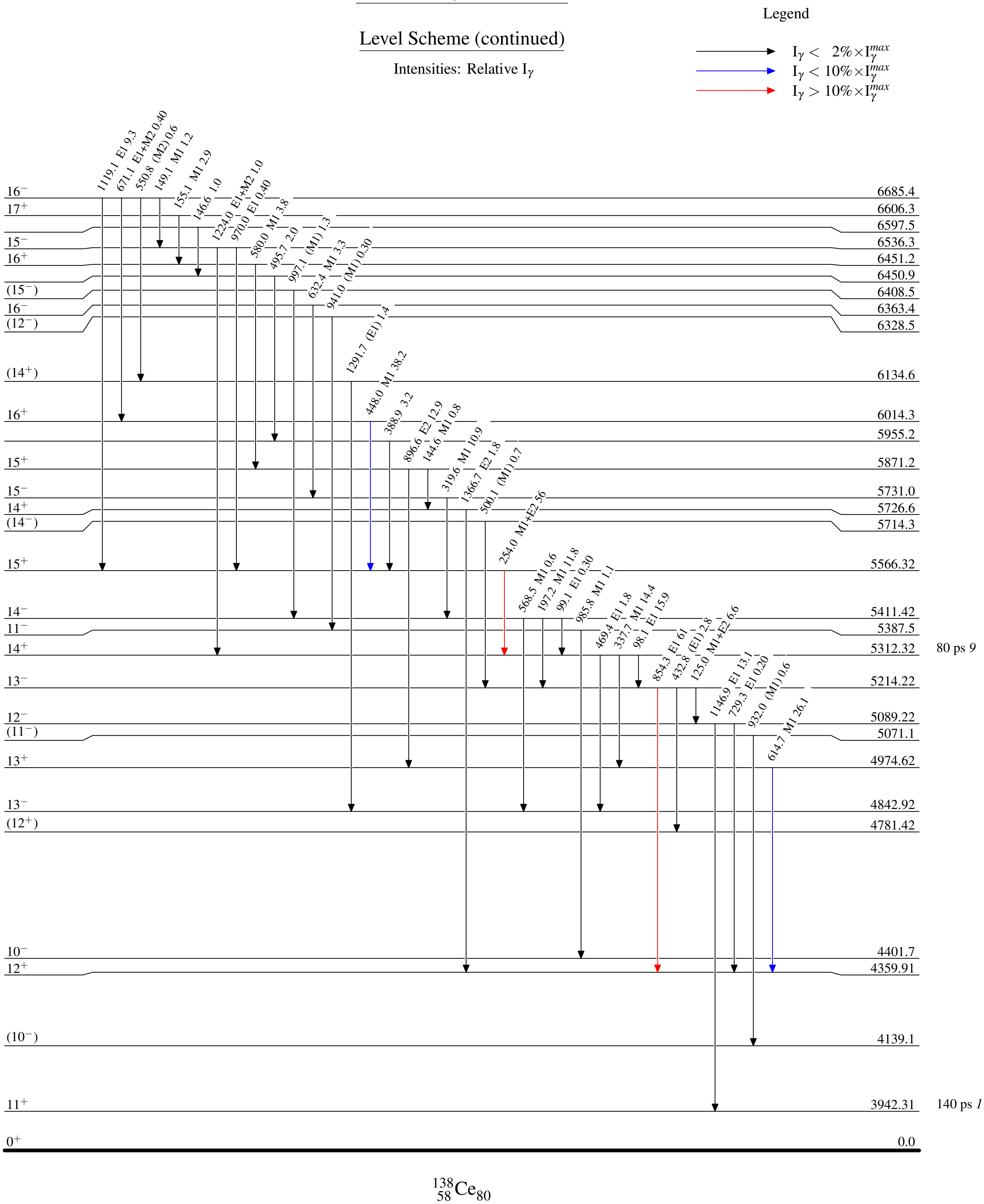
Level Scheme (continued)

