^{80}Se(α,3nγ) 1986Fu03

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	M. Shamsuzzoha Basunia	NDS 199,271 (2025)	1-Sep-2024

See also 1983Fu01.

Eα=35-48 MeV; 96% ^{80}Se target; Ge(Li), high resolution Ge and planar Ge detectors; measured Eγ, Iγ, excit, $\gamma(\theta)$ (at θ=27°, 40°, 55°, 70°, 90° and 152°), $\gamma\gamma$ coin, γ linear polarization, $T_{1/2}$ from DSAM.

^{81}Kr Levels

In 1983Fu01 only the results concerning the positive-parity levels are given. Data from 1986Fu03 supersede those.
The authors′ level scheme is fully supported by extensive $\gamma\gamma$-coin data.

E(level)[†]	J$^\pi$[#]	$T_{1/2}$[‡]	Comments
0	7/2$^+$		
49.52[&] *14*	(9/2)$^+$		
190.70[a] *10*	1/2$^-$		
456.46[b] *16*	5/2$^-$		
700.9[a] *4*	5/2$^-$		
873.39[&] *15*	11/2$^+$		
902.44[b] *19*	(7/2$^-$)		
933.87[f] *20*	11/2$^+$	0.19 ps *6*	
976.0[&] *3*	13/2$^+$	1.5 ps *6*	E(level): misprinted as 995.6-keV level in 1983Fu01.
981.6 *3*	(9/2$^+$)		
1348.83[b] *21*	9/2$^-$		
1443.1[a] *4*	9/2$^-$		
1607.40[f] *25*	13/2$^+$	3.5 ps *21*	
1828.6[b] *4*	(11/2$^-$)		
1993.2[&] *4*	15/2$^+$	0.15 ps *6*	
2135.5[&] *3*	17/2$^+$	0.40 ps *8*	
2165.63 *20*	13/2$^-$		
2192.2 *5*	(15/2$^+$)	>2.1 ps	
2419.84[c] *24*	13/2$^-$		
2533.14[c] *22*	15/2$^-$	1.4 ps *7*	
2694.5[f] *4*	(17/2$^+$)		
2699.19[c] *23*	17/2$^-$		
2784.0[d] *4*	(15/2)		
2827.71 *23*	17/2$^-$	2.4 ps *8*	
3061.20[c] *23*	19/2$^-$	1.5 ps *6*	
3092.2[d] *4*	(17/2)	1.9 ps *6*	
3195.3[&] *4*	19/2$^+$	0.14 ps *6*	
3392.5[&] *5*	21/2$^+$	0.27 ps *6*	
3455.7[d] *7*	(19/2)		
3490.4[c] *8*	21/2$^-$	1.8[@] ps *8*	
3557.8[f] *5*			
3623.7[e] *5*	21/2$^+$	0.33 ps *6*	
3649.6 *3*	(21/2$^-$)		
3854.7[d] *12*	(21/2)		
3956.8[e] *5*	23/2$^+$	0.28 ps *5*	

Continued on next page (footnotes at end of table)

^{80}Se(α,3nγ) 1986Fu03 (continued)

^{81}Kr Levels (continued)

E(level)[†]	J^{π}[#]	$T_{1/2}$[‡]
4099.1[c] *8*	23/2$^-$	1.9 ps *6*
4300.6 *9*	(23/2$^-$)	
4471.9[e] *6*	25/2$^+$	0.16 ps *6*
4713.9[c] *9*	(25/2$^-$)	1.0 ps *6*
5047.2[e] *6*	27/2$^+$	0.10 ps *4*
5759.2?[e] *12*	(29/2$^+$)	

[†] From a least-squares fit to Eγ.

[‡] From Doppler shift analysis (1986Fu03). Also, from $\gamma\gamma$-coin time spectra, no level above 100 keV has $T_{1/2}$ in the ns region.

[#] Authors′ deduction from $\gamma(\theta)$, excit and linear polarization data.

[@] Contribution from component of 428γ depopulating the 3624 level has been taken into account (1986Fu03).

[&] Band(A): ν $g_{9/2}$ band 1.

[a] Band(B): ν $p_{1/2}$ band.

[b] Band(C): ν $f_{5/2}$ band.

[c] Band(D): π=− 3-quasiparticle band. Built on 2420 level (or possibly 2166 level).

[d] Band(E): π=+ 3−quasiparticle band. Includes 2784 level.

[e] Band(F): 3-quasiparticle band 3. Includes 3624 level.

[f] Band(G): ν $g_{9/2}$ band 2.

^{80}Se(α,3nγ) 1986Fu03 (continued)

γ(^{81}Kr)

Anticipated stretched E2 crossover transitions from the 5047 level (1090.4γ), 4472 level (848.2γ and 1079.4γ) and 3957 level (761.9γ) were not observed; 1986Fu03 set limits of 7, 10, 9 and 15 for their respective intensities.

