Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Ictp-2014 Workshop Group	NDS 132, 257 (2016)	15-Jan-2016

Q(β^-)=44.8 *8*; S(n)=6531 *3*; S(p)=5107.5 *23*; Q(α)=5042.19 *14* 2012Wa38
S(2n)=11930 *5*, S(2p)=12548 *12* (2012Wa38).

^{227}Ac evaluated by B. Singh, I. Ami, A. Chakraborty, S. Kumar, M. Latif and D. Yang.

^{227}Ac lies at the border of the octupole-quadrupole and pure quadrupole deformation regions. 1983Sh16 interpreted this nucleus as having a core with a "soft" octupole deformation (1990Ja11). The presence of parity doublet rotational bands, and also of K=1/2 rotational bands with decoupling parameters having opposite signs, suggests a stable octupole deformation for ^{227}Ac (1987Le05). The level structure, (α,t) spectroscopic factors, and the ground state magnetic and quadrupole moments, have been interpreted in terms of a stable octupole deformation with $\varepsilon_3\approx0.1$ (1988Le13,1983Sh16). It should be mentioned, however, that the experimental (α,t) spectroscopic factors of 1988Ma18 agree with theoretical values based on a quadrupole deformation only.

^{227}Ac Levels

Band assignments: parity doublet band assignments are from 1990Ja11. Although octupole deformations are small in this region, the states are not fully characterized by single Nilsson orbitals. Single-particle orbitals, however, are used here to label states rather than to accurately describe their detailed configurations.

Cross Reference (XREF) Flags

A	^{227}Ra β^- decay (42.2 min)	D	^{226}Ra(α,t)
B	^{231}Pa α decay (3.276×10^4 y)	E	^{230}Th(p,α)
C	^{226}Ra(^{3}He,d)		

E(level)‡	Jπ†	$T_{1/2}$	XREF	Comments
0.0#	3/2−	21.772 y *3*	ABCD	%β^-=98.6200 *36*; %α=1.3800 *36* μ=+1.1 *1* (1955Fr26,2014StZZ) Q=+1.7 *2* (1955Fr26,2013StZZ) μ,Q: optical spectroscopy (1955Fr26). %α: from 1970Ki12. Other values: 1.359 *14* (1974Mo05), 1.45 *6* (1965Nu03), 1.25 *2* (1949Pe03), 1939PE02. Jπ: spin from optical spectroscopy (1951To19). Parity from 330γ, M1+E2 from 3/2−. Configuration: α particle branching in ^{231}Pa decay, Iα(exp)=11.0 *5* agrees well with Iα(theory)=12.1 for 3/2−,3/2[532] (1969La04,1965PoZZ). The theoretical magnetic (μ=1.08) and quadrupole (Q=1.44) moments for 3/2−,3/2[532] coupled to a stable octupole deformation of ε_3=0.1 agree well with the experimental values (1988Le13). $T_{1/2}$: weighted average of 21.7728 y *+29−32* (1967JoZX, calorimetric measurement) and 21.7714 y *+56−33* (1963Ei10). Others: 21.6 y *3* (1959Ro51), 21.2 y *8* (1956Sh43), 21.6 y *4* (1955To07), 22.0 y *3* (1950HO79); these values are in general agreement with the adopted value but much less precise. Their inclusion in the weighted averaging procedure does not alter the recommended value.
27.369@ *11*	3/2+	38.3 ns *3*	ABcDe	Jπ: 27.4γ, E1 to 3/2−; αγ(θ). Configuration: α particle branching in ^{231}Pa decay, Iα(exp)≈2.5% disagrees with Iα(theory)=11.8 for 3/2+,3/2[651] (1969La04,1965PoZZ). Coriolis mixing with other N=6 Nilsson orbitals probably affects this branching. $T_{1/2}$: from αγ(t) in ^{231}Pa α decay (1985Is03). Others: 41.0 ns *11* (1972Ga39), 43.0 ns (1963Su10), 42.0 ns *10* (1961Br32), 37.0 ns (1956Fo21), 37.0 ns (1953Mo74), 42.0 ns (1953Te08).
29.978# *11*	5/2−		ABcDe	Jπ: 29.9γ, M1+E2 to 3/2−; 357.1γ, M1+E2 from 7/2−. Configuration: α particle branching in ^{231}Pa decay, Iα(exp)=20.0% *5* compares well

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Adopted Levels, Gammas (continued)

^{227}Ac Levels (continued)

E(level)[‡]	Jπ[†]	$T_{1/2}$	XREF	Comments
				with Iα(theory)=13.3% for 5/2⁻,3/2[532] (1969La04,1965PoZZ).
46.354[@] *13*	5/2+		ABCD	Jπ: 283.7γ, E1 from 3/2⁻; 340.7γ, E1+M2 from 7/2⁻; αγ(θ). The α particle branching in ^{231}Pa decay, Iα(exp)=25.4% *5* was used by 1969La04 to normalize theory (1965PoZZ) and experiment for 5/2+,3/2[651].
74.149[#] *17*	7/2⁻		ABCD	Jπ: 312.9γ, M1+E2 from 7/2⁻; 255.8γ, E2 from 3/2⁻. Configuration: α particle branching in ^{231}Pa decay, Iα(exp)=1.4% agrees well with Iα(theory)=1.6% for 7/2⁻,3/2[532] (1969La04,1965PoZZ).
84.544[@] *14*	7/2+		ABCD	Jπ: 38.19γ, M1+E2 to 5/2+; 302.7γ, E1 from 7/2⁻. Configuration: α particle branching in ^{231}Pa decay, Iα(exp)=0.4%, as compared to Iα(theory)=1.4% for 7/2+,3/2[651] (1969La04,1965PoZZ).
109.992[@] *21*	9/2+		BCDE	Jπ: 63.6γ, E2 to 5/2+; 277.2γ, E1+M2 from 7/2⁻. Configuration: α particle branching in ^{231}Pa decay, Iα(exp)=22.8% as compared to Iα(theory)=16.9% for 9/2+,3/2[651] (1969La04,1965PoZZ).
126.848[#] *22*	9/2⁻		BCDE	Jπ: 96.8γ, E2 to 5/2⁻; L(p,α)=5 from 0+ target. Configuration: α particle branching in ^{231}Pa decay, Iα(exp)=3.0% agrees well with Iα(theory)=2.5% for 9/2⁻,3/2[532] (1969La04,1965PoZZ).
148 *5*			D	
160 *2*			BC	XREF: C(?).
187.34[@] *3*	11/2+		BCD	Jπ: 102.6γ to 7/2+; 60.5γ to 9/2⁻.
198.69[#] *6*	11/2⁻		BCD	Jπ: 71.9γ to 9/2⁻; 124.6γ to 7/2⁻.
210.84[@] *7*	13/2+		BCDE	Jπ: 100.8γ to 9/2+; 23.6γ to 11/2+; L(p,α)=6 from 0+ target.
227 *2*			CD	XREF: C(?).
249 *2*			CD	XREF: C(?).
271.32[#] *7*	(13/2⁻)		BcDe	Jπ: 144.4γ to 9/2⁻; 72.7γ to 11/2⁻. Configuration: α particle branching in ^{231}Pa decay, Iα(exp)=0.04% is the same as Iα(theory)=0.04% for 13/2⁻,3/2[532] (1969La04,1965PoZZ).
273.19[&] *4*	(5/2)⁻		ABcDe	Jπ: 273.1γ, M1+E2 to 3/2⁻; 243.1γ, M1+E2 to 5/2⁻; 198.9γ to 7/2⁻.
304.73[a] *6*	(5/2+)		ABCD	Level is weakly populated in ^{231}Pa α decay. Jπ: 277.4γ to 3/2+; 258.4γ to 5/2+; 219.9γ to 7/2+.
317[&] *2*	(7/2⁻)		CD	
330.040[b] *10*	3/2⁻	<70 ps	ABCDE	Jπ: favored α transition with HF=2.5 from 3/2⁻,1/2[530] ^{231}Pa state; experimental band decoupling parameter (−2.1) agrees with theoretical value for the 1/2[530] Nilsson orbital. $T_{1/2}$: from α(ce)(t) in ^{231}Pa α decay (1963Ab04).
342[a] *5*	(7/2+)		D	
354.50[b] *4*	1/2⁻		AB De	Jπ: 354.5γ, M1+E2 to 3/2⁻. Configuration: α particle branching from ^{231}Pa decay, Iα(exp)≈1% agrees with Iα(theory)=1.4% for 1/2⁻,1/2[530] (1969La04,1965PoZZ).
372[&] *2*	(9/2⁻)		CDe	
387.202[b] *15*	7/2⁻		BCDE	Jπ: 260.2γ, M1+E2 to 9/2⁻; L(p,α)=3 from 0+ target. Configuration: α particle branching from ^{231}Pa decay, Iα(exp)=1.5% as compared to Iα(theory)=2.2% for 7/2⁻,1/2[530] (1969La04,1965PoZZ).
403[a] *5*	(9/2+)		CD	
425.59[c] *5*	5/2+		ABC	Jπ: 379.4γ, M1(+E2) to 5/2+; 398.1γ to 5/2⁻; experimental M1 reduced transition probability ratios B(M1)(398γ)/B(M1)(379γ)=0.28 *3*/1.35 *4* as compared to theoretical values 0.16/1.1 for J,K^{π}=5/2,1/2+ (Alaga rule). Configuration: experimental band decoupling parameter (4.6) agrees wit with theoretical value for the 1/2[660] Nilsson orbital (1983Sh16).
428.4? *2*			A	
435.19[c] *4*	1/2+		ABcdE	Jπ: 407.8γ, M1 to 3/2+; L(p,α)=0 from 0+ target.
437.94[b] *5*	(5/2⁻)		BcdE	Jπ: 438.0γ to 3/2⁻; 410.3γ to 3/2+; 363.8γ to 7/2⁻.

