

Adopted Levels, Gammas

Type	Author	History	Citation	Literature Cutoff Date
Full Evaluation	P. K. Joshi, B. Singh, S. Singh, A. K. Jain		NDS 138, 1 (2016)	15-Oct-2016

Q(β^-)=2314.6 23; S(n)=4723.4 34; S(p)=9316 9; Q(α)=-922 4 [2012Wa38](#)

S(2n)=13335.15 6, S(2p)=17108.5 3 ([2012Wa38](#)).

[1999Am05](#): mass measurement (Penning trap).

Other reactions:

[1989Kr15](#): ¹³⁹La(pol n,p) E \approx res. Compiled and analyzed data for parity violation effects.

¹³⁹Ba Levels

Cross Reference (XREF) Flags

A	¹³⁹ Cs β^- decay (9.27 min)	E	¹³⁸ Ba(n, γ),(n,n):resonances
B	²⁵² Cf SF decay	F	¹³⁸ Ba(pol p,p),(pol p,p'):IAR
C	¹³⁶ Xe(α ,n γ)	G	¹³⁸ Ba(d,p)
D	¹³⁸ Ba(n, γ) E=thermal	H	¹³⁸ Ba(α , ³ He)

E(level) [†]	J $^\pi$	T _{1/2}	XREF	Comments
0.0 ^{&}	7/2 ⁻	82.93 [#] min 9	ABCD FG	% β^- =100 μ =-0.973 5 (1988We07,2014StZZ) Q=-0.573 13 (1988We07,2016St14) RMS charge radius $\langle r^2 \rangle^{1/2}$ =4.8513 fm 49 (2013An02 evaluation). J $^\pi$: spin from Collinear Fast Beam Laser Spectroscopy (CFBLS) (1983Mu12), π from L(d,p)=3. E(level): parent of 16182, 7/2 ⁻ IAR in ¹³⁹ La. μ ,Q: CFBLS (1988We07); Q includes Sternheimer correction. Other: μ =-0.975 17, Q=-0.50 4 (CFBLS, 1983Mu12).
627.318 22	3/2 ⁻		A CD FG	XREF: F(631.0). J $^\pi$: L(d,p)=1; γ to 7/2 ⁻ ; parent of 16812, 3/2 ⁻ IAR in ¹³⁹ La.
1082.01 4	(1/2) ⁻		A D FG	XREF: F(1087.0).
1283.32 3	(9/2) ⁻		A C FGH	J $^\pi$: L(d,p)=1; parent of 17268, 1/2 ⁻ IAR in ¹³⁹ La. XREF: F(1305).
1308.21 ^{&} 5	(11/2) ⁻		ABC	J $^\pi$: γ to 7/2 ⁻ ; γ from (13/2) ⁺ ; possible band member.
1420.67 4	(5/2) ⁻		A D FG	XREF: F(1435). J $^\pi$: L(d,p)=3; parent of 17616, 5/2 ⁻ IAR in ¹³⁹ La.
1539.01 10	(13/2) ⁺		ABC FGH	XREF: F(1575). J $^\pi$: L(d,p)=6; parent of 17756, 13/2 ⁺ IAR in ¹³⁹ La.
1619 10	(9/2) ⁻		FGH	XREF: F(1641). J $^\pi$: L(d,p)=5; parent of 17822, 9/2 ⁻ IAR in ¹³⁹ La.
1620.73 6	(7/2 ⁻ ,9/2 ⁺)		A	J $^\pi$: γ s to 7/2 ⁻ and (11/2 ⁻); γ from 5/2 ⁺ .
1680.78 4	(7/2) ⁻		A D FG	XREF: F(1692). J $^\pi$: L(d,p)=3; parent of 17873, 7/2 ⁻ IAR in ¹³⁹ La.
1698.69 5	(5/2) ⁻		A D FG	XREF: F(1711). J $^\pi$: L(d,p)=3; parent of 17892, 5/2 ⁻ IAR in ¹³⁹ La.
1748.27 5	3/2 ⁻		A D FG	XREF: F(1780). J $^\pi$: L(d,p)=1; γ to 7/2 ⁻ .
1817.78 4	(1/2 ⁻ ,3/2,5/2 ⁻)		A F	XREF: F(1842). J $^\pi$: γ s to 1/2 ⁻ and 5/2 ⁻ .
1828.45 ^{&} 10	(15/2) ⁻		BC	J $^\pi$: Δ J=2, Q transition to (11/2 ⁻); γ to (13/2) ⁺ .
1851.03 6	(11/2 ⁻ ,9/2,7/2 ⁻)		A C	J $^\pi$: γ rays to 7/2 ⁻ and (11/2 ⁻); possible β feeding from 7/2 ⁺ parent; population in (α ,n γ) favors high spin.
1877.38 4	(5/2 ⁻ to 11/2 ⁻)		A	J $^\pi$: γ s to 7/2 ⁻ and (9/2) ⁻ ; β feeding from 7/2 ⁺ parent.

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Adopted Levels, Gammas (continued) ^{139}Ba Levels (continued)

E(level) [†]	J ^π	T _{1/2}	XREF	Comments
1887.54 5	(5/2 ⁻ , 7/2, 9/2 ⁻)		A g	J ^π : γs to (5/2) ⁻ and (9/2) ⁻ .
1895.48 6	1/2, 3/2, 5/2 ⁺		D g	J ^π : primary γ from 1/2 ⁺ .
1933.48 5	(7/2) ⁻		A FG	XREF: F(1943).
1946.04 18	(3/2 ⁻ , 5/2 ⁺)		D	J ^π : L(d,p)=3; parent of 18124, 7/2 ⁻ IAR in ^{139}La .
1949.13 6	(5/2) ⁻		A FG	J ^π : primary γ from 1/2 ⁺ ; γ to 7/2 ⁻ . XREF: F(1963).
1951.54 15			D	J ^π : γs to 3/2 ⁻ and 7/2 ⁻ . L(d,p)=3; parent of 18144, 5/2 ⁻ IAR in ^{139}La for 1949 level. These may belong to 1951 level as well.
1976.89 & 14	(17/2 ⁻)	0.40 ns 25	BC	J ^π : γ to 7/2 ⁻ suggests 3/2 ⁻ to 11/2 ⁻ . See also comment for 1949 level. J ^π : ΔJ=1 (M1) γ to (15/2 ⁻); band member. T _{1/2} : from γ(t) in (α,nγ).
1998.25 6	(7/2 ⁻ , 9/2, 11/2 ⁻)		A	J ^π : γs to 7/2 ⁻ and (11/2) ⁻ .
2020.89 10	(5/2 ⁻ , 7/2 ⁻)		A	J ^π : γs to 3/2 ⁻ and 9/2 ⁻ .
2037.97 5	(3/2 ⁻ , 5/2, 7/2 ⁻)		A	J ^π : γs to 3/2 ⁻ and 7/2 ⁻ .
2079.06 14	(7/2 ⁻ , 9/2, 11/2 ⁻)		A	J ^π : γs to 7/2 ⁻ and (11/2) ⁻ .
2089.89 6	(5/2 ⁻ , 7/2 ⁻)		A	J ^π : γs to 3/2 ⁻ and 9/2 ⁻ .
2091.7 & 4	(19/2 ⁻)		BC	J ^π : γ to (17/2 ⁻); possible band member.
2100.08 11	(5/2 ⁻ , 7/2 ⁻)		A FG	XREF: F(2115)G(2106). J ^π : L(d,p)=(3); γs to 3/2 ⁻ and 7/2 ⁻ . Parent of 19297, 7/2 ⁻ IAR in ^{139}La . In (d,p) and (p,p'), the level may also correspond to the 2100.85 level.
2110.85 6	(5/2 ⁻ to 11/2 ⁻)		A	J ^π : γs to 7/2 ⁻ and (9/2) ⁻ ; β feeding from 7/2 ⁺ parent. See also comment for 2100.07 level.
2129.20 5	3/2 ⁻		D FG	XREF: F(2158). J ^π : L(d,p)=1; γ to 7/2 ⁻ .
2157.00 8	3/2 ⁻ , 5/2 ⁺		A D g	J ^π : primary γ from 1/2 ⁺ ; γ to 7/2 ⁻ . L(d,p)=1 for a 2153 10 group corresponds to 2156.99 and/or 2158.77 levels.
2158.85 6	3/2 ⁻ , 5/2 ⁺		A D g	J ^π : primary γ from 1/2 ⁺ ; log ft < 11 from 7/2 ⁺ . See also comment for 2156.99 level.
2166.72 19	(7/2 ⁻)		A f	XREF: f(2182). J ^π : γs to 3/2 ⁻ and (11/2) ⁻ .
2173.95 5	(5/2 ⁻ , 7/2 ⁻)		A f	XREF: f(2182). J ^π : γs to 3/2 ⁻ and 9/2 ⁻ ; possible parent of 18363, 5/2 ⁻ IAR in ^{139}La .
2185.58 7	1/2 ⁻ , 3/2 ⁻		D FG	XREF: F(2186). J ^π : L(d,p)=1.
2218.93 7	(3/2 ⁻ , 5/2, 7/2 ⁻)		A	J ^π : γs to 3/2 ⁻ and 7/2 ⁻ .
2229.79 9	(5/2 ⁻ to 11/2 ⁻)		A	J ^π : γs to 7/2 ⁻ and (9/2) ⁻ .
2249.85 24	(5/2 ⁻ to 11/2 ⁻)		A	J ^π : γs to 7/2 ⁻ and (9/2) ⁻ .
2304.88 8	(5/2 ⁻ , 7/2 ⁻)		A FG	XREF: F(2335). J ^π : L(d,p)=(3); possible parent of 18516, (5/2 ⁻) IAR in ^{139}La .
2349.81 3	5/2 ⁻ , 7/2 ⁻		A G	XREF: G(2361). J ^π : L(d,p)=3.
2375.80 8	(5/2 ⁻ , 7/2, 9/2 ⁻)		A g	J ^π : γs to 5/2 ⁻ and 9/2 ⁻ . L(d,p)=3 for a 2378 10 group corresponds to 2375.8 and/or 2380.70 levels.
2380.70 7	(3/2 ⁻ to 11/2 ⁻)		A g	J ^π : γ to 7/2 ⁻ ; possible β feeding from 7/2 ⁺ parent. See also comment for 2375.80 level.
2435.28 9	1/2 ⁻ , 3/2 ⁻		D FG	XREF: F(2446). J ^π : L(d,p)=1; possible parent of 18630, (3/2 ⁻) IAR in ^{139}La .
2461.67 7	(5/2 ⁻ , 7/2, 9/2 ⁻)		A	J ^π : γs to 5/2 ⁻ and 9/2 ⁻ .
2479.3 4			B	J ^π : γ to (19/2 ⁻) suggests 15/2 ⁻ to 23/2 ⁻ .
2480.76 5	(3/2 ⁻)		D g	J ^π : primary γ from 1/2 ⁺ ; γ to 7/2 ⁻ . L(d,p)=1 for a 2478 group corresponds to 2480.7 and/or 2485.5 levels.
2485.59 25	1/2, 3/2, 5/2 ⁺		D g	J ^π : primary γ from 1/2 ⁺ . See also comment for 2480.7 level.
2524.30 11	(7/2 ⁻ , 9/2, 11/2 ⁻)		A g	
2529.69 16	(3/2 ⁻ to 9/2 ⁻)		A g	J ^π : γs to 7/2 ⁻ and (5/2) ⁻ .

