Adopted Levels, Gammas

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Y. Akovali	NDS 94,131 (2001)	1-Aug-2001

Q(β^-)=1780 *4*; S(n)=4970 *4*; S(p)=5089 *6*; Q(α)=5531 *syst* 2012Wa38
Note: Current evaluation has used the following Q record 1780 4 *4969* 5 *5087* 6 *5532* 19 1995Au04.

Since the 39.9-h ^{254}Es α decay and ^{249}Bk(n,γ) data presented in this evaluation are considered as preliminary, level schemes and predominant configuration assignments given here, which are based mostly on these data, should Be taken as tentative, particularly in view of some interpretations that are inconsistent with data.
Assuming the level scheme is correct, the inconsistencies noted here can Be explained by large admixtures of other configurations. See 275.7-d ^{254}Es and 39.3-h ^{254}Es α decays and ^{249}Bk(n,γ) data sections for additional remarks.
Additional information 1.

Theoretical studies:
Fission-barrier properties were calculated by 1977Pr10, 1980Ku14, 1984Oh09, 1984Ku05, 1984Ro23.
For discussions and calculations of Gallagher-Moszkovski splitting, and of odd- and even-spin states′ energy shifts (Newby shifts), see, for example, 1986Ho30, 1986Ho36, 1986So12, 1988Fr16, 1989HoZI, 1994No15.

^{250}Bk Levels

Additional information 2.

Cross Reference (XREF) Flags

A ^{254}Es α decay (275.7 d)
B ^{254}Es α decay (39.3 h)
C ^{249}Bk(n,γ):(tentative)

E(level)[f]	J$^\pi$	T$_{1/2}$[g]	XREF	Comments
0.0[†]	2$^-$	3.212 h *5*	ABC	%β^-=100 T$_{1/2}$: measurement of 1979Re01. Other measured half-lives are 3.10 h (1954Gh24), 3.222 h *5* (1959Va02), 3.103 h *19* (1988Po05). J$^\pi$: log *ft*=7.2 for β to 3$^+$ state rules out J<2; from log *ft*′s to 0$^+$ states, J^π Ne 2$^+$ and J is not >2. Among the available Nilsson orbitals, analogy to ^{251}Bk and ^{251}Cf for the proton and neutron states suggests that probable configuration is 2$^-$,(p 3/2[521]+n 1/2[620]).
34.47[†]	(3$^-$)		ABC	J$^\pi$: 34.4γ to g.s. is (M1,E2); rotational parameter.
35.59[‡]	(4$^+$)	29 μs *1*	ABC	J$^\pi$: (M2) to g.s.; α hindrance factor of α from 2.757-d ^{254}Es is consistent with the J^π and configuration assignments.
78.33[‡]	(5$^+$)		ABC	J$^\pi$: (M1+E2) to (4$^+$); α hindrance factor in 275.7-d ^{254}Es α decay.
80.26[†]	(4$^-$)		C	J$^\pi$: 45.79γ to (3$^-$) and 80.26γ to 2$^-$ are (M1+E2) and (E2), respectively, obtained in (n,γ).
86[#] *2*	(7$^+$)	213 μs *8*	A	J$^\pi$: favored α decay from (7$^+$) 275.7-d ^{254}Es.
97.49[@]	(5$^-$)	38 ns *5*	A C	J$^\pi$: 61.91-keV (E1) transition to (4$^+$). Hindrance factor for the α from (7$^+$),(p 7/2[633],n 7/2[613]) 275.7-d ^{254}Es is consistent with J^π=(5$^-$) and the configuration of (p 3/2[521],n 7/2[613]).
103.83[&]	(1$^-$)		BC	J$^\pi$: (M1) to g.s. J^π and configuration was assigned by 1973Ah04 in 39.3-h ^{254}Es α decay and by 1982HoZE in (n,γ) reaction.
115.45[a]	(3$^+$)		BC	J$^\pi$: (M1) transitions from 2$^+$ level at 211.82 and to (4$^+$) level at 35.59. E(level): the order of 96.38- and 79.86-keV gammas, feeding and deexciting the level, respectively, were reversed in 39.3-h ^{254}Es α decay and (n,γ) works, with

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

^{250}Bk Levels (continued)

