Adopted Levels, Gammas

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	C. W. Reich	NDS 113, 2537 (2012)	1-Mar-2012

Q(β^-)=722 *8*; S(n)=7241 *9*; S(p)=9709 *10*; Q(α)=−1.64×10^3 *3* 2017Wa10
S(2n)=13048 *9*; S(2p)=1.811×10^4 *10* 2017Wa10
Additional information 1.
In this data set, the reference "^{156}Pm β^- Decay" generally refers to the decay of the ^{156}Pm g.s. (26.70 s) and not to the decay of the isomer (<5 s).
Some model and theory articles are:
1969Br18: deduced deformation parameter β_4.
1974So02: dependence of p(θ) from ^{154}Sm(t,p) on β_4 deformation.
1975Bi13: 0^+ level energies and B(E2).
1986Be10: Cranked shell-model calculations of the spectrum of two-quasiparticle states.
1987Ap04: nucleon correlations.
1990Ha22: level energies and B(E2).
1998Ga12: HFB-based calculations of expected two-quasiparticle states.
1998Lo07: IBA-based calculations of relative Iγ values of E1 transitions from the first 1^-,3^-,5^- levels to the g.s. band.

^{156}Sm Levels

The level energies are primarily from the ^{156}Pm β^- decay study and secondarily from the ^{252}Cf SF decay studies.

Cross Reference (XREF) Flags

A	^{156}Pm β^- decay (<5 s)	D	^{252}Cf SF decay
B	(HI,xnγ)	E	^{154}Sm(t,p)
C	^{156}Pm β^- decay (26.70 s)		

E(level)	J$^\pi$[†]	T$_{1/2}$	XREF	Comments
0[‡]	0^+	9.4 h *2*	ABCDE	%β^-=100 T$_{1/2}$: From 1963Gu04, γ(t). Others: 9.1 h *7*, β+γ(t) (1960Al33); 15 h *13*, γ(t) (1969WiZX). All values are from ^{156}Sm β^- decay.
75.89[‡] *5*	2^+	>2 ns	ABCDE	J$^\pi$: L=2 in (t,p); E2 to 0^+ g.s. T$_{1/2}$: From 1970ChZH, ^{252}Cf SF decay.
249.71[‡] *7*	4^+		BCDE	J$^\pi$: E2 γ to 2^+ and expected band structure.
517.07[‡] *8*	6^+		BCDE	J$^\pi$: E2 γ to 4^+ and expected band structure.
803.69[#] *22*	(1^-)		A C E	XREF: E(810). J$^\pi$: γ's to 0^+ and 2^+. Probable bandhead of the K$^\pi$=1^- octupole vibrational band.
871.57[‡] *22*	8^+		B D	J$^\pi$: γ to 6^+ and expected band structure.
875.69[#] *11*	(3^-)		C E	J$^\pi$: γ's to 2^+ and 4^+. Level energy suggests that this is the 3^- member of the K$^\pi$=1^- octupole band.
1009.79[#] *9*	(2^-)		C	J$^\pi$: Sole decay mode is γ to 2^+. From level energy, probable 2^- member of the K$^\pi$=1^- octupole band.
1020.62[#] *10*	(5^-)		C	J$^\pi$: γ's to 4^+ and 6^+. From level energy, probably the 5^- member of the K$^\pi$=1^- band.
1068[@] *10*	0^+		E	J$^\pi$: L=0 in (t,p).
1110.11[&] *11*	(3^-)		C E	XREF: E(1120). J$^\pi$: From γ's to 2^+ and 4^+, J$^\pi$=2^+,3,4^+. Agreement of the γ branching to the 2^+ and 4^+ members of the g.s. band with the Alaga-rule predictions for ΔK=0 dipole transitions lends support to the assignment of this state as the 3^- member of the K$^\pi$=0^- octupole band. Hence, J$^\pi$=3^- is reasonable.

