^{120}Sn(^{19}F,4nγ) **1986Se07**

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh, Alexander A. Rodionov And Yuri L. Khazov	NDS 109, 517 (2008)	22-Jan-2008

Includes ^{127}I(^{12}C,4nγ).

1986Se07: ^{120}Sn(^{19}F,4nγ) E=91 MeV. Measured Eγ, Iγ, excitation functions, $\gamma\gamma$, $\gamma\gamma(\theta)$ (DCO at 38° vs. 85°) using six Ge detectors (four with NaI Compton suppression) and 11 NaI detectors as a multiplicity filter. Cranked shell-model calculations.

1998Bo33: ^{123}Sb(^{16}O,4nγ) E=76 MeV. Measured lifetimes by recoil- distance Doppler-shift method.

1987Dr12, 1987Dr14: 72-76 MeV ^{19}F beams on ^{118}Sn, ^{119}Sn, and ^{120}Sn targets. Measured γ, $\gamma\gamma$, $\gamma(\theta)$, excitation functions. A negative (ΔJ=2) parity band from 11/2$^-$ to 31/2$^-$ (1076-1000-853-660-373 cascade) (1987Dr14) and 10 positive parity levels from 5/2$^+$ to 15/2$^+$ (up to 1500 keV of excitation energy) were discussed (1987Dr12). The details of these studies are not available.

1973Co32: ^{127}I(^{12}C,4nγ) E=88 MeV. Four γ rays reported at Eγ(Iγ) of 41.5 (37), 112.4 (11), 203.8 (100), 245.6 (<8).

^{135}Pr Levels

E(level)[†]	J$^\pi$[‡]	T$_{1/2}$	Comments
0.0	3/2$^{(+)}$		
41.0[@] *8*	5/2$^{(+)}$		
245.0[&] *8*	7/2$^{(+)}$		
357.8[a] *12*	11/2$^{(-)}$	105 μs *10*	%IT=100 T$_{1/2}$: from γ(t) (1973Co32).
517.0[@] *10*	(9/2$^+$)		
730.8[a] *13*	(15/2$^-$)	22.9[#] ps *14*	
777.1[&] *10*	(11/2$^+$)		
951.8[b] *13*	(13/2$^-$)		
1231.9[@] *11*	(13/2$^+$)		
1390.7[a] *13*	(19/2$^-$)	2.4[#] ps *6*	
1433.7[b] *14*	(17/2$^-$)		
1478.8 *14*	(17/2$^-$)		
1505.6[&] *12*	(15/2$^+$)		
1928.8 *13*	(19/2$^-$)		
2115.9[@] *15*	(17/2$^+$)		
2158.6[b] *14*	(21/2$^-$)		
2204.9 *14*	(21/2$^-$)		
2244.8[a] *14*	(23/2$^-$)	0.92[#] ps *5*	
2346.8 *15*	(23/2$^-$)		
2355.7 *17*			
2372.7 *14*	(19/2$^+$)		
2395.7[&] *13*	(19/2$^+$)		
2589.7[@] *13*	(21/2$^+$)		
2617.8 *14*	(21/2$^+$)		
2754.7 *14*			
2846.7[&] *14*	(23/2$^+$)		
2900.8 *15*	(23/2$^+$)		
3001.1[b] *14*	(25/2$^-$)		
3123.8[@] *14*	(25/2$^+$)		
3204.7 *17*	(25/2)		
3244.8[a] *16*	(27/2$^-$)		
3421.8[&] *15*	(27/2$^+$)		
3488.8 *16*			
3517.7 *16*			

Continued on next page (footnotes at end of table)

^{120}Sn(^{19}F,4nγ) 1986Se07 (continued)

^{135}Pr Levels (continued)

E(level)[†]	J$^{\pi}$[‡]
3530.8 *15*	
3642.7 *20*	(27/2)
3658.9[@] *16*	$(29/2^+)$
3862.8 *15*	
3957.0[b] *16*	$(29/2^-)$
4107.8[&] *18*	$(31/2^+)$
4219.9 *17*	(31/2)
4292.8 *16*	
4319.8[a] *17*	$(31/2^-)$
4393.8 *19*	
4464.9[@] *19*	$(33/2^+)$
4704.8 *18*	
4964.8[&] *21*	$(35/2^+)$
5030.8 *20*	
5069.0[b] *19*	$(33/2^-)$
5163.8[a] *18*	$(35/2^-)$
5336.8 *19*	
5420.9[@] *22*	$(37/2^+)$
5454.8 *23*	
5953.8 *25*	
5973.8[&] *23*	$(39/2^+)$
5997.8[a] *20*	$(39/2^-)$
6500.9[@] *24*	$(41/2^+)$
6511 *3*	
6879.8[a] *23*	$(43/2^-)$
6978.8[&] *25*	$(43/2^+)$
7515?[@] *3*	$(45/2^+)$
7802.8[a] *25*	$(47/2^-)$
7899?[&] *3*	$(47/2^+)$
8716?[a] *3*	$(51/2^-)$
9004?[&] *3*	$(51/2^+)$
9678?[a] *3*	$(55/2^-)$
10745?[a] *3*	$(59/2^-)$

[†] From least-squares fit to Eγ's.