Intensities: Relative I_γ



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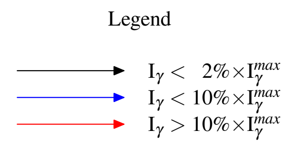
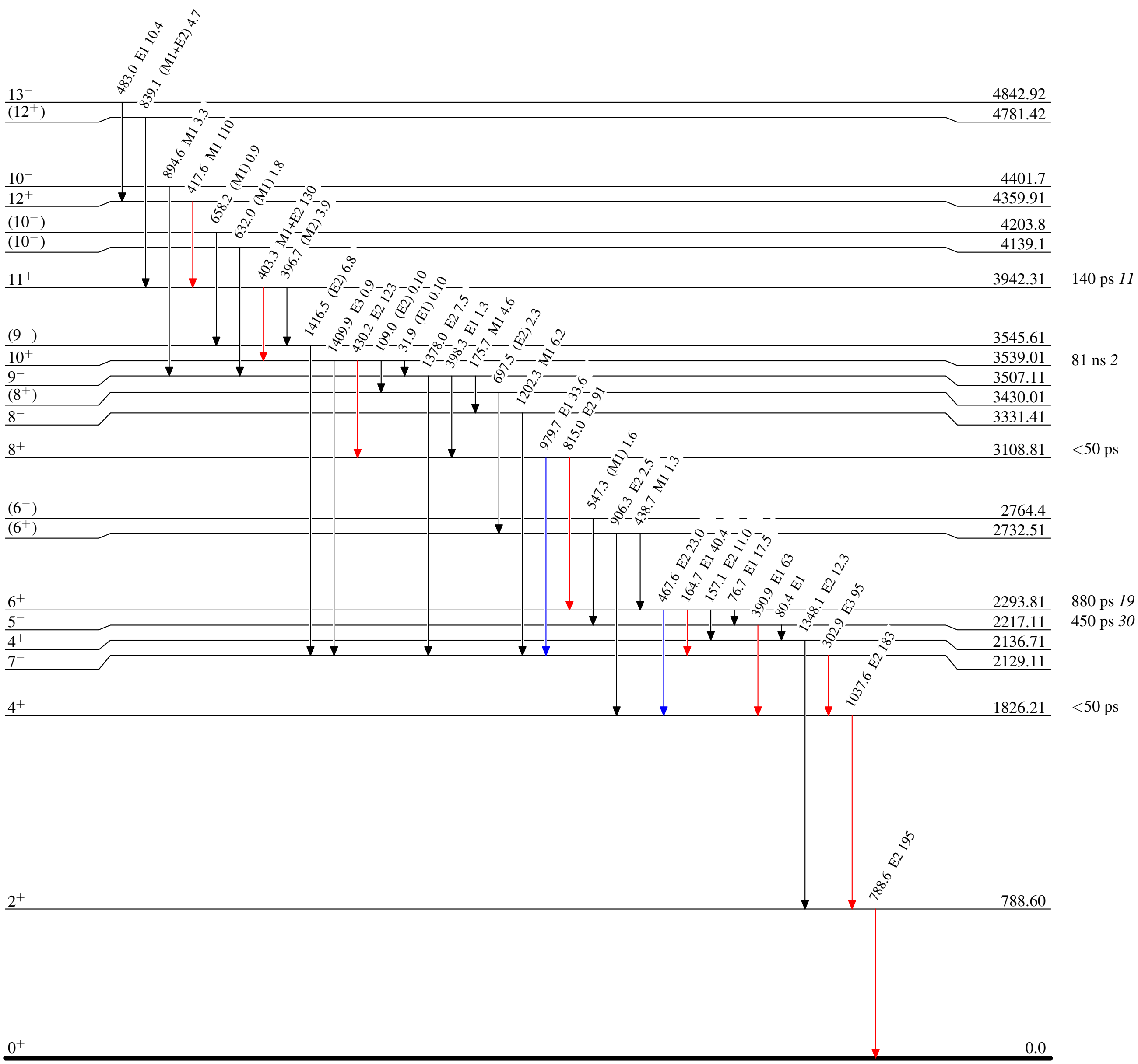
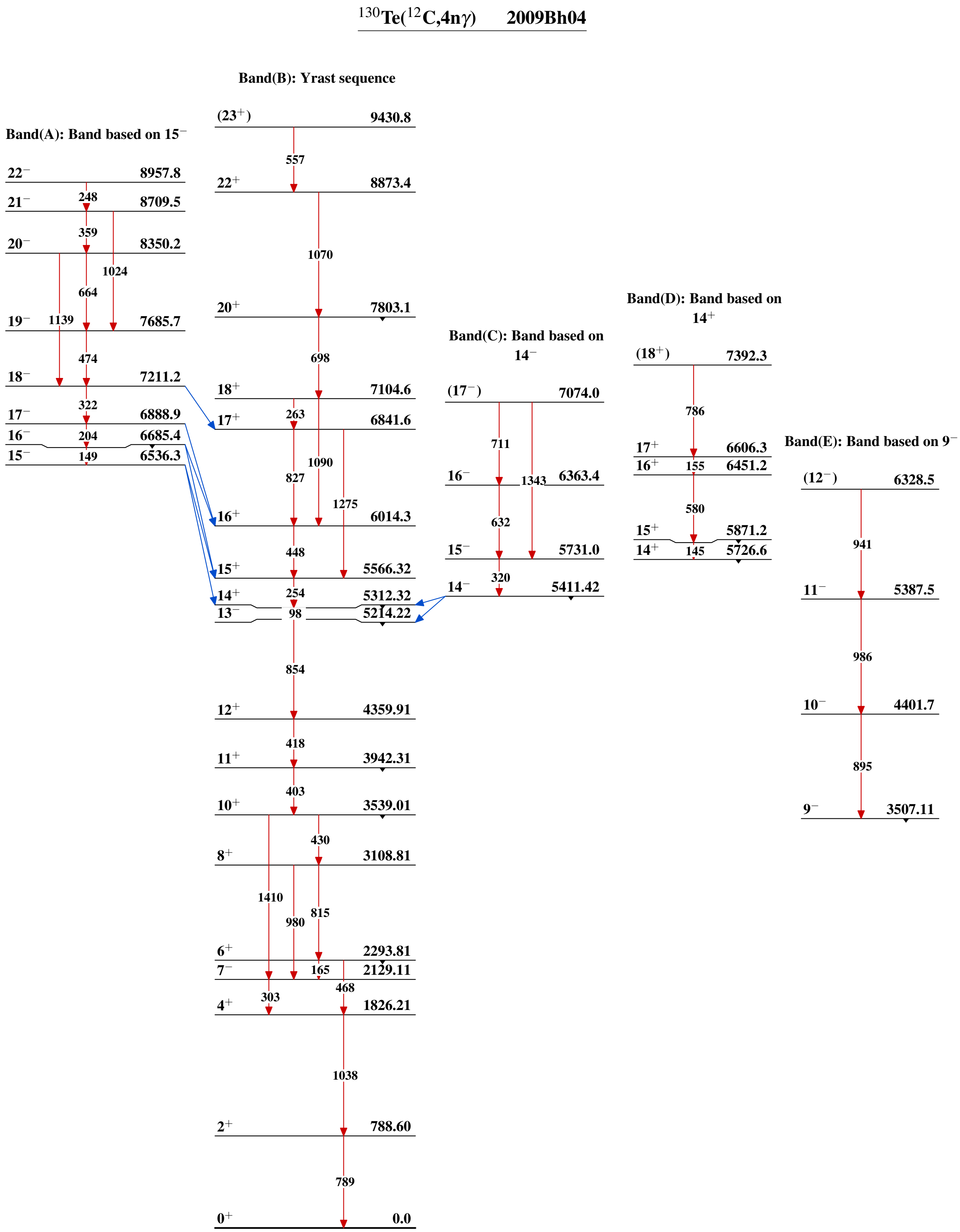
Level Scheme (continued)