E(level)[f]	Jπ	$T_{1/2}$[g]	XREF	Comments
				two different level energies. The same configuration assignment was proposed by 1973Ah04 and by 1982HoZE. The order for these two gammas chosen here is mostly based on the intensity balance in α decay at this level. However, uncertainties on the transition intensities of these gammas do not rule out the reverse order. Therefore, the level energy could very well Be 131.97 keV. Another reason for adopting this order is that if the 3^+ state were at 131.97 keV, the rotational band parameter would Be much too small, assuming the assignment of the 148.60-keV level as the band's 4^+ member is correct. An expected E1 transition to g.s. either 115.45 keV or 131.97 keV, which would determine the level's correct energy, would Be obscured by the $K\alpha_1$ x ray and $K\beta_2'$ x ray. See also the 39.3-h ^{254}Es α decay set.
125.01[&]	(2^-)		BC	Jπ: (M1) transitions to 2^- and (3^-) members of g.s. band; rotational band parameter.
130.49[‡]	(6^+)		ABC	Jπ: 52.16γ and 94.91 γ's to (5^+) and (4^+) states are (M1+E2) and (E2), respectively; α hindrance factor in 275.7-d ^{254}Es α decay.
137.32[†]	(5^-)		ABC	Jπ: (M1) and (E2) transitions to the (4^-) and (3^-) members of the band, respectively; energy fit to the band.
146.43[b]	(2^-)		C	Jπ: assignment was made by 1982HoZE. The (M1) and (M1+E2) transitions to the (3^-) and 2^- states of the g.s. band, respectively, are consistent with the suggested configuration, which is reasonable among the available Nilsson states expected at low energies.
148.60[a]	(4^+)		C	Jπ: (M1) transitions to (4^+) and (5^+) states of the K=4 band, and the energy spacing from the 115.44 level are consistent with this J^π assignment.
156[#] *2*	(8^+)		A	Jπ: α hindrance factor in 275.7-d ^{254}Es α decay; (M1+E2) to (7^+) state at 86 keV.
157.39[&]	(3^-)		C	Jπ: (E2) transition to (1^-) state, (M1) to (4^-) state.
167.09[@]	(6^-)		A C	Jπ: (M1+E2) to (5^-); rotational parameter. α hindrance factor is consistent with the J^π and configuration assignments.
175.13	(1^+)	42 ns *2*	BC	Jπ: (E1) transitions to (2^-) and (1^-) states; no γ to (3^-). The K=0,(p 7/2[633],n 7/2[613]) configuration, assigned by 1973Ah04 in 39.3-h ^{254}Es α decay and by 1982HoZE in (n,γ), is not consistent with HF=270 for the α from 2^+,2 (p 7/2[633],n 3/2[622]) parent state; it is also not consistent with γ transitions to members of K=1 and K=2 bands with (p 3/2[521]±n 1/2[620]) configurations.
179.99[b]	(3^-)		C	Jπ: (M1+E2) and (M1) transitions to 2^- and (3^-) states; band parameter.
190[‡] *2*	(7^+)		A	Jπ: hindrance factor of 2350 for 6324α from 275.7-d ^{254}Es is consistent with its transition from J^π,K=7^+,7,(p 7/2[633],n 7/2[613]) parent to (7^+) of K=4,(p 7/2[633],n 1/2[620]) band.
203.64[&]	(4^-)		C	Jπ: (M1) transitions to (3^-) and (4^-) states of g.s. band. J^π=(4^-) is preferred from nonobservation of γ to 2^- g.s. Energy fit to level is somewhat poor.
211.82[c]	2^+		BC	Jπ: parity is from E1 character of 211.82γ to 2^- g.s. Spin is from favored α decay from 39.3-h ^{254}Es.
215.94	(0^+)		C	Jπ: (M1) and (E1) transitions to (1^+) and (1^-), respectively; no γ t0 J=2 and higher J^π states. A=6.80, if this and 175.12-keV levels are 0^+ and 1^+ members of a K=0 band, as proposed by 1982HoZE.
236.74[c]	(3^+)		BC	Jπ: HF(6357α)=30 *3*, in 39.3-h ^{254}Es α decay, is consistent with α transition from 2^+,2(p 7/2[633],n 3/2[622]) parent to this state with main configuration of 3^+,2(p 7/2[633],n 3/2[622]) . E(level): 121.29γ deexciting this level is assumed to Be incorrectly shown in decay scheme of 1982HoZE to decay to the 148.60-keV level: it is placed here between this level and the 115.44-keV level. E(level)=236 *3* from Eα's.
241[#] *2*	(9^+)		A	Jπ: (M1,E2) to (8^+) member of the K=7 band; HF(α)=380 is consistent with α transition from the 7^+,7(p 7/2[633],n 7/2[613]) parent.
247.9[@] *2*	(7^-)		A	Jπ: (M1,E2) to (6^-) amd γ to (5^-) members of the band; HF=224 *22* for α transition from the 7^+,7(p 7/2[633],n 7/2[613]) parent.