E_γ[†]	I_γ[‡]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	δ[@]	α[&]	Comments
49.5 *2*	≈1000	49.52	(9/2)$^+$	0	7/2$^+$				
113.3 *1*	21 *1*	2533.14	15/2$^-$	2419.84	13/2$^-$	D			A_2=−0.24 *5*; A_4=+0.06 *8*
128.6 *1*	16 *1*	2827.71	17/2$^-$	2699.19	17/2$^-$	D			A_2=+0.28 *4*; A_4=−0.08 *6* A_2, A_4 indicates D ΔJ=0 γ.
166.1 *1*	225 *9*	2699.19	17/2$^-$	2533.14	15/2$^-$	M1(+E2)	≈−0.05	≈0.0332	A_2=−0.34 *2*; A_4=−0.05 *3* Pol=−0.25 *6*.
190.7 *1*	67 *2*	190.70	1/2$^-$	0	7/2$^+$	(E3)		0.476	A_2=0.00 *2*; A_4=−0.02 *2* Pol=+0.07 *12*.
^{x}225.2 *3*	4 *1*								Coincident with 356γ, 510γ.
231.2 *1*	≈17	3623.7	21/2$^+$	3392.5	21/2$^+$	M1(+E2)	−0.05 *5*	0.0141 *3*	A_2=+0.37 *4*; A_4=+0.01 *7* Pol=+08 *3*. Pol datum for doublet dominated by this transition. Iγ=20 *2* for doublet with ^{81}Br line.
233.5 *1*	14 *2*	3061.20	19/2$^-$	2827.71	17/2$^-$	M1+E2	−0.08 *5*	0.0138 *4*	A_2=−0.40 *5*; A_4=+0.08 *9* Pol=−0.4 *3*.
245.0 *5*	≈10	700.9	5/2$^-$	456.46	5/2$^-$				Iγ=36 *3*, A_2=+0.07 *4*, A_4=−0.01 *7* for doublet with ^{80}Br line.
294.5 *1*	31 *2*	2827.71	17/2$^-$	2533.14	15/2$^-$	M1		0.00762	A_2=−0.29 *2*; A_4=−0.01 *4* Pol=−0.4 *2*.
308.2 *1*	35 *2*	3092.2	(17/2)	2784.0	(15/2)	M1+E2	−0.07 *4*	0.00685 *12*	A_2=−0.35 *2*; A_4=−0.05 *5* Pol=−0.43 *15*.
333.1 *1*	43 *2*	3956.8	23/2$^+$	3623.7	21/2$^+$	M1		0.00563	A_2=−0.31 *3*; A_4=+0.06 *7* Pol=−0.27 *11*. δ(D,Q)=−0.01 *2*.
337.1 *3*	11 *2*	2165.63	13/2$^-$	1828.6	(11/2$^-$)				
^{x}356.9 *3*	7 *2*								Coincident with 225γ, 510γ. A_2=+0.07 *18*.
362.0 *1*	207 *9*	3061.20	19/2$^-$	2699.19	17/2$^-$	M1+E2	−0.08 *3*	0.00463	A_2=−0.42 *3*; A_4=−0.03 *6* Pol=−0.19 *3*.
363.5 *5*	19 *3*	3455.7	(19/2)	3092.2	(17/2)				
367.5 *1*	126 *6*	2533.14	15/2$^-$	2165.63	13/2$^-$	M1+E2	−0.09 *3*	0.00447	A_2=−0.40 *2*; A_4=−0.02 *6* Pol=−0.27 *5*.
399 *1*	9 *3*	3854.7	(21/2)	3455.7	(19/2)				A_2=−0.5 *2*
428.8[a] *1*	≈150[a]	3490.4	21/2$^-$	3061.20	19/2$^-$				Mult.: M1 (δ=−0.1) for Iγ=187 *8* triplet including an ^{81}Br γ, based on A_2=−0.34 *4*, A_4=+0.03 *7*, Pol=−0.19 *5*.
428.8[a] *1*	≈25[a]	3623.7	21/2$^+$	3195.3	19/2$^+$				Mult.: M1 (δ=−0.1) for Iγ=187 *8* triplet including an ^{81}Br γ.
446[b]		1348.83	9/2$^-$	902.44	(7/2$^-$)				Shown in fig. 5 of 1986Fu03 but absent from list of observed γ rays.