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Adopted Levels, Gammas (continued)

^{156}Sm Levels (continued)

E(level)	J^{π}[†]	$T_{1/2}$	XREF	Comments
1144.07[#] *9*	(4$^-$)		C	J^{π}: Sole mode of decay is a γ to 4$^+$. From level energy, probably the 4$^-$ member of the K$^{\pi}$=1$^-$ octupole band.
1256.1 *5*			C	
1307.4[‡] *3*	10$^+$		B D	J^{π}: γ to 8$^+$ and expected band structure.
1397.55[a] *9*	5$^-$	185 ns *7*	CD	J^{π}: The γ transitions from this state to the g.s. band have large hindrance factors, indicating a large K value. Examination of the Nilsson orbitals expected to be present among the lowest-lying two-quasiparticle excitations in ^{156}Sm indicates two such pairs, each of which has K$^{\pi}$=5$^-$. Since this state is the more weakly fed of the two in β^- decay, the listed two-neutron-quasiparticle conf is assigned as the dominant component in the make-up of this state. $T_{1/2}$: From 1990He11, ^{156}Pm β^- decay. 2009Si21, in SF decay, report $T_{1/2}$=186 ns *44*. Other: 1974ClZX report a 160 ns *40* activity among the products of ^{252}Cf spontaneous fission, but do not definitely associate it with a specific ^{156}Sm level. See the comment on this level in the ^{252}Cf SF Decay data set.
1441 *10*	2$^+$		E	J^{π}: L=2 in (t,p).
1509.22[d] *9*	4$^+$		C e	XREF: e(1516). J^{π}: γ's to 2$^+$ and 6$^+$.
1511.07[b] *18*	(6$^-$)		D	E(level): Even though the levels immediately above and below this one may be associated with the 1516 proton group in (t,p), the evaluator has chosen not to include this level in that possible association because it is expected that only natural-parity states are excited to any appreciable extent in the (t,p) reaction. J^{π}: The sole decay mode of this state is a γ transition to the K$^{\pi}$=5$^-$ bandhead at 1397 keV, suggesting that this state also has a large K value and is most probably the 6$^-$ member of the band built on that state.
1515.04[c] *9*	5$^-$	4.5 ns *2*	CDe	XREF: e(1516). J^{π}: In an argument similar to that for the 1397, 5$^-$, state, this state has a large K value, for which K$^{\pi}$=5$^-$ is the most likely assignment. See the discussion in the comment on the J^{π} value of the 1397, 5$^-$, state above, as well as in the ^{156}Pm β^- Decay data set.
1610.30 *12*			C E	
1643.74[a] *18*	(7$^-$)		D	
1711 *10*			E	
1738.35 *13*			C E	
1753.2[c] *5*	(7$^-$)		D	
1792 *10*			E	
1794.32[b] *21*	(8$^-$)		D	
1818.7[‡] *4*	12$^+$		B D	J^{π}: γ to 10$^+$ and expected band structure.
1851 *10*			E	
1911 *10*			E	
1963.41[a] *23*	(9$^-$)		D	
1970 *20*			E	
2033.8 *3*			C	
2150.56[b] *24*	(10$^-$)		D	
2199.91 *11*			C	
2265.52 *11*			C	
2341.92 *12*			C	
2355.0[a] *4*	(11$^-$)		D	
2400.1[‡] *4*	14$^+$		B D	J^{π}: γ to 12$^+$ and expected band structure.
2482.6 *3*			C	
2519.04 *11*	3		C	J^{π}: γ's to 2$^+$, (2$^-$), 4$^+$ and (4$^-$) levels indicate J=3. The π assignment is problematic at present. See the discussion in the ^{156}Pm β^- Decay data set.
2526.22 *9*	3		C	J^{π}: γ's to 2$^+$, (2$^-$), 4$^+$ and (4$^+$) levels indicate J=3. The π assignment is problematic at present. See the discussion in the ^{156}Pm β^- Decay data set.

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Adopted Levels, Gammas (continued)

^{156}Sm Levels (continued)

E(level)	J^{π}[†]	XREF	Comments
2576.9[b] *3*	(12$^-$)	C	
2609.7 *3*	(4$^-$)	C	J^{π}: Sole decay mode is a γ to 4$^+$.
2616.51 *21*	(4$^-$)	C	J^{π}: Sole decay mode is a γ to 4$^+$.
2677 *10*		E	
2699.7 *5*		C	
2814.9[a] *4*	(13$^-$)	D	
3044?[‡]	(16$^+$)	D	
3069.5[b] *4*	(14$^-$)	D	
3335?[a]	(15$^-$)	D	

[†] For those levels populated only in the SF-decay studies, the listed values are based on the observed decay properties and the usual considerations of rotational-band structure in strongly deformed nuclei.

[‡] Band(A): $K^{\pi}=0^+$ g.s. band. α=12.72 keV, β=−11.6 eV.