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Adopted Levels, Gammas (continued)

¹³⁹Ba Levels (continued)

E(level) [†]	J ^π	XREF	Comments
2531.83 5	(3/2 ⁻ ,5/2,7/2 ⁻)	A g	J ^π : γs to 3/2 ⁻ and 7/2 ⁻ .
2543 10	(5/2 ⁻ ,7/2 ⁻)	G	J ^π : L(d,p)=(3). E(level): from energy matching, this level could correspond to 2549.7 level, the implied J ^π values are exclusive.
2549.72 16	(3/2 ⁻)	D	J ^π : γ to 7/2 ⁻ ; primary γ from 1/2 ⁺ .
2569.87 13	(3/2 ⁻)	D G	J ^π : L(d,p)=(1); γ to 7/2 ⁻ .
2605.74 4	(3/2 ⁻ to 9/2 ⁻)	A	J ^π : γs to 7/2 ⁻ and (5/2) ⁻ .
2649.38 7	(3/2 ⁻ ,5/2,7/2 ⁻)	A	J ^π : γs to 3/2 ⁻ and 7/2 ⁻ .
2667		G	
2681.2 4		B	J ^π : γ to (19/2 ⁻) suggests 15/2 ⁻ to 23/2 ⁻ .
2739 10		G	
2743.5? 4		C	E(level),J ^π : probably a high-spin level and different from the 2739 level in (d,p).
2797 10		G	
2847.75 7	(5/2 ⁻ to 11/2 ⁻)	A	J ^π : γs to 7/2 ⁻ and (9/2) ⁻ .
2857 15	(1/2 ⁻ ,3/2 ⁻)	G	E(level): from energy matching, this level could correspond to 2847.75 level, however the two sets of implied J ^π values are exclusive. J ^π : L(d,p)=(1).
2909 15		G	
2939 15		G	
2994.43 9	(5/2 ⁻ ,7/2,9/2 ⁻)	A g	J ^π : γs to (5/2) ⁻ and (9/2) ⁻ .
2997.31 8	(7/2 ⁻ ,9/2)	A g	J ^π : 6.2≤log ft≤7.5 via 7/2 ⁺ parent; γs to (9/2) ⁻ and (11/2) ⁻ .
3024.8 2	(1/2 ⁻ ,3/2 ⁻)	D G	XREF: D(?)G(3023). J ^π : L(d,p)=(1).
3080 10	11/2 ⁺ ,13/2 ⁺	GH	J ^π : L(d,p)=6.
3088.6 4		B	J ^π : γ to (19/2 ⁻) suggests 15/2 ⁻ to 23/2 ⁻ .
3100 10		G	
3122.7@ 4	(21/2 ⁻)	B	J ^π : γ to (19/2 ⁻); possible bandhead.
3168.20 21	(1/2 ⁻ ,3/2 ⁻)	D G	J ^π : L(d,p)=(1); primary γ from 1/2 ⁺ .
3177 10		a G	XREF: a(3200).
3210 10	(1/2 ⁻ ,3/2 ⁻)	G	J ^π : L(d,p)=(1).
3231 10		a G	XREF: a(3200).
3259.2 3	1/2,3/2,5/2 ⁺	D G	J ^π : primary γ from 1/2 ⁺ .
3270.28 19	(5/2,7/2,9/2)	A G	J ^π : possible β feeding from 7/2 ⁺ parent.
3336 10		G	
3344.3 4		B	J ^π : probably >15/2, since populated in ²⁵² Cf SF decay.
3381.9 4		B	J ^π : probably >15/2, since populated in ²⁵² Cf SF decay.
3385.10 21	(1/2 ⁻ ,3/2 ⁻)	D G	XREF: G(3379). J ^π : L(d,p)=(1); primary γ from 1/2 ⁺ .
3401.39 14	5/2 ⁻ ,7/2 ⁻	A G	J ^π : L(d,p)=3.
3418.79 14	(5/2,7/2,9/2)	A	J ^π : possible β feeding from 7/2 ⁺ parent.
3434.44 21	(5/2,7/2,9/2)	A	J ^π : possible β feeding from 7/2 ⁺ parent.
3464.40 7	(5/2 ⁻ ,7/2 ⁻)	A G	J ^π : L(d,p)=(3); γs to 3/2 ⁻ and 7/2 ⁻ .
3480 10		G	
3499 10		G	
3524 10		G	
3563 10		G	
3592 10		G	
3603 10		G	
3641 10		G	
3665.66 8	5/2,7/2,9/2	A g	J ^π : γ to 7/2 ⁻ ; allowed or first-forbidden β from 7/2 ⁺ parent.
3674.62 14	(5/2,7/2 ⁻)	A g	J ^π : γ to 3/2 ⁻ ; allowed or first-forbidden β from 7/2 ⁺ parent.
3701.95 14	(5/2 ⁻ ,7/2,9/2 ⁻)	A g	J ^π : γs to (5/2) ⁻ and (9/2) ⁻ .
3724.19 14	(5/2,7/2 ⁻)	A G	J ^π : γ to 3/2 ⁻ ; allowed or first-forbidden β from 7/2 ⁺ parent.
3769.21 11	(5/2,7/2,9/2)	A G	J ^π : possible β feeding from 7/2 ⁺ parent.
3820.05 24	(5/2,7/2,9/2)	A G	XREF: G(3811). J ^π : possible β feeding from 7/2 ⁺ parent.

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Adopted Levels, Gammas (continued) ^{139}Ba Levels (continued)

E(level) [†]	J ^π	XREF	Comments
3839.73 15	(5/2,7/2,9/2)	A G	J ^π : possible β feeding from 7/2 ⁺ parent.
3853.93 16	(5/2,7/2,9/2)	A	J ^π : possible β feeding from 7/2 ⁺ parent.
3887.9 3	(5/2,7/2,9/2)	A	J ^π : possible β feeding from 7/2 ⁺ parent.
3890.9 [@] 4	(25/2 ⁻)	B	J ^π : γ to (21/2 ⁻); band member.
3912.27 21	(5/2,7/2,9/2)	A	J ^π : 6.2≤log ft≤7.5 via 7/2 ⁺ parent.
3930 10		G	
3950.84 12	(5/2) ⁺	A G	J ^π : log ft=5.3 from 7/2 ⁺ parent; γ to 3/2 ⁻ .
3971 10		G	
4010 10		G	
4046.9 4		B	J ^π : probably >15/2, since populated in ²⁵² Cf SF decay.
4616.3 [@] 4	(29/2 ⁻)	B	J ^π : γ to (25/2 ⁻); possible band member.
(4723.51 4)	1/2 ⁺	D	J ^π : s-wave capture in 0 ⁺ g.s. of ¹³⁸ Ba. E(level): S(n)=4723.43 4 (2012Wa38).
4724.07	1/2 ⁻ ,3/2 ⁻ [‡]	E	
4725.36	[3/2] ⁻ [‡]	E	
4725.42	1/2 ⁻ ,3/2 ⁻ [‡]	E	
4728.10	[1/2] ⁻ [‡]	E	
4731.25	1/2 ⁺ [‡]	E	
4733.28	[1/2] ⁻ [‡]	E	
4737.34	[3/2] ⁻ [‡]	E	
4742.94		E	
4743.15		E	
4746.65		E	
4746.80		E	
4747.44	1/2 ⁻ ,3/2 ⁻ [‡]	E	
4749.41		E	
4752.41		E	
4753.02		E	
4753.99	1/2 ⁺ [‡]	E	
4754.41	1/2 ⁻ ,3/2 ⁻ [‡]	E	
4755.77		E	
4757.67		E	
4763.32	3/2 ⁻ [‡]	E	
4766.01		E	
4766.85		E	
4770.51		E	
4770.61		E	
4771.74		E	
4772.56	[3/2] ⁻ [‡]	E	
4773.40	1/2 ⁺ [‡]	E	
4773.41		E	
4776.29	[3/2] ⁻ [‡]	E	
4777.97		E	
4778.22	[1/2] ⁻ [‡]	E	
4781.92		E	
4782.34	1/2 ⁺ [‡]	E	
4783.66	[3/2] ⁻ [‡]	E	
4784.38		E	
4785.74	3/2 ⁻ [‡]	E	
4789.61		E	
4791.83	3/2 ⁻ [‡]	E	

