Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh and Jun Chen	NDS 172, 1 (2021)	31-Jan-2021

Q(β^-)=9050 *14*; S(n)=4749 *13*; S(p)=12095 *12*; Q(α)=−8398 *12* 2017Wa10
S(2n)=11175 *14*, S(2p)=27536 *20*, Q(β^-n)=2222 *15* (2017Wa10).
Q(β^-) measurement: 1984Pa19,1985IaZZ.
Other measurements:

1976SeZN associated a 10.5 μs isomer with ^{100}Y, based on the observation of the following γ rays (each decaying with $T_{1/2}\approx10$ μs) in the A=100 mass-separated fission fragments: 172.7 (Iγ=86, $T_{1/2}$=10.5 μs *20*), 184.9 (Iγ=100, $T_{1/2}$=10.5 μs *20*), 357.5 (Iγ=74, $T_{1/2}$=10.5 μs *20*), 391.6 (Iγ=56, $T_{1/2}$=15 μs *3*), 658.2 (Iγ=30). No level scheme was suggested. The existence of this isomer should be considered as tentative since no confirmatory evidence is as yet available.

2006Ca38: Measured resonance fluorescence spectra using collinear laser spectroscopy.

2007Ch07: Measured static moments using laser-spectroscopic method. In this experiment only one state (arbitrarily assumed by 2007Ch07 as the ground state) is observed. No information about the absolute energy and half-life is available from this experiment. The spin analysis by 2007Ch07 favors J=3; J≥4 cannot reproduce the observed hyperfine structure pattern, J=1 suggests unrealistic β_2>0.7 and J=2 suggest β_2=0.47 which is too large to be consistent with a rigid, strongly deformed nucleus. According to e-mail reply from the first author (B. Cheal) of 2007Ch07 on February 1, 2007, there seems uncertainty as to which of the two activities is observed in their experiment, but they claim to have observed only one state which they assume as the g.s. Further work by this group is planned to return to the question of isomerism in ^{100}Y. In the meantime 2007Ha32, in mass measurements have confirmed the existence of isomerism in this nucleus but there is no information about half-life and spin assignments. Following 2007Ch07, evaluators have also assigned the state reported by 2007Ch07 to the ground state, even though, the spin of 3 proposed in this work is inconsistent with adopted $J^\pi=1^-,2^-$. The source of ^{100}Y produced by proton (30 MeV beam) fission of uranium.

2007Ha32: Precision measurement of masses of g.s. and isomer using JYFLTRAP at IGISOL facility in Jyvaskyla. In this work the ground state (most bound state) is populated with twice the intensity of the second (isomeric) state. But there is no information about spins and half-lives from this experiment. The source of ^{100}Y produced by proton (30 MeV beam) fission of uranium, the same method as in 2007Ch07.

2009Pe06, 2012Qu01: ^{100}Y formed by fragmentation of 120 MeV/nucleon ^{136}Xe beam at NSCL facility using Coupled Cyclotrons and A1900 fragment separator. Measured β and γ radiation, half-life of ^{100}Y g.s. decay, and %β^-n. Analysis used least-squares fits and maximum likelihood method.

Theory references: consult the NSR database (www.nndc.bnl.gov/nsr/) for three primary references, two dealing with nuclear structure calculations and one with decay modes and half-lives.

Additional information 1.

With Nilsson configuration of $\pi5/2[422]\otimes\nu3/2[411]$ for the 1^+ level at 10.7 keV and the 4^+ isomer at 145 keV, Gallagher-Moszkowski rule would suggest that 4^+ isomer should be lower in energy than the 1^+ state. This anomaly is inexplicable in the present level scheme. Further experimental work is needed to confirm the relative positions of the 732-ms and 0.94-s activities.

