Adopted Levels, Gammas

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh, Jun Chen and Ameenah R. Farhan	NDS 194,3 (2024)	8-Jan-2024

Q(β^-)=6916.3 *20*; S(n)=5907.3 *21*; S(p)=11026.7 *28*; Q(α)=−8938.6 *24* 2021Wa16
S(2n)=14390 *4*, S(2p)=24868 *6* (2021Wa16).

1961Ta08: production and identification of ^{76}Ga in ^{76}Ge(n,p) reaction using fast neutron beam from the University of Tokyo cyclotron facility. Measured Eβ, Eγ and half-life of the decay of ^{76}Ga. Later studies of ^{76}Ga decay: 1970OsZZ, 1971Ca39, 1974Gr29, 1981Ru07.

2011Ma45: ^{76}Ga produced by neutron induced fission of a thick uranium carbide target. Neutrons were produced by 1.4 GeV protons on tantalum. Ga isotopes were ionized using RILIS laser ion source. Laser spectroscopy was performed on the Ga isotopes at ISOLDE, CERN. The g.s. spins and moments were extracted from measured hyperfine spectra. Comparison with shell model calculations.

2012Pr11: measured optical spectra, hyperfine coefficients, isotope shifts, mean-square charge radii using collinear laser spectroscopy. RILIS source at ISOLDE, CERN facility.

2016Do05: ^{76}Ga activity produced in $^{9}Be(^{76}Ge^{32+}$,X), E=130 MeV/nucleon, and separated by A1900 fragment separator at NSCL-MSU. Secondary beam consisting of 73% $^{76}Ga^{31+}$ and 27% $^{74}Zn^{30+}$ was passed through the NSCL gas stopping station where primarily the $^{76}Ga^{31+}$ beam was extracted and stopped in the gas cell. A scan of the activity as a function of mass of the extracted ions showed the molecular ion $[^{76}Ga(H_2O)]^+$ as the main activity delivered to the counting station. The ^{76}Ga ions with an energy of ≈40 keV and intensity of ≈500 particles/s were implanted into an aluminum target foil. Measured total absorption gamma-ray (TAS) spectrum using segmented NaI(Tl)(SuN) detector, and electrons from ^{76}Ga β^- decay by a silicon surface barrier detector located inside the bore hole of the SuN detector. Also detected were $\beta\gamma$-coincidences.

Mass measurement: 2007Gu09 (also 2005Gu36), 1981Al20.

Additional information 1.

2020Ve08, 2012Sr01: thoeretical structure calculations.

Theoretical calculations: five primary references for structure and four for decay characteristics retrieved from the NSR database (www.nndc.bnl.gov/nsr/) are listed in this dataset under ‘document’ records.

^{76}Ga Levels

Cross Reference (XREF) Flags

A ^{76}Zn β^- decay (5.7 s)

E(level)†	J$^\pi$	T$_{1/2}$	XREF	Comments
0.0	$2^{(-)}$	30.5 s *4*	A	%β^-=100 μ=−0.945 *4* (2011Ma45,2019StZV) Q=+0.329 *19* (2011Ma45,2021StZZ) Mean-square charge radius <r^2>(^{71}Ga,^{76}Ga)=+0.276 *5 64* (2012Pr11), first uncertainty is statistical, second is systematic. J$^\pi$: from laser hyperfine spectroscopy (2011Ma45), J=1 is ruled out by the number of atomic transitions and selection rules. J=2,3,4 are analyzed and reduced χ^2 considered for the fitting of the hyperfine spectrum; J=2 is the most likely assignment. Spins higher than J=3 give poor match to the observed spectra. Negative parity is suggested by the comparison of measured and theoretical magnetic dipole moments and electric quadrupole moments. $J^\pi=2^-$ is also supported by 2016Do05 in comparison of their TAS data with their theoretical shell-model calculations, although a definite conclusion about J^π is not made due to the presence of several states in a narrow range in the theoretical level energy spectrum. T$_{1/2}$: weighted average (NRM) of 30.6 s *3* (2016Do05, from decay curve for implanted activity in the counting system and TAS detector); 32.6 s *6* (1985Ta01, from decay curve of 546γ+563γ); 29.8 s *4* (1974Gr29) (from integral β spectrum; previous measurements at the same laboratory: 23.9 s *19* (1981Ru07), 30 s (1972MaWL) and

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Adopted Levels, Gammas (continued)

^{76}Ga Levels (continued)