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Adopted Levels, Gammas (continued) ^{139}Ba Levels (continued)

<u>E(level)[†]</u>	<u>J^π</u>	<u>XREF</u>
4791.94		E
4792.22		E
4795.42		E
4795.92		E
4797.12	[1/2] ⁻ $\frac{3}{2}$	E
4800.64		E
4802.32	1/2 ⁺ $\frac{3}{2}$	E
4804.30		E
4804.51		E
4806.52		E
4810.18		E
4811.89	[3/2] ⁻ $\frac{3}{2}$	E
4813.97		E
4814.52		E
4817.95		E
4819.26		E
4819.52		E
4820.47		E
4822.11		E
4822.48		E
4822.61		E
4823.33		E
4823.71		E
4824.44		E
4825.04		E
4825.99	[1/2] ⁻ $\frac{3}{2}$	E
4826.55		E
4828.12	1/2 ⁺ $\frac{3}{2}$	E
4829.84	[3/2] ⁻ $\frac{3}{2}$	E
4830.70		E
4831.49		E
4831.79		E
4832.03		E
4832.63		E
4834.58	1/2 ⁺ $\frac{3}{2}$	E
4835.33	[3/2] ⁻ $\frac{3}{2}$	E
4838.26		E
4839.08	3/2 ⁻ $\frac{3}{2}$	E
4839.23	1/2 ⁺ $\frac{3}{2}$	E
4839.70		E
4846.11		E
4847.62		E
4849.20	[1/2] ⁻ $\frac{3}{2}$	E
4849.53		E
4849.86		E
4852.14	3/2 ⁻ $\frac{3}{2}$	E
4852.34		E
4854.60		E
4855.32		E
4856.16		E
4856.91		E
4859.45	1/2 ⁺ $\frac{3}{2}$	E
4861.31		E

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Adopted Levels, Gammas (continued) ^{139}Ba Levels (continued)

E(level) [†]	J ^π	XREF	Comments
4861.48	[3/2] ⁻ [‡]	E	
4862.58		E	
4863.34		E	
4864.68		E	
4865.61		E	
4866.94		E	
4869.12		E	
4869.35		E	
4869.96		E	
4872.75		E	
4873.71	3/2 ⁻ [‡]	E	
4874.84		E	
4877.18		E	
4879.37		E	
4880.70	[3/2] ⁻ [‡]	E	
4883.25		E	
4883.75		E	
4885.24		E	
4885.76		E	
4887.47		E	
4889.05		E	
4889.22		E	
4890.49		E	
4890.86	[3/2] ⁻ [‡]	E	
4891.59		E	
4894.15	[3/2] ⁻ [‡]	E	
4895.66	3/2 ⁻ [‡]	E	
4897.70		E	
4898.11		E	
4899.08		E	
4901.81	[3/2] ⁻ [‡]	E	
4903.68	1/2 ⁺ [‡]	E	
4906.18		E	
4907.90		E	
4909.62		E	
4910.51		E	
4911.68		E	
4912.10	[1/2] ⁻ [‡]	E	
4913.00		E	
4913.80		E	
4914.38		E	
4916.29		E	
4916.80	1/2 ⁺ [‡]	E	
4918.35		E	
4919.68		E	
4920.53		E	
4920.91		E	
4921.78		E	
4956.6 [@] 4	(31/2 ⁻)	B	J ^π : γ to (27/2 ⁻); possible band member.

[†] Primary γ rays from (n,γ) were included in the least-squares analysis with the capture-state energy held fixed.

Adopted Levels, Gammas (continued)

 ^{139}Ba Levels (continued)

- ‡ From [2006MuZX](#), based on the analysis of s-wave ($L=0, J^\pi=1/2^+$) and p-wave ($L=1, J^\pi=1/2^-$ or $3/2^-$) neutron resonance data.
- # From unweighted average of 83.09 min 9 ([2012Da17](#), γ counting for several samples and γ rays counted for more than 5 half-lives, long-lived source used as reference); 83.25 min 8 ([2012Da04](#), γ counting, several samples counted over ≈ 4 half-lives, long-lived source used as reference); 82.57 min 12 ([2008Ni02](#), average of 82.60 min 8 and 82.54 min 8 from K x-ray and 165 γ counting for two samples); 83.06 min 28 ([1980Ge04](#), γ counting over seven half-lives, details provided); 82.71 min 18 ([1972Em01](#), β counting for 2.4 $T_{1/2}$ G-M detector); 82.9 min 2 ([1962Fr04](#), β counting); 82.9 min 1 ([1958Bu04](#), 2π counting for 6-10 half-lives). Other values which seem either imprecise or discrepant: 84.547 min 15 ([1989Ab05](#), γ counting over 0.7 half-life; no details given); 84.44 min 22 ([1985An25](#), γ counting over six half-lives); 84.63 min 34 ([1972Eh02](#), β counting, proportional counter); 85.2 min 8 ([1969Su01](#)); 85 min 1 ([1960Wi10](#), [1953Pa25](#)); 84.0 min 2 ([1957Ba16](#), 4π counting for nine half-lives); 85.0 min 5 ([1950Di04](#)); 85.6 min ([1937Po03](#)), 85 min 3 ([1960Ke06](#)) and 84 min 1 ([1948Sh27](#)). Weighted average of all the values (but with uncertainty of 0.08 min in [1989Ab05](#) value) above is 83.44 min 19 with reduced $\chi^2=20$, showing the discrepant nature of the dataset.
- @ Band(A): γ sequence based on $(21/2^-)$.
- & Band(B): γ sequence based on $7/2^-$, g.s..

Adopted Levels, Gammas (continued)

$\gamma(^{139}\text{Ba})$

See β^- decay and (n, γ) E=thermal for unplaced γ rays.

$E_i(\text{level})$	J_i^π	E_γ^\dagger	I_γ^\dagger	E_f	J_f^π	Mult. [‡]	$\alpha^\#$	Comments
627.318	3/2 ⁻	627.24 3	100	0.0	7/2 ⁻			
1082.01	(1/2) ⁻	454.66 6	100	627.318	3/2 ⁻			
1283.32	(9/2) ⁻	1283.23 5	100	0.0	7/2 ⁻			
1308.21	(11/2) ⁻	1308.13 6	100	0.0	7/2 ⁻	(Q)		
1420.67	(5/2) ⁻	793.28 7	9.6 7	627.318	3/2 ⁻			
		1420.66 6	100 6	0.0	7/2 ⁻			
1539.01	(13/2) ⁺	230.76 9	100	1308.21	(11/2) ⁻	(D)		
1620.73	(7/2 ⁻ ,9/2 ⁺)	312.31 21	1.9 4	1308.21	(11/2) ⁻			
		1620.74 6	100 5	0.0	7/2 ⁻			
1680.78	(7/2) ⁻	260.6 4	1.2 4	1420.67	(5/2) ⁻	[M1,E2]	0.0707 12	$\alpha(\text{K})=0.0587$ 18; $\alpha(\text{L})=0.0095$ 16; $\alpha(\text{M})=0.0020$ 4; $\alpha(\text{N})=0.00043$ 8; $\alpha(\text{O})=6.2 \times 10^{-5}$ 9 $\alpha(\text{P})=3.6 \times 10^{-6}$ 4
		1680.72 6	100 5	0.0	7/2 ⁻			
1698.69	(5/2) ⁻	1698.66 7	100	0.0	7/2 ⁻			
1748.27	3/2 ⁻	666.07 11	63 3	1082.01	(1/2) ⁻			
		1120.89 10	100 5	627.318	3/2 ⁻			
		1748.5 3	28 3	0.0	7/2 ⁻			
1817.78	(1/2 ⁻ ,3/2,5/2 ⁻)	396.9 3	8.6 24	1420.67	(5/2) ⁻			
		735.68 9	34.8 28	1082.01	(1/2) ⁻			
		1190.42 6	100 6	627.318	3/2 ⁻			
1828.45	(15/2) ⁻	289.39 10	1.0	1539.01	(13/2) ⁺			γ from ^{252}Cf SF decay only.
		520.29 10	100	1308.21	(11/2) ⁻	Q		
1851.03	(11/2 ⁻ ,9/2,7/2 ⁻)	542.71 15	23 3	1308.21	(11/2) ⁻			
		567.72 & 5	100 & 8	1283.32	(9/2) ⁻			
		1850.7 4	10 3	0.0	7/2 ⁻			
1877.38	(5/2 ⁻ to 11/2 ⁻)	196.51 18	2.5 4	1680.78	(7/2) ⁻			
		594.02 5	20.7 13	1283.32	(9/2) ⁻			
		1877.45 7	100 6	0.0	7/2 ⁻			
1887.54	(5/2 ⁻ ,7/2,9/2 ⁻)	188.88 20	3.6 7	1698.69	(5/2) ⁻			
		466.70 12	9.2 10	1420.67	(5/2) ⁻			
		604.22 6	19.3 13	1283.32	(9/2) ⁻			
		1887.57 7	100 6	0.0	7/2 ⁻			
1895.48	1/2,3/2,5/2 ⁺	1268.2	100	627.318	3/2 ⁻			
1933.48	(7/2) ⁻	1306.09 11	43 4	627.318	3/2 ⁻			
		1933.48 7	100 6	0.0	7/2 ⁻			
1946.04	(3/2 ⁻ ,5/2 ⁺)	1318.5 2	70 8	627.318	3/2 ⁻			
		1946.9 4	100 23	0.0	7/2 ⁻			
1949.13	(5/2) ⁻	1321.77 6	100 6	627.318	3/2 ⁻			
		1949.26 14	14.2 16	0.0	7/2 ⁻			