$^{81}_{36}Kr_{45}$-3

γ(^{81}Kr) (continued)

E_γ[†]	I_γ[‡]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	δ[@]	α[&]	Comments
446.1 *2*	31 *2*	902.44	(7/2$^-$)	456.46	5/2$^-$	(D+Q)			Mult.: A_2=+0.37 *8*, A_4=+0.18 *13*; consistent with D+Q, but γ may have an additional placement.
456.6 *2*	99 *6*	456.46	5/2$^-$	0	7/2$^+$	(E1)		1.22×10^{-3}	A_2=−0.09 *3*; A_4=+0.02 *5* Pol=−0.04 *10*.
510 *1*	≈60	700.9	5/2$^-$	190.70	1/2$^-$				
515.1 *3*	84 *9*	4471.9	25/2$^+$	3956.8	23/2$^+$	M1+E2	−0.10 *4*	0.00201	A_2=−0.49 *9* Pol=−0.40 *11*.
528.1 *3*	3 *1*	3061.20	19/2$^-$	2533.14	15/2$^-$				A_2=+0.2 *3*
533.6 *3*	29 *4*	2699.19	17/2$^-$	2165.63	13/2$^-$	E2		0.00262	A_2=+0.32 *4*; A_4=−0.08 *6* Pol=+0.9 *4*.
559.0 *4*	42 *5*	2694.5	(17/2$^+$)	2135.5	17/2$^+$				A_2=+0.17 *10*
564[b]		2699.19	17/2$^-$	2135.5	17/2$^+$				Shown in fig. 5 of 1986Fu03 but absent from list of observed γ rays. Placement not included in Adopted Levels, Gammas.
564.3 *2*	91 *3*	3956.8	23/2$^+$	3392.5	21/2$^+$	M1+E2	−0.10 *3*	1.63×10^{-3} *2*	A_2=−0.44 *4*; A_4=+0.08 *8* Pol=−0.18 *13*.
575.3 *2*	39 *4*	5047.2	27/2$^+$	4471.9	25/2$^+$	M1+E2	−0.10 *4*	1.56×10^{-3} *2*	A_2=−0.50 *5*; A_4=−0.02 *8* Pol=−0.19 *19*.
588.4[b] *4*	6 *2*	3649.6	(21/2$^-$)	3061.20	19/2$^-$				
[x]603.8 *3*	≈5								Coincident with 166γ, 362γ, 367γ, 428γ; A_2=−0.7 *3*. Iγ=11 *2* for doublet with a γ from ^{81}Br.
608.7 *2*	48 *3*	4099.1	23/2$^-$	3490.4	21/2$^-$	M1+E2	−0.20 *6*	1.38×10^{-3} *2*	A_2=−0.61 *8* Pol=+0.01 *19*.
615 *1*	≈10	4713.9	(25/2$^-$)	4099.1	23/2$^-$				
631.1 *4*	33 *4*	1607.40	13/2$^+$	976.0	13/2$^+$				A_2=−0.15 *11*
673.6 *2*	83 *5*	1607.40	13/2$^+$	933.87	11/2$^+$	M1+E2	−0.5 *3*	0.00114 *6*	A_2=−0.91 *3*; A_4=+0.01 *6* Pol=+0.02 *10*.
701.0 *4*	≈10	2694.5	(17/2$^+$)	1993.2	15/2$^+$				
706.0[a] *3*	≈10[a]	2533.14	15/2$^-$	1828.6	(11/2$^-$)				Iγ=61 *6*, A_2=−0.28 *3*, A_4=−0.02 *4*, Pol=+0.2 *3* for doublet.
706.0[a] *3*	≈50[a]	2699.19	17/2$^-$	1993.2	15/2$^+$	(E1)		4.36×10^{-4}	Iγ=61 *6*, A_2=−0.28 *3*, A_4=−0.02 *4*, Pol=+0.2 *3* for doublet dominated by this transition.
712 *1*	14 *4*	5759.2?	(29/2$^+$)	5047.2	27/2$^+$				
722.8 *2*	≈40	2165.63	13/2$^-$	1443.1	9/2$^-$	E2		1.11×10^{-3}	Iγ=46 *5*, A_2=+0.39 *3*, A_4=−0.04 *5*, Pol=+0.6 *4* for doublet with ^{81}Br γ.
734[b] *1*	≈6	1607.40	13/2$^+$	873.39	11/2$^+$				
742.2 *2*	61 *3*	1443.1	9/2$^-$	700.9	5/2$^-$	E2		1.04×10^{-3}	A_2=+0.32 *3*; A_4=−0.09 *5* Pol=+0.7 *4*.
791 *1*	16 *4*	3490.4	21/2$^-$	2699.19	17/2$^-$				
810.2 *5*	13 *3*	4300.6	(23/2$^-$)	3490.4	21/2$^-$	D+Q			A_2=−1.1 *2*; A_4=+0.3 *3*
816.7 *2*	80 *5*	2165.63	13/2$^-$	1348.83	9/2$^-$	E2		8.11×10^{-4}	A_2=+0.34 *12* Pol=+0.7 *3*.

