Adopted Levels, Gammas

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

Q(β^-)=−7.17×10^3 *17*; S(n)=1.136×10^4 *9*; S(p)=1.67×10^3 *7*; Q(α)=1.85×10^3 *8* 2012Wa38
Note: Current evaluation has used the following Q record −7.12E3 17 *11310* 80 *1620* 60 *1880* 80 2003Au03.
Q(εp)=1250 *70* (2003Au03).
Identical bands (systematics): 1992Zh10.

^{135}Pm Levels

Cross Reference (XREF) Flags

A	^{135}Sm ε decay (10.3 s)	D	^{116}Sn(^{24}Mg,p4nγ)
B	^{92}Mo(^{46}Ti,3pγ)	E	^{136}Eu εp decay (3.3 s+3.8 s)
C	^{107}Ag(^{32}S,2p2nγ)		

E(level)†	J$^\pi$‡	T$_{1/2}$	XREF	Comments
0+x	(3/2$^+$,5/2$^+$)	49 s *3*	A	%ε+%β^+=100 Additional information 1. E(level): this level may Be the ground state of ^{135}Pm. J$^\pi$: from ε feeding (1989Vi04,1989Ko07) of low-spin states in ^{135}Nd and from systematics of neighboring odd Pm and Pr nuclides (as shown in figure 3 of 1993BrZU). 1989Vi04 proposed population of two isomers of J^π=(3/2,5/2$^+$) and (9/2$^-$,11/2$^-$) from the decay of ^{135}Sm, with the level scheme of ^{135}Pm based mainly on the decay of the high-spin isomer. But a single low-spin activity is suggested by the following discussion: 1. High-spin assignments made by 1989Vi04 to low lying levels populated by ^{135}Sm decay were based, presumably, on the identification of one common γ ray at 286 keV in ^{135}Sm decay and in high-spin studies on ^{135}Pm (1987Be22,1988Wa01). From $\gamma\gamma$ evidence, 1989Vi04 proposed that 286γ deexcites a level at 341 keV. Three other γ rays at 160, 237 and 341 keV also deexcited this level. In the in-beam γ study (1987Be22,1988Wa01) there is no evidence in the $\gamma\gamma$ spectra (figure 3 in 1987Be22 and figure 1 in 1988Wa01) for the existence of either the strong 237γ or the weaker (but likely to be seen by 1988Wa01 and 1987Be22) 341γ. It should also be noted that Eγ=285.9 *2* (1989Vi04) in ^{135}Sm decay does not agree with 286.8 *1* (1987Be22) in in-beam study, although 1988Wa01 report 286.2 *2*. The γ-ray energies reported by 1988Wa01 are systematically lower by ≈1 keV as compared to those in 1987Be22. Based on the $\gamma\gamma$ evidence and γ-ray energies, the evaluators suggest that either the placement of 286γ is incorrect in ^{135}Sm decay (1989Vi04) or that it is independent of the 286 γ seen in the in-beam studies. 2. In high-spin studies, the low lying states are proposed as 3/2$^+$ and 7/2$^+$ from band structures and cranked shell-model calculations (1987Mu12,1989MuZR,1996MuZZ). From these studies, there seems no evidence for a long-lived 9/2$^-$ or 11/2$^-$ isomer. A low-lying level 9/2$^-$ level is proposed with T$_{1/2}$=7 to 35 ns. 3. 1989Vi04 report a single half-life for delayed protons, γ rays and x rays, indicating the existence of only one 10.3 s ^{135}Sm activity. T$_{1/2}$: from Iγ as a function of time. Weighted average of 49 s *3* (1989Ko07) and 45 s *10* (1989Vi04). Others (composite for both isomers): 44 s *9* (1975Va14), 55 s *10* (1977Bo02).
0+y	(5/2$^+$)		C	Additional information 2. E(level): this level may correspond to 0+x level but no experimental evidence exists to confirm this. In case it is the same as the 0+x level, then it may also

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Adopted Levels, Gammas (continued)

^{135}Pm Levels (continued)