^{100}Y Levels

Cross Reference (XREF) Flags

A	^{100}Sr β^- decay (200 ms)
B	^{101}Sr β^-n decay (118 ms)
C	^{252}Cf SF decay
D	^{7}Li(^{98}Rb,T2NG)

E(level)†	J$^\pi$‡	$T_{1/2}$	XREF	Comments
0.0	(1)$^-$	732 ms *5*	ABCD	%β^-=100; %β^-n=1.02 *6* Evaluated rms charge radius $<r^2>^{1/2}$=4.471 fm *23* (2013An02). Evaluated $\delta<r^2>(^{89}Y,^{100}Sr)$=1.985 fm^2 *1* (2013An02). J$^\pi$: E1 10.7γ from 1$^+$; evidence of β feedings to 2$^+$ and 0$^+$ levels in ^{100}Zr; 1$^-$ favored

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Adopted Levels, Gammas (continued)

^{100}Y Levels (continued)

E(level)[†]	Jπ[‡]	$T_{1/2}$	XREF	Comments
				by proposed configuration=π5/2[303]⊗ν3/2[411] (1987Wo07). From available experimental data, 2^- is less likely, but not totally excluded. $T_{1/2}$: weighted average (NRM) of 0.66 s *+15−12* (2009Pe06); 0.71 s *3* (1996Me09); 0.638 s *17* (1993Ru01); 0.735 s *4* (1986ReZU, supersedes 728 ms *4* in 1986Wa17); 0.735 s *7* (1986Wo01); 0.65 s *15* (1985IaZZ); 0.682 s *18* (1983Mu19); and 0.55 s *15* (1977Kh03). Conventional weighted average gives 729 ms *8*, but with reduced χ^2=5.8, larger than 2.0 at 95% confidence level. Others: 0.845 s *75* (least-squares fit method), 0.840 s *97* (maximum likelihood method), both from 2012Qu01; 0.740 s *20* (1987PfZX). %β^-n: weighted average of 1.8 *6* (1996Me09), 1.08 *5* (1993Ru01), 0.9 *3* (1987PfZX), 0.85 *9* (1986ReZU, supersedes 0.81 *4* in 1986Wa17), and 0.9 *2* (1986Wo01). Note that this value corresponds to one or both the activities: 732-ms g.s. and/or 0.94-s. Other: ≤10 (2009Pe06). Additional information 2.
10.70[@] *2*	1^+		A CD	Jπ: allowed β feeding (log *ft*≈4.6) from 0^+ parent.
76.15[@] *3*	$(2)^+$	72 ps *7*	A CD	Jπ: M1(+E2) γ to 1^+; band member. $T_{1/2}$: from βγγ(t) in ^{100}Sr β^- decay (1990Ma08).
99.16 *2*	(0,1,2)[#]		A	Jπ: 88.5γ to 1^+, 99.2γ to $(1)^-$.
145 *15*	4^+	0.94 s *3*		%β^-=100; %β^-n=1.02 *6* μ=+2.75 *1* (2007Ch07,2010Ba31,2019StZV) Q=+1.85 *20* (2007Ch07,2010Ba31,2016St14) E(level): from JYFLTRAP mass measurements (2007Ha32) at IGISOL facility in Jyvaskyla. 2017Au03 give 144 *16*. Note that measurement by 2007Ha32 gives only the energy difference between the two activities, not the association of either the spin or the half-life with each of the two activities. In β^- spectra measured by 1988GrZX (also M. Graefenstedt et al., in Conf. Proc. AIP 164, 30 (1987)), Q(β)=9310 keV *70* for 0.94-s activity, which gives isomer energy of 260 keV *72*, using Q(β)(for the g.s.)=9050 keV *14* (2017Wa10). $T_{1/2}$: from decay curves of 352γ and 212.5γ: weighted average of 0.94 s *3* (1977Kh03) and 0.8 s *3* (1977Pf01). Jπ: spin from collinear laser spectroscopy technique (2010Ba31), where 0.94-s activity is associated with the 4^+ state. Parity from comparison of measured μ=+2.71 μ_n 1 (2007Ch07) with theoretical values of +2.92 μ_n for the expected 4^+ state with π5/2[422]⊗ν3/2[411] configuration, and +0.46 μ_n for the expected 4^- state with π5/2[503]⊗ν3/2[411] configuration. In 2007Ch07 experiment, J=3 was favored in spin, while J≥4 ruled out from the observed hyperfine structure pattern, J=1 suggested unrealistic β_2>0.7, and J=2 suggested β_2=0.47, much too large to be consistent with a rigid, strongly deformed nucleus. In their later experiment (2010Ba31), J=4 was confirmed. %β^-n: for one or both the 732-ms and 0.94-s activities. See detailed comment about %β^-n value for the g.s. μ,Q: laser-hyperfine spectroscopy (2007Ch07). According to an e-mail reply from the first author (B. Cheal) of 2007Ch07 on February 1, 2007, there seemed uncertainty as to which of the two activities was observed, but they claimed to have observed only one state which they arbitrarily assumed as the g.s., but their later work in 2010Ba31 associated the activity produced with the 0.94-s activity. Note that μ=+2.55 *1* and Q=+1.71 *19* in 2007Ch07 were for J(145 level)=3. In the later 2010Ba31, μ and Q values for J=1,2,3,4 and 5 are listed. Δ<r²>(^{100}Y−^{89}Y)=+1.94 fm² *20* (2007Ch07,2010Ba31) for J(145)=4. 2010Ba31 list also values for J=1,2,3 and 5.
172.03[@] *4*	(3^+)		A CD	Jπ: 95.9γ to $(2)^+$; band member.
194.98 *2*	$(0,1,2^-)$		A	Jπ: 195γ to $(1)^-$; possible β feeding from 0^+ parent.
303.1[@] *5*	(4^+)		C	Jπ: 131.1γ to (3^+); band member.
309.83 *3*	$(0^+,1,2)$[#]		A	Jπ: 299γ to 1^+, 309.7γ to $(1)^-$, 76.2γ to $(2)^+$.
355.75 *4*			A	