Intensities: Relative I_γ





$^{138}_{58}Ce_{80}$


$^{130}Te(^{12}C,4n\gamma)$ 2009Bh04
Band(A): Band based on 15⁻
Band(B): Yrast sequence
Band(C): Band based on 14⁻
Band(D): Band based on 14⁺
Band(E): Band based on 9⁻
22⁻ 8957.8
21⁻ 8709.5
20⁻ 8350.2
19⁻ 7685.7
18⁻ 7211.2
17⁻ 6888.9
16⁻ 6685.4
15⁻ 6536.3
(23⁺) 9430.8
22⁺ 8873.4
20⁺ 7803.1
18⁺ 7104.6
17⁺ 6841.6
16⁺ 6014.3
15⁺ 5566.32
14⁺ 5312.32
13⁻ 5214.22
12⁺ 4359.91
11⁺ 3942.31
10⁺ 3539.01
8⁺ 3108.81
6⁺ 2293.81
7⁻ 2129.11
4⁺ 1826.21
2⁺ 788.60
0⁺ 0.0
(17⁻) 7074.0
16⁻ 6363.4
15⁻ 5731.0
14⁻ 5411.42
(18⁺) 7392.3
17⁺ 6606.3
16⁺ 6451.2
15⁺ 5871.2
14⁺ 5726.6
(12⁻) 6328.5
11⁻ 5387.5
10⁻ 4401.7
9⁻ 3507.11
248
359
1024
664
1139
474
322
204
149
557
1070
698
263
1090
827
1275
448
254
98
854
418
403
430
1410
980
815
165
468
303
1038
789
711
1343
632
320
786
155
580
145
941
986
895

$^{138}_{58}Ce_{80}$