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Adopted Levels, Gammas (continued)

^{250}Bk Levels (continued)

E(level)[f]	Jπ	XREF	Comments
270.46[c]	(4+)	BC	Jπ: (E2) to (2+) member of the band; HF(α)=79 for α from 2+,2 (p 7/2[633],n 3/2[622]) parent.
298 *2*		B	
316[c] *3*	(5+)	B	Jπ: HF(α)=650 *150* for α transition from 2+,2 (p 7/2[633],n 3/2[622]).
316.46[d]	(5+)	C	Jπ: $J^{\pi}=5^+$ of K=5,(p 7/2[633]+n 3/2[622]) band assignment was made by 1982HoZE from M1 γ transitions to 4^+ and 5^+ members of K=4,(p 7/2[633],n 1/2[620]) band. The level observed at 316 keV in 39.3-h ^{254}Es α decay was assigned by 1973Ah04 to $J^{\pi}=5^+$ of K=2,(p 7/2[633]-n 3/2[622]) band. Both of these 5^+ states may Be populated by α in 39.3-h ^{254}Es.
325 *2*		A	
333 *2*		A	
≈341		A	
369.61[d]	(6+)	C	Jπ: (M1) transitions to (5+) and (6+) members of K=4 band; (6+) is inferred from non-observation of an E2 to the band's (4+) member.
406	(6+)	C	Jπ: K,$J^{\pi}=6,6^+$, (p 5/2[642],n 7/2[613]) state was proposed by 1982HoZE from (n,γ), and also by 1982KoZZ in ^{254}Es α decay data which is not included in this evaluation, since it is tentative. It should Be pointed out that an α transition to this state from the $7,7^+$ (p 7/2[633],n 7/2[613]) parent is expected to have low hindrance factor.
413[e] *3*		A	E(level): calculated from Q(α)(^{254}Es)=6615.7 *15* and Eα=6105 *2*. This level may Be identical to the state identified in (n,γ) at 406-keV. However, in their preliminary α decay work, 1982KoZZ observed a new α to 406-keV level, presumably in addition to an α to the 413-keV level. If the 6105α is a doublet, HF(α to 406)≥22 which is consistent with an α transition between the 7^+,7(p 7/2[633],n 7/2[613]) parent and a 6^+,6(p 5/2[642],n 7/2[613]) daughter state. α and γ spectra with higher resolution are needed to resolve whether or not these two levels are the same.
471[e] *2*		A	
526		C	Jπ: J^{π},K=3^-,3 (p 7/2[633],n 1/2[761]) was assigned from (n,γ) data.
527[e] *20*		A	Additional information 3.
552		C	Jπ: J^{π},K=6^+,6 (p 7/2[633],n $5/2^+$[622]) was proposed from (n,γ) data. The same configuration was assigned by 1982KoZZ to a level at 355.3 keV from ^{254}Es α decay.
566		C	Jπ: J^{π},K=4^-,4 (p 7/2[633],n 1/2[761]) was proposed from (n,γ) data.

† Band(A): K=2. A=5.7; configuration: (p 3/2[521],n 1/2[620]).

‡ Band(B): K=4. A=4.27; configuration: (p 7/2[633],n 1/2[620]).

Band(C): K=7. A=4.4; configuration: (p 7/2[633],n 7/2[613]).

@ Band(D): K=5. A=5.7; (p 3/2[521],n 7/2[613]) configuration was proposed by 1966Mc02. Since the deexcitation of the 97.49 level by 61.91γ to the 4^+,4(p 7/2[633],n 1/2[620]) level at 35.59 is not consistent with 5^+,5(p 3/2[521],n 7/2[613]) assignment for the 97.49 level (a γ transition between these states would require both proton and neutron states to change during decay), large admixture with other states would Be expected.