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Adopted Levels, Gammas (continued)

$\gamma(^{139}\text{Ba})$ (continued)

$E_i(\text{level})$	J_i^π	E_γ^\dagger	I_γ^\dagger	E_f	J_f^π	Mult.‡	$\alpha^\#$	Comments
1951.54		1951.53 15	100	0.0	7/2 ⁻			
1976.89	(17/2 ⁻)	148.44 10	100	1828.45	(15/2 ⁻)	(M1)	0.325	B(M1)(W.u.)=0.013 8 $\alpha(\text{K})=0.278$ 5; $\alpha(\text{L})=0.0371$ 6; $\alpha(\text{M})=0.00765$ 12; $\alpha(\text{N})=0.001650$ 25; $\alpha(\text{O})=0.000252$ 4 $\alpha(\text{P})=1.83 \times 10^{-5}$ 3 Mult.: $\Delta J=1$, dipole from $\gamma(\theta)$ in $(\alpha, n\gamma)$; band assignment suggests M1.
1998.25	(7/2 ⁻ , 9/2, 11/2 ⁻)	690.04 9	30 3	1308.21	(11/2 ⁻)			
		714.90 6	100 6	1283.32	(9/2 ⁻)			
		1998.46 15	40 4	0.0	7/2 ⁻			
2020.89	(5/2 ⁻ , 7/2 ⁻)	737.60 12	33 4	1283.32	(9/2 ⁻)			
		1393.2 3	12 3	627.318	3/2 ⁻			
		2020.76 25	100 34	0.0	7/2 ⁻			
2037.97	(3/2 ⁻ , 5/2, 7/2 ⁻)	357.01 16	9.1 15	1680.78	(7/2 ⁻)			
		616.91 21	16 3	1420.67	(5/2 ⁻)			
		1410.58 7	100 6	627.318	3/2 ⁻			
		2038.10 11	28.2 24	0.0	7/2 ⁻			
2079.06	(7/2 ⁻ , 9/2, 11/2 ⁻)	770.56 19	40 7	1308.21	(11/2 ⁻)			
		2079.33 19	100 12	0.0	7/2 ⁻			
2089.89	(5/2 ⁻ , 7/2 ⁻)	806.32 21	9.0 16	1283.32	(9/2 ⁻)			
		1462.43 19	26 5	627.318	3/2 ⁻			
		2089.91 9	100 7	0.0	7/2 ⁻			
2091.7	(19/2 ⁻)	114.8 3	100	1976.89	(17/2 ⁻)	[M1]	0.672 11	$\alpha(\text{K})=0.575$ 10; $\alpha(\text{L})=0.0771$ 13; $\alpha(\text{M})=0.0159$ 3; $\alpha(\text{N})=0.00343$ 6; $\alpha(\text{O})=0.000524$ 9 $\alpha(\text{P})=3.79 \times 10^{-5}$ 6 E_γ : unweighted average.
2100.08	(5/2 ⁻ , 7/2 ⁻)	419.3 3	20 6	1680.78	(7/2 ⁻)			
		1472.6 5	25 11	627.318	3/2 ⁻			
		2100.13 17	100 13	0.0	7/2 ⁻			
2110.85	(5/2 ⁻ to 11/2 ⁻)	233.45 22	1.4 4	1877.38	(5/2 ⁻ to 11/2 ⁻)			
		430.20 16	5.5 5	1680.78	(7/2 ⁻)			
		827.52 7	16.7 11	1283.32	(9/2 ⁻)			
		2110.91 9	100 6	0.0	7/2 ⁻			
2129.20	3/2 ⁻	708.4 1	58 6	1420.67	(5/2 ⁻)			
		1047.4 1	100 5	1082.01	(1/2 ⁻)			
		1501.81 19	86 9	627.318	3/2 ⁻			
		2129.2 1	57 7	0.0	7/2 ⁻			
2157.00	3/2 ⁻ , 5/2 ⁺	339.4 4	14 6	1817.78	(1/2 ⁻ , 3/2, 5/2 ⁻)			
		1529.3 3	63 14	627.318	3/2 ⁻			
		2156.94 13	100 11	0.0	7/2 ⁻			
2158.85	3/2 ⁻ , 5/2 ⁺	738.4 2	56 3	1420.67	(5/2 ⁻)			γ from (n, γ) only.
		1077.01 17	100 7	1082.01	(1/2 ⁻)			
		1531.3 3	76 9	627.318	3/2 ⁻			

Adopted Levels, Gammas (continued)

$\gamma(^{139}\text{Ba})$ (continued)					
$E_i(\text{level})$	J_i^π	E_γ †	I_γ †	E_f	J_f^π
2166.72	(7/2 ⁻)	858.4 3	89 23	1308.21	(11/2 ⁻)
		883.5 3	100 28	1283.32	(9/2) ⁻
		2166.7 4	94 28	0.0	7/2 ⁻
2173.95	(5/2 ⁻ , 7/2 ⁻)	890.54 8	36.7 25	1283.32	(9/2) ⁻
		1546.63 13	15.1 18	627.318	3/2 ⁻
		2173.98 7	100 6	0.0	7/2 ⁻
2185.58	1/2 ⁻ , 3/2 ⁻	1103.2 2	86 6	1082.01	(1/2) ⁻
		1558.3 2	100 10	627.318	3/2 ⁻
2218.93	(3/2 ⁻ , 5/2, 7/2 ⁻)	401.08 22	19 4	1817.78	(1/2 ⁻ , 3/2, 5/2 ⁻)
		538.35 24	25 6	1680.78	(7/2) ⁻
		598.17 18	22 4	1620.73	(7/2 ⁻ , 9/2 ⁺)
		798.01 14	49 7	1420.67	(5/2) ⁻
		1591.73 11	100 9	627.318	3/2 ⁻
2229.79	(5/2 ⁻ to 11/2 ⁻)	2218.91 23	40 6	0.0	7/2 ⁻
		946.46 8	100 7	1283.32	(9/2) ⁻
2249.85	(5/2 ⁻ to 11/2 ⁻)	2229.9 3	14 3	0.0	7/2 ⁻
		966.6 3	100 25	1283.32	(9/2) ⁻
2304.88	(5/2 ⁻ , 7/2 ⁻)	2249.7 4	67 17	0.0	7/2 ⁻
		1677.44 10	100 8	627.318	3/2 ⁻
2349.81	5/2 ⁻ , 7/2 ⁻	2304.97 16	34 4	0.0	7/2 ⁻
		249.89 18	1.8 4	2100.08	(5/2 ⁻ , 7/2 ⁻)
		416.49 22	2.2 5	1933.48	(7/2) ⁻
		531.98 4	38.6 21	1817.78	(1/2 ⁻ , 3/2, 5/2 ⁻)
		601.48 5	11.6 7	1748.27	3/2 ⁻
		651.08 7	8.3 7	1698.69	(5/2) ⁻
		668.97 8	7.5 7	1680.78	(7/2) ⁻
		929.18 6	41.6 22	1420.67	(5/2) ⁻
		1722.55 9	13.5 9	627.318	3/2 ⁻
		2349.92 6	100 6	0.0	7/2 ⁻
2375.80	(5/2 ⁻ , 7/2, 9/2 ⁻)	558.1 3	12 4	1817.78	(1/2 ⁻ , 3/2, 5/2 ⁻)
		955.19 19	42 6	1420.67	(5/2) ⁻
		1092.23 12	60 3	1283.32	(9/2) ⁻
		2375.95 11	100 9	0.0	7/2 ⁻
2380.70	(3/2 ⁻ to 11/2 ⁻)	2380.66 7	100	0.0	7/2 ⁻
2435.28	1/2 ⁻ , 3/2 ⁻	687.6 5	11.2 14	1748.27	3/2 ⁻
		1353.1 2	100 10	1082.01	(1/2) ⁻
2461.67	(5/2 ⁻ , 7/2, 9/2 ⁻)	528.20 10	54 19	1933.48	(7/2) ⁻
		1040.93 22	47 5	1420.67	(5/2) ⁻
		1178.35 9	100 9	1283.32	(9/2) ⁻
2479.3		387.65 10	100	2091.7	(19/2 ⁻)
2480.76	(3/2 ⁻)	295 ^d 5	<46	2185.58	1/2 ⁻ , 3/2 ⁻
		352 ^d 5	<46	2129.20	3/2 ⁻
		1060.1 3		1420.67	(5/2) ⁻

