Adopted Levels, Gammas

History			
Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh	ENSDF	30-Sep-2020

Q(β^-)=5220.5 *24*; S(n)=7767 *3*; S(p)=10978.3 *28*; Q(α)=−9430 *3* 2017Wa10
S(2n)=13670 *3*, S(2p)=26099 *3* (2017Wa10).
Measured mass excess for ^{77}Ga=−65995.0 keV *42* (2019Hu15), as compared to −65992.3 keV *24* in 2017Wa10 leads to Q(β^-)=5217.9 keV *42*.
1968Wi11: ^{77}Ga isotope identified and produced in ^{235}U(n,F), and subsequent counting of γ spectra.
2010Ch16: measurement of spin and static magnetic and quadrupole moment of g.s. E(p)=1.4 GeV; target=UC_x. Measured optical hyperfine spectra ISOLDE, CERN using collinear laser spectroscopy. Deduced spin, magnetic moment and quadrupole moment. Comparison with shell-model calculations.
2012Pr11: E(p)=1.4 GeV incident on UC_x target at ISOLDE-CERN facility. Fragments diffused out of target and surface ionized, then accelerated to 30 keV, followed by mass separation and bunched by gas-filled Paul Trap (ISCOOL). Isotope shifts were measured by collinear laser spectroscopy using COLLAPS setup at ISOLDE-CERN. Deduced rms charge radius and isotope shift.
2019Hu15: measured mass excess=−65995.0 keV *42*, as compared to −65992.3 keV *24* in 2017Wa10.
Theoretical calculations: consult the NSR database at www.nndc.bnl.gov for five primary theory references dealing with nuclear structure calculations.
Additional information 1.

^{77}Ga Levels

Cross Reference (XREF) Flags

- A ^{77}Zn β^- decay (2.08 s)
- B ^{77}Zn β^- decay (1.05 s)
- C ^{238}U(^{76}Ge,Xγ)

E(level)[†]	J$^\pi$[‡]	$T_{1/2}$[a]	XREF	Comments
0.0[b]	3/2$^{(-)}$	13.2 s *2*	A C	%β^-=100 μ=+2.018 *3* (2010Ch16,2019StZV) Q=−0.208 *13* (2010Ch16,2016St14) Measured δ<r^2>(^{71}Ga,^{77}Ga)=+0.308 fm^2 *4*(stat) *74*(syst) (2012Pr11). Measured isotope shift $\delta\nu$(^{71}Ga,^{77}Ga)=−109.4 MHz *15*(stat) *110*(syst) (2012Pr11). J$^\pi$: spin from hyperfine structure and collinear laser spectroscopy; parity from dominant configuration=$\pi f^3_{5/2}$ (2010Ch16) deduced from magnetic dipole moment. Proposed configuration=$\pi f^2_{5/2}\otimes\pi p_{3/2}$) (2011Ma45). μ,Q: collinear laser spectroscopy (2010Ch16). See also 2017Ne04 review article. Measured μ=+2.020 *3* by 2010Ch16 is re-evaluated to μ=+2.018 *3*. $T_{1/2}$: from 1977Al17. Other: 17.1 s *15* (1968Wi11).
105.66 *4*	(1/2$^-$)[#]	<4 ns	A	
160.95 *3*	(3/2$^-$)[#]	<2 ns	A	
189.49[c] *3*	(5/2$^-$)[#]	<2 ns	A C	
474.064 *25*	(5/2$^-$)		A C	
626.41[b] *3*	(7/2$^-$)		A C	
873.35 *3*	(7/2$^-$)		A	J$^\pi$: γ to 3/2$^{(-)}$; γ from (11/2$^-$).
1116.33[c] *4*	(9/2$^-$)		A C	
1233.97 *5*	(3/2$^-$,5/2$^-$)		A	J$^\pi$: gammas to (1/2$^-$) and (5/2$^-$); possible beta seeding from (7/2$^+$).
1282.38 *5*	(7/2$^-$,9/2$^-$)		A	J$^\pi$: γ to (5/2$^-$); γ from (11/2$^-$).
1403.19 *8*			A	
1477.33[b] *6*	(11/2$^-$)		A C	
1515.89 *6*			A	