γ(^{81}Kr) (continued)

E_γ[†]	I_γ[‡]	E_i(level)	J_i^π	E_f	J_f^π	Mult.[#]	δ[@]	α[&]	Comments
822.1[b] *4*	≈30	3649.6	(21/2$^-$)	2827.71	17/2$^-$				
823.9 *2*	113 *6*	873.39	11/2$^+$	49.52	(9/2)$^+$	(M1+E2)	≈−0.7	≈7.30×10^{-4}	A_2=−0.66 *4*; A_4=+0.10 *6* Pol=−0.11 *11*.
834.5 *4*	40 *5*	2827.71	17/2$^-$	1993.2	15/2$^+$				A_2=−0.12 *6*; A_4=+0.09 *10*
852.7 *4*	35 *4*	902.44	(7/2$^-$)	49.52	(9/2)$^+$	D			A_2=−0.18 *8*; A_4=−0.04 *13*
863.3 *3*	30 *5*	3557.8		2694.5	(17/2$^+$)				A_2=+0.2 *1*
873.4 *2*	70 *7*	873.39	11/2$^+$	0	7/2$^+$	E2		6.86×10^{-4}	A_2=+0.22 *4*; A_4=−0.05 *6* Pol=+0.8 *4*.
884.4 *2*	250 *8*	933.87	11/2$^+$	49.52	(9/2)$^+$	M1+E2	−0.4 *1*	6.10×10^{-4} *10*	A_2=−0.80 *5*; A_4=−0.05 *11* Pol=+0.12 *8*.
892.4 *3*	57 *4*	1348.83	9/2$^-$	456.46	5/2$^-$	E2		6.50×10^{-4}	A_2=+0.30 *7*; A_4=−0.04 *12* Pol=+0.3 *3*.
902.3 *3*	22 *3*	902.44	(7/2$^-$)	0	7/2$^+$				A_2=+0.22 *11*; A_4=−0.03 *17*
926.4[a] *2*	≈950[a]	976.0	13/2$^+$	49.52	(9/2)$^+$	E2		5.94×10^{-4}	Iγ=1000, A_2=+0.35 *2*, A_4=−0.11 *4*, Pol=+0.53 *4* for triplet dominated by this transition.
926.4[a] *2*	≈40[a]	1828.6	(11/2$^-$)	902.44	(7/2$^-$)				Iγ=1000, A_2=+0.35 *2*, A_4=−0.11 *4*, Pol=+0.53 *4* for triplet.
926.4[a] *2*	≈8[a]	2533.14	15/2$^-$	1607.40	13/2$^+$				Iγ=1000, A_2=+0.35 *2*, A_4=−0.11 *4*, Pol=+0.53 *4* for triplet.
932.0 *4*	29 *5*	981.6	(9/2$^+$)	49.52	(9/2)$^+$				A_2=+0.49 *16*
934[b] *1*	≈15	933.87	11/2$^+$	0	7/2$^+$				
950.3 *3*	39 *3*	3649.6	(21/2$^-$)	2699.19	17/2$^-$				A_2=+0.31 *19*
976.7 *3*	19 *2*	2419.84	13/2$^-$	1443.1	9/2$^-$				A_2=+0.41 *13*
981.7 *4*	12 *4*	981.6	(9/2$^+$)	0	7/2$^+$				A_2=−0.05 *19*
987[b] *1*	≈10	1443.1	9/2$^-$	456.46	5/2$^-$				
1017.5 *3*	≈120	1993.2	15/2$^+$	976.0	13/2$^+$	(M1+E2)	≈−0.8	≈4.58×10^{-4}	Iγ=210 *10*, A_2=−0.31 *4*, A_4=+0.05 *7*, Pol≈+0.2 for doublet with ^{80}Kr γ.
1038 *1*	28 *4*	4099.1	23/2$^-$	3061.20	19/2$^-$	Q			A_2=+0.28 *9*; A_4=−0.29 *16*
1059.7 *2*	84 *7*	3195.3	19/2$^+$	2135.5	17/2$^+$	M1+E2	≈−0.2	≈4.12×10^{-4}	A_2=−0.50 *5*; A_4=+0.08 *13* Pol=+0.4 *3*.
1087.2 *4*	17 *3*	2694.5	(17/2$^+$)	1607.40	13/2$^+$				A_2=+0.50 *11*
1119.8 *3*	≈90	1993.2	15/2$^+$	873.39	11/2$^+$	E2		3.84×10^{-4}	Iγ=110 *10*, A_2=−0.27 *4*, A_4=−0.07 *11*, Pol=+0.6 *3* for doublet with ^{81}Br γ; doublet dominated by this component.
1159.5 *2*	490 *10*	2135.5	17/2$^+$	976.0	13/2$^+$	E2		3.58×10^{-4}	A_2=+0.38 *2*; A_4=−0.10 *3* Pol=+0.49 *11*.
1176.5 *3*	23 *2*	2784.0	(15/2)	1607.40	13/2$^+$				A_2=−0.36 *7*; A_4=−0.14 *11*
1189.7 *3*	47 *3*	2165.63	13/2$^-$	976.0	13/2$^+$				A_2=+0.08 *11*
1202.2 *4*	33 *4*	3195.3	19/2$^+$	1993.2	15/2$^+$				A_2=+0.30 *9*
1216.2 *4*	20 *3*	2192.2	(15/2$^+$)	976.0	13/2$^+$	D+Q			A_2=−0.65 *9*
1223.5 *4*	24 *3*	4713.9	(25/2$^-$)	3490.4	21/2$^-$				A_2=+0.26 *19*
1231.7 *3*	37 *4*	2165.63	13/2$^-$	933.87	11/2$^+$				A_2=−0.16 *8*; A_4=+0.06 *11*