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Adopted Levels, Gammas (continued)

^{100}Y Levels (continued)

E(level)[†]	J^{π}[‡]	XREF	Comments
376.07 *3*	$(1^+,2,3^+)$[#]	A	J^{π}: 365.3γ to 1^+; 204.1γ to (3^+).
461.1[@] *7*	(5^+)	C	J^{π}: 158.0γ to (4^+); band member.
483.58 *5*	$(1^+$ to $4^+)$[#]	A	J^{π}: 407γ to $(2)^+$, 311.6γ to (3^+).
656.6[@] *9*	(6^+)	C	J^{π}: 195.5γ to (5^+); band member.
698.71 *8*	$(1^+$ to $4^+)$[#]	A	J^{π}: 622γ to $(2)^+$; 526.7γ to (3^+).
734.03 *6*	$(1^+,2,3^+)$[#]	A	J^{π}: 562.1γ to (3^+), 723.3γ to 1^+.
776.24 *5*		A	
827.97 *8*	$(1^+,2,3^+)$[#]	A	J^{π}: 633.0γ to (1^+), 655.9γ to (3^+).
849.45 *8*		A	
860.60 *4*		A	
861.19 *6*		A	
874.0[@] *10*	(7^+)	C	J^{π}: 217.4γ to (6^+); band member.
974.60 *4*	1^+	A	J^{π}: allowed β feeding (log $ft\approx4.4$) from 0^+ parent. Configuration=π5/2[422]⊗ν3/2[422] (1987Wo07).
1045.70 *13*		A	
1146.33 *9*		A	
1149.46 *9*		A	
1340.74 *6*		A	
1379.16 *4*	$(0^+,1,2^-)$	A	J^{π}: 1379γ to $(1)^-$; 1302γ to $(2)^+$; possible β feeding from 0^+ parent.
1389.85 *11*		A	
1412.14 *14*	$(1^+,2,3^+)$[#]	A	J^{π}: 1401.2γ to 1^+, 1240.1γ to (3^+).
1699.99 *10*		A	

† From a least-squares fit to γ-ray energies.

‡ Since levels are populated by the decay of ^{100}Sr β^- (J^{π}(g.s.)=0^+), J values are expected to be <4. In four cases where levels are populated by strong β^- branches and associated log *ft* values in the range 4.4-5.7, J^{π} is restricted to 1^+ for the two very strong (≈40%) branches and to (1^+) for two medium intensity (≈3%) branches. Log *ft* values for levels with β^- feedings of ≈1% or less have not been used in J^{π} assignments since possible unobserved transitions can affect these feedings significantly.