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Adopted Levels, Gammas (continued)

^{77}Ga Levels (continued)

E(level)[†]	Jπ[‡]	$T_{1/2}$[a]	XREF	E(level)[†]	Jπ[‡]	XREF
1797.11 *21*			A	2385.01 *6*		A
1831.99 *4*	(+)[&]		A	2425.68 *5*		A
1857.85 *6*			A	2620.91 *22*	(13/2+)	C
1872.55 *4*			A	2698.77 *5*	(+)[&]	A
1970.01 *4*	(11/2−)		A C	2805.72 *6*	(+)[&]	A
2028.29 *5*			A	2828.59 *21*		A
2028.81 *7*	(9/2+)[@]	4.4 ns *8*	A C	2861.8 *3*		A
2138.03 *4*	(+)[&]		A	3217.7[c] *3*	(17/2−)	C
2149.31 *6*			A	3242.97 *12*		A
2207.14[c] *21*	(13/2−)		C	3267.63 *5*	(+)[&]	A
2327.5 *8*			A	3529.92 *16*		A
2348.52 *5*			A	3945.89 *21*		A
2357.15 *5*			A			

[†] From least-squares fit to Eγ data. Reduced χ^2=2.0 with increased uncertainties for five γ-ray energies.
[‡] log *ft* values for levels above 200 keV restrict J^π to 5/2, 7/2 or 9/2, assuming J^π=7/2 for ^{77}Zn g.s. J^π=9/2 is not likely for the levels that decay to g.s. with $J^\pi=3/2^{(-)}$. For high-spin (J>9/2) states, tentative assignments are based on shell-model predictions and comparisons of band structures in neighboring odd A Ga nuclides.
[#] From comparison to neighboring odd A nuclides (1986Ek01). Parity from γ ray multipolarities.
[@] No gammas to low-spin states (≤5/2) from this isomer. 1986Ek01 assign 9/2+ on the basis of systematics of neighboring nuclides.
[&] Possible allowed β transition from log *ft*=5.2 to 5.5 from (7/2+).
[a] For excited levels, values are from γγ(t) in ^{77}Zn β− decay (2.08 s).
[b] Seq.(A): γ cascade based on $3/2^{(-)}$.
[c] Seq.(B): γ cascade based on (5/2−).

γ(^{77}Ga)

E_i(level)	J_i^π	E_γ	I_γ	E_f	J_f^π	Mult.[#]	α[a]	Comments
105.66	(1/2−)	105.66 *5*	100	0.0	$3/2^{(-)}$	(M1)	0.0602	B(M1)(W.u.)>0.0044 α(K)=0.0536 *8*; α(L)=0.00568 *8*; α(M)=0.000830 *12*; α(N)=4.41×10−5 *7*
160.95	(3/2−)	55.1 *2*	23.3 *10*	105.66	(1/2−)	(M1)	0.364 *7*	B(M1)(W.u.)>0.011 α(K)=0.324 *6*; α(L)=0.0348 *6*; α(M)=0.00510 *9*; α(N)=0.000268 *5*
		160.93 *5*	100 *10*	0.0	$3/2^{(-)}$			
189.49	(5/2−)	189.49 *4*	100	0.0	$3/2^{(-)}$	(M1)	0.01298	B(M1)(W.u.)>0.0016 α(K)=0.01159 *17*; α(L)=0.001206 *17*; α(M)=0.0001766 *25*; α(N)=9.45×10−6 *14*
474.064	(5/2−)	284.56 *5*	9.0 *9*	189.49	(5/2−)			
		313.12 *6*	12.0 *9*	160.95	(3/2−)			
		368.44 *5*	20.6 *7*	105.66	(1/2−)			
		473.94 *5*	100 *10*	0.0	$3/2^{(-)}$			
626.41	(7/2−)	152.43 *6*	75 *7*	474.064	(5/2−)	[D,E2]	0.08 *6*	I_γ: other: 29 *3* in ^{238}U(^{76}Ge,Xγ).
		436.80 *8*	58 *5*	189.49	(5/2−)			
		465.5 *2*	65 *5*	160.95	(3/2−)			
		626.40 *5*	100 *10*	0.0	$3/2^{(-)}$			
873.35	(7/2−)	246.90 *5*	12.8 *20*	626.41	(7/2−)			
		399.16[‡] *5*	72 *8*	474.064	(5/2−)			E_γ: level-energy difference=399.29.
		684.0 *1*	26.4 *16*	189.49	(5/2−)			