E(level)[†]	J^{π}[‡]	$T_{1/2}$	XREF	Comments
				correspond to the g.s.
55.38+x *12*	(+)		A	J^{π}: 1989Vi04 proposed 11/2$^-$, but see comment for 0.0+y level. From syst 1993BrZU suggested 5/2$^+$. (M1,E2) γ to (3/2$^+$,5/2$^+$) suggests positive parity.
68.7+y[@] *22*	(11/2$^-$)	45 s *4*	B D	%ε+%β^+=100 E(level): systematics (see figure 3 in 1993BrZU) suggest 11/2$^-$ as g.s. However, experimental evidence is lacking, as to which of the two activities corresponds to the ground state. See also comment for the 49-s isomer labeled 0.0+x. If 0+x is the ground state, then (11/2$^-$) state may be at an absolute energy of 68.7 keV. 2003Au03 give 50 *100* from systematics. $T_{1/2}$: from timing of γ rays. Average of 49 s *3* (1989Vi04) and 40 s *3* (1989Ko07). Others (for both isomers): 44 s *9* (1975Va14), 55 s *10* (1977Bo02). J^{π}: from systematics (1993BrZU).
104.57+x *13*			A	J^{π}: 1989Vi04 proposed (9/2$^-$ to 13/2$^-$), but see comment for 0.0+y level. From syst 1993BrZU suggested 5/2$^+$.
126.0+y[d] *10*			C	
181.70+x *11*			A	J^{π}: 1989Vi04 proposed (13/2$^-$), but see comment for 0.0+y level. From syst 1993BrZU suggested 7/2$^+$.
251.0+y[d] *15*			C	
341.24+x *12*			A	J^{π}: 1989Vi04 proposed 15/2$^-$, but see comment for 0.0+y level.
355.5+y[@] *22*	(15/2$^-$)	49[#] ps *2*	BCD	
418.31+x *13*			A	
489.0+y[d] *18*			C	
531.62+x *17*			A	
554.0+y[&] *15*	(11/2$^+$)		C	
609.85+x *21*			A	J^{π}: 1989Vi04 proposed (15/2), but see comment for 0.0+y level.
725.25+x *21*			A	
754.70+x *16*			A	
814.0+y[d] *20*			C	
869.2+y[@] *22*	(19/2$^-$)	4.2[#] ps *5*	BCD	
1092.0+y[&] *18*	(15/2$^+$)		C	
1205.0+y[d] *23*			C	
1232.2+y[e] *24*			C	
1242.2+y[b] *24*	(19/2$^+$)		C	
1313.8+x *6*			A	
1367.2+y[c] *24*	(21/2$^+$)		C	
1527.6+y[@] *22*	(23/2$^-$)	1.7[#] ps *4*	BCD	
1643.0+y[d] *25*			C	
1657.0+y[&] *20*	(19/2$^+$)		C	
1786+y[e] *3*			C	
1855+y[b] *3*	(23/2$^+$)		C	
1988+y[c] *3*	(25/2$^+$)		C	
2062.4+y[a] *22*	(21/2$^+$)		BCD	
2116+y[d] *3*			C	
2183.8+y[&] *22*	(23/2$^+$)		C	
2276.7+y[@] *22*	(27/2$^-$)		BCD	
2346+y[e] *3*			C	
2465.9+y[a] *22*	(25/2$^+$)		BCD	

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Adopted Levels, Gammas (continued)

^{135}Pm Levels (continued)