Assignments of 2^+, 3 or 4 will not be possible if definite β feeding from 0^+ parent is determined in future experiments.

@ Band(A): $K^{\pi}=1^+$, π5/2[422]⊗ν3/2[411]. This band was interpreted by 1987Wo07 (also 1985PeZZ) as a 'pairing-free' rotational band, meaning that moment of inertia was nearly equal to that for a rigid spheroid. However, theoretical calculations by 1987Kr02 using Random-phase approximation (RPA) refuted this claim, and concluded that pairing was reduced only by 50-60%.

$\gamma(^{100}Y)$

E_i(level)	J^π_i	E_γ[†]	I_γ[†]	E_f	J^π_f	Mult.	δ	α[#]	Comments
10.70	1$^+$	10.68 *3*	100	0.0	(1)$^-$	E1		8.55 *14*	α(L)=7.21 *12*; α(M)=1.197 *20*; α(N)=0.1389 *23*; α(O)=0.00506 *8* Mult.: from ^{100}Sr β^- decay, based on intensity balance and expected β feeding.
76.15	(2)$^+$	65.46 *3*	100	10.70	1$^+$	M1(+E2)	<0.1	0.62 *2*	B(M1)(W.u.)=0.67 *+9−7* Mult.,δ: from ce data in ^{100}Sr β^- decay. RUL=300 (for E2) gives δ<0.05.
99.16	(0,1,2)	88.50 *3*	100 *5*	10.70	1$^+$				
		99.20 *3*	90 *4*	0.0	(1)$^-$				
172.03	(3$^+$)	95.94 *4*	100	76.15	(2)$^+$				
194.98	(0,1,2$^-$)	95.91 *4*	23.1 *16*	99.16	(0,1,2)				
		195.01 *3*	100 *5*	0.0	(1)$^-$				
303.1	(4$^+$)	131.1[‡]		172.03	(3$^+$)				
309.83	(0$^+$,1,2)	114.86 *5*	15.7 *11*	194.98	(0,1,2$^-$)				
		233.77 *4*	32.9 *18*	76.15	(2)$^+$				
		299.03 *5*	100 *7*	10.70	1$^+$				
		309.68 *6*	67 *4*	0.0	(1)$^-$				
355.75		256.63 *4*	100	99.16	(0,1,2)				
376.07	(1$^+$,2,3$^+$)	66.0 *6*	34 *5*	309.83	(0$^+$,1,2)				
		181.17 *3*	76 *4*	194.98	(0,1,2$^-$)				
		204.11 *8*	8.1 *13*	172.03	(3$^+$)				
		276.90 *6*	29 *3*	99.16	(0,1,2)				
		299.70 *6*	34.2 *22*	76.15	(2)$^+$				
		365.31 *4*	100 *5*	10.70	1$^+$				
461.1	(5$^+$)	158.0[‡]		303.1	(4$^+$)				
483.58	(1$^+$ to 4$^+$)	107.43 *11*	92 *13*	376.07	(1$^+$,2,3$^+$)				
		127.65 *11*	25 *4*	355.75					
		288.7 *3*	7.7 *19*	194.98	(0,1,2$^-$)				
		311.62 *19*	54 *12*	172.03	(3$^+$)				
		384.55 *14*	81 *14*	99.16	(0,1,2)				
		407.43 *8*	100 *12*	76.15	(2)$^+$				
656.6	(6$^+$)	195.5[‡]		461.1	(5$^+$)				
698.71	(1$^+$ to 4$^+$)	526.72 *8*	46 *8*	172.03	(3$^+$)				
		622.47 *11*	100 *12*	76.15	(2)$^+$				
734.03	(1$^+$,2,3$^+$)	562.08 *18*	3.8 *9*	172.03	(3$^+$)				
		657.84 *9*	30 *3*	76.15	(2)$^+$				
		723.33 *6*	100 *9*	10.70	1$^+$				
776.24		466.46 *6*	100 *7*	309.83	(0$^+$,1,2)				
		581.26 *6*	63 *4*	194.98	(0,1,2$^-$)				
827.97	(1$^+$,2,3$^+$)	633.04 *10*	89 *9*	194.98	(0,1,2$^-$)				
		655.87 *11*	100 *16*	172.03	(3$^+$)				
849.45		473.33 *15*	100 *15*	376.07	(1$^+$,2,3$^+$)				