E(level)[†]	J^π	$T_{1/2}$	XREF	Comments
				29.0 s *3* (1970OsZZ)); 32 s *3* (1961Ta08, from integral β^- spectrum above 3.2 MeV). Weighted average is 30.6 s *5* but with reduced χ^2=5.1 as compared to χ^2=2.6 at 95% confidence level. Others: 27.1 s *2* (1971Ca39, from γ-ray spectrum in the range 300-800 keV); 42 s (1966Se04, method not known) seem discrepant. μ,Q: Laser Resonance Spectroscopy (LRS) (2011Ma45).
172.29 *3*	(1^+,2^+,3^+)		A	J^π: 102.88γ (E2) (probably from ce data) from 1^+.
199.50 *3*	1^+	34 ns *8*	A	J^π: log *ft*=4.7 from 0^+. $T_{1/2}$: 34 ns *1*(stat) *8*(syst) from 2022Ch09, weighted average of 33.9 ns *11* from (γ rays in coin with the 199γ)(199γ)(t) and 30 ns *4* from βγ(t) in ^{76}Zn β^- decay. Structure of this isomeric state is proposed by 2022Ch09 as a highly-mixed state of negative-parity proton configurations coupled to $1/2^-$ neutron configurations.
275.28 *3*	1^+		A	J^π: log *ft*=4.8 from 0^+.
281.57 *3*	(0^- to 3^+)[‡]		A	
369.81 *6*	(0 to 3^+)[‡]		A	
565.53 *3*	1^+		A	J^π: log *ft*=5.0 from 0^+.
680.83 *3*	(0^- to 3^+)[‡]		A	
781.55 *5*	(0 to 3^+)[‡]		A	J^π: 763.9γ from 1^+.
1030.30 *3*	1^+		A	J^π: log *ft*=4.8 from 0^+.
1106.03 *8*	(1)		A	J^π: log *ft*=6.5 from 0^+.
1545.44 *3*	1^+		A	J^π: log *ft*=4.8 from 0^+.
1568.12 *4*	1^+		A	J^π: log *ft*=5.4 from 0^+.
1621.22 *8*	(1^+)		A	J^π: log *ft*=5.8 *1* from 0^+.
1750.14 *3*	1^+		A	J^π: log *ft*=4.97 from 0^+.
1810.50 *6*	(1^+)		A	J^π: log *ft*=5.7 *1* from 0^+.
1825.99 *7*	1^+		A	J^π: log *ft*=5.3 from 0^+.
1896.05 *6*	(1)		A	J^π: log *ft*=6.0 from 0^+.
1977.41 *6*	(1^+)		A	J^π: log *ft*=5.7 *1* from 0^+.
2091.02 *4*	1^+		A	J^π: log *ft*=4.65 from 0^+.
2166.64 *12*	(1^+)		A	J^π: log *ft*=5.7 *1* from 0^+.
2422.73 *11*	1^+		A	J^π: log *ft*=5.4 from 0^+.
2602.44 *11*	1^+		A	J^π: log *ft*=5.3 from 0^+.

† From least-squares fit to Eγ data.

‡ γ to/from 1^+. log *ft* value (considered only approximate for this level) from 0^+ suggests J=0,1. In some cases γ to $2^{(-)}$ g.s. does not allow 0^+.

γ(^{76}Ga)

E_i(level)	J^π_i	E_γ	I_γ	E_f	J^π_f	Mult.	α[‡]	Comments
172.29	(1^+,2^+,3^+)	172.44 *5*	100	0.0	$2^{(-)}$	(D)[†]	0.014 *2*	
199.50	1^+	199.2 *5*	100	0.0	$2^{(-)}$	(E1)[†]	0.00815 *13*	B(E1)(W.u.)=1.40×10^{-6} *+43−27*
275.28	1^+	75.9 *5*	100 *16*	199.50	1^+	(M1)[†]	0.149	
		102.88 *5*	5.3 *6*	172.29	(1^+,2^+,3^+)	(E2)[†]	0.629	
		275.34 *5*	20.0 *12*	0.0	$2^{(-)}$			
281.57	(0^- to 3^+)	82.1 *3*	90 *8*	199.50	1^+			
		109.23 *8*	15 *3*	172.29	(1^+,2^+,3^+)			
		281.56 *5*	100 *8*	0.0	$2^{(-)}$			
369.81	(0 to 3^+)	88.3 *2*	33 *11*	281.57	(0^- to 3^+)			
		94.53 *5*	100 *11*	275.28	1^+			