[‡] From $\gamma\gamma(\theta)$ (DCO), $\gamma(\theta)$ and band associations.

[#] From recoil-distance Doppler-shift method (1998Bo33).

[@] Band(A): $\pi g_{7/2}$ 5/2[413], α=+1/2. The first band crossing is observed at 320 keV interpreted as due to alignment of a pair of $h_{11/2}$ protons ('ab' crossing) and the second band crossing is observed at 490 keV due possible to a pair of $h_{11/2}$ neutrons ('AB' crossing). The shape is nearly prolate ($\gamma\approx0°$) before the first crossing but $\gamma\approx+10°$ due to alignment of a pair of $h_{11/2}$ protons. The 1128γ and 1172γ present in the $\gamma\gamma$ coin spectrum (figure 5b in 1986Se07) may form a cascade above 1014γ thus extending the band up to $53/2^+$.

[&] Band(a): $\pi g_{7/2}$ 5/2[413], α=−1/2. See comment for α=+1/2 signature partner for band crossings and triaxial shape parameter.

[a] Band(B): $\pi h_{11/2}$ 3/2[541], α=−1/2. The first band crossing is observed at 460 keV interpreted as due to alignment of a pair of $h_{11/2}$ protons ('bc' crossing) and the second band crossing is observed at 480 keV due possible to a pair of $h_{11/2}$ neutrons ('AB' crossing). The shape is nearly prolate before the first crossing but the alignment of $h_{11/2}$ protons would result in slightly positive γ deformation.

[b] Band(b): $\pi h_{11/2}$ 3/2[541], α=+1/2.

γ(^{135}Pr)

R(DCO)(38° vs. 85°) from total projection $\gamma\gamma$ coin matrix (first quoted value) and gated (with known E2) $\gamma\gamma$ coin spectrum (second quoted value) is given under comments. In cases where only one value is given it is from the projection method, unless otherwise indicated.

E$_\gamma$	I$_\gamma$[†]	E$_i$(level)	J$^{\pi}_i$	E$_f$	J$^{\pi}_f$	Mult.[‡]	Comments
41 *1*	2.8[#] *8*	41.0	$5/2^{(+)}$	0.0	$3/2^{(+)}$		
194 *1*	9.4 *19*	2589.7	$(21/2^+)$	2395.7	$(19/2^+)$	D	R(DCO)=0.72 *5*, 0.51 *5*.
204 *1*	24.3[@] *24*	245.0	$7/2^{(+)}$	41.0	$5/2^{(+)}$		R(DCO)=0.92 *7*.
217 *1*	3.1[#] *9*	2589.7	$(21/2^+)$	2372.7	$(19/2^+)$	D	R(DCO)=0.74 *6*, 0.55 *8*.
221 *1*	0.8 *4*	951.8	$(13/2^-)$	730.8	$(15/2^-)$	D	R(DCO)=0.64 *8*.
245 *1*	2.2[@] *7*	245.0	$7/2^{(+)}$	0.0	$3/2^{(+)}$		
257 *1*	17.2[#] *26*	2846.7	$(23/2^+)$	2589.7	$(21/2^+)$	D	R(DCO)=0.64 *5*, 0.46 *4*.
260 *1*	1.8 *5*	777.1	$(11/2^+)$	517.0	$(9/2^+)$		
263 *1*	1.0[#] *3*	4219.9	(31/2)	3957.0	$(29/2^-)$		
272 *1*	1.1 *3*	517.0	$(9/2^+)$	245.0	$7/2^{(+)}$	D	R(DCO)=0.44 *5*.
274 *1*	1.7 *5*	1505.6	$(15/2^+)$	1231.9	$(13/2^+)$	D	R(DCO)=0.63 *6*.
277 *1*	7.8 *16*	3123.8	$(25/2^+)$	2846.7	$(23/2^+)$	D	R(DCO)=0.64 *5*, 0.37 *8*.
317 *1*	1.0[#] *5*	357.8	$11/2^{(-)}$	41.0	$5/2^{(+)}$		

Continued on next page (footnotes at end of table)

^{120}Sn(^{19}F,4nγ) **1986Se07** (continued)

γ(^{135}Pr) (continued)