γ(^{81}Kr) (continued)

E_γ[†]	I_γ[‡]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[#]	α[&]	Comments
1257.0 *2*	≈200	3392.5	21/2$^+$	2135.5	17/2$^+$	E2	3.15×10^{-4}	Iγ=250 *10*, A_2=+0.40 *2*, A_4=−0.06 *3*, Pol=+0.54 *18* for (1257.0γ+1258γ) doublet dominated by this transition. Divided intensity given.
1258 *1*	≈50	2192.2	(15/2$^+$)	933.87	11/2$^+$			Iγ=250 *10*, A_2=+0.40 *2*, A_4=−0.06 *3*, Pol=+0.54 *18* for (1257γ+1258γ) doublet. Divided intensity given.
1292.3 *3*	35 *4*	2165.63	13/2$^-$	873.39	11/2$^+$			A_2=−0.06 *8*
1299 *1*	20 *9*	1348.83	9/2$^-$	49.52	(9/2)$^+$			A_2=+0.11 *13*
1348.2 *5*	48 *9*	1348.83	9/2$^-$	0	7/2$^+$			A_2=−0.03 *18*
1488.2 *3*	75 *8*	3623.7	21/2$^+$	2135.5	17/2$^+$			A_2=+0.30 *9*
1557.2 *3*	160 *10*	2533.14	15/2$^-$	976.0	13/2$^+$	(E1)	3.91×10^{-4}	A_2=−0.22 *4*; A_4=−0.02 *6* Pol=+0.1 *2*.
1809[b] *1*	≈10	2784.0	(15/2)	976.0	13/2$^+$			

[†] Additional lines, having Eγ=201.3, 204.7, 583.9 and 756.3, are coincident with 166γ; they may also be ^{81}Kr γ rays (1986Fu03).

[‡] Iγ for Eα=43 MeV relative to I(926γ)=1000; Iγ for complex lines taken from $\gamma\gamma$-coin data (1986Fu03).

[#] From $\gamma(\theta)$ and γ linear polarization (Pol) (1986Fu03) if $\Delta\pi$ is given; from $\gamma(\theta)$ otherwise.

[@] Approximate δ from $\gamma(\theta)$, allowing for attenuation.

[&] 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 intensity suitably divided.

[b] Placement of transition in the level scheme is uncertain.

[x] γ ray not placed in level scheme.