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Adopted Levels, Gammas (continued)

^{227}Ac Levels (continued)

E(level)[‡]	J$^{\pi}$[†]	XREF	Comments
			Configuration: α particle branching from ^{231}Pa decay, Iα(exp)≈0.1% agrees with Iα(theory)=0.17 for 5/2$^-$,1/2[530] (1969La04,1967Po05).
469.27[c] *9*	9/2$^+$	BCD	J$^{\pi}$: 359.3γ to 9/2$^+$; 384.7γ to 7/2$^+$.
501.29 *8*	(3/2$^-$,5/2$^-$)	ABCDE	J$^{\pi}$: 501.4γ to 3/2$^-$; 471.3γ to 5/2$^-$; possible 146.9γ to 1/2$^-$; possible γ to 7/2$^-$; log *ft*=7.2 from 3/2$^+$ parent. E(level): level weakly populated in ^{231}Pa α decay.
514.36[c] *9*	(3/2,5/2)$^+$	A CDE	J$^{\pi}$: L(p,α)=2 from 0$^+$ target.
527[a] *3*	(13/2$^+$)	CDe	
537.02 *10*	(3/2$^+$)	ABC e	E(level): level weakly populated in ^{231}Pa α decay. J$^{\pi}$: 510.0γ to 3/2$^+$; 490.7γ to 5/2$^+$; band head of a K^{π}=3/2$^+$ parity doublet rotational band (1988Le13). Previous assignment to 1/2[660] rotational band by 1988Ma18 is inconsistent with experimental (α,t) spectroscopic factor.
549 *3*		D	
562.78 *14*	(3/2$^+$,5/2)	ABCDe	J$^{\pi}$: 478.4γ to 7/2$^+$; log *ft*=7.0 from 3/2$^+$ parent.
577[b]	(9/2$^-$)	De	
592[c] *2*	(13/2)$^+$	CDE	XREF: C(589). J$^{\pi}$: L(p,α)=6 from 0$^+$ target.
639.09[d] *15*	1/2$^+$	A CDE	J$^{\pi}$: L(p,α)=0 from 0$^+$ target.
656.4[c] *4*	(7/2$^+$)	BCD	J$^{\pi}$: 609γ to 5/2$^+$; 546.5γ to 9/2$^+$.
669 *3*		E	
698.56[d] *15*	(3/2)$^+$	A CDE	J$^{\pi}$: L(p,α)=2 from 0$^+$ target.
725 *4*		E	
790.13 *17*	(1/2$^-$,3/2,5/2)	A CDE	J$^{\pi}$: 789.8γ to 3/2$^-$; 760.3γ to 5/2$^-$; log *ft*=7.4 from 3/2$^+$ parent.
816 *4*		E	
863.64 *22*	(1/2,3/2,5/2)	A CDe	J$^{\pi}$: 863.5γ to 3/2$^-$; 836.4γ to 3/2$^+$.
874.68 *18*	(1/2$^+$,3/2,5/2)	A CDe	J$^{\pi}$: 874.7γ to 3/2$^-$; 836.4γ to 3/2$^+$; 828.9γ to 5/2$^+$.
895 *2*	(3/2)$^+$	E	J$^{\pi}$: L(p,α)=2 from 0$^+$ target; possible configuration=π3/2[402].
920 *2*		E	
950 *4*		E	
992 *3*		E	
1070 *3*		CDE	
1091 *2*		CD	
1117 *2*		E	
1148 *2*		E	
1183 *3*		E	
1215 *3*		E	
1274 *4*		E	
1311 *2*		E	
1385 *2*		E	
1438 *2*		E	
1483 *2*		E	
1550 *2*		E	
1591 *2*		E	
1629 *4*		E	

† Spin and parity assignments are based on rotational structure, γ-ray multipolarities and decay patterns, $\alpha\gamma(\theta)$ data from 1971Le10, and comparison of experimental and theoretical cross sections (and spectroscopic factors) in ^{226}Ra(α,t) reaction for band members based on Nilsson model configurations ("finger-print" method). Nilsson orbital assignments are based on their energy systematics in neighboring odd-Z nuclei, favored α decay transitions from ^{231}Pa parent with ground-state J^{π}=3/2$^-$ and configuration of π1/2[530], and also on comparison of experimental and theoretical relative α-particle branches (1965PoZZ). Other specific arguments, based on γ transitions, are given with individual levels.

‡ From least-squares fit to adopted γ-ray energies, unless otherwise specified.

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Adopted Levels, Gammas (continued)

^{227}Ac Levels (continued)

[#] Band(A): π3/2[532] parity doublet band. Rotational parameter: A=6.0 (1990Ja11).
[@] Band(B): π3/2[651] parity doublet band. Coriolis mixed with other N=6 rotational bands.
[&] Band(C): π5/2[523] parity doublet band. Rotational parameter: A=6.3 (1990Ja11).
[a] Band(D): π5/2[642] parity doublet band. Coriolis mixed with other N=6 rotational bands.
[b] Band(E): π1/2[530] parity doublet band. Rotational parameters: A=6.7, a=−2.21 (1990Ja11).
[c] Band(F): π1/2[660] parity doublet band. Coriolis mixed with other N=6 rotational bands.
[d] Band(G): π1/2[400] band.