E$_\gamma$	I$_\gamma$[†]	E$_i$(level)	J$^\pi_i$	E$_f$	J$^\pi_f$	Mult.[‡]	α[&]	Comments
326 *1*	7.8 *16*	5030.8		4704.8				
332 *1*	3.7[#] *11*	3862.8		3530.8				
345 *1*	1.5 *5*	3862.8		3517.7				
358 *1*	10.6 *16*	3204.7	(25/2)	2846.7	(23/2$^+$)	D		R(DCO)=0.60 *5*, 0.25 *4*.
373 *1*	100 *5*	730.8	(15/2$^-$)	357.8	11/2$^{(-)}$	(E2)	0.0259 *5*	α(K)=0.0211 *4*; α(L)=0.00379 *7*; α(M)=0.000817 *14*; α(N+..)=0.000209 *4* α(N)=0.000180 *3*; α(O)=2.75×10^{-5} *5*; α(P)=1.424×10^{-6} *23* R(DCO)=1.41 *10*.
374 *1*	5.4 *11*	3862.8		3488.8				
385 *1*	1.9[@] *6*	4704.8		4319.8	(31/2$^-$)			
412 *1*	5.9[@] *12*	4704.8		4292.8				
424 *1*	4.0[@] *12*	5454.8		5030.8				
430 *1*	8.0[#] *16*	4292.8		3862.8				
438 *1*	2.7[#] *8*	3642.7	(27/2)	3204.7	(25/2)	D		R(DCO)=0.42 *4*, 0.33 *11*.
450 *1*	4.0[#] *12*	1928.8	(19/2$^-$)	1478.8	(17/2$^-$)	D		R(DCO)=0.64 *5*, 0.40 *11*.
451 *1*	0.6[@] *3*	2846.7	(23/2$^+$)	2395.7	(19/2$^+$)			
455 *1*	0.8[@] *4*	1231.9	(13/2$^+$)	777.1	(11/2$^+$)			
476 *1*	6.1 *12*	517.0	(9/2$^+$)	41.0	5/2$^{(+)}$			
482 *1*	2.2[#] *7*	1433.7	(17/2$^-$)	951.8	(13/2$^-$)			
495 *1*	1.0[@] *3*	1928.8	(19/2$^-$)	1433.7	(17/2$^-$)			
499 *1*	2.0 *6*	5953.8		5454.8				
506 *1*	3.3 *10*	3123.8	(25/2$^+$)	2617.8	(21/2$^+$)	(Q)		R(DCO)=1.27 *13*.
521 *1*	6.4 *13*	3421.8	(27/2$^+$)	2900.8	(23/2$^+$)	Q		R(DCO)=1.89 *18*, 0.94 *14*.
527 *1*	0.6[@] *3*	1478.8	(17/2$^-$)	951.8	(13/2$^-$)			
532 *1*	23.2 *23*	777.1	(11/2$^+$)	245.0	7/2$^{(+)}$	(Q)		R(DCO)=1.25 *11*.
535 *1*	18.4 *28*	3658.9	(29/2$^+$)	3123.8	(25/2$^+$)	(Q)		R(DCO)=1.4 *4*.
554 *1*	4.0 *12*	2900.8	(23/2$^+$)	2346.8	(23/2$^-$)	(D)		R(DCO)=1.4 *4* (E2 gated) indicates ΔJ=0, dipole.
557 *1*	1.1[@] *3*	6511		5953.8				
561 *1*	7.1 *14*	4219.9	(31/2)	3658.9	(29/2$^+$)	D		R(DCO)=0.47 *4*.
575 *1*	3.3 *10*	3421.8	(27/2$^+$)	2846.7	(23/2$^+$)	(Q)		R(DCO)=1.41 *15*.
594 *1*	2.8[@] *8*	951.8	(13/2$^-$)	357.8	11/2$^{(-)}$			
596 *1*	3.6[#] *11*	2754.7		2158.6	(21/2$^-$)			
656 *1*	6.6 *13*	2900.8	(23/2$^+$)	2244.8	(23/2$^-$)	(D)		R(DCO)=1.56 *25* (E2 gated) indicates ΔJ=0, dipole.
660 *1*	86 *4*	1390.7	(19/2$^-$)	730.8	(15/2$^-$)	(E2)	0.00550	α(K)=0.00464 *7*; α(L)=0.000684 *10*; α(M)=0.0001451 *22*; α(N+..)=3.76×10^{-5} *6* α(N)=3.22×10^{-5} *5*; α(O)=5.08×10^{-6} *8*; α(P)=3.29×10^{-7} *5* R(DCO)=1.41 *10*, 1.05 *07*.
686 *1*	12.0 *18*	4107.8	(31/2$^+$)	3421.8	(27/2$^+$)	(Q)		R(DCO)=1.53 *12*.
689 *1*	9.6 *19*	2617.8	(21/2$^+$)	1928.8	(19/2$^-$)			
703 *1*	1.4[#] *4*	1433.7	(17/2$^-$)	730.8	(15/2$^-$)			
715 *1*	2.6[@] *8*	1231.9	(13/2$^+$)	517.0	(9/2$^+$)	(Q)		R(DCO)=1.62 *17*.
725 *1*	1.1[@] *3*	2158.6	(21/2$^-$)	1433.7	(17/2$^-$)			
726 *1*	2.3[@] *7*	2204.9	(21/2$^-$)	1478.8	(17/2$^-$)			
728 *1*	19.7 *29*	1505.6	(15/2$^+$)	777.1	(11/2$^+$)	(Q)		R(DCO)=1.46 *11*.
748 *1*	10.2 *15*	1478.8	(17/2$^-$)	730.8	(15/2$^-$)	D		R(DCO)=0.42 *3*, 0.19 *4*.
756 *1*	2.3 *7*	3001.1	(25/2$^-$)	2244.8	(23/2$^-$)	D		R(DCO)=0.93 *10*, 0.27 *19*.
763 *1*	2.0[@] *6*	3517.7		2754.7				