E(level)[†]	J^{π}[‡]	XREF	Comments
2504+y[b] 3	(27/2$^+$)	C	
2686+y[c] 3	(29/2$^+$)	C	
2739.8+y[&] 24	(27/2$^+$)	C	
2920+y[e] 3		C	
3029.6+y[a] 22	(29/2$^+$)	CD	
3081.9+y[@] 22	(31/2$^-$)	BCD	
3201+y[b] 3	(31/2$^+$)	C	
3397+y[&] 3	(31/2$^+$)	C	
3438+y[c] 3	(33/2$^+$)	C	
3541+y[e] 4		C	
3769.6+y[a] 22	(33/2$^+$)	CD	
3929.0+y[@] 23	(35/2$^-$)	BCD	
3969+y[b] 4	(35/2$^+$)	C	
4186+y[&] 3	(35/2$^+$)	C	
4260+y[e] 4		C	
4265+y[c] 4	(37/2$^+$)	C	
4616.6+y[a] 25	(37/2$^+$)	C	
4773.1+y? 24	(39/2$^-$)	D	
4816+y[b] 4	(39/2$^+$)	C	
4827.8+y[@] 23	(39/2$^-$)	BC	
5048+y[&] 3	(39/2$^+$)	C	
5192+y[c] 4	(41/2$^+$)	C	
5.5×10^3 15		A	E(level): levels in the range 4000-7000 (1989Vi04) fed by ^{135}Sm β decay which deexcite by delayed protons.
5517+y[a] 3	(41/2$^+$)	C	
5792.5+y[@] 23	(43/2$^-$)	BC	
5950+y[&] 4	(43/2$^+$)	C	
6513+y[a] 3	(45/2$^+$)	C	
6824.3+y[@] 25	(47/2$^-$)	BC	

† From least-squares fit to Eγ's.

‡ For high-spin states (J>11/2) the assignments are mostly based on band assignments augmented by $\gamma\gamma(\theta)$(DCO) and $\gamma(\theta)$ data for selected transitions.

From RDDS (1987Wa02) in ^{92}Mo(^{46}Ti,3pγ).

@ Band(A): $\pi h_{11/2}$ 3/2[541], α=−1/2. triaxial shape ($\gamma\approx-15°$) is indicated by single-particle Routhian plots calculated by 1987Be22. The alignment plot shows a backbend at a crossing rotational frequency h°$\omega\approx$420 keV, attributed to the alignment of a pair of protons from lower $h_{11/2}$ midshell. There does not seem any evidence for alignment of a pair of neutrons from upper $h_{11/2}$ midshell. VMI analysis: parameter Δ=120 keV.

& Band(B): Band based on (11/2$^+$), α=−1/2. Possible configuration=$\pi g_{7/2}$5/2[413]⊗$\pi h^2_{11/2}$, α=−1/2. VMI analysis: parameter Δ=97 keV, 128 keV for both signature partners treated as one band.

a Band(b): Band based on (21/2$^+$), α=+1/2. Possible configuration=$\pi g_{7/2}$5/2[413]⊗$\pi h^2_{11/2}$. VMI analysis: parameter Δ=68 keV, 128 keV for both signature partners treated as one band.

b Band(C): Band based on (19/2$^+$), α=−1/2. Weakly populated band. VMI analysis: parameter Δ=14 keV, 74 keV for both signature partners treated as one band.

c Band(c): Band based on (21/2$^+$), α=+1/2. Weakly populated band. VMI analysis: parameter Δ=10 keV, 74 keV for both signature partners treated as one band.

d Band(D): γ cascade. Possibly ΔJ=1 band.

e Band(E): γ cascade. Possibly ΔJ=2 band.

Adopted Levels, Gammas (continued)