$\gamma(^{227}Ac)$

E_i(level)	J^π_i	E_γ[†]	I_γ[‡]	E_f	J^π_f	Mult.[a]	δ[a]	α[b]	Comments
27.369	3/2+	27.36 *2*	100	0.0	3/2−	E1(+M2)	<0.0020	4.5 *4*	B(E1)(W.u.)>3.9×10−5 δ: ce data suggest δ=0.0070 *13*. Value given here is estimated from RUL=1 for M2 transitions. α: from experimental ce data in ^{231}Pa α decay; suggests anomalous conversion coefficient for E1 transition, since from BrIcc code, theoretical value=3.59 *7* for E1(+M2) with δ<0.0020.
29.978	5/2−	29.97 *2*	100	0.0	3/2−	M1+E2	0.22 *3*	2.7×10² *5*	α(L)=2.0×10² *4*; α(M)=52 *9* α(N)=13.8 *23*; α(O)=3.1 *5*; α(P)=0.52 *8*; α(Q)=0.0213 *4*
46.354	5/2+	16.5 *1*	119 *5*	29.978	5/2−	[E1]		8.58 *12*	α: BrIcc code cannot be used for this transition since its energy is within 1 keV of L_3 electronic shell binding energy. The total conversion coefficient listed here is taken from the DDEP evaluation of Feb 2010 by A. Arinc, where it was calculated by T. Kibedi using the RAINE code, giving conversion coefficient of 5.06 *7* for the L_3 shell.
		19.6	186 *53*	27.369	3/2+	[M1]		112.8	α(L)=2.34 *4*; α(M)=82.5 *12*; α(N)=21.9 *3*; α(O)=5.09 *8*; α(P)=0.942 *14*; α(Q)=0.0840 *12*
		46.35 *2*	100 *5*	0.0	3/2−	(E1)		0.879	α(L)=0.663 *10*; α(M)=0.1634 *23* α(N)=0.0423 *6*; α(O)=0.00913 *13*; α(P)=0.001417 *20*; α(Q)=5.89×10−5 *9* Mult.: δ(Q/D)=+0.11 *10* from $\gamma\gamma(\theta)$ in ^{231}Pa decay (1982An02), consistent with pure dipole.
74.149	7/2−	44.14 *2*	100 *8*	29.978	5/2−	[M1]		37.4	α(L)=28.3 *4*; α(M)=6.80 *10* α(N)=1.80 *3*; α(O)=0.420 *6*; α(P)=0.0777 *11*; α(Q)=0.00691 *10*
		74.15 *4*	40.2 *15*	0.0	3/2−	[E2]		42.5	α(L)=31.2 *5*; α(M)=8.52 *13* α(N)=2.27 *4*; α(O)=0.493 *7*; α(P)=0.0768 *11*; α(Q)=0.000234 *4*
84.544	7/2+	38.20 *2*	100 *3*	46.354	5/2+	M1+E2	0.19 *9*	92 *38*	α(L)=69 *28*; α(M)=17.4 *76* α(N)=4.6 *20*; α(O)=1.04 *44*; α(P)=0.180 *67*; α(Q)=0.0104 *3*
		54.60 *2*	48 *3*	29.978	5/2−	[E1]		0.569	α(L)=0.429 *6*; α(M)=0.1052 *15* α(N)=0.0273 *4*; α(O)=0.00594 *9*; α(P)=0.000940 *14*; α(Q)=4.17×10−5 *6*
		57.19[c] *3*	22.6[c] *15*	27.369	3/2+	(E2)		148.0	α(L)=108.5 *16*; α(M)=29.6 *5* α(N)=7.87 *12*; α(O)=1.709 *25*; α(P)=0.266 *4*; α(Q)=0.000688 *10*
109.992	9/2+	25.48 *6*	100 *11*	84.544	7/2+	[M1]		189	α(L)=143.1 *23*; α(M)=34.5 *6* α(N)=9.16 *15*; α(O)=2.13 *4*; α(P)=0.394 *7*; α(Q)=0.0351 *6*
		35.83 *3*	13.6 *8*	74.149	7/2−	[E1]		1.742	α(L)=1.310 *19*; α(M)=0.327 *5* α(N)=0.0843 *12*; α(O)=0.0179 *3*; α(P)=0.00268 *4*; α(Q)=0.0001001 *15*
		63.64 *3*	37.5 *13*	46.354	5/2+	E2		88.4	α(L)=64.8 *10*; α(M)=17.7 *3* α(N)=4.70 *7*; α(O)=1.023 *15*; α(P)=0.1592 *23*; α(Q)=0.000437 *7*
126.848	9/2−	52.71 *3*	92 *5*	74.149	7/2−	[M1]		22.2	α(L)=16.82 *24*; α(M)=4.04 *6* α(N)=1.071 *16*; α(O)=0.249 *4*; α(P)=0.0461 *7*; α(Q)=0.00410 *6*
		96.84 *3*	100.0 *25*	29.978	5/2−	E2		12.04	α(L)=8.83 *13*; α(M)=2.41 *4*

$^{227}_{89}Ac_{138}$-5

$\gamma(^{227}Ac)$ (continued)

E_i(level)	J_i^π	E_γ [†]	I_γ [‡]	E_f	J_f^π	Mult. [a]	δ [a]	α [b]	Comments
									α(N)=0.642 *9*; α(O)=0.1399 *20*; α(P)=0.0219 *3*; α(Q)=8.55×10^{-5} *12*
187.34	11/2$^+$	60.50 *3*	9.2 *12*	126.848	9/2$^-$	[E1]		0.433	α(L)=0.327 *5*; α(M)=0.0798 *12* α(N)=0.0208 *3*; α(O)=0.00454 *7*; α(P)=0.000726 *11*; α(Q)=3.35×10^{-5} *5*
		77.34 *3*	100 *3*	109.992	9/2$^+$	[M1]		7.24	α(L)=5.48 *8*; α(M)=1.315 *19* α(N)=0.349 *5*; α(O)=0.0811 *12*; α(P)=0.01501 *21*; α(Q)=0.001334 *19*
		102.6 *5*	<23	84.544	7/2$^+$	[E2]		9.20 *25*	α(L)=6.74 *19*; α(M)=1.84 *5* α(N)=0.490 *14*; α(O)=0.107 *3*; α(P)=0.0167 *5*; α(Q)=6.99×10^{-5} *16*
198.69	11/2$^-$	71.9 *1*	46 *15*	126.848	9/2$^-$	[M1]		8.96	α(L)=6.78 *10*; α(M)=1.626 *24* α(N)=0.432 *7*; α(O)=0.1004 *15*; α(P)=0.0186 *3*; α(Q)=0.001650 *24*
		124.58 *8*	100 *9*	74.149	7/2$^-$	[E2]		4.04	α(K)=0.285 *4*; α(L)=2.75 *4*; α(M)=0.752 *11* α(N)=0.200 *3*; α(O)=0.0436 *7*; α(P)=0.00686 *10*; α(Q)=3.71×10^{-5} *6*
210.84	13/2$^+$	(23.6)	20 *4*	187.34	11/2$^+$	[M1]		237	α(L)=179 *3*; α(M)=43.3 *6* α(N)=11.50 *16*; α(O)=2.67 *4*; α(P)=0.495 *7*; α(Q)=0.0441 *7*
		100.85 *6*	100 *4*	109.992	9/2$^+$	[E2]		9.96	α(L)=7.30 *11*; α(M)=2.00 *3* α(N)=0.531 *8*; α(O)=0.1157 *17*; α(P)=0.0181 *3*; α(Q)=7.42×10^{-5} *11*
271.32	(13/2$^-$)	72.67 *6*	26 *6*	198.69	11/2$^-$	[M1]		8.68	α(L)=6.57 *10*; α(M)=1.577 *23* α(N)=0.418 *6*; α(O)=0.0973 *14*; α(P)=0.0180 *3*; α(Q)=0.001599 *23*
		144.40 *8*	100 *9*	126.848	9/2$^-$	[E2]		2.18	α(K)=0.263 *4*; α(L)=1.408 *20*; α(M)=0.384 *6* α(N)=0.1023 *15*; α(O)=0.0223 *4*; α(P)=0.00353 *5*; α(Q)=2.38×10^{-5} *4*
		161.0[d] *10*		109.992	9/2$^+$	[M2]		22.8 *6*	α(K)=15.0 *4*; α(L)=5.75 *17*; α(M)=1.51 *5* α(N)=0.408 *12*; α(O)=0.094 *3*; α(P)=0.0170 *5*; α(Q)=0.00133 *4* E_γ: evaluators treat this γ as questionable due to implied high multipolarity.
273.19	(5/2)$^-$	198.89 *10*	7.3 *7*	74.149	7/2$^-$	[M1+E2]		1.53 *90*	α(K)=1.05 *90*; α(L)=0.355 *11*; α(M)=0.091 *4* α(N)=0.0241 *10*; α(O)=0.00543 *10*; α(P)=0.00093 *7*; α(Q)=4.9×10^{-5} *39* I_γ: other: 3.1 in ^{227}Ra decay.
		226.6[#@d] *1*	3.1[#]	46.354	5/2$^+$	[E1]		0.0688	α(K)=0.0548 *8*; α(L)=0.01057 *15*; α(M)=0.00253 *4* α(N)=0.000666 *10*; α(O)=0.0001511 *22*; α(P)=2.65×10^{-5} *4*; α(Q)=1.81×10^{-6} *3*
		243.11 *9*	58 *4*	29.978	5/2$^-$	M1+E2	1.1 *3*	0.80 *17*	α(K)=0.56 *16*; α(L)=0.176 *10*; α(M)=0.0445 *16* α(N)=0.0118 *5*; α(O)=0.00268 *12*; α(P)=0.00046 *3*; α(Q)=2.60×10^{-5} *70*
		246.04 *9*	20 *6*	27.369	3/2$^+$	[E1]		0.0568	α(K)=0.0454 *7*; α(L)=0.00864 *13*; α(M)=0.00207 *3* α(N)=0.000544 *8*; α(O)=0.0001237 *18*; α(P)=2.18×10^{-5} *3*;