Continued on next page (footnotes at end of table)

^{120}Sn(^{19}F,4nγ) 1986Se07 (continued)

γ(^{135}Pr) (continued)

E$_\gamma$	I$_\gamma$[†]	E$_i$(level)	J$^\pi_i$	E$_f$	J$^\pi_f$	Mult.[‡]	α[&]	Comments
768 *1*	3.4[@] *10*	2158.6	$(21/2^-)$	1390.7	$(19/2^-)$			
776 *1*	3.6[#] *11*	3530.8		2754.7				
796 *1*	5.5 *11*	3001.1	$(25/2^-)$	2204.9	$(21/2^-)$	(Q)		R(DCO)=1.39 *12*, 0.85 *30*.
806 *1*	8.5 *17*	4464.9	$(33/2^+)$	3658.9	$(29/2^+)$	(Q)		R(DCO)=1.42 *12*.
814 *1*	3.2[@] *10*	2204.9	$(21/2^-)$	1390.7	$(19/2^-)$	D		R(DCO)=0.25 *7* (E2 gated).
826 *1*	2.4 *7*	2754.7		1928.8	$(19/2^-)$			
834 *1*	6.4[#] *13*	5997.8	$(39/2^-)$	5163.8	$(35/2^-)$	(Q)		R(DCO)=1.09 *9*, 0.98 *24*.
843 *1*	1.0[@] *3*	3001.1	$(25/2^-)$	2158.6	$(21/2^-)$			
844 *1*	8.5[#] *17*	5163.8	$(35/2^-)$	4319.8	$(31/2^-)$	(Q)		R(DCO)=0.91 *15* (E2 gated).
854 *1*	43 *4*	2244.8	$(23/2^-)$	1390.7	$(19/2^-)$	(E2)	0.00301	α(K)=0.00255 *4*; α(L)=0.000356 *5*; α(M)=7.52$\times10^{-5}$ *11*; α(N+..)=1.96$\times10^{-5}$ *3* α(N)=1.674$\times10^{-5}$ *24*; α(O)=2.66$\times10^{-6}$ *4*; α(P)=1.83$\times10^{-7}$ *3* R(DCO)=1.40 *11*, 0.99 *6*.
857 *1*	5.4[#] *11*	4964.8	$(35/2^+)$	4107.8	$(31/2^+)$	(Q)		R(DCO)=1.44 *12*, 0.94 *21*.
867 *1*	4.8 *14*	2372.7	$(19/2^+)$	1505.6	$(15/2^+)$	(Q)		R(DCO)=1.46 *13*.
871 *1*	7.1[#] *14*	3488.8		2617.8	$(21/2^+)$			
871 *1*	1.2[#] *4*	5163.8	$(35/2^-)$	4292.8				
879 *1*	7.7 *15*	3123.8	$(25/2^+)$	2244.8	$(23/2^-)$	D		R(DCO)=0.83 *7*, 0.45 *7*.
882 *1*	1.9 *6*	6879.8	$(43/2^-)$	5997.8	$(39/2^-)$	(Q)		R(DCO)=0.91 *23* (E2 gated).
884 *1*	0.8[@] *4*	2115.9	$(17/2^+)$	1231.9	$(13/2^+)$			
890 *1*	13.6 *20*	2395.7	$(19/2^+)$	1505.6	$(15/2^+)$	(Q)		R(DCO)=1.44 *12*.
913[a] *1*	1.0[@] *5*	8716?	$(51/2^-)$	7802.8	$(47/2^-)$			
920[a] *1*	0.8[@] *4*	7899?	$(47/2^+)$	6978.8	$(43/2^+)$			
923 *1*	1.2 *4*	7802.8	$(47/2^-)$	6879.8	$(43/2^-)$			
956 *1*	7.7[#] *15*	2346.8	$(23/2^-)$	1390.7	$(19/2^-)$	Q		R(DCO)=1.03 *13* (E2 gated).
956 *1*	2.0[#] *6*	3957.0	$(29/2^-)$	3001.1	$(25/2^-)$			
956 *1*	5.2[#] *10*	5420.9	$(37/2^+)$	4464.9	$(33/2^+)$	(Q)		R(DCO)=1.0 *5* (E2 gated).
962[a] *1*	1.0[@] *5*	9678?	$(55/2^-)$	8716?	$(51/2^-)$	(Q)		R(DCO)=1.23 *18*.
965 *1*	3.2[#] *10*	2355.7		1390.7	$(19/2^-)$			
1000 *1*	14.2 *21*	3244.8	$(27/2^-)$	2244.8	$(23/2^-)$	Q		R(DCO)=1.31 *11*, 1.00 *10*.
1005 *1*	0.8 *4*	6978.8	$(43/2^+)$	5973.8	$(39/2^+)$	(Q)		R(DCO)=1.7 *4*.
1009 *1*	1.3 *4*	5973.8	$(39/2^+)$	4964.8	$(35/2^+)$	(Q)		R(DCO)=3.6 *10*.
1014[a] *1*	1.7[@] *5*	7515?	$(45/2^+)$	6500.9	$(41/2^+)$			
1044 *1*	1.9[#] *6*	5336.8		4292.8				
1048 *1*	3.7 *11*	4292.8		3244.8	$(27/2^-)$			
1067[a] *1*	0.6[@] *3*	10745?	$(59/2^-)$	9678?	$(55/2^-)$	(Q)		R(DCO)=1.5 *5*.
1075 *1*	9.9 *20*	4319.8	$(31/2^-)$	3244.8	$(27/2^-)$	(Q)		R(DCO)=1.41 *15*.
1080 *1*	2.8 *8*	6500.9	$(41/2^+)$	5420.9	$(37/2^+)$	(Q)		R(DCO)=1.55 *24*.
1105[a] *1*	0.8 *4*	9004?	$(51/2^+)$	7899?	$(47/2^+)$	(Q)		R(DCO)=1.1 *3*.
1112 *1*	1.8 *5*	5069.0	$(33/2^-)$	3957.0	$(29/2^-)$	(Q)		R(DCO)=1.06 *15*.
1149 *1*	1.9 *5*	4393.8		3244.8	$(27/2^-)$			
1198 *1*	4.6[#] *14*	1928.8	$(19/2^-)$	730.8	$(15/2^-)$	(Q)		R(DCO)=0.99 *15* (E2 gated).
1199 *1*	7.1[#] *14*	2589.7	$(21/2^+)$	1390.7	$(19/2^-)$	D		R(DCO)=0.45 *12* (E2 gated).
1227 *1*	3.7 *11*	2617.8	$(21/2^+)$	1390.7	$(19/2^-)$			
1286 *1*	3.2 *10*	3530.8		2244.8	$(23/2^-)$			
1364 *1*	5.7 *11*	2754.7		1390.7	$(19/2^-)$			