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Adopted Levels, Gammas (continued)

γ(^{77}Ga) (continued)

E_i(level)	J_i^π	E_γ	I_γ	E_f	J_f^π	Mult.[#]	Comments
873.35	(7/2$^-$)	712.41 *5*	10.0 *16*	160.95	(3/2$^-$)		
		873.44 *5*	100 *12*	0.0	3/2$^{(-)}$		
1116.33	(9/2$^-$)	489.7 *2*	3.7 *18*	626.41	(7/2$^-$)		
		926.84 *5*	100 *11*	189.49	(5/2$^-$)		
		1116.6 *3*	2.6 *4*	0.0	3/2$^{(-)}$	[M3]	
1233.97	(3/2$^-$,5/2$^-$)	759.82 *6*	24 *3*	474.064	(5/2$^-$)		
		1128.34 *9*	27 *3*	105.66	(1/2$^-$)		
		1234.1 *1*	100 *6*	0.0	3/2$^{(-)}$		
1282.38	(7/2$^-$,9/2$^-$)	408.5[†b] *2*	14.3 *14*	873.35	(7/2$^-$)		
		808.29 *5*	100 *14*	474.064	(5/2$^-$)		
		1093.1 *1*	25.0 *21*	189.49	(5/2$^-$)		
1403.19		1242.1 *1*	20 *10*	160.95	(3/2$^-$)		
		1403.3 *1*	100 *10*	0.0	3/2$^{(-)}$		
1477.33	(11/2$^-$)	195.0 *2*	10 *3*	1282.38	(7/2$^-$,9/2$^-$)		
		361.1 *2*	21 *3*	1116.33	(9/2$^-$)		I$_\gamma$: 37 *4* in ^{238}U(^{76}Ge,Xγ).
		850.89 *7*	100 *8*	626.41	(7/2$^-$)		
1515.89		1041.81 *5*	100 *8*	474.064	(5/2$^-$)		
		1326.8 *4*	24 *3*	189.49	(5/2$^-$)		
1797.11		1607.6 *2*	100	189.49	(5/2$^-$)		
1831.99	(+)	597.8 *3*	16.1 *16*	1233.97	(3/2$^-$,5/2$^-$)		
		1357.90 *5*	43 *3*	474.064	(5/2$^-$)		
		1832.0 *2*	100 *7*	0.0	3/2$^{(-)}$		
1857.85		1751.60[‡&] *7*	100 *8*	105.66	(1/2$^-$)		E$_\gamma$: level-energy difference=1752.17.
		1857.82 *7*	56 *6*	0.0	3/2$^{(-)}$		
1872.55		756.17 *5*	65 *13*	1116.33	(9/2$^-$)		
		999.22 *4*	100 *8*	873.35	(7/2$^-$)		
1970.01	(11/2$^-$)	688.0[‡@] *1*	9 *4*	1282.38	(7/2$^-$,9/2$^-$)		E$_\gamma$: level-energy difference=687.7.
		853.70 *6*	63 *19*	1116.33	(9/2$^-$)		
		1096.61 *5*	100 *6*	873.35	(7/2$^-$)		
		1343.9 *5*	19.4 *19*	626.41	(7/2$^-$)		
2028.29		196.8[‡] *2*	8.4 *21*	1831.99	(+)		E$_\gamma$: level-energy difference=196.3.
		1154.86 *5*	48 *3*	873.35	(7/2$^-$)		
		1401.5 *6*	18.9 *21*	626.41	(7/2$^-$)		
		1554.55[‡@] *7*	28 *4*	474.064	(5/2$^-$)		E$_\gamma$: level-energy difference=1554.21.
		1838.75 *8*	100 *4*	189.49	(5/2$^-$)		
2028.81	(9/2$^+$)	551.47 *5*	100 *5*	1477.33	(11/2$^-$)	[E1]	B(E1)(W.u.)=3.9×10^{-7} *8*
		746.6 *4*	8.3 *21*	1282.38	(7/2$^-$,9/2$^-$)	[E1]	B(E1)(W.u.)=1.3×10^{-8} *4*
		912.0 *10*	23 *5*	1116.33	(9/2$^-$)	[E1]	B(E1)(W.u.)=2.0×10^{-8} *6* I$_\gamma$: 34 *5* in ^{238}U(^{76}Ge,Xγ).
2138.03	(+)	168.09 *5*	6.2 *14*	1970.01	(11/2$^-$)		
		305.94 *5*	100 *10*	1831.99	(+)		
		855.7 *6*	38 *14*	1282.38	(7/2$^-$,9/2$^-$)		
		1021.6 *5*	2.4 *9*	1116.33	(9/2$^-$)		
		1264.60 *5*	71 *5*	873.35	(7/2$^-$)		
		1511.73 *7*	30 *3*	626.41	(7/2$^-$)		
		1663.93 *7*	71 *5*	474.064	(5/2$^-$)		
2149.31		291.42 *5*	100 *10*	1857.85			
		1988.7[@] *1*	40 *4*	160.95	(3/2$^-$)		
2207.14	(13/2$^-$)	1090.8 *2*	100	1116.33	(9/2$^-$)		
2327.5		357.5 *8*	100	1970.01	(11/2$^-$)		
2348.52		378.48 *5*	23 *3*	1970.01	(11/2$^-$)		
		516.57 *6*	100 *8*	1831.99	(+)		
2357.15		219.07 *5*	82 *8*	2138.03	(+)		
		387.0 *1*	22 *6*	1970.01	(11/2$^-$)		