& Band(E): K=1. A=5.3; configuration, (p 3/2[521],n 1/2[620]), was assigned by 1983Ah02 in 39.3-h ^{254}Es α decay and by 1982HoZE in (n,γ) reaction.

a Band(F): K=3. A=4.14; (p 7/2[633],n 1/2[620]) configuration was assigned by 1982HoZE. This assignment was proposed by 1973Ah04 to a level at 131.6 keV.

b Band(G): K=2. A=5.59; (p 3/2[521],n 7/2[613]) configuration was proposed by 1982HoZE.

c Band(H): K=2. A=4.15. From the favored α decay of 39.3-h ^{254}Es, the configuration is (p 7/2[633],n 3/2[622]), as assigned by 1973Ah04. However, the γ's shown to decay to g.s. band are not consistent with the configuration assigned. Some admixture with other bands is needed to explain the γ deexcitations.

d Band(I): K=5. A=4.43; configuration of (p 7/2[633],n 3/2[622]) was assigned by 1982HoZE.

e The authors of 1966Mc02 tentatively suggested that the 413-,471- and 527-keV levels might Be members of a rotational band. They may possibly Be the 6^+, 7^+ and 8^+ members of the K=6 band, identified at 406 keV.

f From 275.7-d and 39.3-h ^{254}Es α decay and from ^{249}Bk(n,γ) reaction studies.

g Excited states' half-lives are from 275.7-d and 39.3-h ^{254}Es α decay.

Adopted Levels, Gammas (continued)

$\gamma(^{250}Bk)$

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Mult.[#]	α[@]	$I_{(\gamma+ce)}$	Comments
34.47	(3^-)	34.47		0.0	2^-	(M1,E2)	18×10^2 *16*		
35.59	(4^+)	(1.12)		34.47	(3^-)	[E1]		$\approx5.5\times10^5$	B(E1)(W.u.)$\approx1\times10^{-6}$ The N-, O-, P- subshell, and the total conversion coefficient were calculated by 1991Ba63 for 0.95-, 1.1- and 1.25-keV γ transitions with E1 multipolarity. The authors calculated total $\alpha(1.1\gamma)$=986. From intensity balance in ^{254}Es α decay, 30% of I(γ+ce) from the 35.59 level decays through the 1.12-keV γ.
		35.59	100	0.0	2^-	(M2)	1.287×10^4	12.9×10^5	B(M2)(W.u.)$\approx$0.026
78.33	(5^+)	42.74		35.59	(4^+)	(M1+E2)			
80.26	(4^-)	45.79		34.47	(3^-)	(M1+E2)			
		80.26		0.0	2^-	(E2)			
86	(7^+)	(8)		78.33	(5^+)	[E2]	1.3×10^6		B(E2)(W.u.)=0.0007 *5* Transition has not been observed; energy is from level scheme.
97.49	(5^-)	61.91		35.59	(4^+)	(E1)	0.508		B(E1)(W.u.)=1.25×10^{-5} *18*
103.83	(1^-)	103.83		0.0	2^-	(M1)	7.47		
115.45	(3^+)	79.86		35.59	(4^+)	(M1)	16.05		
125.01	(2^-)	90.53	100 *30*	34.47	(3^-)	(M1)	11.13		
		125.01	75 *30*	0.0	2^-	(M1)	4.38		
130.49	(6^+)	52.16		78.33	(5^+)	(M1+E2)	2.6×10^2 *20*		
		94.91		35.59	(4^+)	(E2)	26.7		
137.32	(5^-)	57.06		80.26	(4^-)	(M1)	42.8		
		102.84		34.47	(3^-)	(E2)	18.4		
146.43	(2^-)	111.96		34.47	(3^-)	(M1)	6.01		
		146.43		0.0	2^-	(M1+E2)	8.3 *41*		
148.60	(4^+)	70.27		78.33	(5^+)	(M1)	23.3		
		113.01		35.59	(4^+)	(M1)	5.85		
156	(8^+)	70.4 *2*		86	(7^+)	(M1+E2)	66 *43*		
157.39	(3^-)	53.59		103.83	(1^-)	(E2)	402.8		
		77.13		80.26	(4^-)	(M1)	17.78		
		122.95		34.47	(3^-)	(M1)	4.59		
167.09	(6^-)	69.60		97.49	(5^-)	(M1+E2)	69 *24*		
175.13	(1^+)	50.12	22 *3*	125.01	(2^-)	(E1)	0.882		B(E1)(W.u.)=3.5×10^{-6} *7*
		71.30	100 *10*	103.83	(1^-)	(E1)	0.352		B(E1)(W.u.)=5.6×10^{-6} *8*
		175.12	6.5 *14*	0.0	2^-	[E1+M2]	2.76		B(E1)(W.u.)=2.2×10^{-8} *6*; B(M2)(W.u.)=0.30 *8* α: for E1+M2, δ=0.3. B(M2)(W.u.) for δ=0.3.
179.99	(3^-)	145.56		34.47	(3^-)	(M1)	12.9		
		179.99		0.0	2^-	(M1+E2)	4.3 *27*		
203.64	(4^-)	123.37		80.26	(4^-)	(M1)	4.55		
		169.19		34.47	(3^-)	(M1)	8.40		
211.82	2^+	(36.7)		175.13	(1^+)				This transition was not observed; existence was deduced from $\alpha\gamma$-coincidence data