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Adopted Levels, Gammas (continued)

γ(^{227}Ac) (continued)

E_i(level)	J^π_i	E_γ†	I_γ‡	E_f	J^π_f	Mult.[a]	δ[a]	α[b]	Comments
									α(Q)=1.515×10^{-6} *22* I_γ: other: 3.1 in ^{227}Ra decay.
		273.15 *6*	100.0 *14*	0.0	3/2$^-$	M1+E2	0.7 *3*	0.74 *15*	α(K)=0.57 *14*; α(L)=0.131 *11*; α(M)=0.0323 *21* α(N)=0.0086 *6*; α(O)=0.00197 *15*; α(P)=0.00035 *4*; α(Q)=2.6×10^{-5} *6*

$^{227}_{89}Ac_{138}$-7

γ(^{227}Ac) (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[‡]	E_f	J_f^π	Mult.[a]	δ[a]	α[b]	Comments
304.73	(5/2+)	219.90[#] *15*	10.5[#]	84.544	7/2+	[M1+E2]		1.14 *70*	α(K)=0.80 *67*; α(L)=0.250 *25*; α(M)=0.0635 *25* α(N)=0.0169 *7*; α(O)=0.00382 *25*; α(P)=0.00066 *9*; α(Q)=3.7×10^{-5} *30*
		230.0[&] *10*	70[&] *35*	74.149	7/2−	[E1]		0.0664 *12*	α(K)=0.0530 *10*; α(L)=0.01019 *18*; α(M)=0.00244 *5* α(N)=0.000642 *12*; α(O)=0.000146 *3*; α(P)=2.56×10^{-5} *5*; α(Q)=1.75×10^{-6} *3*
		258.37 *10*	100 *18*	46.354	5/2+	[M1+E2]		0.71 *46*	α(K)=0.52 *42*; α(L)=0.15 *3*; α(M)=0.037 *6* α(N)=0.0097 *14*; α(O)=0.0022 *4*; α(P)=0.00039 *9*; α(Q)=2.4×10^{-5} *19*
		277.39[#] *10*	145[#]	27.369	3/2+	[M1+E2]		0.58 *38*	α(K)=0.43 *35*; α(L)=0.12 *3*; α(M)=0.029 *6* α(N)=0.0077 *15*; α(O)=0.0018 *4*; α(P)=3.09×10^{-4} *84*; α(Q)=2.0×10^{-5} *16*
330.040	3/2−	57.19[cd] *3*	0.71[c]	273.19	(5/2)−	[M1+E2]		83 *66*	α(L)=61 *48*; α(M)=16 *14* α(N)=4.4 *36*; α(O)=0.95 *76*; α(P)=0.15 *12*; α(Q)=0.0020 *13* E_γ,I_γ: energy from ^{231}Pa α decay. Placement and branching ratio from ^{227}Ra decay only. In ^{231}Pa decay, this γ ray is placed from 84.5 and 387.2 levels. Evaluators treat this transition as uncertain since not confirmed in ^{231}Pa α decay.
		245.60 *13*	0.407 *32*	84.544	7/2+	[M2]		5.23	α(K)=3.70 *6*; α(L)=1.141 *17*; α(M)=0.293 *5* α(N)=0.0787 *12*; α(O)=0.0182 *3*; α(P)=0.00331 *5*; α(Q)=0.000268 *4* Deduced B(M2)(W.u.)>7.6 is inconsistent with RUL=1 for M2 transitions. The transition could be mixed with E3 or the level half-life is longer than reported by 1963Ab04.
		255.78 *7*	6.42 *6*	74.149	7/2−	E2		0.265	α(K)=0.0993 *14*; α(L)=0.1218 *18*; α(M)=0.0328 *5* α(N)=0.00872 *13*; α(O)=0.00192 *3*; α(P)=0.000310 *5*; α(Q)=5.37×10^{-6} *8*
		283.682 *16*	100	46.354	5/2+	E1		0.0410	α(K)=0.0329 *5*; α(L)=0.00614 *9*; α(M)=0.001468 *21* α(N)=0.000386 *6*; α(O)=8.81×10^{-5} *13*; α(P)=1.561×10^{-5} *22*; α(Q)=1.117×10^{-6} *16*
		300.066 *10*	146.1 *18*	29.978	5/2−	M1+E2	−0.12 *7*	0.764 *17*	α(K)=0.613 *15*; α(L)=0.1146 *20*; α(M)=0.0275 *5* α(N)=0.00728 *12*; α(O)=0.00169 *3*; α(P)=0.000313 *6*; α(Q)=2.75×10^{-5} *7*
		302.667[c] *9*	138[c] *20*	27.369	3/2+	E1		0.0355	α(K)=0.0285 *4*; α(L)=0.00527 *8*; α(M)=0.001260 *18* α(N)=0.000331 *5*; α(O)=7.56×10^{-5} *11*; α(P)=1.344×10^{-5} *19*; α(Q)=9.74×10^{-7} *14*
		330.055 *15*	82.3 *10*	0.0	3/2−	M1+E2	+0.36 *7*	0.540 *21*	α(K)=0.430 *19*; α(L)=0.0836 *22*; α(M)=0.0202 *5*

$^{227}_{89}$Ac$_{138}$-8

Adopted Levels, Gammas (continued)

γ(^{227}Ac) (continued)