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Adopted Levels, Gammas (continued)

γ(^{77}Ga) (continued)

E_i(level)	J_i^π	E_γ	I_γ	E_f	J_f^π
2357.15		1483.96 *7*	100 *6*	873.35	(7/2$^-$)
2385.01		235.68 *5*	39 *8*	2149.31	
		1269.0 *2*	29 *5*	1116.33	(9/2$^-$)
		1758.8 *2*	100 *11*	626.41	(7/2$^-$)
		2195.43 *8*	79 *8*	189.49	(5/2$^-$)
2425.68		2264.74 *7*	100 *10*	160.95	(3/2$^-$)
		2425.64 *7*	100 *10*	0.0	3/2$^{(-)}$
2620.91	(13/2$^+$)	592.1 *2*	100	2028.81	(9/2$^+$)
2698.77	($^+$)	560.74 *5*	100 *5*	2138.03	($^+$)
		669.95 *10*	66 *22*	2028.81	(9/2$^+$)
		670.46 *10*	66 *22*	2028.29	
2805.72	($^+$)	667.7 *1*	35 *12*	2138.03	($^+$)
		835.70 *5*	100 *12*	1970.01	(11/2$^-$)
2828.59		800.3 *2*	100	2028.29	
2861.8		2672.3 *3*	100	189.49	(5/2$^-$)
3217.7	(17/2$^-$)	1010.6 *2*	100	2207.14	(13/2$^-$)
3242.97		1385.1 *1*	100	1857.85	
3267.63	($^+$)	842.00 *9*	100 *10*	2425.68	
		919.0 *10*	68 *15*	2348.52	
		1436.0[@] *1*	51 *7*	1831.99	($^+$)
		2793.6 *1*	49 *7*	474.064	(5/2$^-$)
		3106.4[†b] *1*	154 *15*	160.95	(3/2$^-$)
		3267.5 *1*	61 *7*	0.0	3/2$^{(-)}$
3529.92		1560.4 *4*	57 *10*	1970.01	(11/2$^-$)
		3056.3 *3*	100 *10*	474.064	(5/2$^-$)
		3340.0 *2*	52 *14*	189.49	(5/2$^-$)
3945.89		3756.3 *2*	100	189.49	(5/2$^-$)