$\gamma(^{135}Pm)$

E_i(level)	J^π_i	E_γ[†]	I_γ	E_f	J^π_f	Mult.	α[&]	Comments
55.38+x	($^+$)	55.4 2	100	0+x	(3/2$^+$,5/2$^+$)	(M1,E2)	15 7	α(K)=5.9 15; α(L)=7 7; α(M)=1.6 15; α(N+..)=0.44 Mult.: estimated from α(exp) in ^{135}Sm ε decay (1989Vi04).
104.57+x		49.1 2	22 7	55.38+x	($^+$)			
		104.6 2	100 22	0+x	(3/2$^+$,5/2$^+$)			
126.0+y		126		0+y	(5/2$^+$)			
181.70+x		77.2[a] 2	36[a] 11	104.57+x				
		126.3 2	100 11	55.38+x	($^+$)			
		181.7 2	25 6	0+x	(3/2$^+$,5/2$^+$)			
251.0+y		125		126.0+y				
341.24+x		159.5 4	3 1	181.70+x				
		236.6[a] 3	≈52[a]	104.57+x				
		285.9 2	100 12	55.38+x	($^+$)			
		341.3 2	≈8	0+x	(3/2$^+$,5/2$^+$)			
355.5+y	(15/2$^-$)	286.8 1	100	68.7+y	(11/2$^-$)	E2[@]		B(E2)(W.u.)=138 6
418.31+x		77.2[a] 2	≈1[a]	341.24+x				
		236.6[a] 3	≈54[a]	181.70+x				
		313.4 4	12 4	104.57+x				
		363.0 2	100 12	55.38+x	($^+$)			
		418.2 2	31 6	0+x	(3/2$^+$,5/2$^+$)			
489.0+y		238		251.0+y				
531.62+x		190.3 2	100 10	341.24+x				
		350.0 2	20 5	181.70+x				
554.0+y	(11/2$^+$)	428		126.0+y				
609.85+x		428.2 2	100	181.70+x				
725.25+x		115.5 3	31 8	609.85+x				
		543.5 2	100 19	181.70+x				
754.70+x		573.0 2	75 20	181.70+x				
		754.7 2	100 25	0+x	(3/2$^+$,5/2$^+$)			
814.0+y		325		489.0+y				
869.2+y	(19/2$^-$)	513.7 1	100	355.5+y	(15/2$^-$)	E2[@]		B(E2)(W.u.)=91 11
1092.0+y	(15/2$^+$)	538		554.0+y	(11/2$^+$)			
1205.0+y		391		814.0+y				
1232.2+y		363		869.2+y	(19/2$^-$)			
1242.2+y	(19/2$^+$)	373		869.2+y	(19/2$^-$)			
1313.8+x		1132.1 5	100	181.70+x				
1367.2+y	(21/2$^+$)	498		869.2+y	(19/2$^-$)			
1527.6+y	(23/2$^-$)	658.4 2	100	869.2+y	(19/2$^-$)	E2[@]		B(E2)(W.u.)=66 16
1643.0+y		438		1205.0+y				
1657.0+y	(19/2$^+$)	565		1092.0+y	(15/2$^+$)			
		788		869.2+y	(19/2$^-$)			
1786+y		554		1232.2+y				
1855+y	(23/2$^+$)	613		1242.2+y	(19/2$^+$)			
1988+y	(25/2$^+$)	621		1367.2+y	(21/2$^+$)			
2062.4+y	(21/2$^+$)	1193.1 2	100	869.2+y	(19/2$^-$)	D[#]		
2116+y		473		1643.0+y				
2183.8+y	(23/2$^+$)	527		1657.0+y	(19/2$^+$)			
		656		1527.6+y	(23/2$^-$)			
2276.7+y	(27/2$^-$)	749.1 1	100	1527.6+y	(23/2$^-$)	(Q)[‡]		
2346+y		560		1786+y				
2465.9+y	(25/2$^+$)	403.5 1	100 7	2062.4+y	(21/2$^+$)	Q[‡]		
		938.4 3	<96	1527.6+y	(23/2$^-$)			I_γ: unresolved doublet.

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Adopted Levels, Gammas (continued)