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Adopted Levels, Gammas (continued)

$\gamma(^{76}Ga)$ (continued)

E_i(level)	J^π_i	E_γ	I_γ	E_f	J^π_f	Comments
565.53	1^+	290.23 *8*	12 *2*	275.28	1^+	
		365.98 *5*	100 *4*	199.50	1^+	
		393.20 *5*	16 *3*	172.29	$(1^+,2^+,3^+)$	
		565.52 *5*	21 *3*	0.0	$2^{(-)}$	
680.83	$(0^-$ to $3^+)$	405.5 *1*	10 *3*	275.28	1^+	
		481.42 *5*	40 *4*	199.50	1^+	
		508.8 *2*	100 *20*	172.29	$(1^+,2^+,3^+)$	
		680.70 *4*	20 *3*	0.0	$2^{(-)}$	E_γ: somewhat poor fit in the level scheme, level-energy difference=680.82.
781.55	$(0$ to $3^+)$	609.29 *5*	100	172.29	$(1^+,2^+,3^+)$	
1030.30	1^+	748.72 *5*	70 *8*	281.57	$(0^-$ to $3^+)$	
		755.03 *2*	100 *6*	275.28	1^+	
		830.7 *5*	41 *4*	199.50	1^+	
		857.98 *5*	28 *4*	172.29	$(1^+,2^+,3^+)$	
		1030.26 *5*	17 *1*	0.0	$2^{(-)}$	
1106.03	(1)	736.21 *6*	100	369.81	$(0$ to $3^+)$	
1545.44	1^+	763.9 *1*	2.2 *11*	781.55	$(0$ to $3^+)$	
		864.59 *5*	22 *3*	680.83	$(0^-$ to $3^+)$	
		979.85 *5*	21 *3*	565.53	1^+	
		1263.89 *5*	89 *11*	281.57	$(0^-$ to $3^+)$	
		1345.94 *5*	100 *11*	199.50	1^+	
		1373.1 *1*	3.9 *11*	172.29	$(1^+,2^+,3^+)$	
		1545.48 *5*	54 *3*	0.0	$2^{(-)}$	
1568.12	1^+	786.5 *1*	6 *3*	781.55	$(0$ to $3^+)$	
		1286.53 *5*	100 *7*	281.57	$(0^-$ to $3^+)$	
		1368.59 *4*	42 *4*	199.50	1^+	
		1395.94 *7*	21 *3*	172.29	$(1^+,2^+,3^+)$	
1621.22	(1^+)	1251.40 *5*	100	369.81	$(0$ to $3^+)$	
1750.14	1^+	968.7 *2*	5.8 *8*	781.55	$(0$ to $3^+)$	
		1069.22 *5*	38 *4*	680.83	$(0^-$ to $3^+)$	
		1184.49 *8*	11 *3*	565.53	1^+	
		1468.53 *5*	100 *8*	281.57	$(0^-$ to $3^+)$	
		1550.60 *7*	15 *2*	199.50	1^+	
		1578.00 *5*	23 *3*	172.29	$(1^+,2^+,3^+)$	E_γ: somewhat poor fit in the level scheme, level-energy difference=1577.82.
		1750.06 *6*	19 *2*	0.0	$2^{(-)}$	
1810.50	(1^+)	1610.99 *5*	100	199.50	1^+	
1825.99	1^+	1456.16 *4*	100	369.81	$(0$ to $3^+)$	
1896.05	(1)	1723.74 *5*	100	172.29	$(1^+,2^+,3^+)$	
1977.41	(1^+)	1695.7 *1*	64 *21*	281.57	$(0^-$ to $3^+)$	
		1702.12 *9*	100 *14*	275.28	1^+	
		1977.5 *1*	57 *14*	0.0	$2^{(-)}$	
2091.02	1^+	1309.6 *1*	3.1 *12*	781.55	$(0$ to $3^+)$	
		1410.2 *1*	6.2 *12*	680.83	$(0^-$ to $3^+)$	
		1815.62 *5*	55 *3*	275.28	1^+	
		1918.9 *1*	5.6 *12*	172.29	$(1^+,2^+,3^+)$	
		2091.0 *1*	100 *12*	0.0	$2^{(-)}$	
2166.64	(1^+)	1796.8 *1*	100	369.81	$(0$ to $3^+)$	
2422.73	1^+	2223.2 *1*	100	199.50	1^+	
2602.44	1^+	2402.9 *1*	100	199.50	1^+	

† From 1986Ek01 in ^{76}Zn β^- decay, probably deduced by the authors based on their measured ce data which however are not given in the paper.