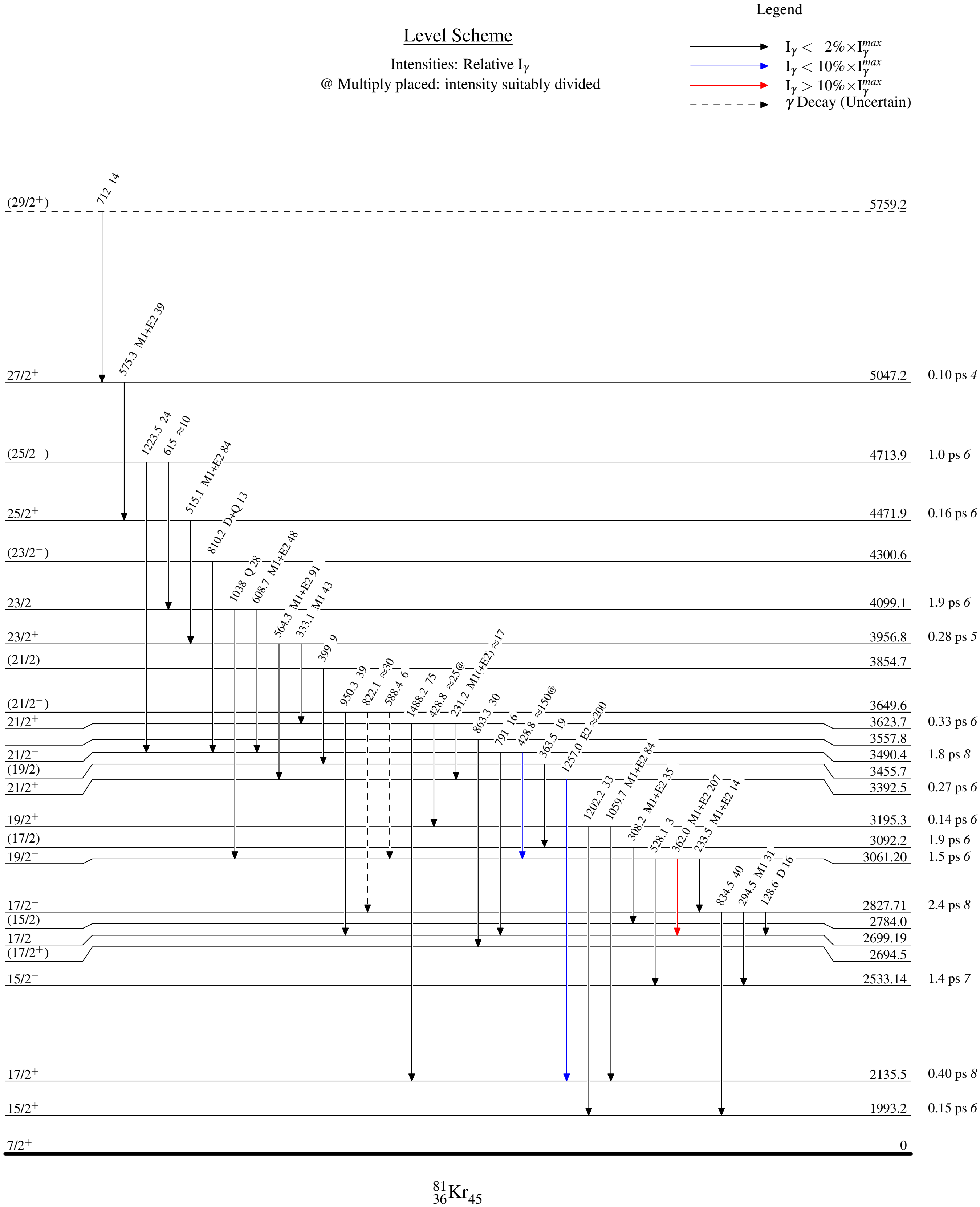
$^{81}_{36}$Kr$_{45}$-6

^{80}Se(α,3nγ) 1986Fu03

Level Scheme

Intensities: Relative I_γ

@ Multiply placed: intensity suitably divided

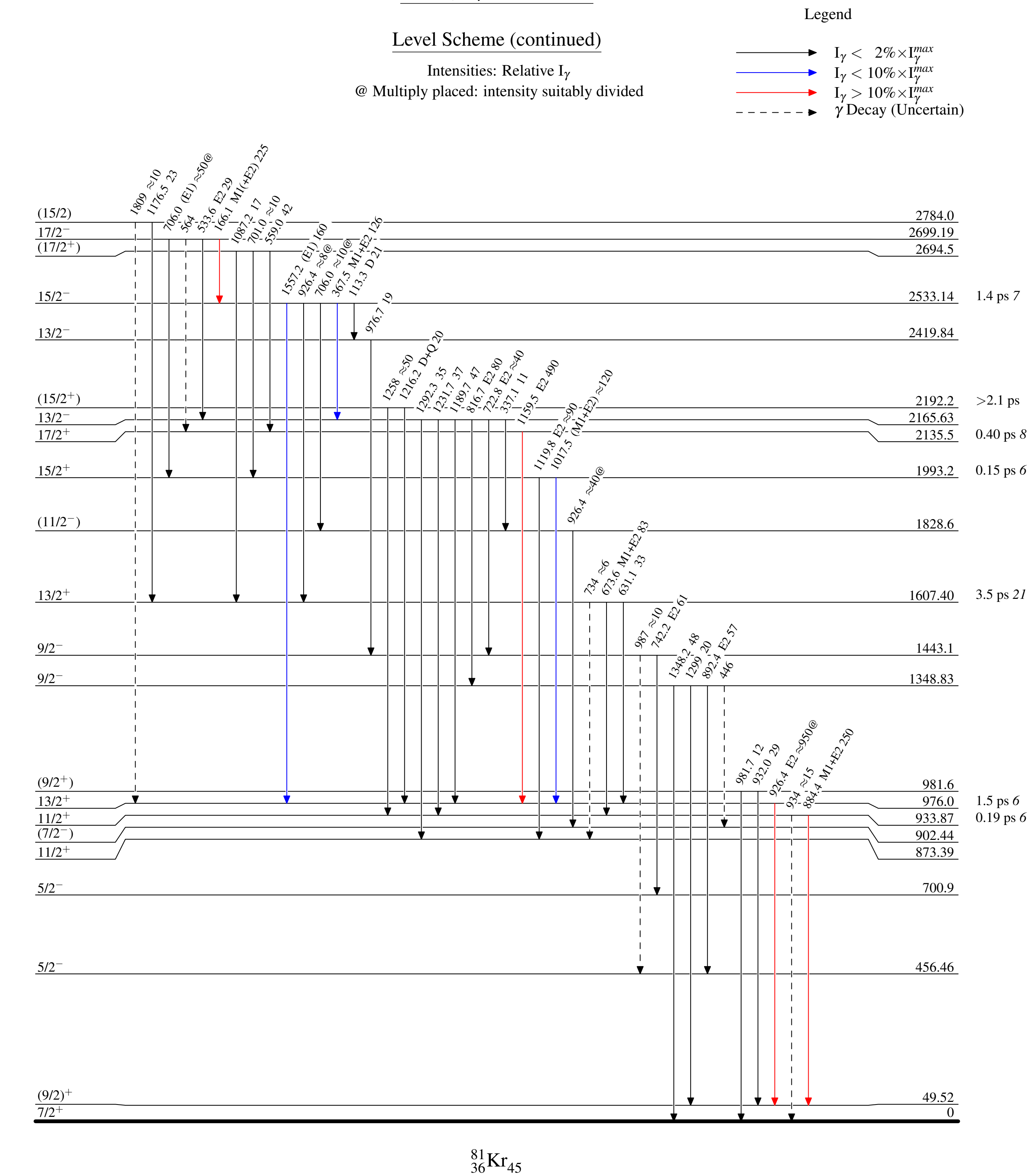