γ(^{135}Pm) (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ	E_f	J^π_f	Mult.
2504+y	(27/2$^+$)	649		1855+y	(23/2$^+$)	
2686+y	(29/2$^+$)	698		1988+y	(25/2$^+$)	
2739.8+y	(27/2$^+$)	556		2183.8+y	(23/2$^+$)	
2920+y		574		2346+y		
3029.6+y	(29/2$^+$)	563.7 *2*	100	2465.9+y	(25/2$^+$)	
3081.9+y	(31/2$^-$)	805.2 *2*	100	2276.7+y	(27/2$^-$)	Q[‡]
3201+y	(31/2$^+$)	697		2504+y	(27/2$^+$)	
3397+y	(31/2$^+$)	657		2739.8+y	(27/2$^+$)	
3438+y	(33/2$^+$)	752		2686+y	(29/2$^+$)	
3541+y		621		2920+y		
3769.6+y	(33/2$^+$)	740.0 *3*	100	3029.6+y	(29/2$^+$)	
3929.0+y	(35/2$^-$)	847.1 *4*	100	3081.9+y	(31/2$^-$)	Q[‡]
3969+y	(35/2$^+$)	768		3201+y	(31/2$^+$)	
4186+y	(35/2$^+$)	789		3397+y	(31/2$^+$)	
4260+y		719		3541+y		
4265+y	(37/2$^+$)	827		3438+y	(33/2$^+$)	
4616.6+y	(37/2$^+$)	847		3769.6+y	(33/2$^+$)	
4773.1+y?	(39/2$^-$)	844.1 *9*	100	3929.0+y	(35/2$^-$)	
4816+y	(39/2$^+$)	847		3969+y	(35/2$^+$)	
4827.8+y	(39/2$^-$)	898.8 *4*	100	3929.0+y	(35/2$^-$)	Q[‡]
5048+y	(39/2$^+$)	862		4186+y	(35/2$^+$)	
5192+y	(41/2$^+$)	927		4265+y	(37/2$^+$)	
5517+y	(41/2$^+$)	900		4616.6+y	(37/2$^+$)	
5792.5+y	(43/2$^-$)	964.7 *4*	100	4827.8+y	(39/2$^-$)	Q[‡]
5950+y	(43/2$^+$)	902		5048+y	(39/2$^+$)	
6513+y	(45/2$^+$)	996		5517+y	(41/2$^+$)	
6824.3+y	(47/2$^-$)	1031.8 *8*	100	5792.5+y	(43/2$^-$)	Q[‡]

† For high-spin levels, energies quoted with uncertainties are from ^{116}Sn(^{24}Mg,p4nγ) reaction, others are from ^{107}Ag(^{32}S,2p2nγ).

‡ $\gamma(\theta)$ and/or $\gamma\gamma(\theta)$ indicate ΔJ=2, quadrupole (E2).

$\gamma(\theta)$ and/or $\gamma\gamma(\theta)$ indicate ΔJ=1, dipole.

@ $\gamma\gamma(\theta)$ and RUL(for E2 and M2).