$^{100}_{39}Y_{61}$-4

$\gamma(^{100}Y)$ (continued)

E_i(level)	J^π_i	E_γ†	I_γ†	E_f	J^π_f
849.45		539.64 *8*	89 *11*	309.83	(0$^+$,1,2)
860.60		376.96 *7*	100 *7*	483.58	(1$^+$ to 4$^+$)
		484.77 *8*	89 *8*	376.07	(1$^+$,2,3$^+$)
		505.09 *8*	66 *6*	355.75	
		550.45 *19*	21 *4*	309.83	(0$^+$,1,2)
		665.45 *8*	58 *6*	194.98	(0,1,2$^-$)
861.19		762.06 *6*	100 *10*	99.16	(0,1,2)
		861.02 *11*	62 *7*	0.0	(1)$^-$
874.0	(7$^+$)	217.4‡		656.6	(6$^+$)
974.60	1$^+$	875.45 *11*	1.56 *17*	99.16	(0,1,2)
		898.50 *4*	86 *4*	76.15	(2)$^+$
		963.85 *4*	100 *4*	10.70	1$^+$
1045.70		873.90 *14*	100 *20*	172.03	(3$^+$)
		969.02 *21*	59 *14*	76.15	(2)$^+$
1146.33		285.11 *8*	100 *15*	861.19	
		951.46 *16*	97 *15*	194.98	(0,1,2$^-$)
1149.46		1073.31 *8*	100	76.15	(2)$^+$

E_i(level)	J^π_i	E_γ†	I_γ†	E_f	J^π_f
1340.74		564.56 *7*	30.0 *22*	776.24	
		964.57 *8*	100 *9*	376.07	(1$^+$,2,3$^+$)
		1241.66 *19*	27 *5*	99.16	(0,1,2)
1379.16	(0$^+$,1,2$^-$)	518.67 *6*	100 *6*	860.60	
		602.95 *9*	65 *6*	776.24	
		1003.04 *11*	37 *7*	376.07	(1$^+$,2,3$^+$)
		1069.24 *6*	97 *7*	309.83	(0$^+$,1,2)
		1183.90 *17*	12 *3*	194.98	(0,1,2$^-$)
		1280.08 *17*	23 *6*	99.16	(0,1,2)
		1302.89 *16*	18 *2*	76.15	(2)$^+$
		1379.25 *15*	61 *7*	0.0	(1)$^-$
1389.85		240.64@ *8*	62 *6*	1149.46	
		1313.70 *10*	100 *7*	76.15	(2)$^+$
1412.14	(1$^+$,2,3$^+$)	1240.12 *14*	100 *10*	172.03	(3$^+$)
		1401.2 *4*	50 *13*	10.70	1$^+$
1699.99		1623.78 *10*	100 *6*	76.15	(2)$^+$
		1689.61 *25*	27 *8*	10.70	1$^+$

† From ^{100}Sr β^- decay, unless otherwise stated.

‡ From ^{252}Cf SF decay.

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.