Continued on next page (footnotes at end of table)

^{120}Sn(^{19}F,4nγ) 1986Se07 (continued)

γ(^{135}Pr) (continued)

[†] From total projection of $\gamma\gamma$ coin matrix, unless otherwise stated.

[‡] From $\gamma\gamma(\theta)$ (DCO) data. In the geometry used in this experiment for E2 gated spectra, R(DCO)=1.0 indicates ΔJ=2, quadrupole (E2); R(DCO)≤0.69 indicates ΔJ=1, dipole; and R(DCO)≥1.14 for rare cases of ΔJ=0, dipole. For projection spectra, R(DCO)>1 for ΔJ=2, quadrupole (E2) and R(DCO)<1 for ΔJ=1, dipole (1986Se07).

[#] Subtracted component from an unresolved doublet.

[@] From $\gamma\gamma$ coin (gated) spectrum.

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

^{120}Sn(^{19}F,4nγ) 1986Se07

Level Scheme

Intensities: Relative I_γ

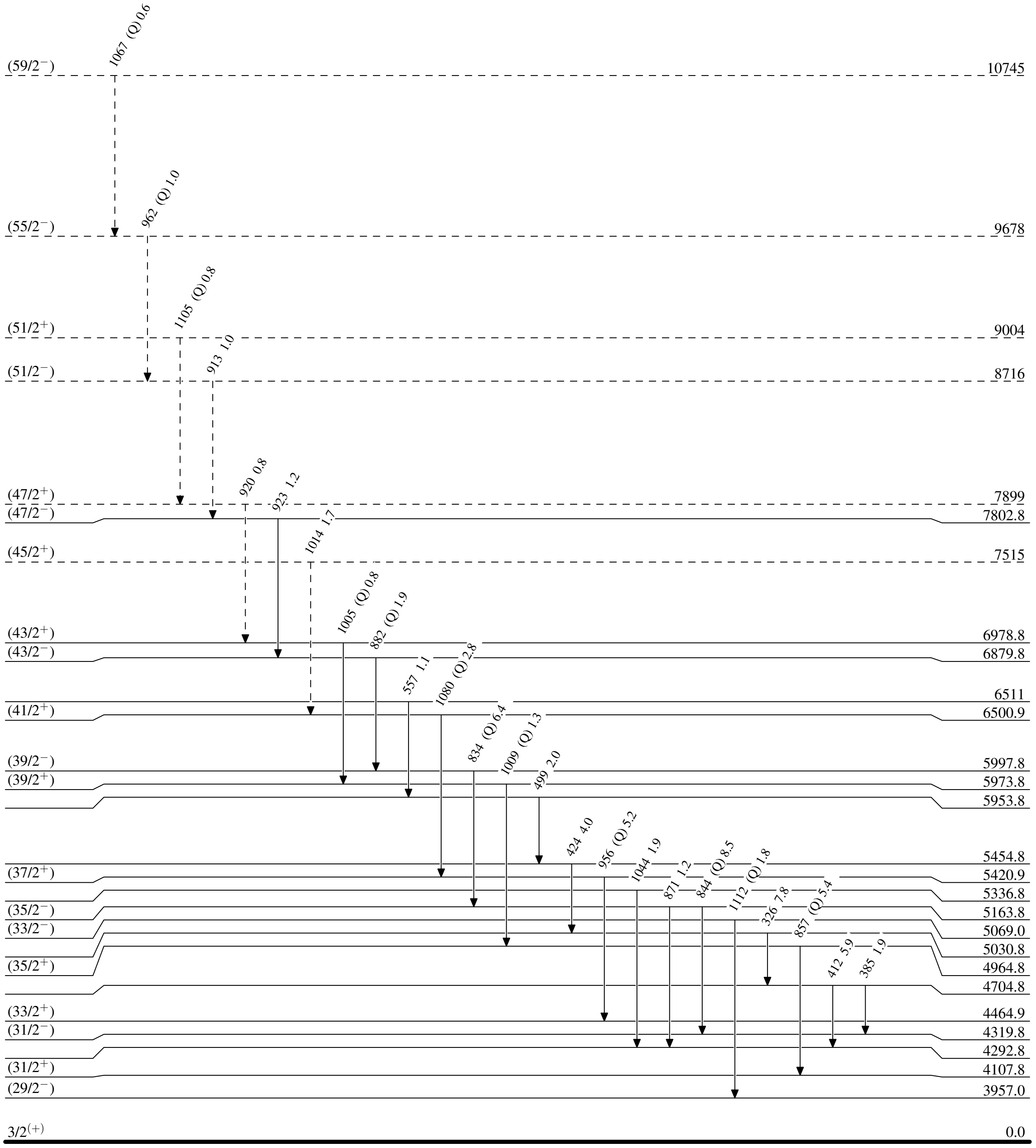
Legend

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

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

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

γ Decay (Uncertain)



$^{135}_{59}\mathrm{Pr}_{76}$

^{120}Sn(^{19}F,4nγ) 1986Se07

Level Scheme (continued)