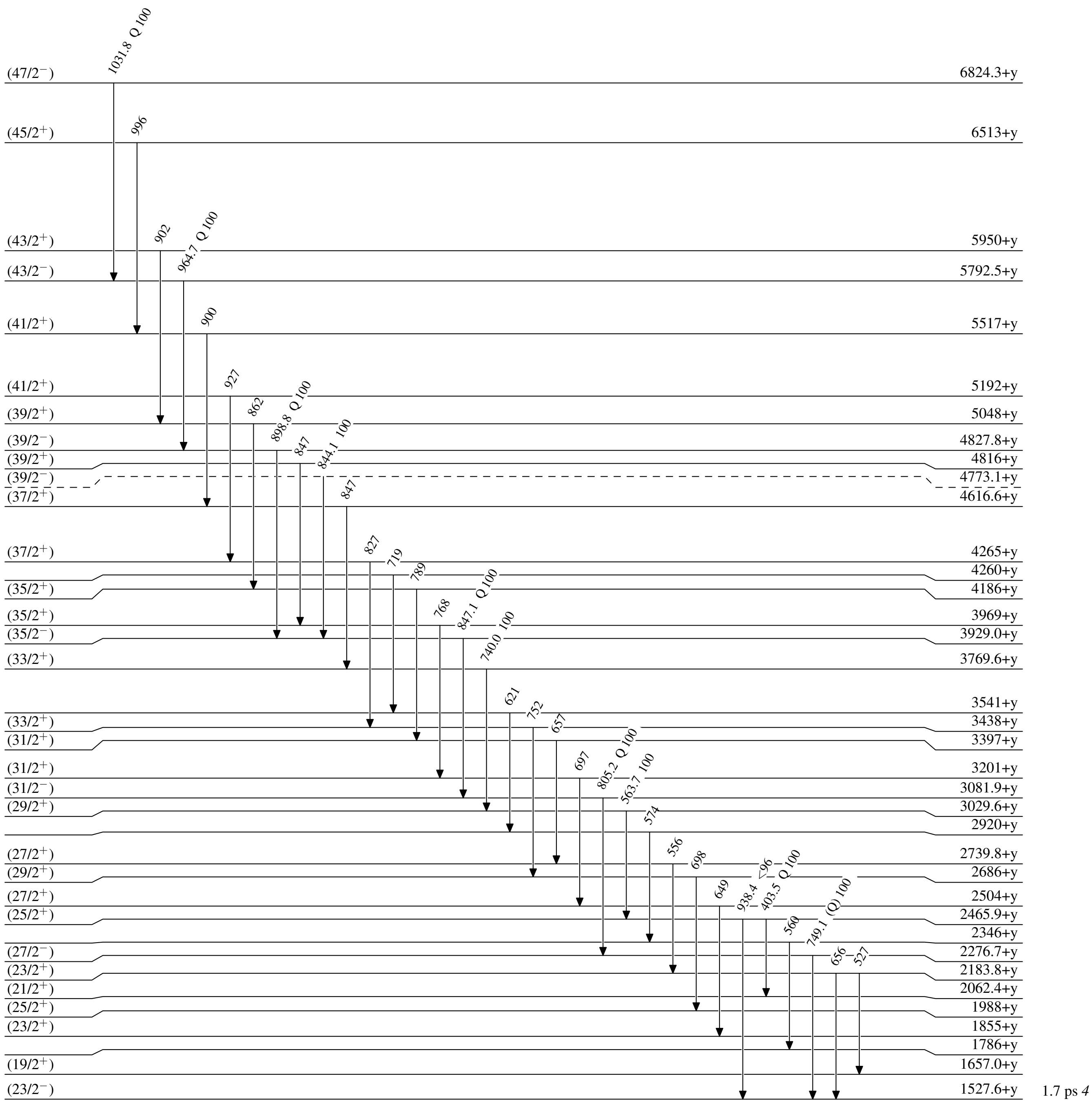
& Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

a Multiply placed with intensity suitably divided.