E_i(level)	J^π_i	E_γ[†]	I_γ[‡]	E_f	J^π_f	Mult.[a]	δ[a]	α[b]	Comments
									α(N)=0.00535 13; α(O)=0.00124 3; α(P)=0.000228 6; α(Q)=1.93×10^{-5} 8
354.50	1/2⁻	24.5 1	≈5.1	330.040	3/2⁻	[M1]		213 4	α(L)=161 3; α(M)=38.8 8 α(N)=10.29 20; α(O)=2.39 5; α(P)=0.443 9; α(Q)=0.0395 8
		327.14 7	37.4 7	27.369	3/2⁺	(E1)		0.0298	α(K)=0.0240 4; α(L)=0.00440 7; α(M)=0.001050 15 α(N)=0.000276 4; α(O)=6.32×10^{-5} 9; α(P)=1.125×10^{-5} 16; α(Q)=8.28×10^{-7} 12
		354.48 5	100.0 14	0.0	3/2⁻	M1+E2	+2.8 +14−6	0.143 24	α(K)=0.090 21; α(L)=0.0391 24; α(M)=0.0101 5 α(N)=0.00269 14; α(O)=0.00060 4; α(P)=0.000102 7; α(Q)=4.2×10^{-6} 9
387.202	7/2⁻	57.19[c] 3	1.54[c] 27	330.040	3/2⁻	E2		148.0	α(L)=108.5 16; α(M)=29.6 5 α(N)=7.87 12; α(O)=1.709 25; α(P)=0.266 4; α(Q)=0.000688 10
		260.19 8	100.0 12	126.848	9/2⁻	M1+E2	1.5 3	0.53 10	α(K)=0.35 9; α(L)=0.131 7; α(M)=0.0338 12 α(N)=0.0090 3; α(O)=0.00202 8; α(P)=0.000345 19; α(Q)=1.6×10^{-5} 4
		277.22 7	37.4 5	109.992	9/2⁺	(E1+M2)	0.40 5	0.52 11	α(K)=0.37 8; α(L)=0.107 23; α(M)=0.027 6 α(N)=0.0073 16; α(O)=0.0017 4; α(P)=0.00031 7; α(Q)=2.5×10^{-5} 6
		302.667[c] 9	96[c] 24	84.544	7/2⁺	E1		0.0355	α(K)=0.0285 4; α(L)=0.00527 8; α(M)=0.001260 18 α(N)=0.000331 5; α(O)=7.56×10^{-5} 11; α(P)=1.344×10^{-5} 19; α(Q)=9.74×10^{-7} 14
		312.92 5	55.3 6	74.149	7/2⁻	M1+E2	1.5 +9−5	0.31 11	α(K)=0.216 94; α(L)=0.070 10; α(M)=0.0178 19 α(N)=0.0047 5; α(O)=0.00107 13; α(P)=0.00018 3; α(Q)=1.00×10^{-5} 42
		340.71 6	97.4 12	46.354	5/2⁺	E1+M2	0.23 4	0.115 31	α(K)=0.086 23; α(L)=0.0215 62; α(M)=0.0054 16 α(N)=0.00144 42; α(O)=3.32×10^{-4} 97; α(P)=6.0×10^{-5} 18; α(Q)=4.9×10^{-6} 15
		357.11 8	92.3 11	29.978	5/2⁻	M1(+E2)	<0.8	0.40 8	α(K)=0.32 7; α(L)=0.064 8; α(M)=0.0155 16 α(N)=0.0041 5; α(O)=0.00095 11; α(P)=0.000174 21; α(Q)=1.4×10^{-5} 3
		387.0 1	0.16 5	0.0	3/2⁻	[E2]		0.0774	α(K)=0.0430 6; α(L)=0.0254 4; α(M)=0.00669 10 α(N)=0.001778 25; α(O)=0.000396 6; α(P)=6.58×10^{-5} 10; α(Q)=2.09×10^{-6} 3
425.59	5/2⁺	341.1[#@d] 1	47[#]	84.544	7/2⁺	[M1+E2]		0.33 22	α(K)=0.25 19; α(L)=0.061 21; α(M)=0.0150 44 α(N)=0.0040 12; α(O)=9.1×10^{-4} 29; α(P)=1.62×10^{-4} 59; α(Q)=1.12×10^{-5} 84
		351.5 1	7.6 23	74.149	7/2⁻	[E1]		0.0255	α(K)=0.0206 3; α(L)=0.00373 6; α(M)=0.000890 13 α(N)=0.000234 4; α(O)=5.36×10^{-5} 8; α(P)=9.57×10^{-6}

Adopted Levels, Gammas (continued)

γ(^{227}Ac) (continued)

E_i(level)	$J^π_i$	$E_γ$[†]	$I_γ$[‡]	E_f	$J^π_f$	Mult.[a]	δ[a]	α[b]	Comments
									14; α(Q)=7.14×10^{-7} *10* γ not reported in ^{227}Ra decay, probably because of detection limit.
425.59	5/2$^+$	379.35 *7*	100.0 *17*	46.354	5/2$^+$	M1(+E2)	<1.1	0.32 *9*	α(K)=0.250 *78*; α(L)=0.051 *10*; α(M)=0.0125 *20* α(N)=0.0033 *6*; α(O)=0.00076 *13*; α(P)=0.00014 *3*; α(Q)=1.12×10^{-5} *34*
		395.45 *10*	4.7 *3*	29.978	5/2$^-$	[E1]		0.0198	α(K)=0.01603 *23*; α(L)=0.00287 *4*; α(M)=0.000682 *10* α(N)=0.000180 *3*; α(O)=4.12×10^{-5} *6*; α(P)=7.38×10^{-6} *11*; α(Q)=5.62×10^{-7} *8*
		398.14 *8*	19.0 *5*	27.369	3/2$^+$	[M1+E2]		0.21 *15*	α(K)=0.16 *13*; α(L)=0.038 *15*; α(M)=0.0094 *34* α(N)=0.00248 *88*; α(O)=5.7×10^{-4} *22*; α(P)=1.02×10^{-4} *43*; α(Q)=7.4×10^{-6} *55*
428.4?		398.4[d] *4*	97	29.978	5/2$^-$				$I_γ$: doublet in ^{227}Ra decay; intensity split based on its intensity in ^{231}Pa decay, where the 398γ is a single line, placed from 425 level.
		428.4[d] *2*	100	0.0	3/2$^-$				
435.19	1/2$^+$	390.4[#@d] *6*	3.3[#]	46.354	5/2$^+$				
		407.82 *4*	100.0 *14*	27.369	3/2$^+$	M1		0.334	α(K)=0.269 *4*; α(L)=0.0496 *7*; α(M)=0.01187 *17* α(N)=0.00315 *5*; α(O)=0.000732 *11*; α(P)=0.0001354 *19*; α(Q)=1.200×10^{-5} *17*
		435.2 *1*	8.2 *5*	0.0	3/2$^-$				
437.94	(5/2$^-$)	50.83 *15*	25 *4*	387.202	7/2$^-$	[M1]		24.7	α(L)=18.7 *3*; α(M)=4.49 *8* α(N)=1.192 *20*; α(O)=0.277 *5*; α(P)=0.0513 *9*; α(Q)=0.00456 *8*
		363.84 *10*	100 *3*	74.149	7/2$^-$	[M1+E2]		0.27 *19*	α(K)=0.21 *16*; α(L)=0.050 *18*; α(M)=0.0123 *40* α(N)=0.0033 *11*; α(O)=7.5×10^{-4} *26*; α(P)=1.33×10^{-4} *52*; α(Q)=9.4×10^{-6} *70*
		391.61 *9*	84.5 *25*	46.354	5/2$^+$	[E1]		0.0202	α(K)=0.01636 *23*; α(L)=0.00293 *5*; α(M)=0.000697 *10* α(N)=0.000184 *3*; α(O)=4.21×10^{-5} *6*; α(P)=7.54×10^{-6} *11*; α(Q)=5.74×10^{-7} *8*
		410.30 *12*	23 *3*	27.369	3/2$^+$	[E1]		0.0183	α(K)=0.01484 *21*; α(L)=0.00264 *4*; α(M)=0.000629 *9* α(N)=0.0001656 *24*; α(O)=3.80×10^{-5} *6*; α(P)=6.81×10^{-6} *10*; α(Q)=5.22×10^{-7} *8*
		438.01 *9*	57 *3*	0.0	3/2$^-$	[M1+E2]		0.17 *11*	α(K)=0.128 *94*; α(L)=0.029 *13*; α(M)=0.0071 *28* α(N)=0.00187 *72*; α(O)=4.3×10^{-4} *18*; α(P)=7.7×10^{-5} *35*; α(Q)=5.7×10^{-6} *42*
469.27	9/2$^+$	359.33 *15*	100 *3*	109.992	9/2$^+$	[M1+E2]		0.28 *19*	α(K)=0.21 *17*; α(L)=0.052 *19*; α(M)=0.0128 *41* α(N)=0.0034 *11*; α(O)=7.8×10^{-4} *26*; α(P)=1.39×10^{-4} *53*; α(Q)=9.7×10^{-6} *73*
		384.7 *1*	43.2 *23*	84.544	7/2$^+$	[M1+E2]		0.24 *16*	α(K)=0.18 *14*; α(L)=0.042 *17*; α(M)=0.0104 *36* α(N)=0.00275 *94*; α(O)=6.3×10^{-4} *23*; α(P)=1.13×10^{-4} *46*; α(Q)=8.1×10^{-6} *60*
501.29	(3/2$^-$,5/2$^-$)	146.9[#d] *5*	<29[#]	354.50	1/2$^-$				