[#] Band(B): Probable $K^{\pi}=1^-$ octupole band. This band probably contains a sizeable component of the two-neutron quasiparticle state ν5/2[642]-ν3/2[521].

[@] Band(C): Bandhead of the first excited $K^{\pi}=0^+$ band.

[&] Band(D): Possible 3$^-$ member of the $K^{\pi}=0^-$ octupole band.

[a] Band(E): $K^{\pi}=5^-$ band, α=1 branch. Dominant conf=ν5/2[642]+ν5/2[523]. α=9.49 keV, β=−0.64 eV, computed from the energies of the 5$^-$ through 8$^-$ levels. This state is most likely appreciably mixed with the $K^{\pi}=5^-$ state at 1515 keV. 1998Ga12 (in SF decay) propose that this (1397) state is the two-proton quasiparticle state with conf=π5/2[532]+π5/2[413].

[b] Band(e): $K^{\pi}=5^-$ band, α=0 branch. See the comments on the α=1 branch.

[c] Band(F): $K^{\pi}=5^-$ band. Dominant conf=π5/2[532]+π5/2[413]. α=8.49 keV, computed from the energies of the 5$^-$ and 7$^-$ levels. See the comment on the other 5$^-$ band regarding possible mixing of these two bands.

[d] Band(G): Probable $K^{\pi}=4^+$ bandhead. Probable conf is ν3//2[521]+ν5/2[523]. For another proposed configuration (which is not adopted here), see the discussion of this level in the ^{156}Pm β^- Decay data set.

$\gamma(^{156}Sm)$

E_i(level)	J_i^{π}	E_{γ}	I_{γ}	E_f	J_f^{π}	Mult.	α[†]	Comments
75.89	2$^+$	75.88 *5*	100	0	0$^+$	E2	6.51	B(E2)(W.u.)<300
249.71	4$^+$	173.75 *5*	100	75.89	2$^+$	E2	0.336	
517.07	6$^+$	267.32 *5*	100	249.71	4$^+$	E2	0.0808	
803.69	(1$^-$)	727.6 *3*	82 *18*	75.89	2$^+$			
		803.9 *3*	100 *18*	0	0$^+$			
871.57	8$^+$	354.5 *2*	100	517.07	6$^+$			
875.69	(3$^-$)	626.37 *20*	17 *3*	249.71	4$^+$			
		799.70 *10*	100 *11*	75.89	2$^+$			
1009.79	(2$^-$)	934.00 *10*	100	75.89	2$^+$			
1020.62	(5$^-$)	503.37 *20*	12 *4*	517.07	6$^+$			
		770.77 *10*	100 *12*	249.71	4$^+$			
1110.11	(3$^-$)	860.26 *20*	79 *7*	249.71	4$^+$			
		1034.25 *10*	100 *7*	75.89	2$^+$			
1144.07	(4$^-$)	894.35 *10*	100	249.71	4$^+$			
1256.1		380.4 *4*	100	875.69	(3$^-$)			
1307.4	10$^+$	435.8 *2*	100	871.57	8$^+$			
1397.55	5$^-$	376.75 *10*	4.4 *5*	1020.62	(5$^-$)	[M1,E2]	0.036 *9*	
		880.39 *10*	50.7 *25*	517.07	6$^+$	[E1]	0.00132	B(E1)(W.u.)=6.0×10^{-10} *4* I_{γ}: Value from 1990He11, ^{156}Pm β^- decay.

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Adopted Levels, Gammas (continued)

γ(^{156}Sm) (continued)