† Placement suggested by the evaluators, based on reported γγ data of 1986Ek01.
‡ Somewhat poor energy fit.
# From ce data.
@ Uncertainty of Eγ doubled to get an acceptable fit.
& Uncertainty of Eγ tripled to get an acceptable fit.
[a] 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.
[b] Placement of transition in the level scheme is uncertain.

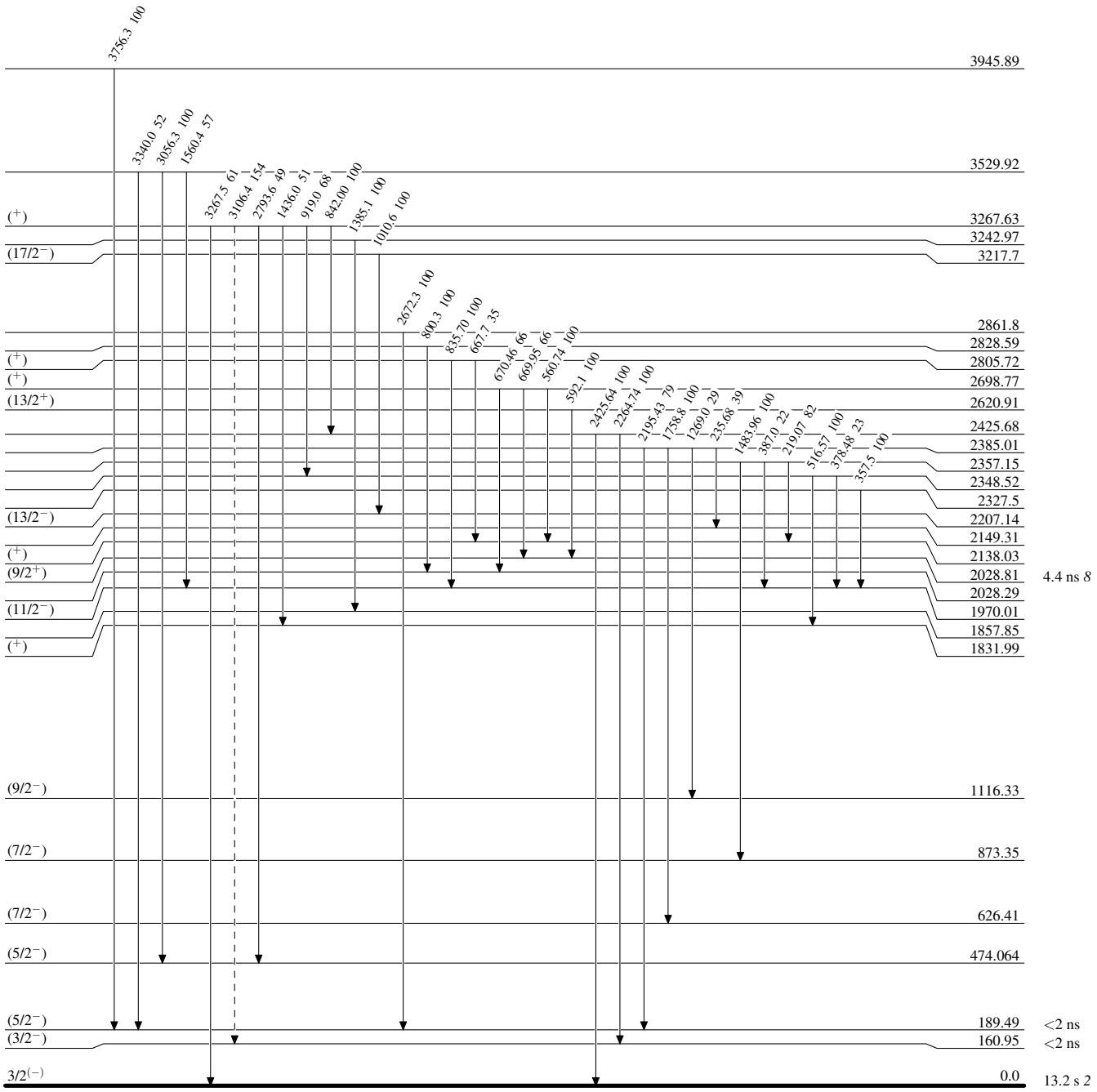
Adopted Levels, Gammas

Legend

Level Scheme

Intensities: Relative photon branching from each level

- - - - - - ► γ Decay (Uncertain)