$^{227}_{89}Ac_{138}$-10

Adopted Levels, Gammas (continued)

γ(^{227}Ac) (continued)

E_i(level)	J^π_i	E_γ†	I_γ‡	E_f	J^π_f	Mult.[a]	α[b]	Comments
501.29	(3/2$^-$,5/2$^-$)	228.00# *10*	40#	273.19	(5/2)$^-$			
		427.0&d *1*	&	74.149	7/2$^-$			I_γ: 85 *42* in ^{231}Pa decay for a weak γ.
		471.3# *5*	26#	29.978	5/2$^-$			
		501.4# *1*	100#	0.0	3/2$^-$			
514.36	(3/2,5/2)$^+$	209.6 *2*	4.4	304.73	(5/2$^+$)			
		468.5 *5*	10.8	46.354	5/2$^+$			
		486.98 *10*	100	27.369	3/2$^+$			
537.02	(3/2$^+$)	232.20# *10*	100#	304.73	(5/2$^+$)	[M1+E2]	0.97 *61*	α(K)=0.69 *57*; α(L)=0.21 *3*; α(M)=0.053 *4* α(N)=0.0140 *11*; α(O)=0.0032 *4*; α(P)=0.00055 *10*; α(Q)=3.2×10^{-5} *26*
		490.7 *5*	50	46.354	5/2$^+$			
		510.0 *2*	117 *50*	27.369	3/2$^+$			I_γ: value given only in ^{231}Pa decay.
562.78	(3/2$^+$,5/2)	478.4# *4*	8.6#	84.544	7/2$^+$			
		486.827&d *23*	113& *11*	74.149	7/2$^-$			
		516.2 *2*	100 *11*	46.354	5/2$^+$			
		535.6 *2*	45 *5*	27.369	3/2$^+$			
639.09	1/2$^+$	611.4 *2*	100	27.369	3/2$^+$			
		639.4 *2*	18	0.0	3/2$^-$			
656.4	(7/2$^+$)	546.5 *5*	11.6 *19*	109.992	9/2$^+$			
		571.6 *8*	7 *3*	84.544	7/2$^+$			
		583 *2*	60.5 *23*	74.149	7/2$^-$			
		609 *2*	100 *5*	46.354	5/2$^+$			
698.56	(3/2)$^+$	652.2 *2*	100	46.354	5/2$^+$			
		671.2 *2*	67	27.369	3/2$^+$			
790.13	(1/2$^-$,3/2,5/2)	760.3 *2*	81	29.978	5/2$^-$			
		789.8 *3*	100	0.0	3/2$^-$			
863.64	(1/2,3/2,5/2)	836.4 *3*	63	27.369	3/2$^+$			
		863.5 *3*	100	0.0	3/2$^-$			
874.68	(1/2$^+$,3/2,5/2)	828.9 *3*	33	46.354	5/2$^+$			
		846.7 *3*	<67	27.369	3/2$^+$			
		874.7 *3*	100 *20*	0.0	3/2$^-$			

† Weighted average from ^{231}Pa α decay and ^{227}Ra β^- decay.
‡ Best value from ^{231}Pa α decay and ^{227}Ra β^- decay.
# From ^{227}Ra β^- decay.
@ With the intensity reported in ^{227}Ra decay, the γ ray should have been seen in ^{231}Pa α decay. Evaluators treat this transition as uncertain.
& γ reported only in ^{231}Pa α decay. With the intensity reported, it should have been seen in ^{227}Ra β^- decay. Evaluators treat this transition as uncertain.
[a] From ^{231}Pa α decay, based on ce, γγ(θ) and γ(θ,H,T) data.

$^{227}_{89}$Ac$_{138}$-11

$\gamma(^{227}Ac)$ (continued)

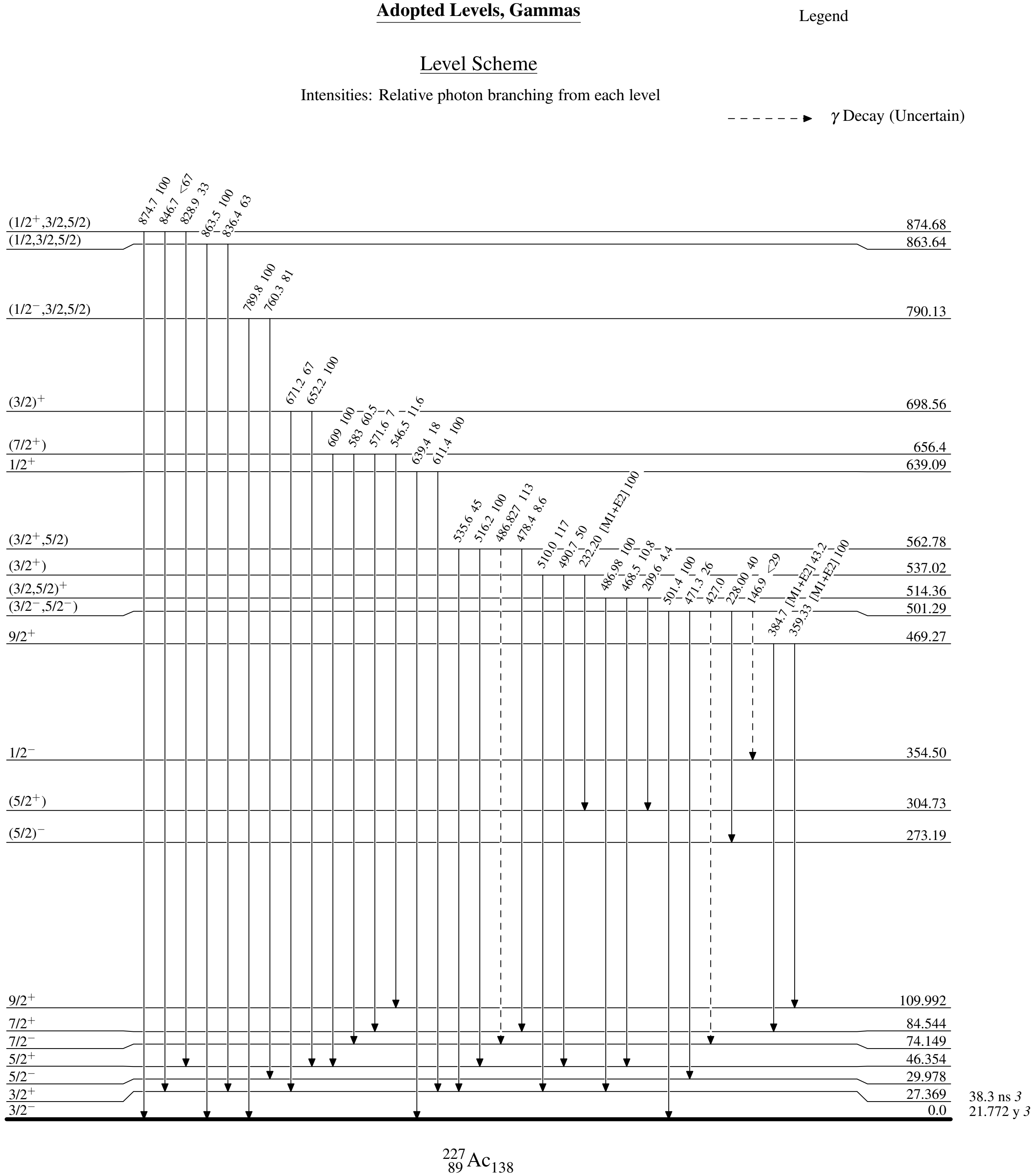
[b] From BrIcc v2.3b (16-Dec-2014) 2008Ki07, “Frozen Orbitals” appr. α value overlaps M1 and E2 when δ(E2/M1) not given.
[c] Multiply placed with intensity suitably divided.
[d] Placement of transition in the level scheme is uncertain.