E_i(level)	J_i^π	E_γ	I_γ	E_f	J_f^π	Mult.	α†	Comments
								From ^{252}Cf SF decay, 1995Zh15 report Iγ=152, while 1998Ga12 report Iγ=87.
1397.55	5⁻	1147.84 *10*	100.0 *5*	249.71	4⁺	[E1]	0.00081	B(E1)(W.u.)=5.4×10^{-10} *2* Additional information 2.
1509.22	4⁺	992.0 *10*	2.4 *8*	517.07	6⁺			
		1259.44 *10*	100 *5*	249.71	4⁺			
		1433.70 *10*	67 *3*	75.89	2⁺			
1511.07	(6⁻)	113.6 *2*	100	1397.55	5⁻			
1515.04	5⁻	117.42 *5*	100 *5*	1397.55	5⁻	M1	1.068	B(M1)(W.u.)=0.00142 *12*
		370.94 *10*	4.4 *7*	1144.07	(4⁻)	[M1,E2]	0.038 *9*	
		494.4 *4*	2.2 *7*	1020.62	(5⁻)	[M1,E2]	0.018 *5*	
1610.30		1360.58 *10*	100	249.71	4⁺			
1643.74	(7⁻)	132.6 *2*	230 *40*	1511.07	(6⁻)			
		246.1 *2*	100	1397.55	5⁻			
1738.35		223.31 *10*	100	1515.04	5⁻			
1753.2	(7⁻)	237.8‡ *2*	100	1515.04	5⁻			
1794.32	(8⁻)	150.1 *2*	90 *14*	1643.74	(7⁻)			
		283.4 *2*	100	1511.07	(6⁻)			
1818.7	12⁺	511.3 *2*	100	1307.4	10⁺			
1963.41	(9⁻)	168.9 *2*	120 *18*	1794.32	(8⁻)			
		320.0 *2*	100	1643.74	(7⁻)			
2033.8		518.4 *4*	90 *10*	1515.04	5⁻			
		524.9 *4*	100 *10*	1509.22	4⁺			
2150.56	(10⁻)	187.2 *2*	50 *11*	1963.41	(9⁻)			
		356.1 *2*	100	1794.32	(8⁻)			
2199.91		684.65 *10*	37.5 *18*	1515.04	5⁻			
		690.90 *10*	100 *5*	1509.22	4⁺			
2265.52		750.26 *10*	100 *10*	1515.04	5⁻			
		756.51 *10*	100 *10*	1509.22	4⁺			
2341.92		827.03 *10*	50 *8*	1515.04	5⁻			
		832.08 *20*	100 *17*	1509.22	4⁺			
2355.0	(11⁻)	204.4 *2*	80 *16*	2150.56	(10⁻)			
		391.6 *2*	100	1963.41	(9⁻)			
2400.1	14⁺	581.4 *2*	100	1818.7	12⁺			
2482.6		2406.7 *3*	100	75.89	2⁺			
2519.04	3	1374.91 *10*	82 *7*	1144.07	(4⁻)			
		1509.12 *20*	100 *11*	1009.79	(2⁻)			
		2269.9 *4*	25 *4*	249.71	4⁺			
		2443.34 *20*	86 *7*	75.89	2⁺			
2526.22	3	1382.24 *10*	77 *4*	1144.07	(4⁻)			
		1516.56 *10*	100 *5*	1009.79	(2⁻)			
		2276.18 *20*	9.5 *14*	249.71	4⁺			
		2450.17 *10*	36 *4*	75.89	2⁺			
2576.9	(12⁻)	222.2 *2*	35 *12*	2355.0	(11⁻)			
		426.2 *2*	100	2150.56	(10⁻)			
2609.7	(4⁻)	2360.0 *3*	100	249.71	4⁺			
2616.51	(4⁻)	2366.78 *20*	100	249.71	4⁺			
2699.7		1555.6 *5*	100	1144.07	(4⁻)			
2814.9	(13⁻)	460.0 *2*	100	2355.0	(11⁻)			
3044?	(16⁺)	644‡	100	2400.1	14⁺			
3069.5	(14⁻)	492.6 *2*	100	2576.9	(12⁻)			
3335?	(15⁻)	520‡	100	2814.9	(13⁻)			

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Adopted Levels, Gammas (continued)

$\gamma(^{156}Sm)$ (continued)

† 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.

‡ Placement of transition in the level scheme is uncertain.