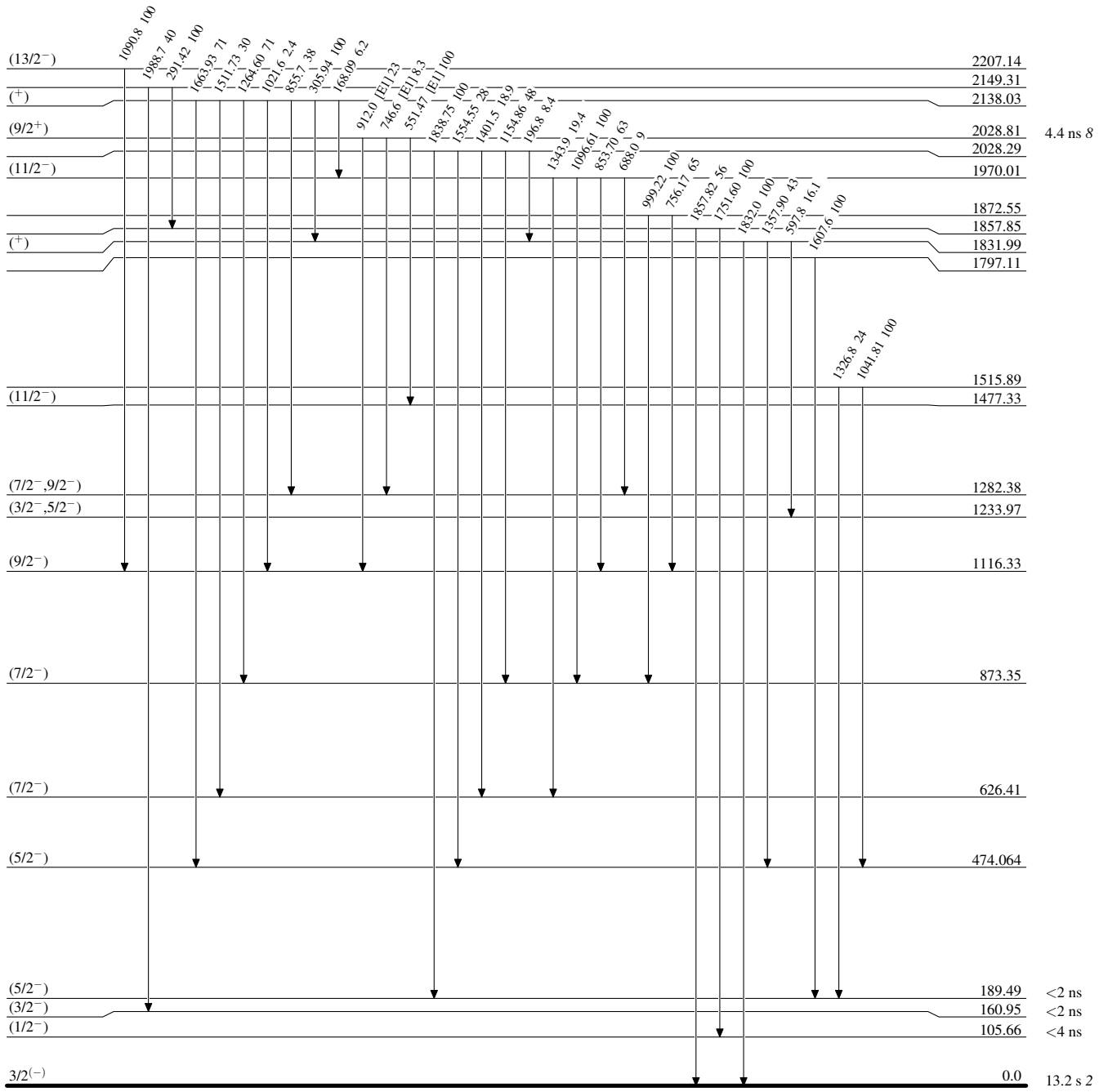


$^{77}_{31}Ga_{46}$

Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level



$^{77}_{31}Ga_{46}$