Adopted Levels, Gammas

Level Scheme

Intensities: Relative photon branching from each level

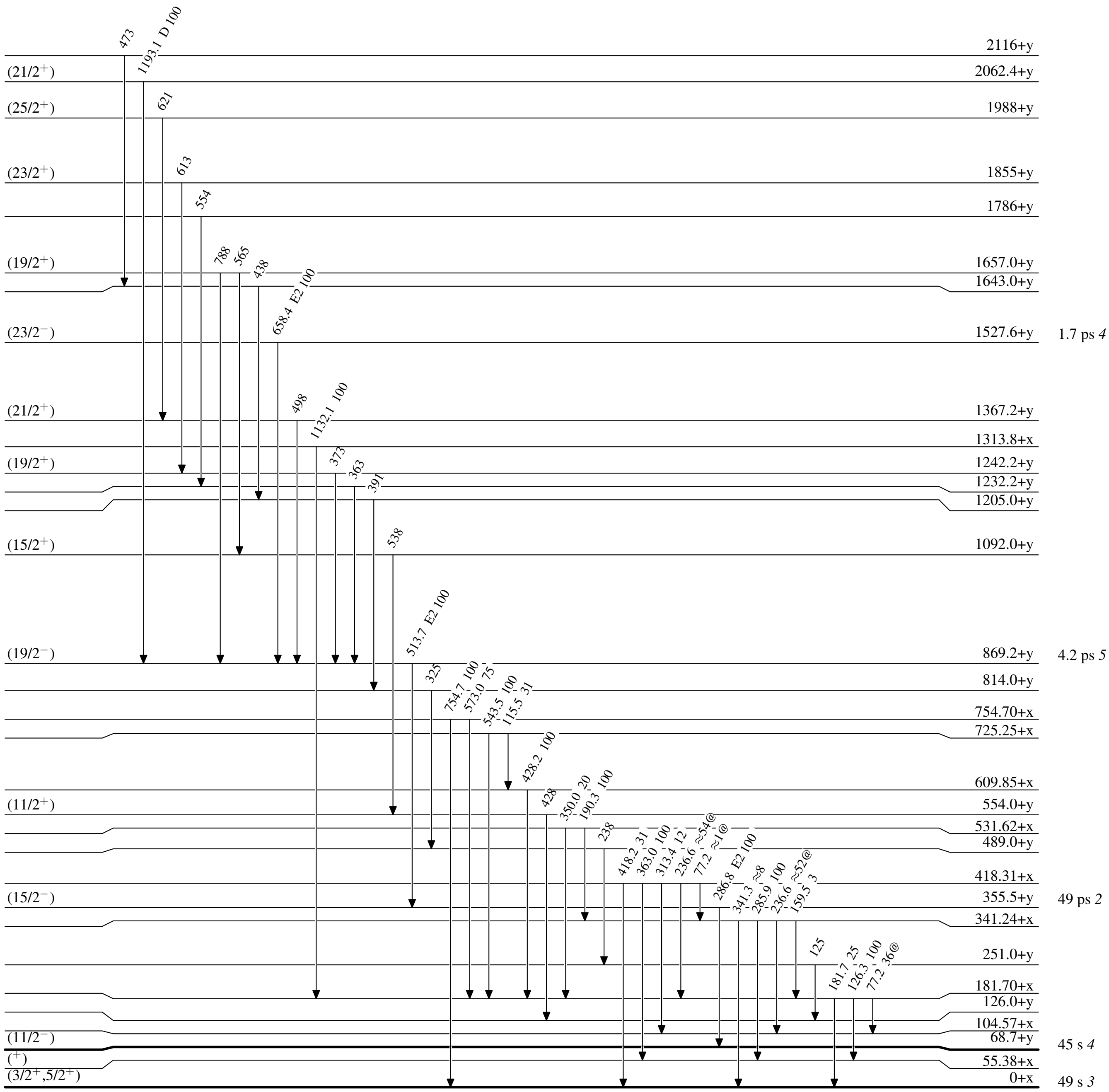


$^{135}_{61}Pm_{74}$

Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level
@ Multiply placed: intensity suitably divided