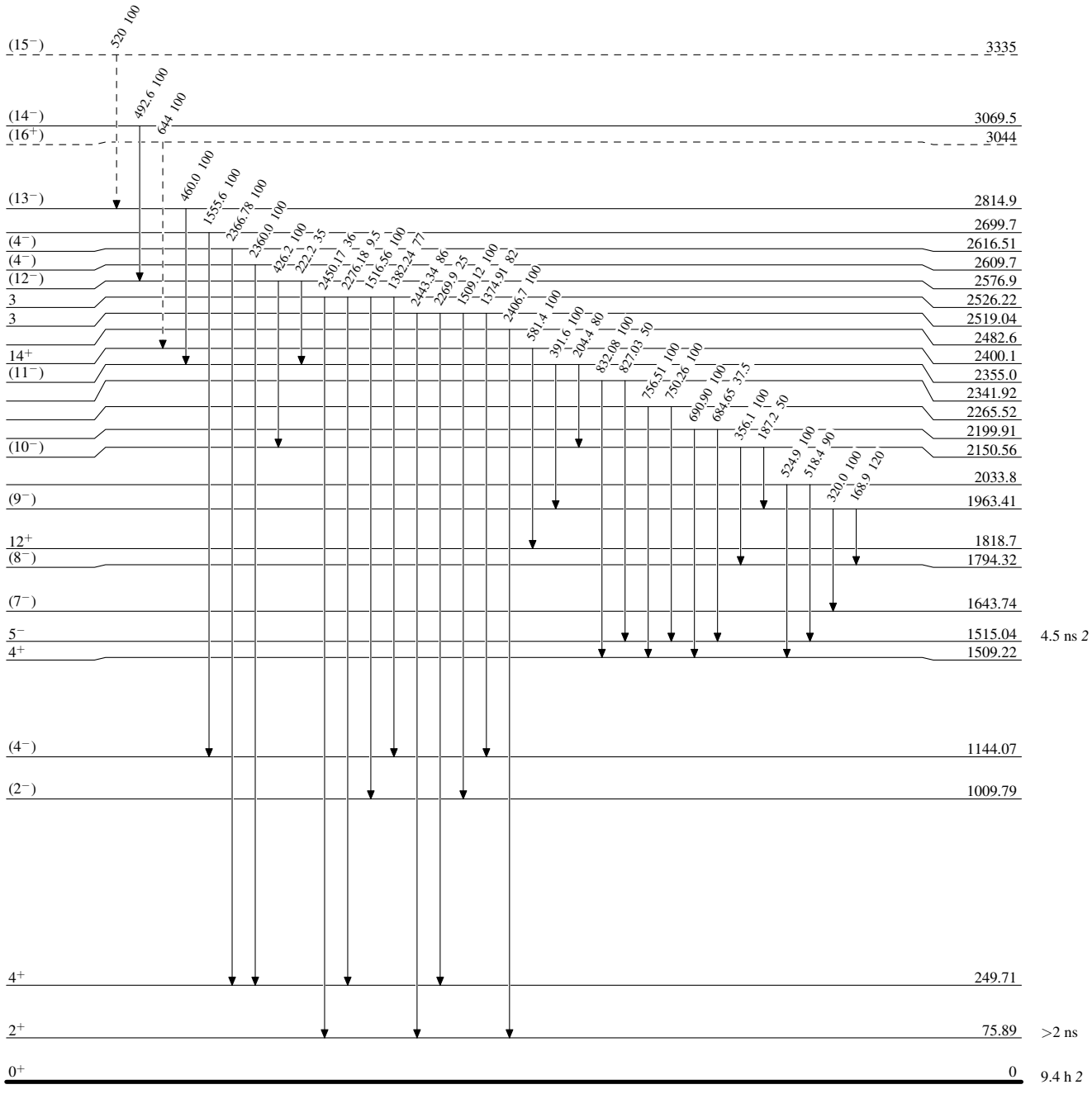
Adopted Levels, Gammas

Legend

Level Scheme

Intensities: Relative photon branching from each level

γ Decay (Uncertain)