$^{227}_{89}Ac_{138}$-12

Adopted Levels, Gammas

Level Scheme

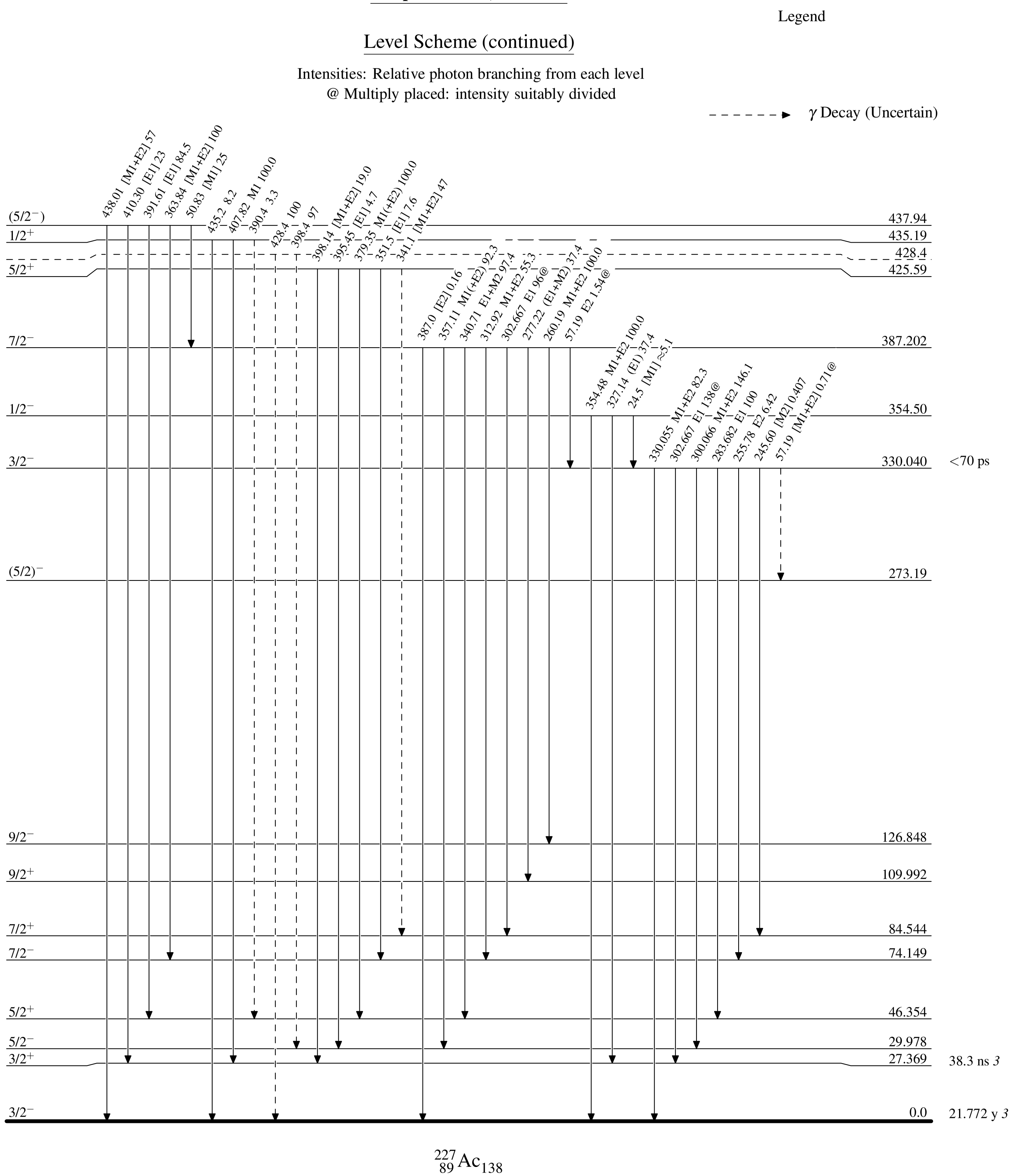
Intensities: Relative photon branching from each level



Adopted Levels, Gammas

Level Scheme (continued)

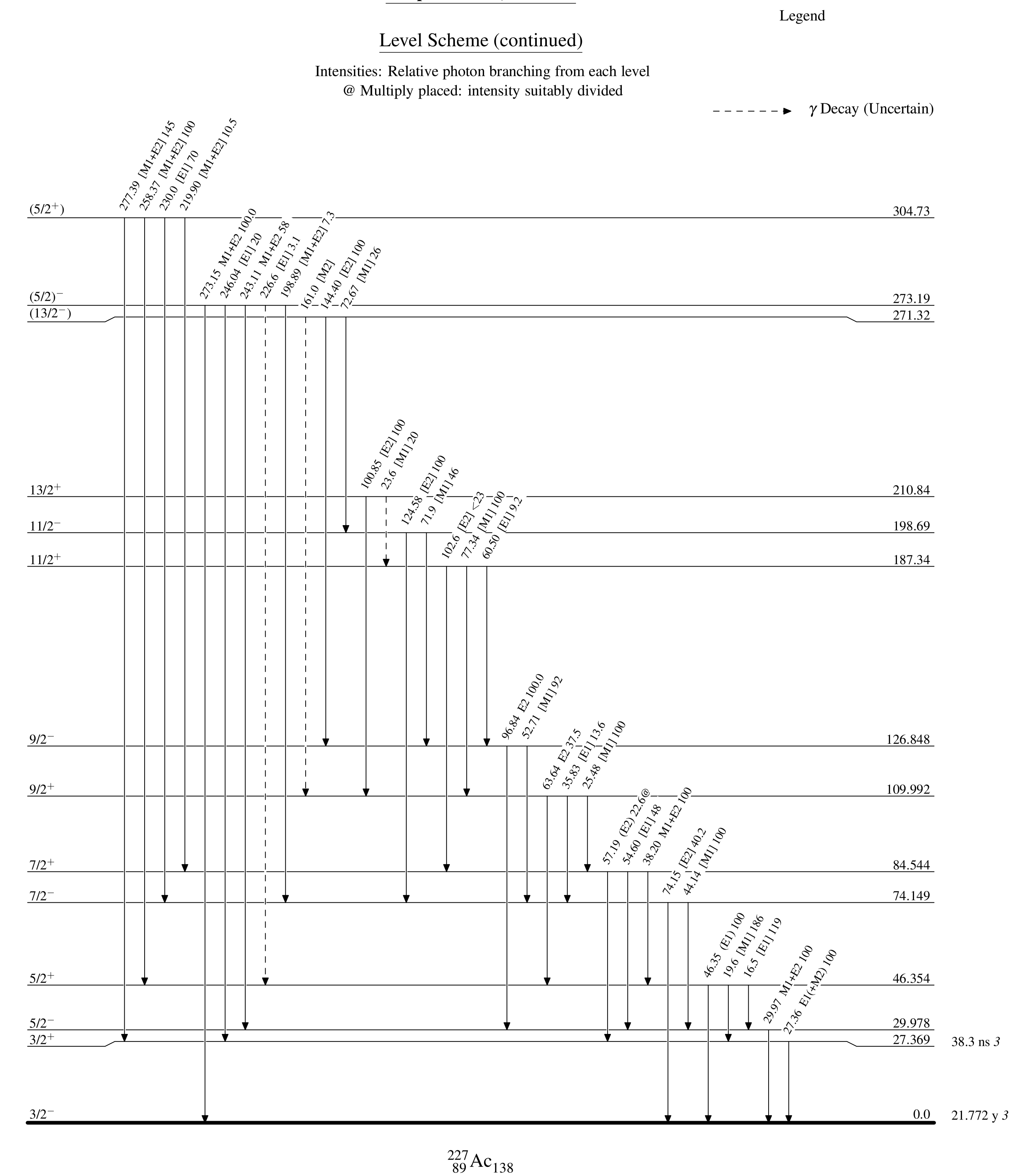
Intensities: Relative photon branching from each level
@ Multiply placed: intensity suitably divided