Adopted Levels, Gammas (continued)

γ(¹³⁹Ba) (continued)

<u>E_i(level)</u>	<u>J_i^π</u>	<u>E_γ[†]</u>	<u>I_γ[†]</u>	<u>E_f</u>	<u>J_f^π</u>
2480.76	(3/2 ⁻)	1853.31 9	100 7	627.318	3/2 ⁻
		2480.68 12	30 6	0.0	7/2 ⁻
2485.59	1/2,3/2,5/2 ⁺	1403.4 4	100	1082.01	(1/2) ⁻
2524.30	(7/2 ⁻ ,9/2,11/2 ⁻)	434.23 20	49 11	2089.89	(5/2 ⁻ ,7/2 ⁻)
		1216.14 19	74 13	1308.21	(11/2 ⁻)
		1240.93 25	54 11	1283.32	(9/2) ⁻
		2524.47 22	100 16	0.0	7/2 ⁻
2529.69	(3/2 ⁻ to 9/2 ⁻)	1108.93 18	51 8	1420.67	(5/2) ⁻
		2529.9 3	100 28	0.0	7/2 ⁻
2531.83	(3/2 ⁻ ,5/2,7/2 ⁻)	1110.9 4	6.4 12	1420.67	(5/2) ⁻
		1904.50 7	29.5 17	627.318	3/2 ⁻
		2531.84 7	100 7	0.0	7/2 ⁻
2549.72	(3/2 ⁻)	1129.3 3	21 6	1420.67	(5/2) ⁻
		1468 ^a		1082.01	(1/2) ⁻
		1921.8 4	100 11	627.318	3/2 ⁻
		2550.8 5	90 21	0.0	7/2 ⁻
2569.87	(3/2 ⁻)	1150.1 8	18 6	1420.67	(5/2) ⁻
		1488.9 9	64 9	1082.01	(1/2) ⁻
		2569.68 13	100 9	0.0	7/2 ⁻
2605.74	(3/2 ⁻ to 9/2 ⁻)	375.91 ^a 7	16.0 12	2229.79	(5/2 ⁻ to 11/2 ⁻)
		448.76 12	12.4 15	2157.00	3/2 ⁻ ,5/2 ⁺
		505.4 3	3.8 12	2100.08	(5/2 ⁻ ,7/2 ⁻)
		515.86 7	21.3 18	2089.89	(5/2 ⁻ ,7/2 ⁻)
		567.72 ^{&} 5	15 ^{&} 3	2037.97	(3/2 ⁻ ,5/2,7/2 ⁻)
		656.58 13	12.7 15	1949.13	(5/2) ⁻
		672.21 15	7.8 12	1933.48	(7/2) ⁻
		728.38 9	16.6 15	1877.38	(5/2 ⁻ to 11/2 ⁻)
		788.3 4	3.6 12	1817.78	(1/2 ⁻ ,3/2,5/2 ⁻)
		924.96 8	27.2 21	1680.78	(7/2) ⁻
		1185.21 17	12.1 18	1420.67	(5/2) ⁻
		2605.75 6	100 6	0.0	7/2 ⁻
2649.38	(3/2 ⁻ ,5/2,7/2 ⁻)	832.2 3	7.3 26	1817.78	(1/2 ⁻ ,3/2,5/2 ⁻)
		2022.1 5	39 26	627.318	3/2 ⁻
		2649.32 7	100 6	0.0	7/2 ⁻
2681.2		589.51 10	100	2091.7	(19/2 ⁻)
2743.5?		1204.5 ^a 3	100	1539.01	(13/2) ⁺
2847.75	(5/2 ⁻ to 11/2 ⁻)	849.7 3	10 3	1998.25	(7/2 ⁻ ,9/2,11/2 ⁻)
		1564.63 13	30 4	1283.32	(9/2) ⁻
		2847.63 8	100 6	0.0	7/2 ⁻
2994.43	(5/2 ⁻ ,7/2,9/2 ⁻)	613.4 3	19 6	2380.70	(3/2 ⁻ to 11/2 ⁻)
		1573.84 15	32 4	1420.67	(5/2) ⁻
		1711.09 11	100 8	1283.32	(9/2) ⁻
2997.31	(7/2 ⁻ ,9/2)	1063.7 4	12 6	1933.48	(7/2) ⁻

Adopted Levels, Gammas (continued)

γ(¹³⁹Ba) (continued)

E _i (level)	J _i ^π	E _γ [†]	I _γ [†]	E _f	J _f ^π
2997.31	(7/2 ⁻ ,9/2)	1316.4 4	15 5	1680.78	(7/2) ⁻
		1689.04 25	23 5	1308.21	(11/2) ⁻
		1713.6 4	18 5	1283.32	(9/2) ⁻
		2997.32 9	100 7	0.0	7/2 ⁻
3088.6		996.86 10	100	2091.7	(19/2) ⁻
3122.7	(21/2 ⁻)	1031.05 10	100	2091.7	(19/2) ⁻
3259.2	1/2,3/2,5/2 ⁺	2176.1		1082.01	(1/2) ⁻
		2632.5		627.318	3/2 ⁻
3270.28	(5/2,7/2,9/2)	1249.41 22	100 19	2020.89	(5/2 ⁻ ,7/2 ⁻)
		3270.2 3	67 10	0.0	7/2 ⁻
3344.3		255.71 10	100	3088.6	
3381.9		902.56 10	100	2479.3	
3401.39	5/2 ⁻ ,7/2 ⁻	2774.04 13	100	627.318	3/2 ⁻
3418.79	(5/2,7/2,9/2)	1737.9 3	76 8	1680.78	(7/2) ⁻
		3418.77 15	100 9	0.0	7/2 ⁻
3434.44	(5/2,7/2,9/2)	973.0 4	58 20	2461.67	(5/2 ⁻ ,7/2,9/2 ⁻)
		1344.4 4	55 16	2089.89	(5/2 ⁻ ,7/2 ⁻)
		2352.6 6	100 36	1082.01	(1/2) ⁻
3464.40	(5/2 ⁻ ,7/2 ⁻)	933.0 3	12 4	2531.83	(3/2 ⁻ ,5/2,7/2 ⁻)
		1159.30 17	24 4	2304.88	(5/2 ⁻ ,7/2 ⁻)
		1353.92 19	20 4	2110.85	(5/2 ⁻ to 11/2 ⁻)
		2836.88 16	25.2 26	627.318	3/2 ⁻
		3464.34 9	100 6	0.0	7/2 ⁻
3665.66	5/2,7/2,9/2	1059.9 3	11 4	2605.74	(3/2 ⁻ to 9/2 ⁻)
		3665.61 8	100 6	0.0	7/2 ⁻
3674.62	(5/2,7/2 ⁻)	1500.5 3	49 12	2173.95	(5/2 ⁻ ,7/2 ⁻)
		1563.9 4	34 10	2110.85	(5/2 ⁻ to 11/2 ⁻)
		3047.29 16	100 10	627.318	3/2 ⁻
3701.95	(5/2 ⁻ ,7/2,9/2 ⁻)	267.6 3	65 20	3434.44	(5/2,7/2,9/2)
		1768.19 21	95 15	1933.48	(7/2) ⁻
		1814.6 4	85 25	1887.54	(5/2 ⁻ ,7/2,9/2 ⁻)
		2003.4 3	100 20	1698.69	(5/2) ⁻
		2418.9 4	85 20	1283.32	(9/2) ⁻
3724.19	(5/2,7/2 ⁻)	3096.4 4	33 9	627.318	3/2 ⁻
		3724.20 15	100 9	0.0	7/2 ⁻
3769.21	(5/2,7/2,9/2)	3769.16 11	100	0.0	7/2 ⁻
3820.05	(5/2,7/2,9/2)	3819.99 24	100	0.0	7/2 ⁻
3839.73	(5/2,7/2,9/2)	1818.5 3	84 20	2020.89	(5/2 ⁻ ,7/2 ⁻)
		3839.78 17	100 8	0.0	7/2 ⁻
3853.93	(5/2,7/2,9/2)	3853.87 16	100	0.0	7/2 ⁻
3887.9	(5/2,7/2,9/2)	3887.8 3	100	0.0	7/2 ⁻
3890.9	(25/2 ⁻)	768.18 10	100	3122.7	(21/2) ⁻
3912.27	(5/2,7/2,9/2)	3912.21 21	100	0.0	7/2 ⁻

Adopted Levels, Gammas (continued)

γ(¹³⁹Ba) (continued)