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

γ(^{250}Bk) (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Mult.[#]	α[@]	Comments
								observed in 39.3-h ^{254}Es α decay. E_γ: from level scheme.
211.82	2^+	96.38	5.9 *7*	115.45	(3^+)	(M1)	9.28	
		177.36	59 *6*	34.47	(3^-)	(E1)	0.145	
		211.82	100 *10*	0.0	2^-	E1	0.0967	
215.94	(0^+)	40.82		175.13	(1^+)	(M1)	113.7	
		112.116		103.83	(1^-)	(E1)	0.109	
236.74	(3^+)	121.29		115.45	(3^+)	(M1)	4.78	
		202.27		34.47	(3^-)			E_γ: deduced from level energies shown in 1982HoZE. γ energy was not given in the decay scheme of 1982HoZE.
241	(9^+)	85.1 *1*		156	(8^+)	(M1,E2)		
247.9	(7^-)	80.8 *1*		167.09	(6^-)	(M1,E2)		
		150 *2*		97.49	(5^-)			
270.46	(4^+)	58.64		211.82	2^+	(E2)	261	
		235.98		34.47	(3^-)			
316.46	(5^+)	238.14		78.33	(5^+)	(M1)	3.21	
		280.88		35.59	(4^+)	(M1)	2.03	
325		233[&] *2*	32 *4*	97.49	(5^-)			Existence of this transition is questionable.
		249 *2*	100 *16*	78.33	(5^+)			
369.61	(6^+)	239.18		130.49	(6^+)	(M1)	3.17	
		291.36		78.33	(5^+)	(M1)	1.81	
413		316 *2*		97.49	(5^-)			This γ could deexcite the 406-keV level, if it is also populated by an α from ^{254}Es g.s. An E1 γ transition would Be expected between the J^π,K=6^+,6(p 5/2[642],n 7/2[613]) and 5^-,5(p 3/2[521],n 7/2[613]) states.
471		304 *2*		167.09	(6^-)			

[†] From (n,γ), 276-d and 39.3-h ^{254}Es α decays.
[‡] Relative photon intensities deexciting each level. These branchings are deduced from Iγ′s measured in ^{254}Es α decays.
[#] Deduced in ^{254}Es α decays and (n,γ) work.
[@] 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.