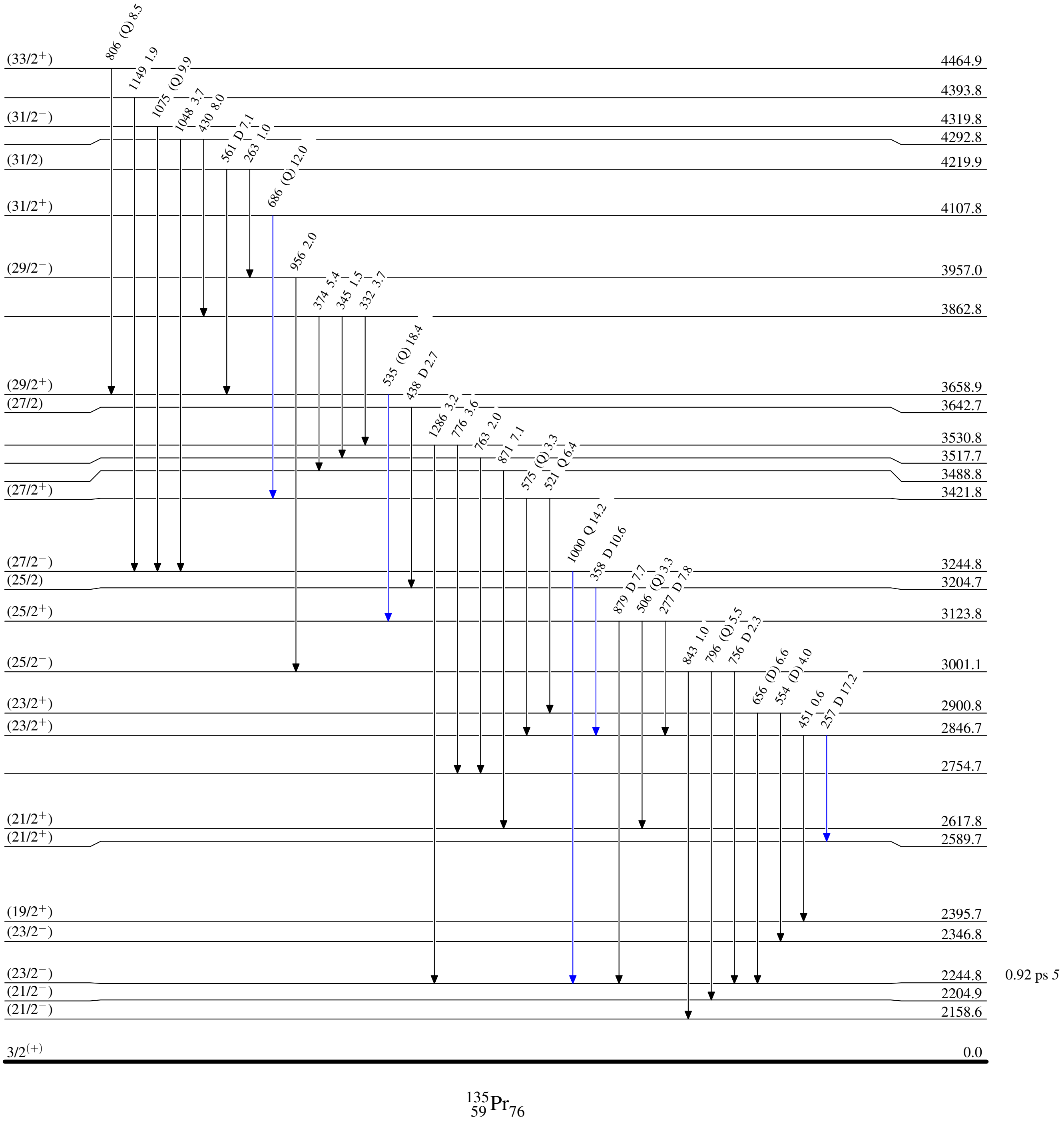
Intensities: Relative I_γ

Legend

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

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

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



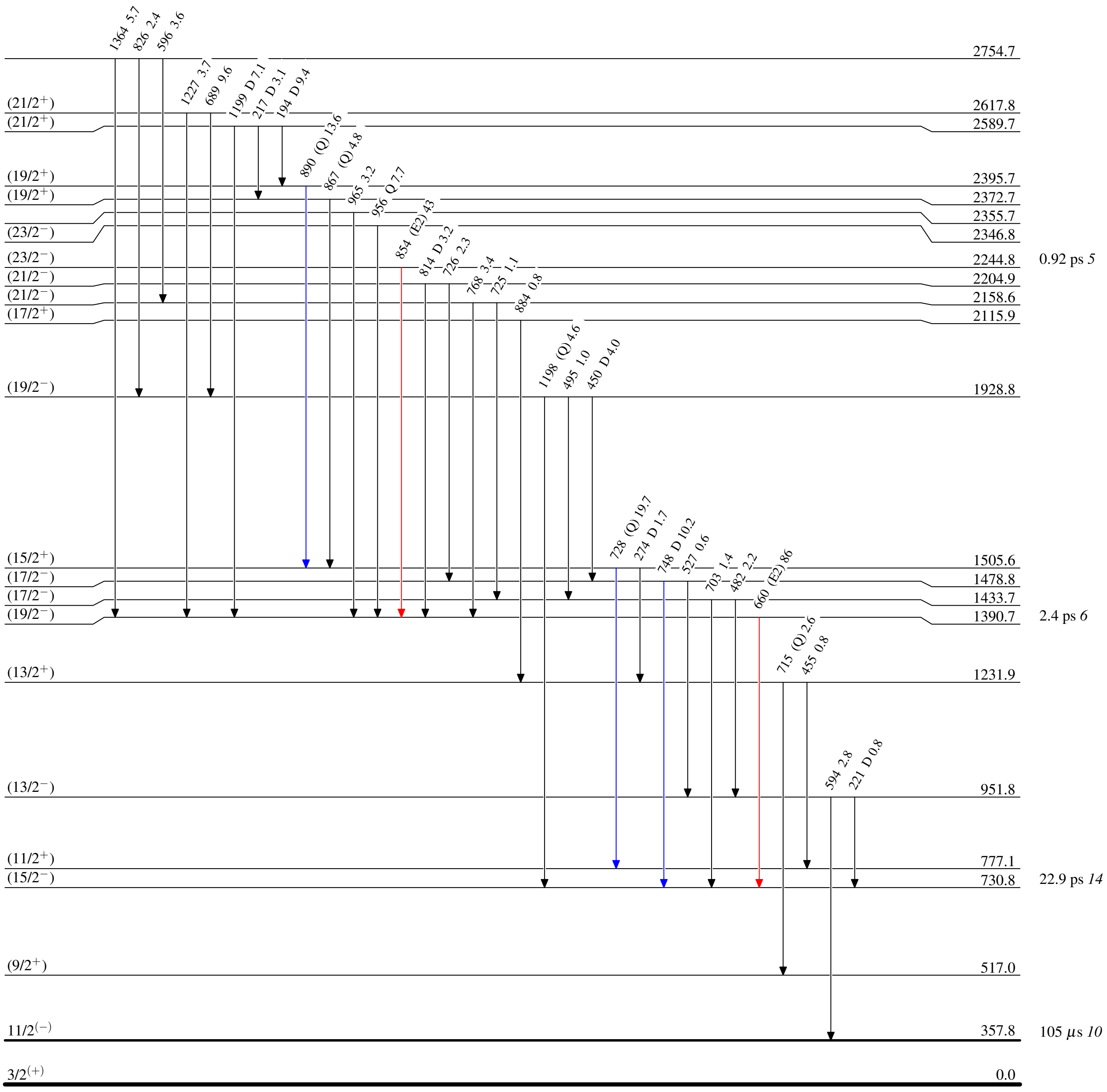
^{120}Sn(^{19}F,4nγ) 1986Se07

Level Scheme (continued)

Intensities: Relative I_γ

Legend

- $I_\gamma < 2\% \times I_\gamma^{max}$
- $I_\gamma < 10\% \times I_\gamma^{max}$
- $I_\gamma > 10\% \times I_\gamma^{max}$



$^{135}_{59}\mathrm{Pr}_{76}$

$^{120}Sn(^{19}F,4n\gamma)$ **1986Se07**

Level Scheme (continued)