<i>E_i</i> (level)	<i>J_i^π</i>	<i>E_γ[†]</i>	<i>I_γ[‡]</i>	<i>E_f</i>	<i>J_f^π</i>	<i>E_i</i> (level)	<i>J_i^π</i>	<i>E_γ[†]</i>	<i>I_γ[‡]</i>	<i>E_f</i>	<i>J_f^π</i>
3950.84	(5/2) ⁺	1600.7 5	39 15	2349.81	5/2 ⁻ ,7/2 ⁻	(4723.51)	1/2 ⁺	2237.8 3	1.8 4	2485.59	1/2,3/2,5/2 ⁺
		1793.63 17	43 6	2157.00	3/2 ⁻ ,5/2 ⁺			2242.67 6	6.8 4	2480.76	(3/2 ⁻)
		2330.2 6	20 9	1620.73	(7/2 ⁻ ,9/2 ⁺)			2288.19 9	4.3 5	2435.28	1/2 ⁻ ,3/2 ⁻
		3323.66 15	100 10	627.318	3/2 ⁻			2537.88 6	6.6 4	2185.58	1/2 ⁻ ,3/2 ⁻
4046.9		702.61 ^a		3344.3				2564.66 5	3.4 5	2158.85	3/2 ⁻ ,5/2 ⁺
		958.33 10	100	3088.6				2594.29 4	11.3 5	2129.20	3/2 ⁻
4616.3	(29/2 ⁻)	725.33 10	100	3890.9	(25/2 ⁻)			2777.5 7	0.77 23	1946.04	(3/2 ⁻ ,5/2 ⁺)
(4723.51)	1/2 ⁺	1338.4 2	0.98 11	3385.10	(1/2 ⁻ ,3/2 ⁻)			2828.00 4	2.89 23	1895.48	1/2,3/2,5/2 ⁺
		1464.3 3	0.70 11	3259.2	1/2,3/2,5/2 ⁺			2975.3 9	5.38 9	1748.27	3/2 ⁻
		1555.3 2	1.00 11	3168.20	(1/2 ⁻ ,3/2 ⁻)			3641.47 5	37 3	1082.01	(1/2) ⁻
		1698.6 ^{@a} 2	2.3 [@] 3	3024.8	(1/2 ⁻ ,3/2 ⁻)			4096.14 4	100 5	627.318	3/2 ⁻
		2152.5 4	1.09 9	2569.87	(3/2 ⁻)	4956.6	(31/2 ⁻)	340.38 10	100	4616.3	(29/2 ⁻)
		2173.96 23	1.00 11	2549.72	(3/2 ⁻)						

[†] Values represent averages when available from different datasets, except as noted.

[‡] From γ(θ) in (α,nγ).

Theoretical values using BrIcc code. If δ(E2/M1) is not given, value overlaps those for pure M1 and pure E2.

@ Multiply placed with undivided intensity.

& Multiply placed with intensity suitably divided.

^a Placement of transition in the level scheme is uncertain.

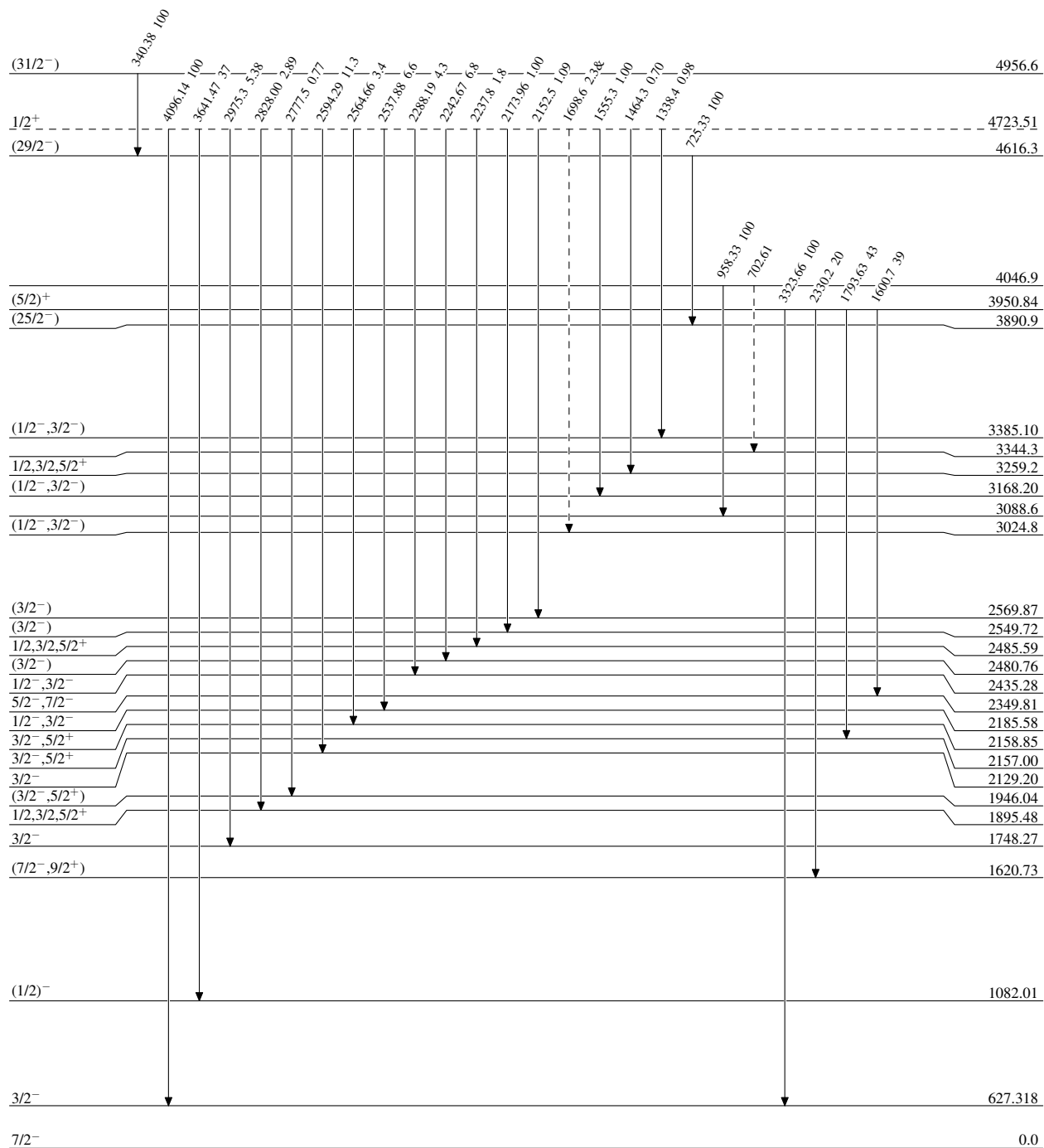
Adopted Levels, Gammas

Legend

Level Scheme

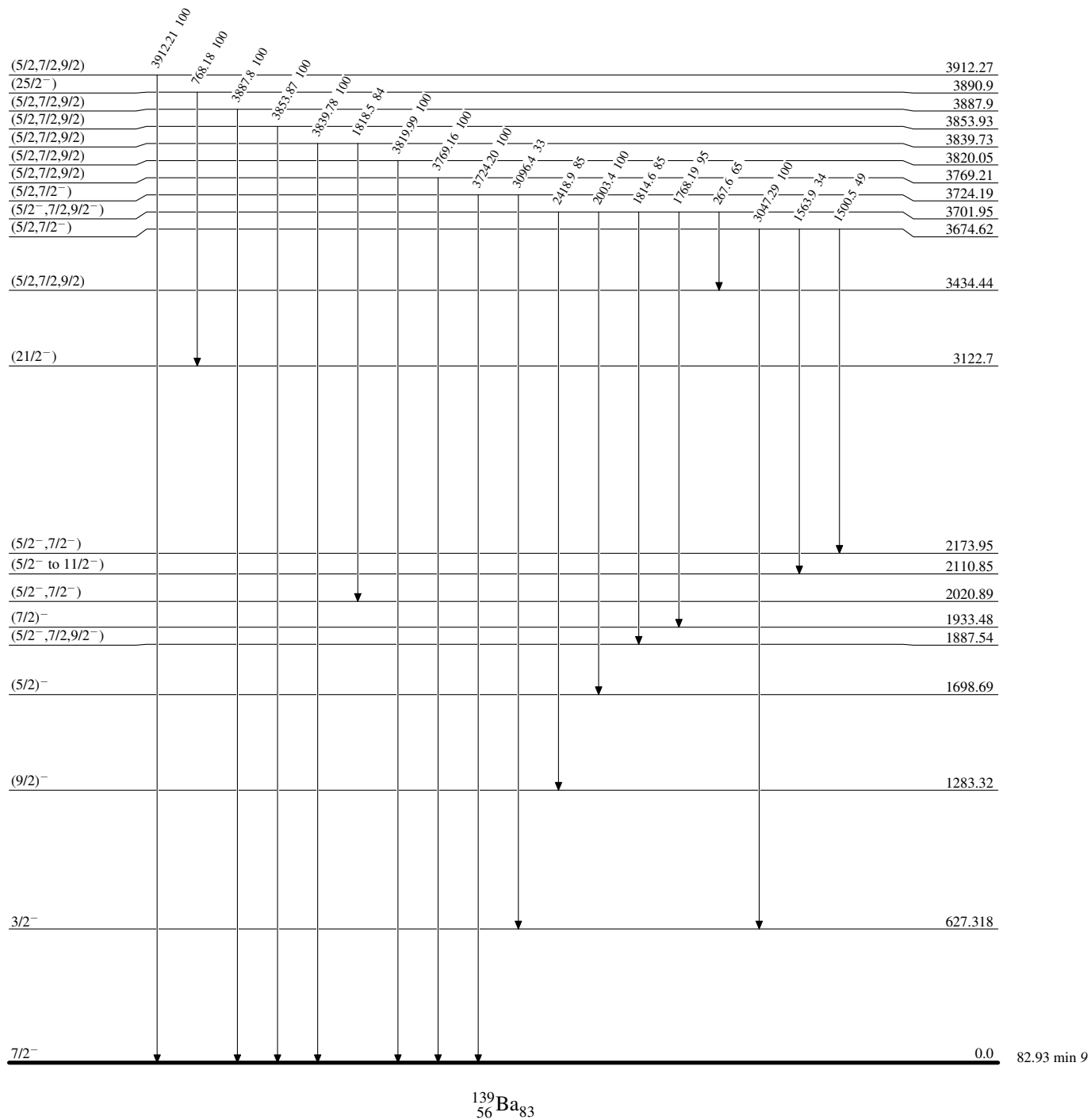
Intensities: Relative photon branching from each level
& Multiply placed: undivided intensity given