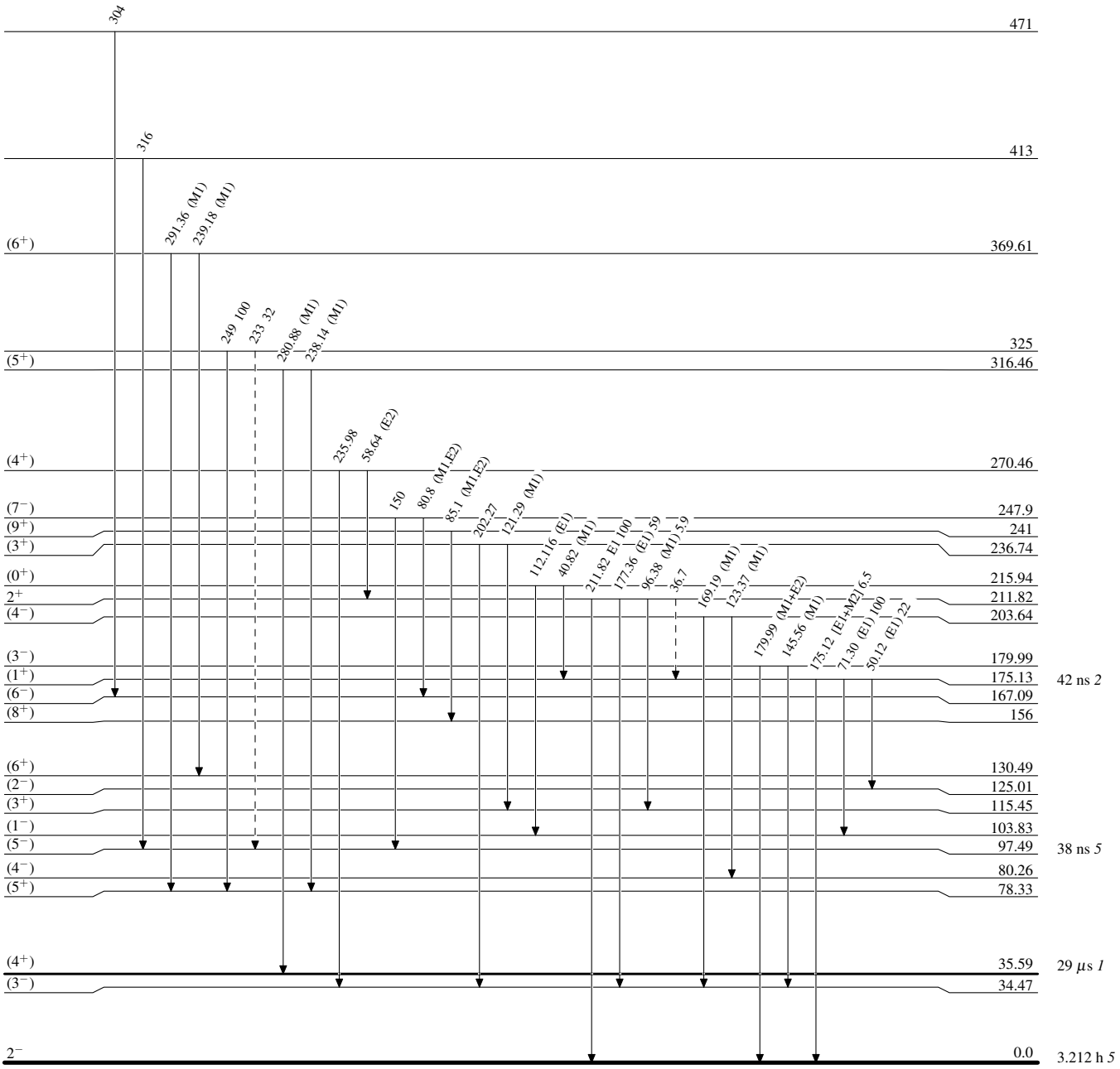
Adopted Levels, Gammas

Legend

Level Scheme

Intensities: Relative photon branching from each level

- - - - - - ► γ Decay (Uncertain)