$^{80}Se(\alpha,3n\gamma)$ 1986Fu03

Level Scheme (continued)

Intensities: Relative I_γ

@ Multiply placed: intensity suitably divided

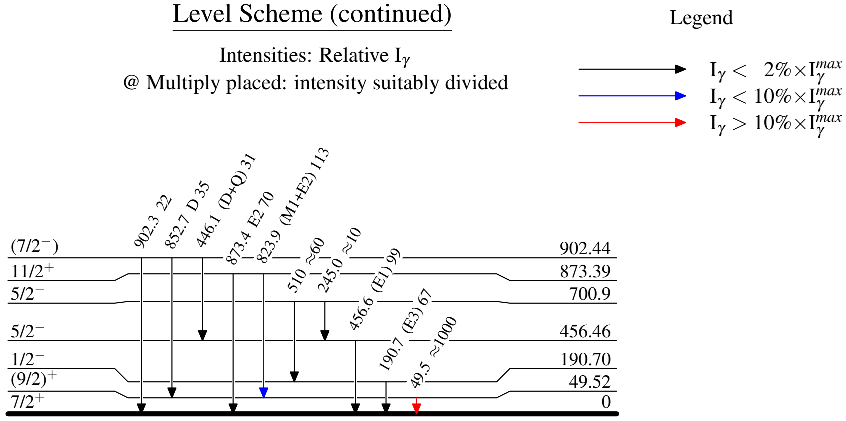


^{80}Se(α,3nγ) 1986Fu03

Level Scheme (continued)