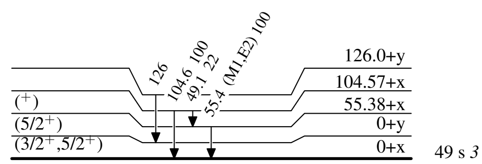


$^{135}_{61}Pm_{74}$

Adopted Levels, Gammas

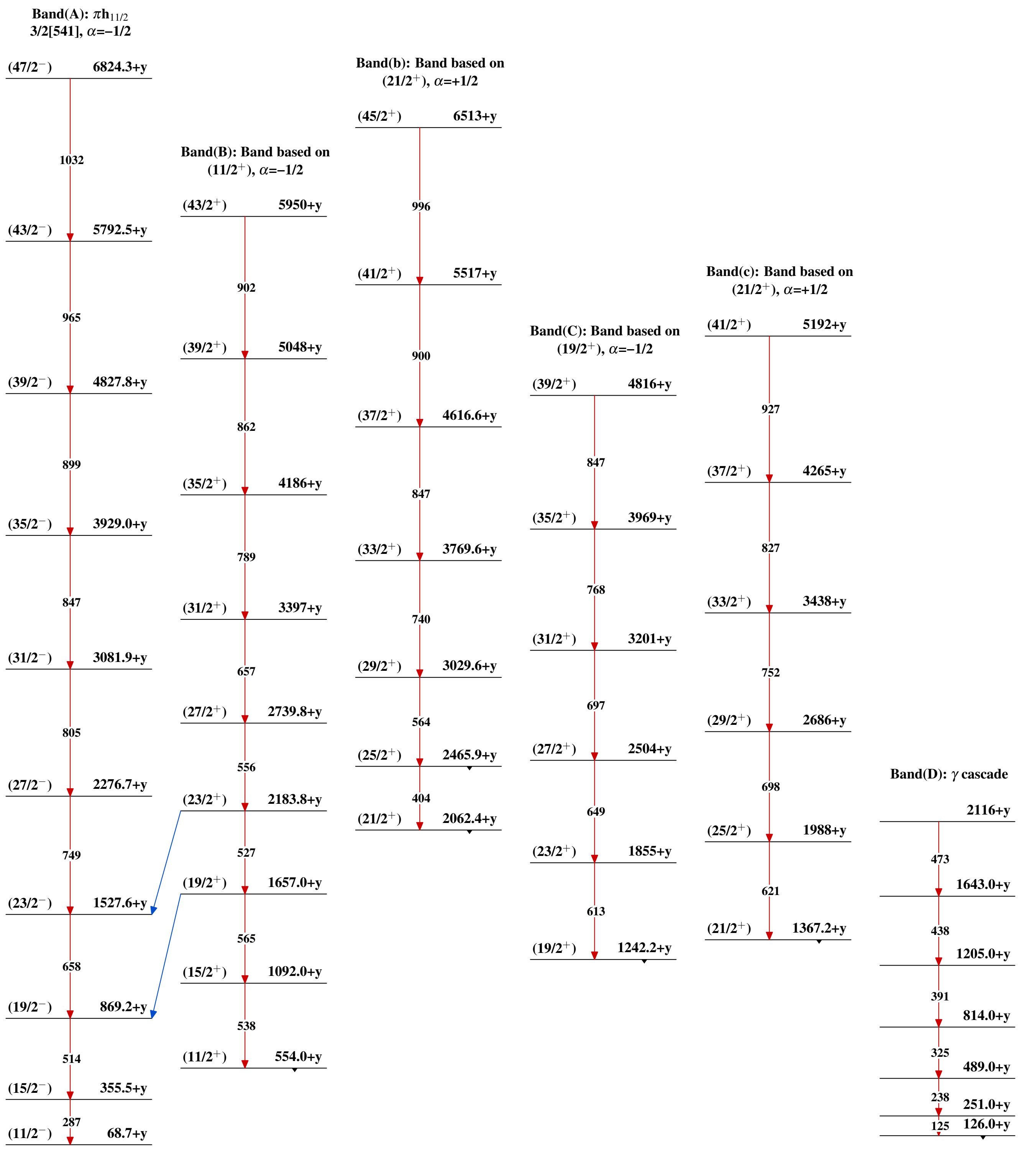
Level Scheme (continued)

Intensities: Relative photon branching from each level
@ Multiply placed: intensity suitably divided



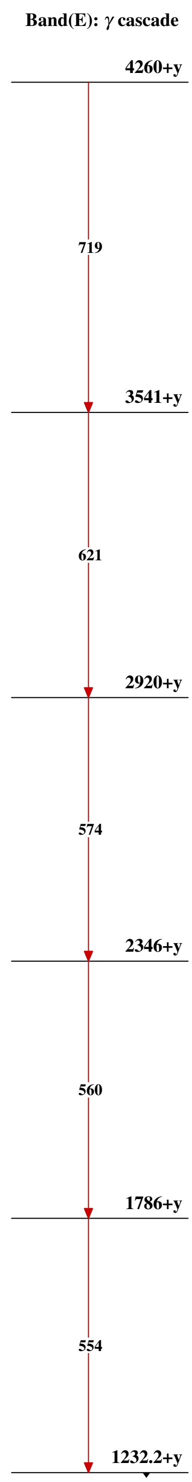
$^{135}_{61}Pm_{74}$

Adopted Levels, Gammas



$^{135}_{61}Pm_{74}$

Adopted Levels, Gammas (continued)



$^{135}_{61}Pm_{74}$