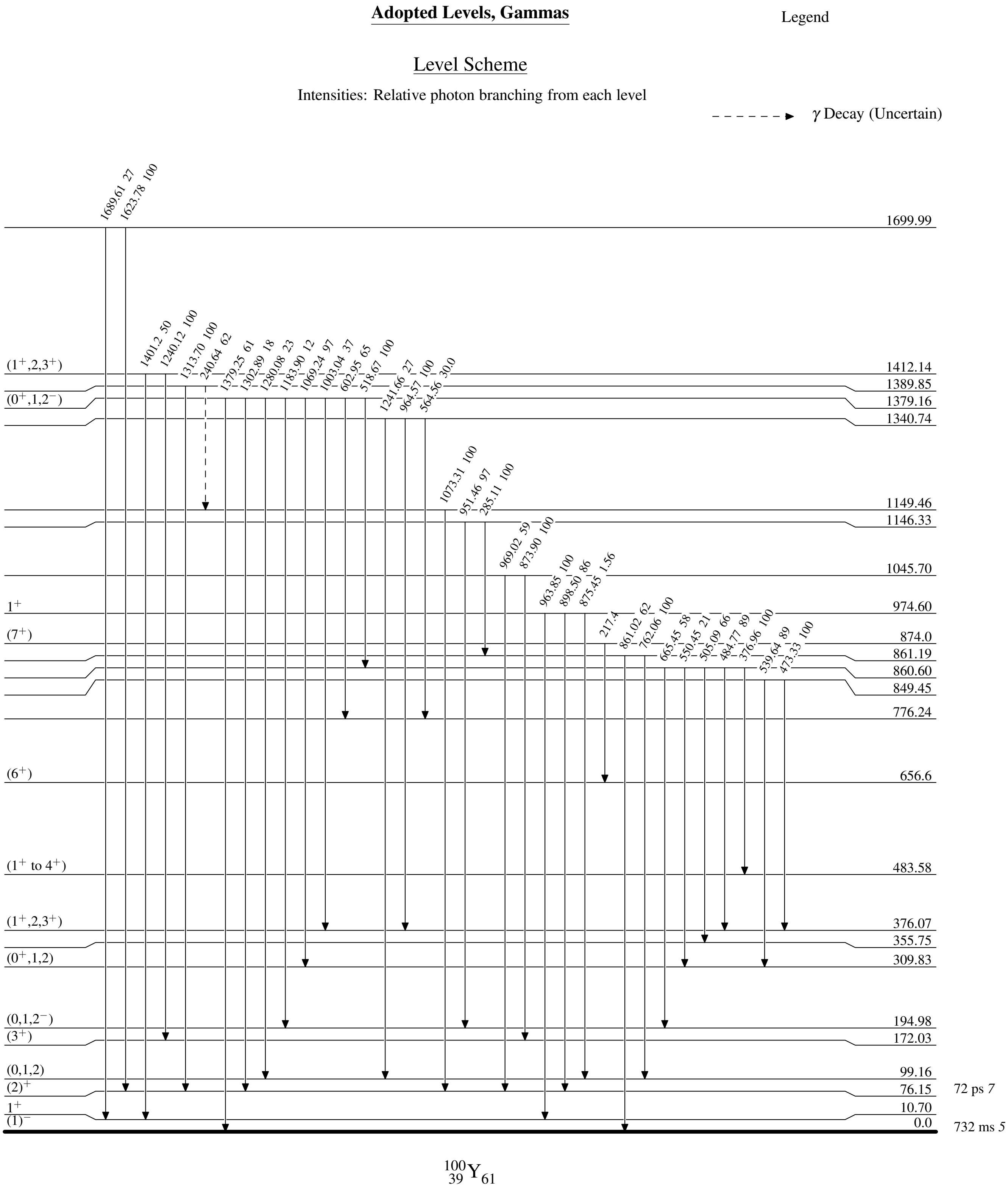
@ Placement of transition in the level scheme is uncertain.