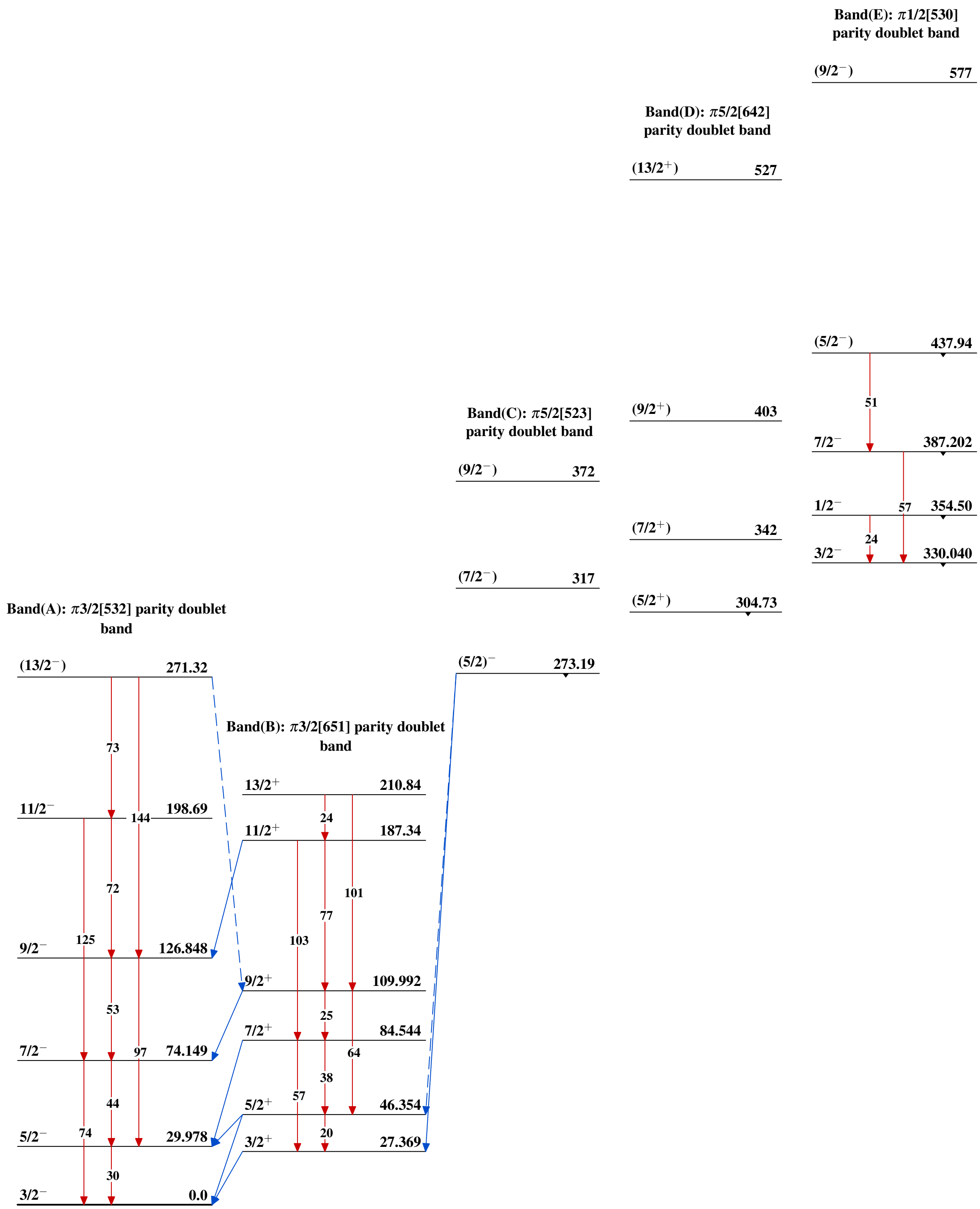
Adopted Levels, Gammas

Level Scheme (continued)

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

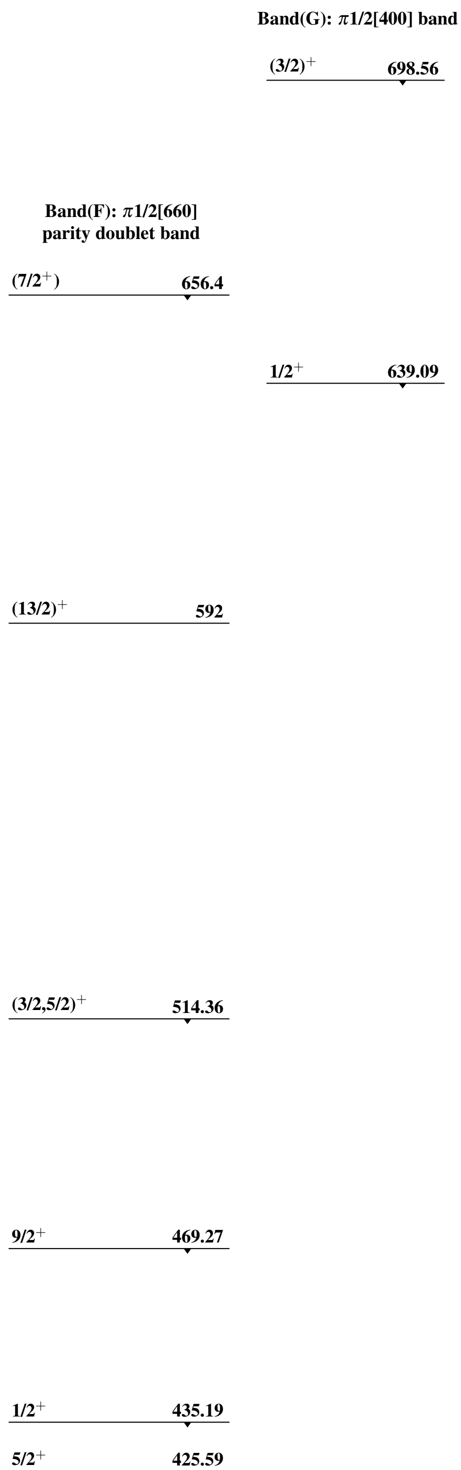


Adopted Levels, Gammas



$^{227}_{89}Ac_{138}$

Adopted Levels, Gammas (continued)



$^{227}_{89}Ac_{138}$