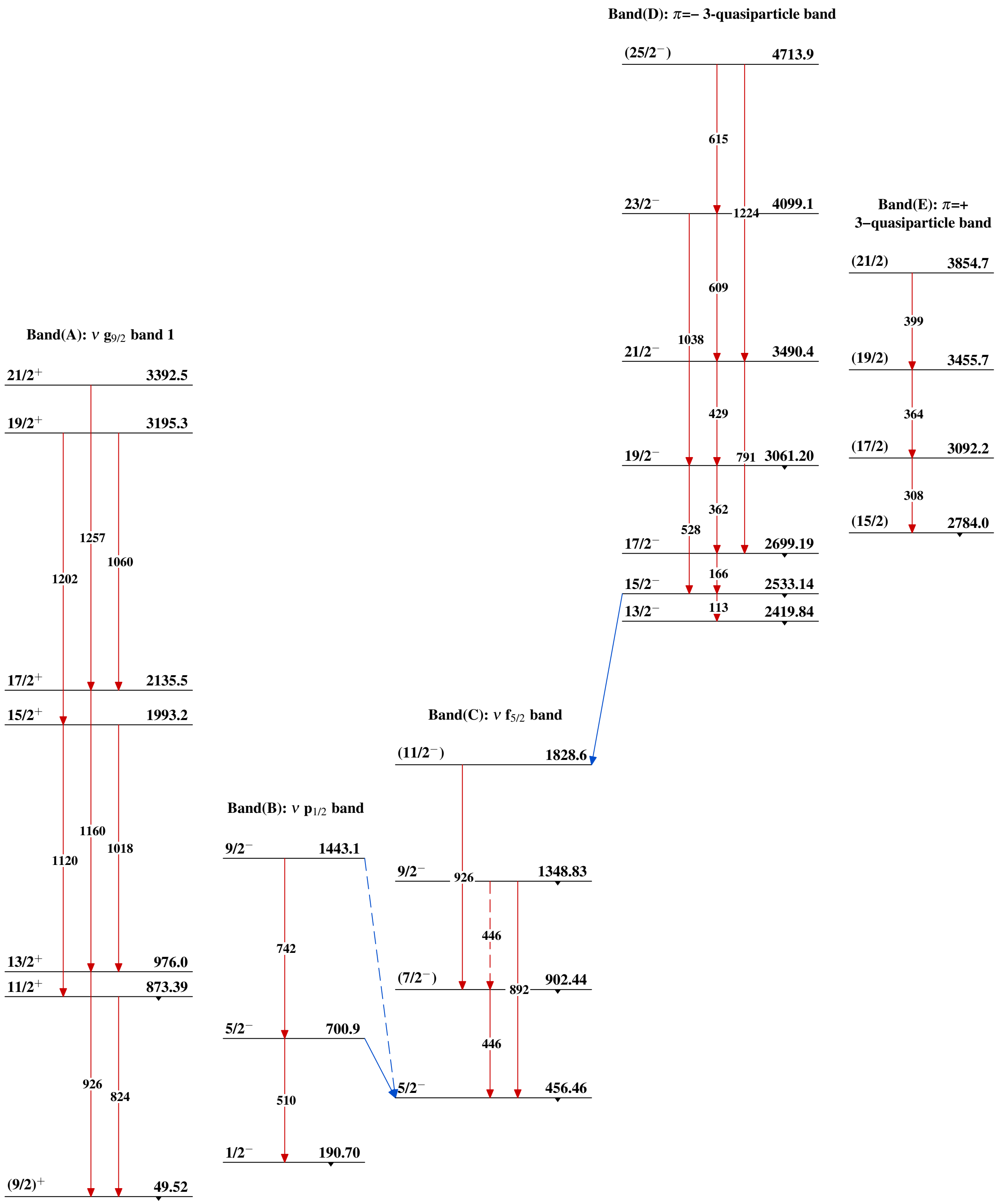
Intensities: Relative I_γ

@ Multiply placed: intensity suitably divided



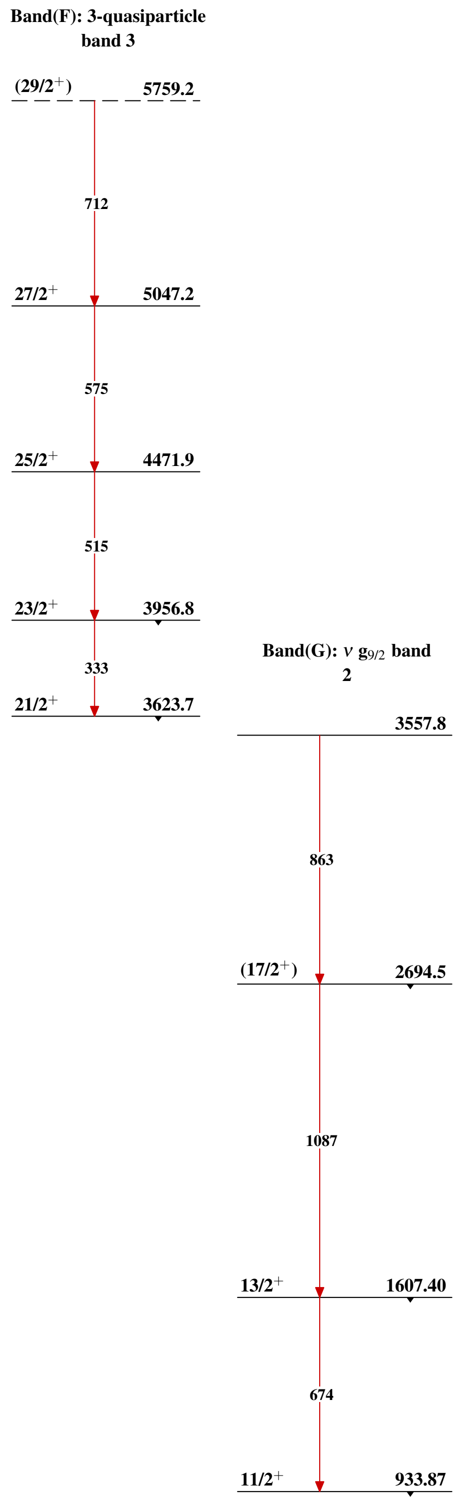
$^{81}_{36}Kr_{45}$

$^{80}Se(\alpha,3n\gamma)$ 1986Fu03



$^{81}_{36}Kr_{45}$

^{80}Se(α,3nγ) 1986Fu03 (continued)



$^{81}_{36}Kr_{45}$