$^{250}_{97}Bk_{153}$

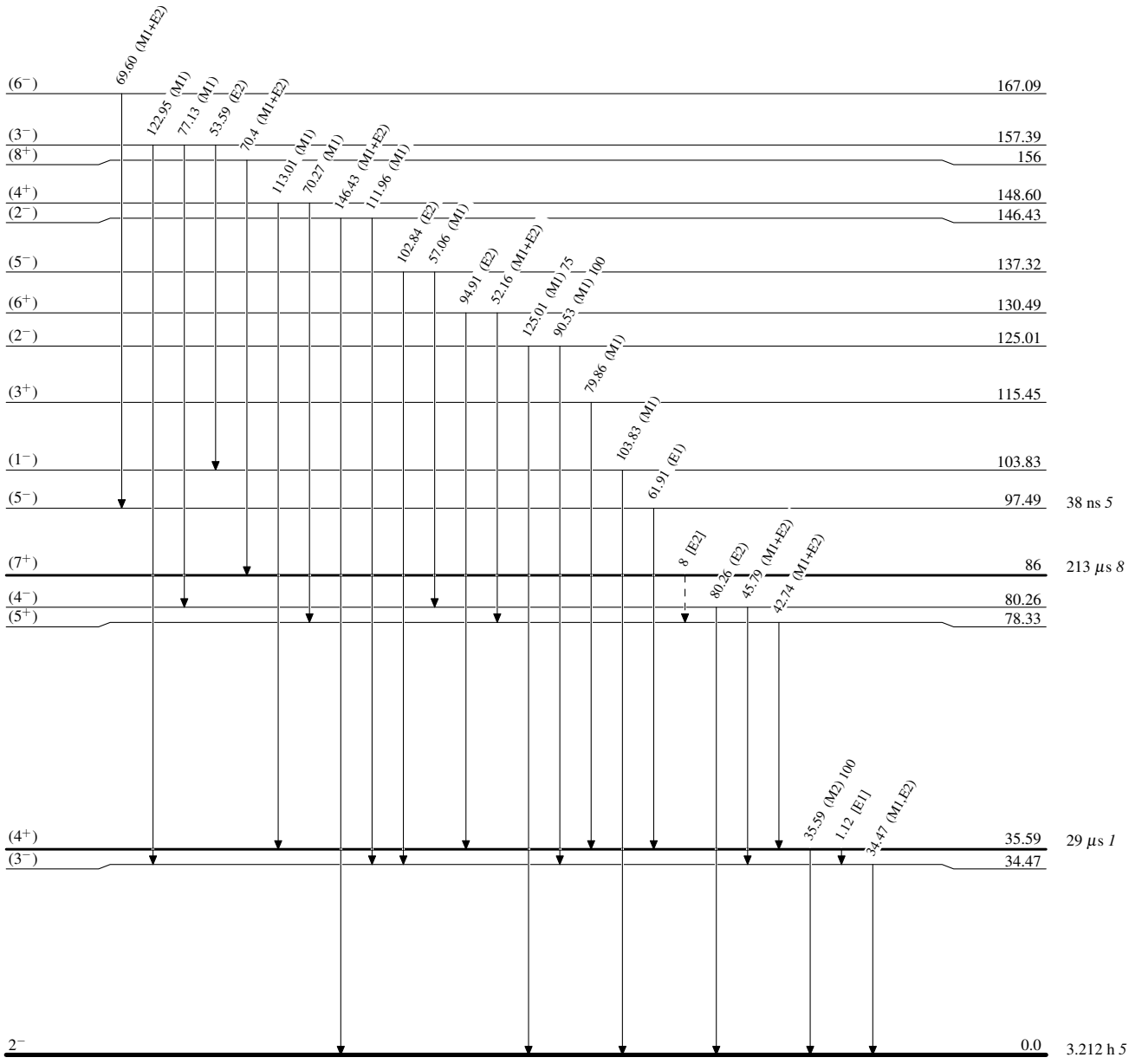
Adopted Levels, Gammas

Legend

Level Scheme (continued)

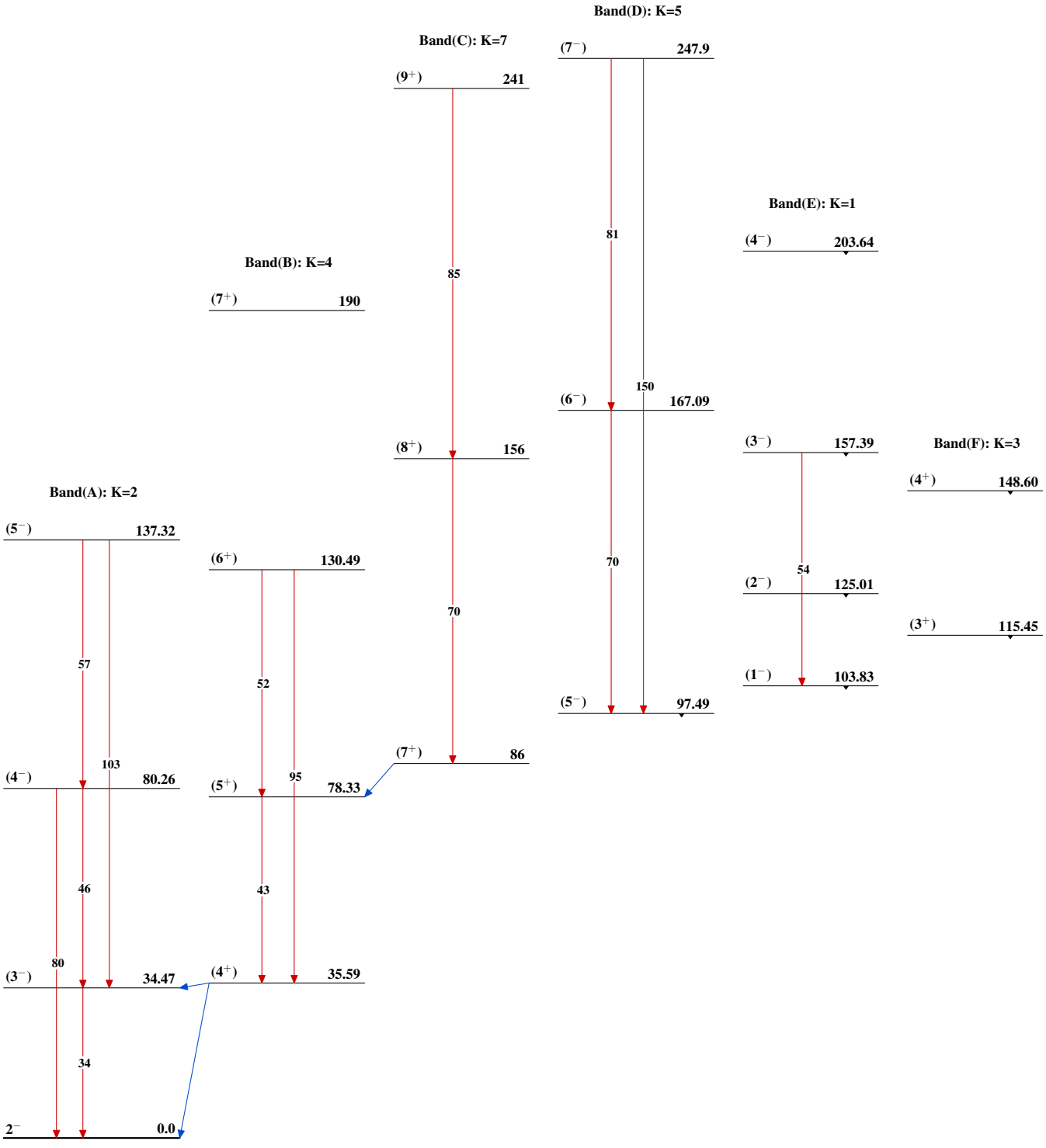
Intensities: Relative photon branching from each level