$^{156}_{62}Sm_{94}$

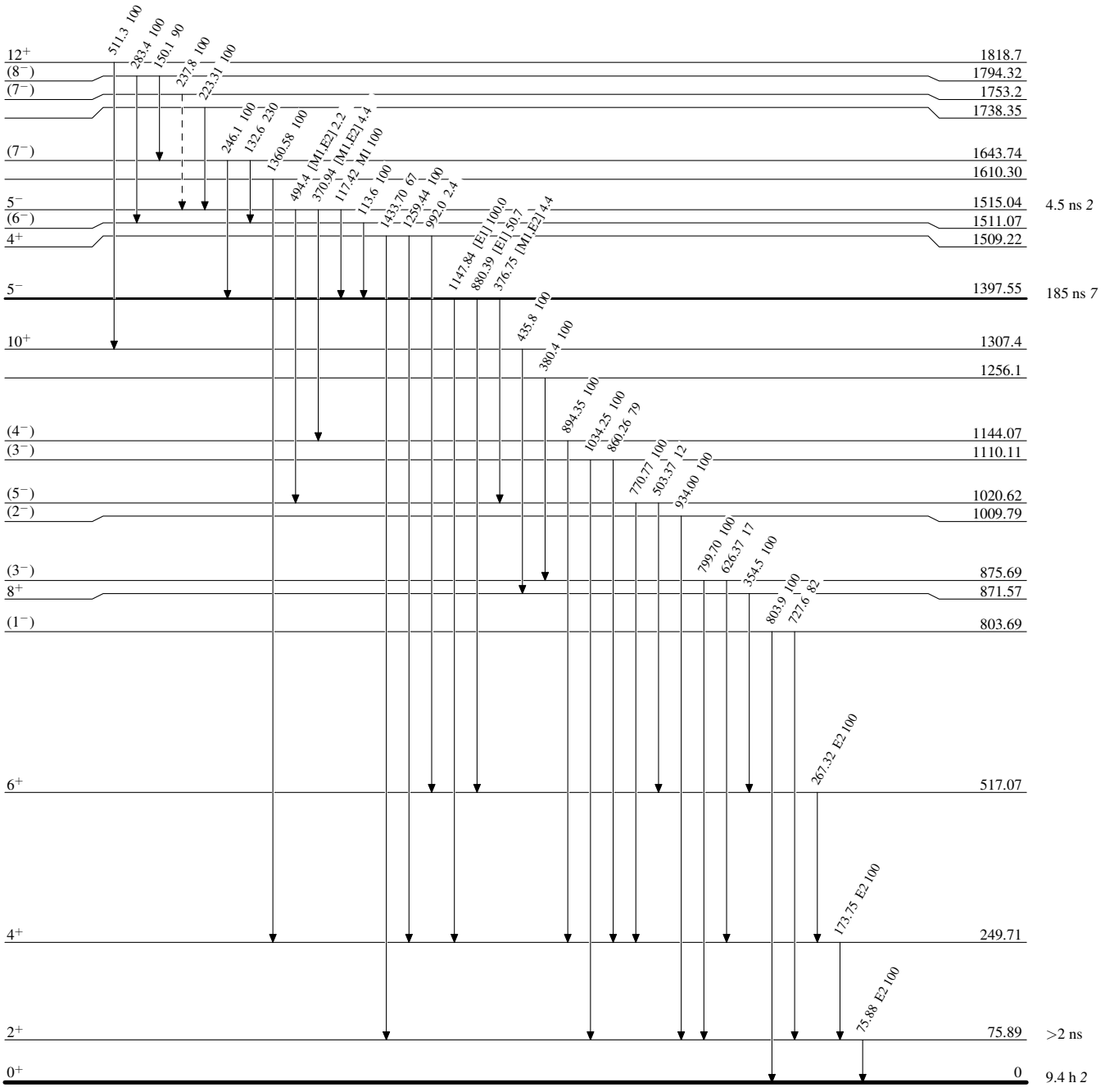
Adopted Levels, Gammas

Legend

Level Scheme (continued)

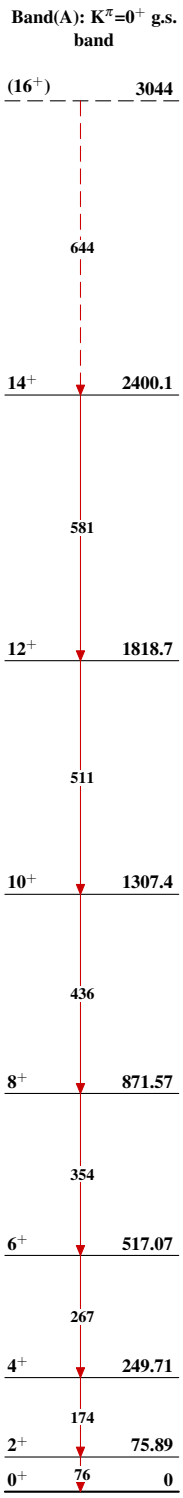
Intensities: Relative photon branching from each level

γ Decay (Uncertain)



$^{156}_{62}Sm_{94}$

Adopted Levels, Gammas



$^{156}_{62}Sm_{94}$

Adopted Levels, Gammas (continued)