$^{100}_{39}Y_{61}$-5

Adopted Levels, Gammas

Level Scheme

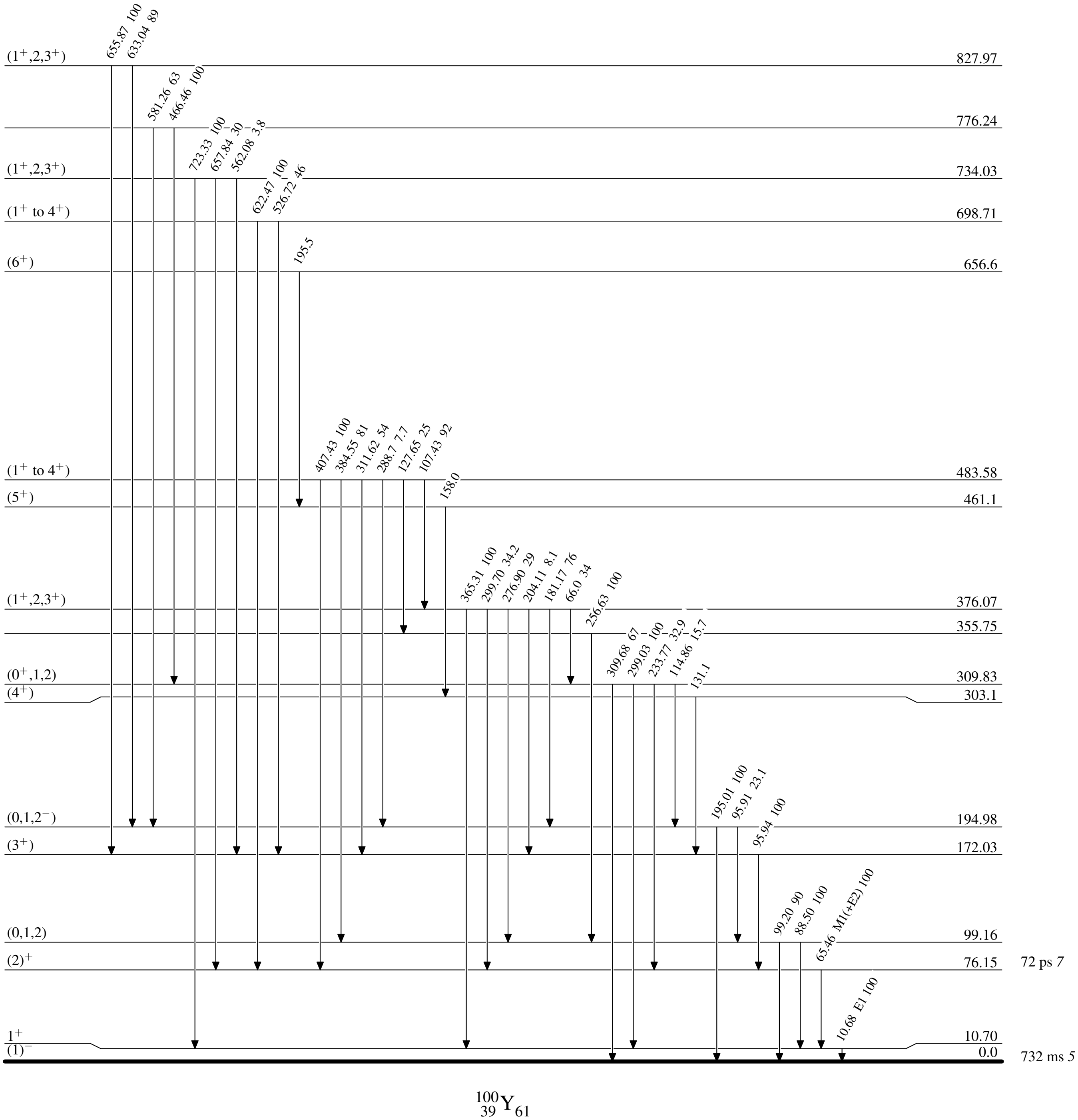
Intensities: Relative photon branching from each level



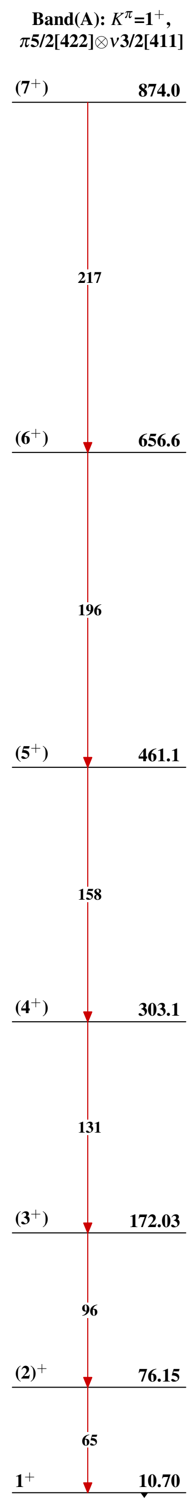
Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level



Adopted Levels, Gammas



$^{100}_{39}Y_{61}$