-----▶ γ Decay (Uncertain)



Adopted Levels, Gammas**Level Scheme (continued)**

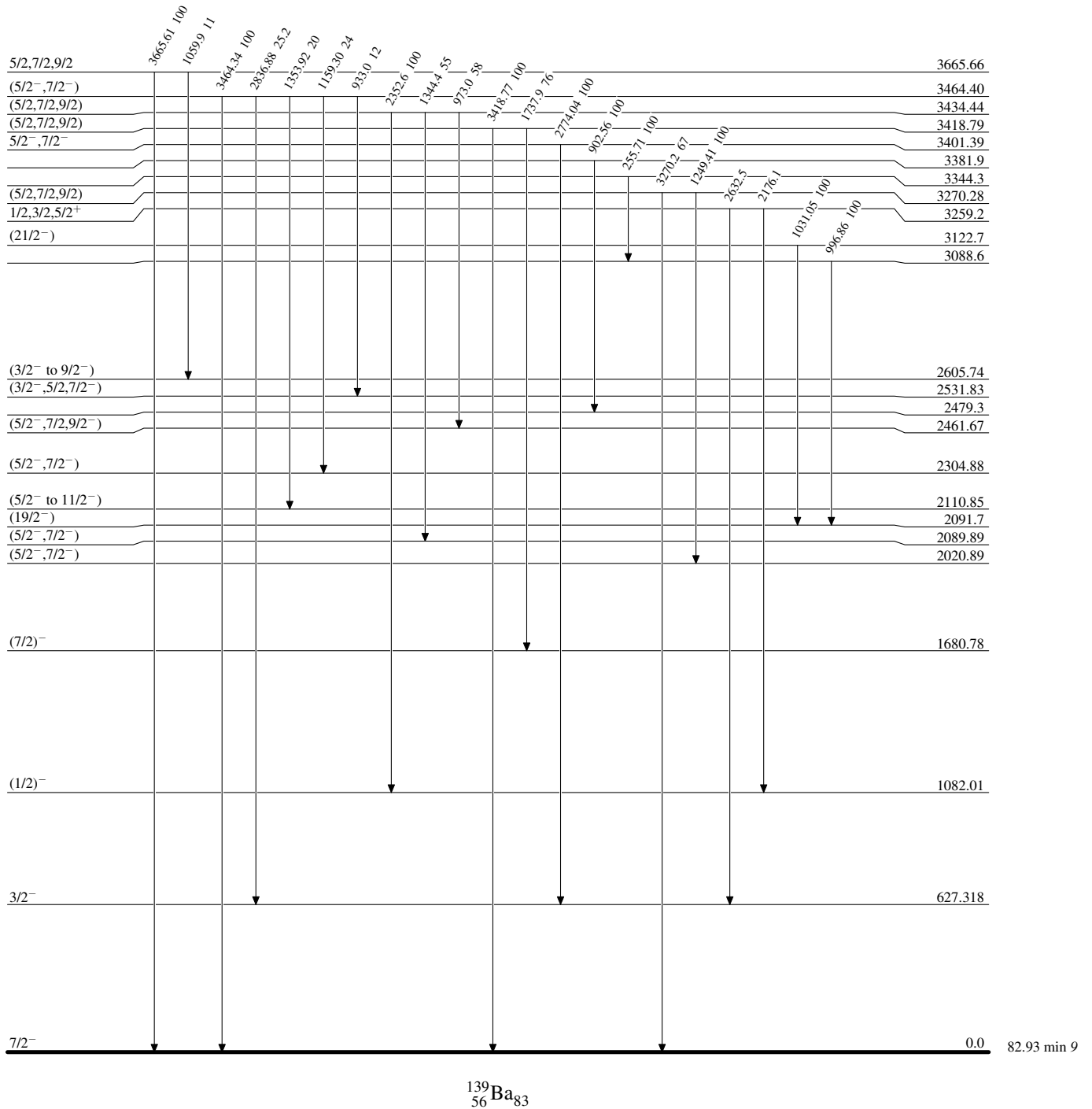
Intensities: Relative photon branching from each level
& Multiply placed: undivided intensity given



Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level
& Multiply placed: undivided intensity given



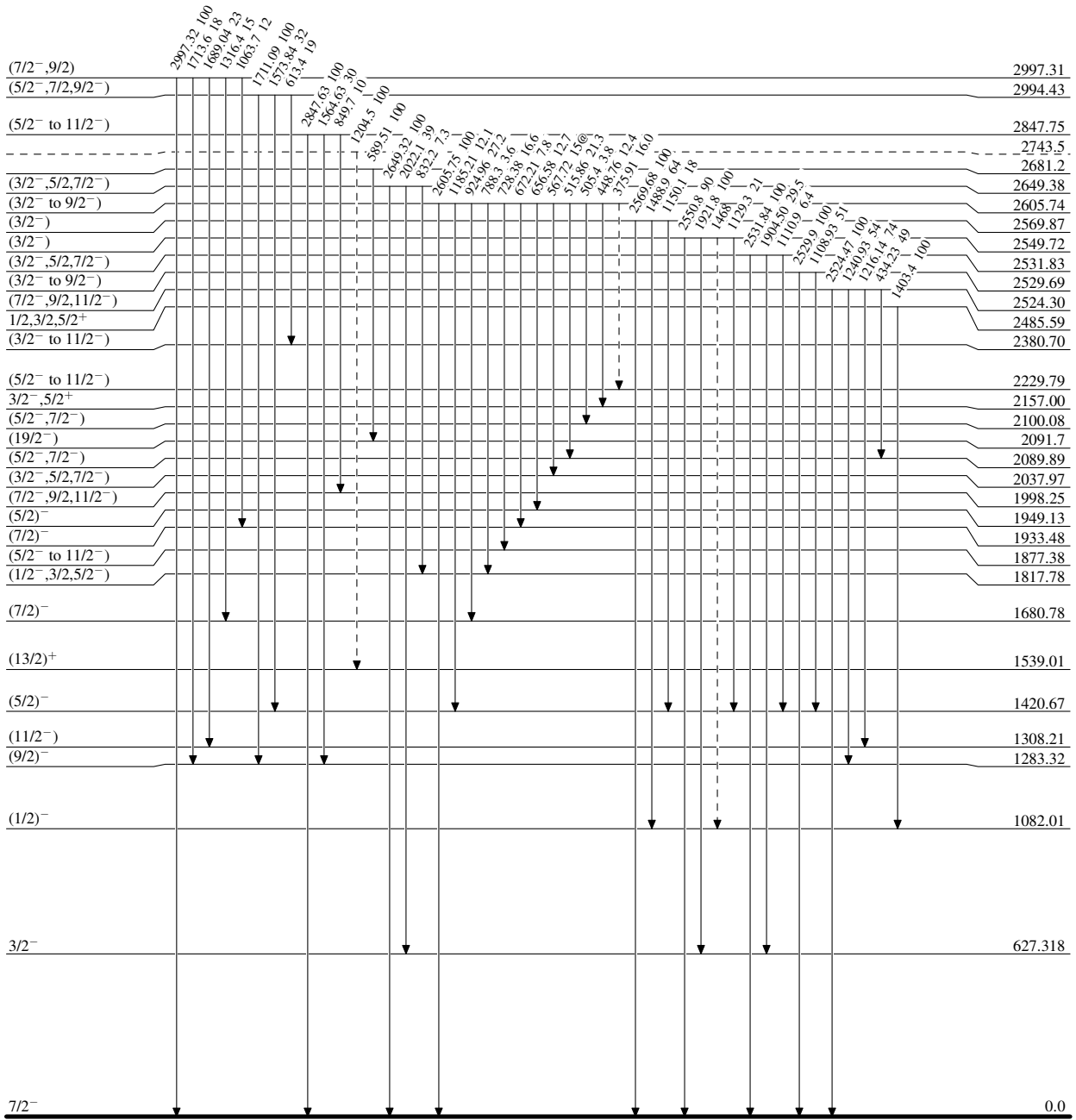
Adopted Levels, Gammas

Level Scheme (continued)

Legend

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

-----▶ γ Decay (Uncertain)