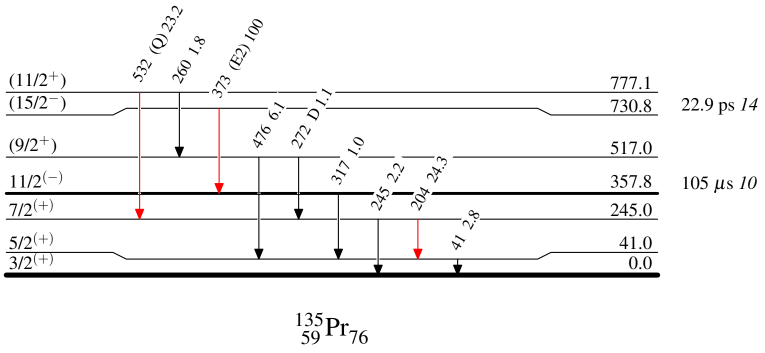
Intensities: Relative I_γ

Legend

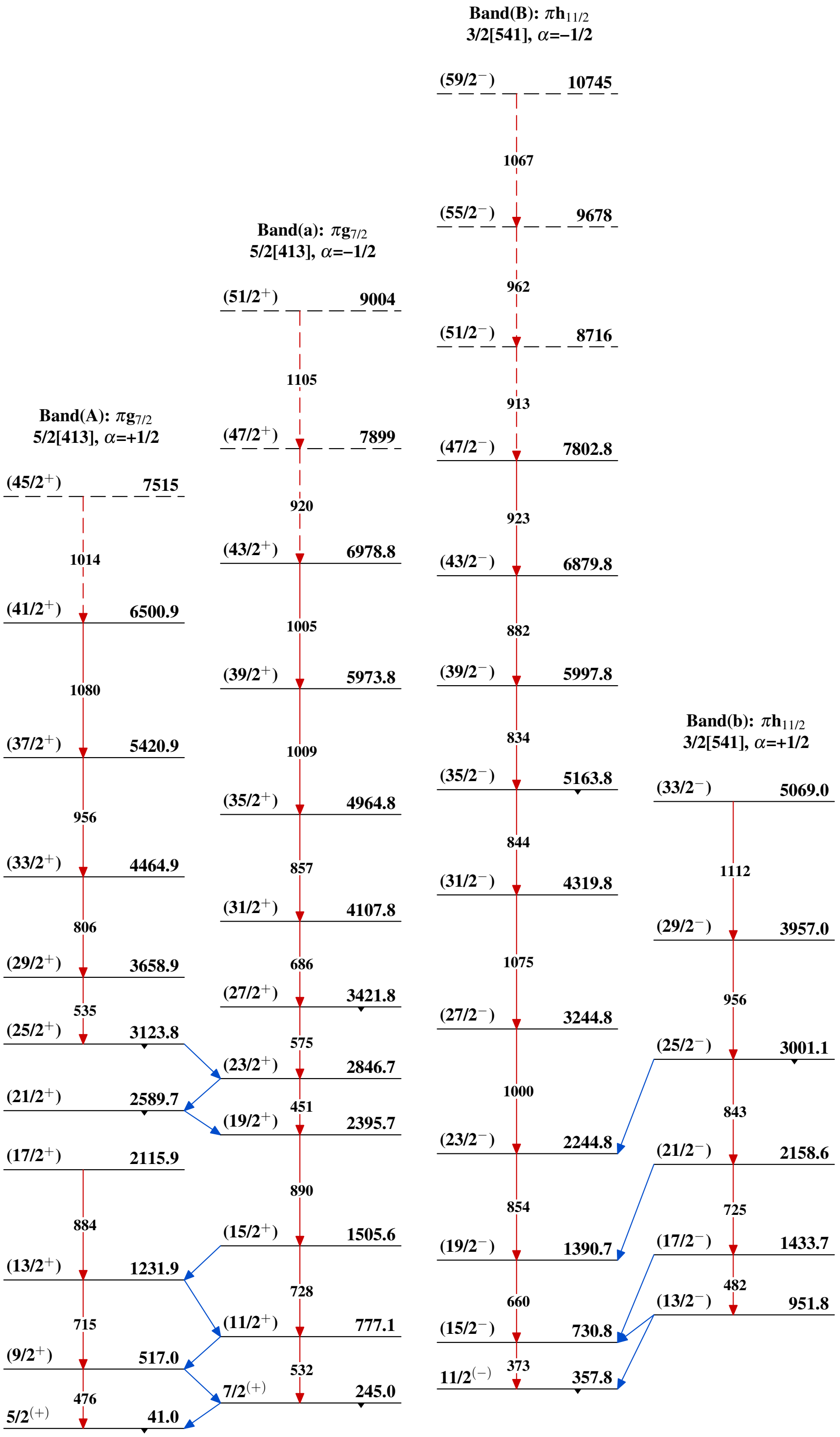
$I_\gamma < 2\% \times I_\gamma^{max}$

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

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



^{120}Sn(^{19}F,4nγ) 1986Se07



$^{135}_{59}$Pr$_{76}$