Band(B): Probable $K^{\pi}=1^{-}$ octupole band

(4^{-}) 1144.07

Band(D): Possible 3^{-} member of the $K^{\pi}=0^{-}$ octupole band

(3^{-}) 1110.11

Band(C): Bandhead of the first excited $K^{\pi}=0^{+}$ band

0^{+} 1068

(5^{-}) 1020.62

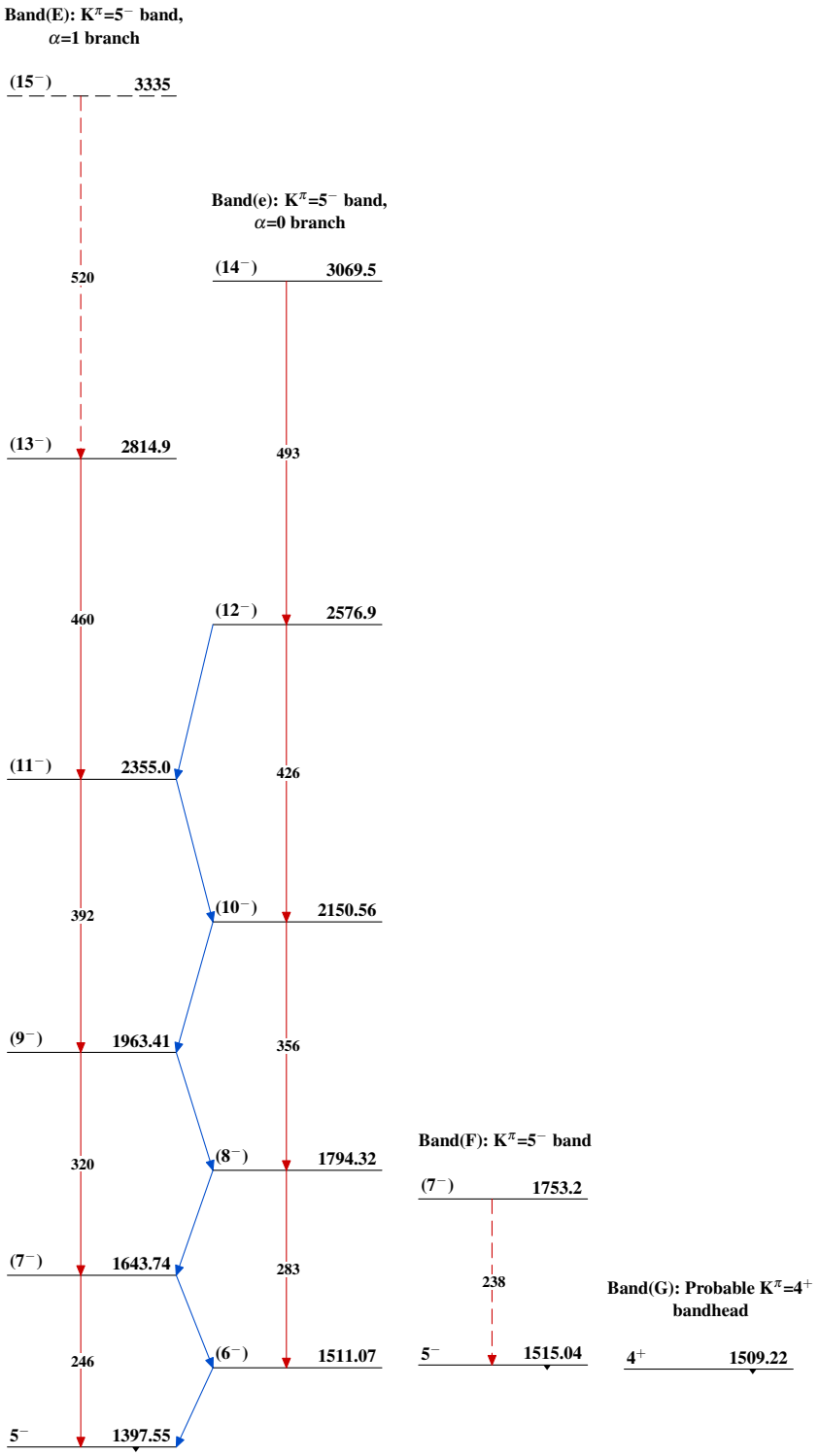
(2^{-}) 1009.79

(3^{-}) 875.69

(1^{-}) 803.69

$^{156}_{62}Sm_{94}$

Adopted Levels, Gammas (continued)



$^{156}_{62}Sm_{94}$