¹³⁹Ba₈₃

82.93 min 9

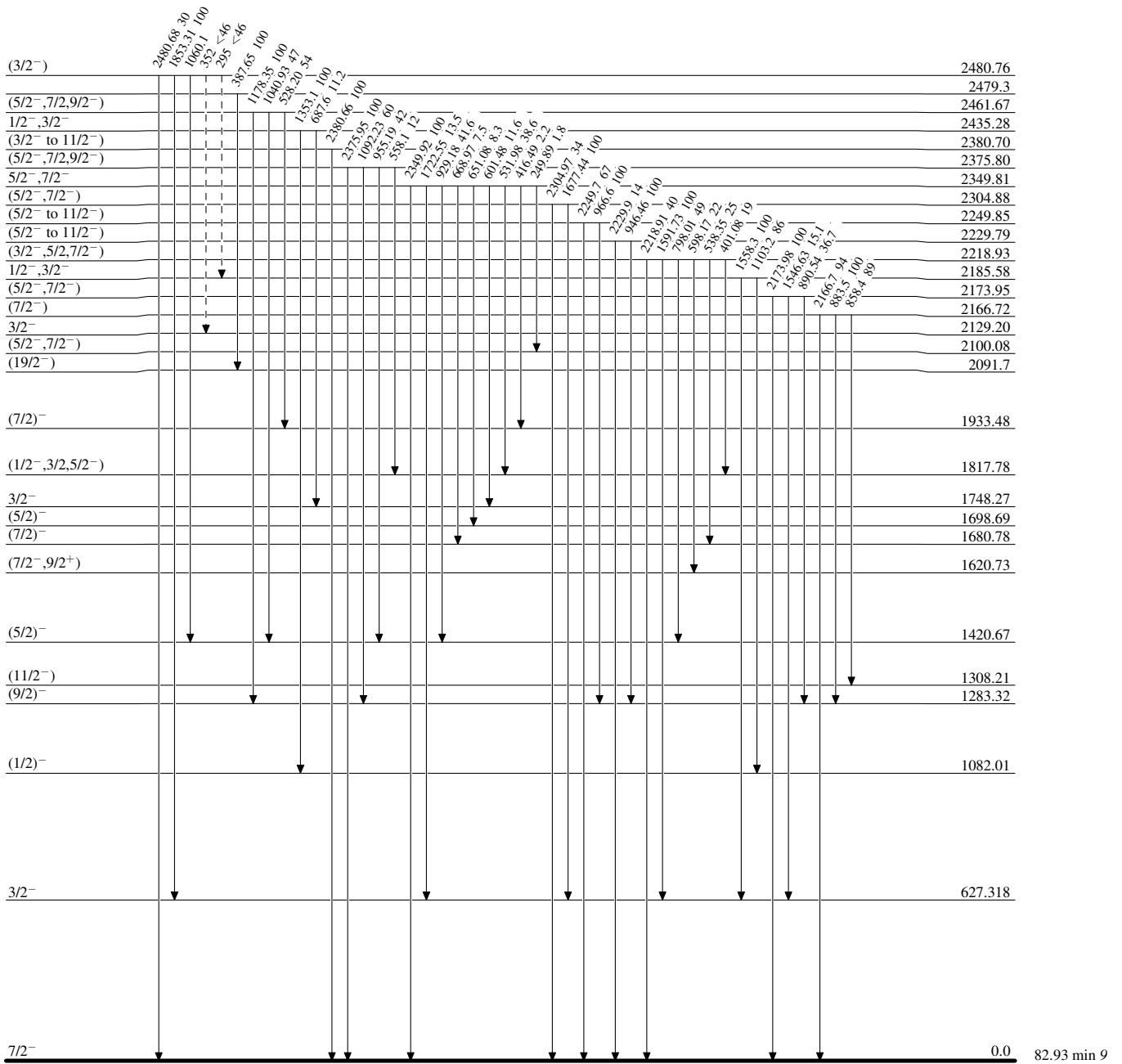
Adopted Levels, Gammas

Level Scheme (continued)

Legend

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

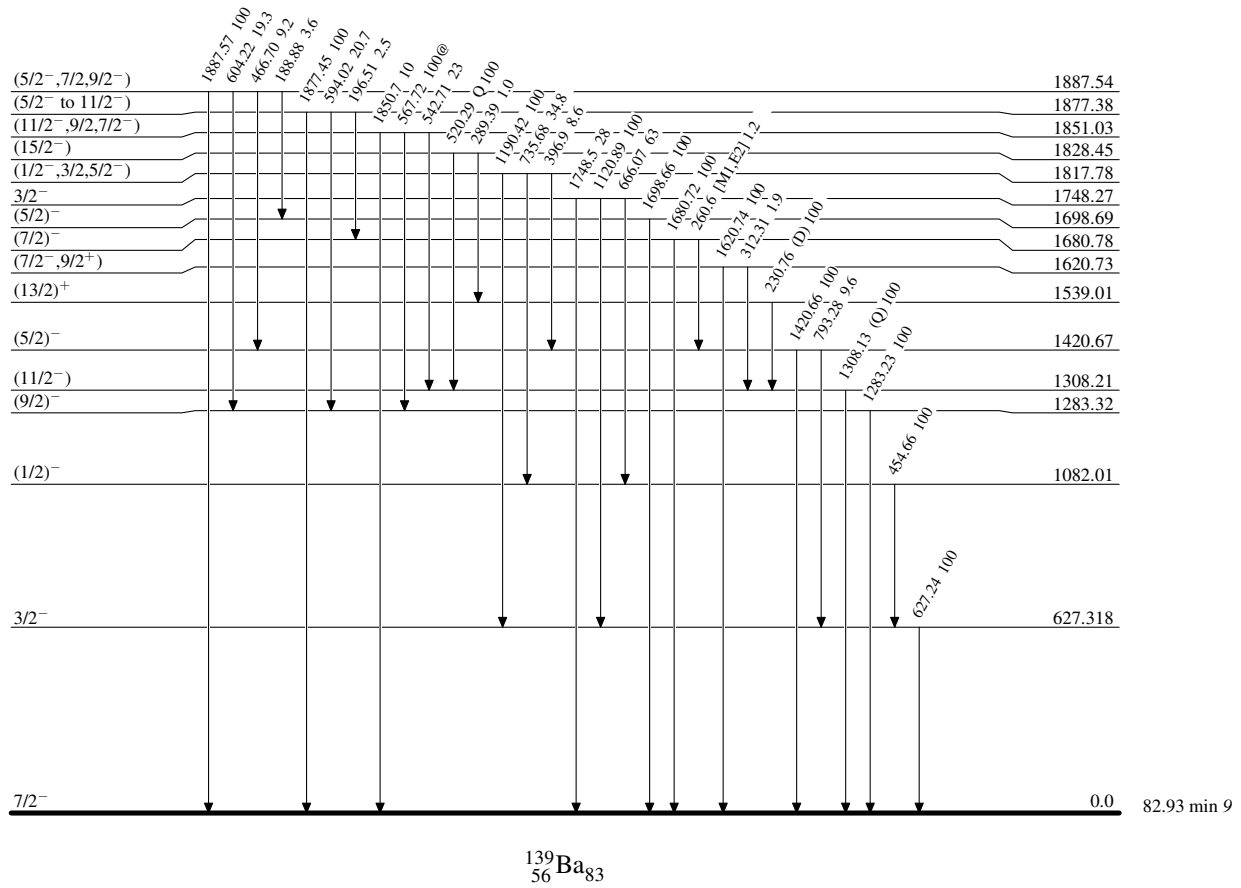
-----▶ γ Decay (Uncertain)

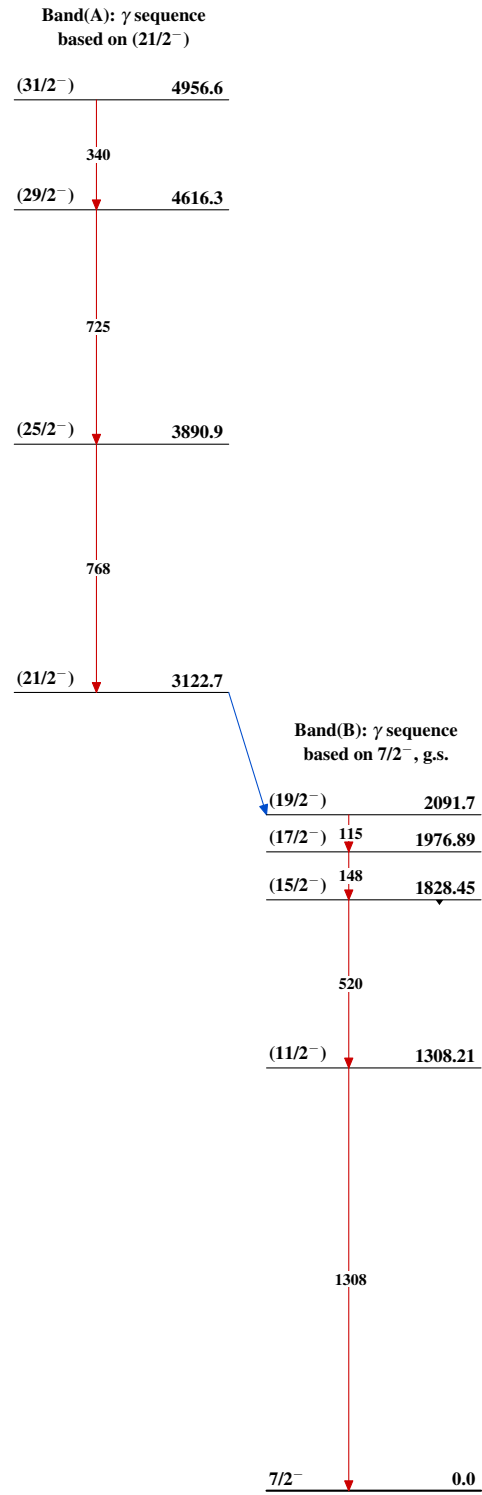


¹³⁹Ba₈₃

Adopted Levels, Gammas**Level Scheme (continued)**

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



Adopted Levels, Gammas $^{139}_{56}\text{Ba}_{83}$