- - - - - - ► γ Decay (Uncertain)



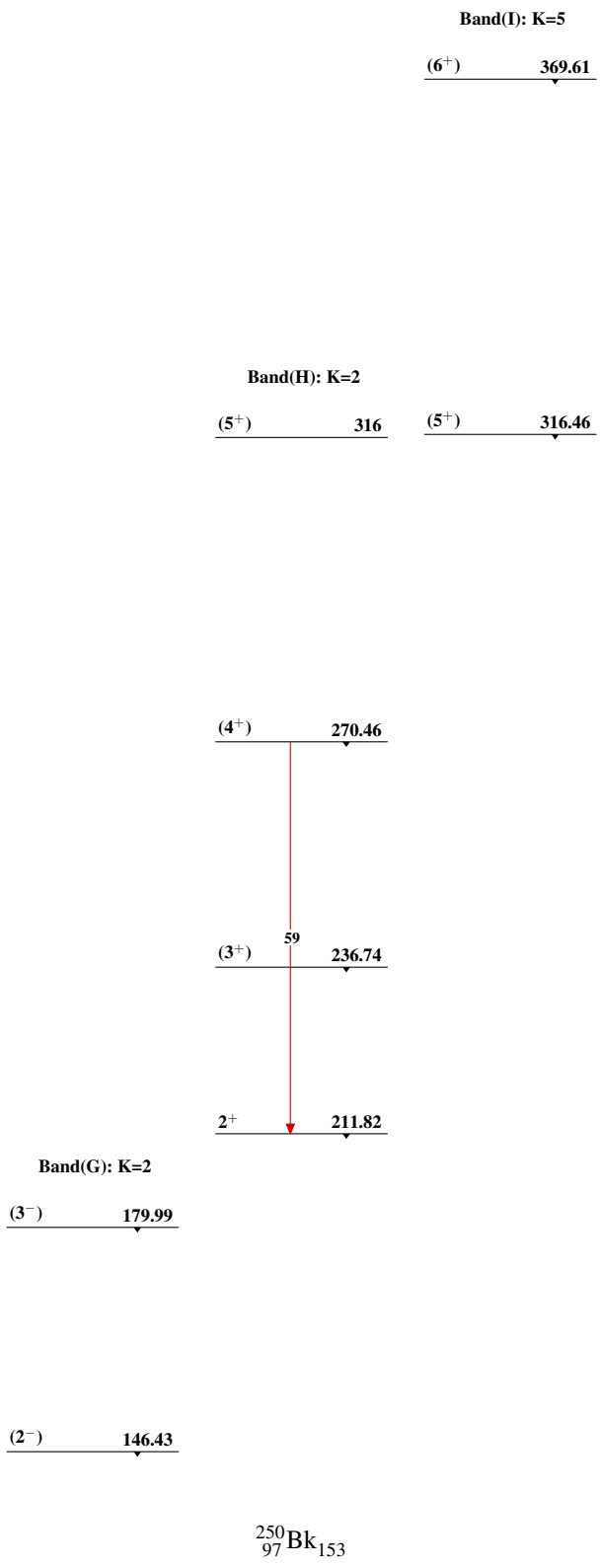
$^{250}_{97}Bk_{153}$

Adopted Levels, Gammas



$^{250}_{97}Bk_{153}$

Adopted Levels, Gammas (continued)



$^{250}_{97}Bk_{153}$