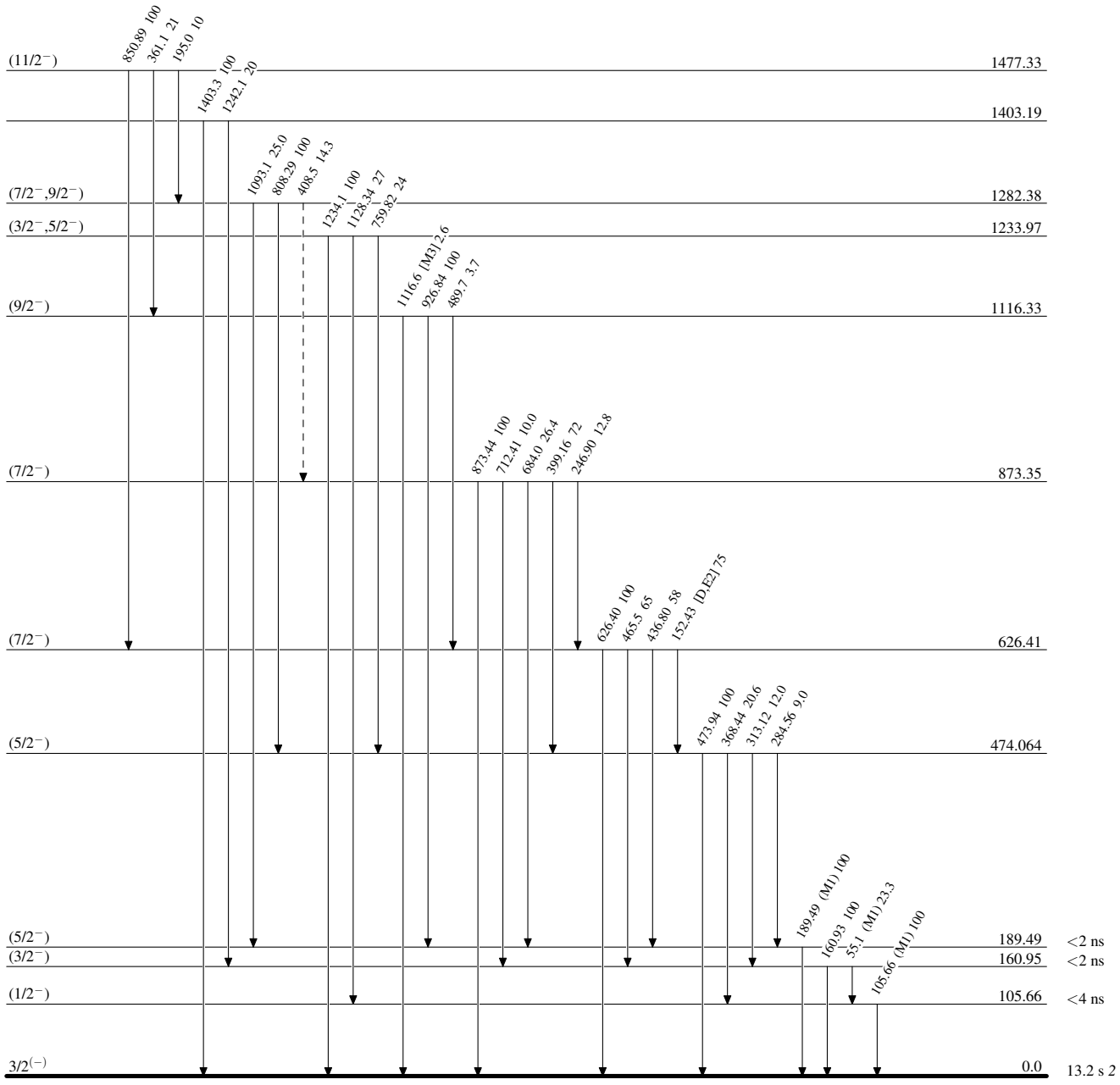
Adopted Levels, Gammas

Legend

Level Scheme (continued)

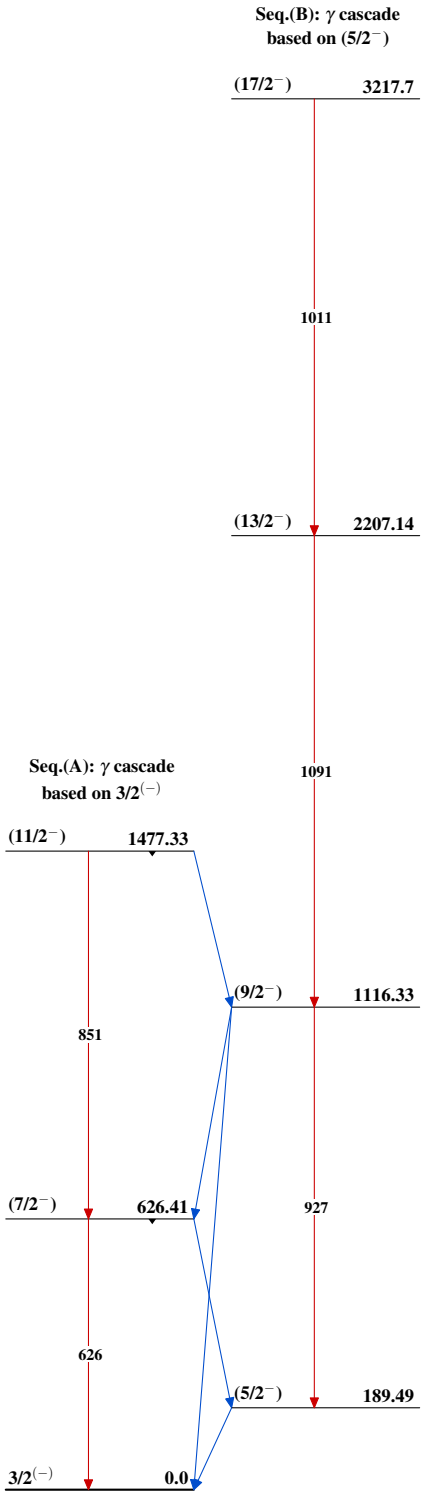
Intensities: Relative photon branching from each level

γ Decay (Uncertain)



$^{77}_{31}Ga_{46}$

Adopted Levels, Gammas



$^{77}_{31}Ga_{46}$