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Adopted Levels, Gammas (continued)

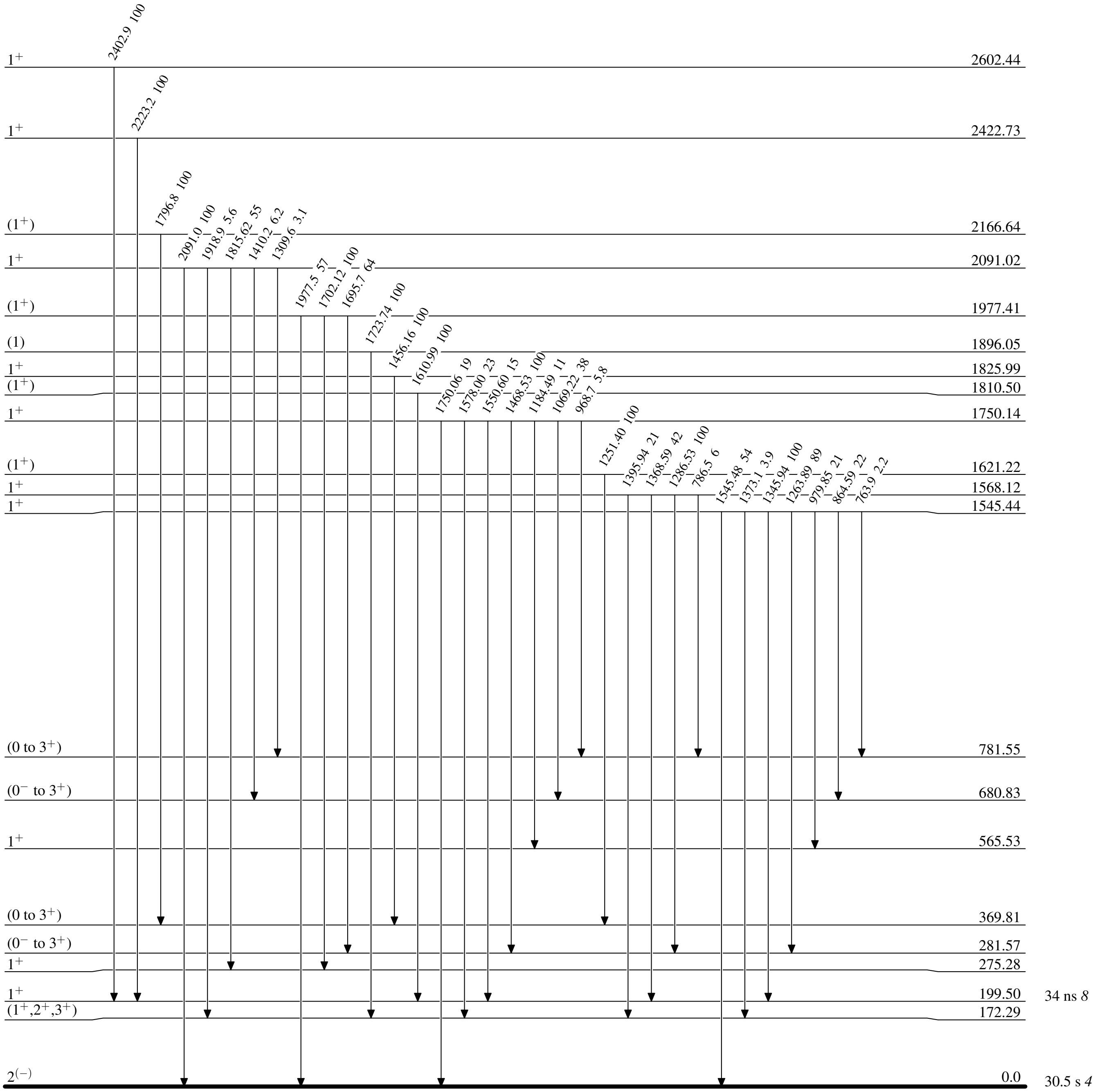
$\gamma(^{76}Ga)$ (continued)

‡ 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.

Adopted Levels, Gammas

Level Scheme

Intensities: Relative photon branching from each level

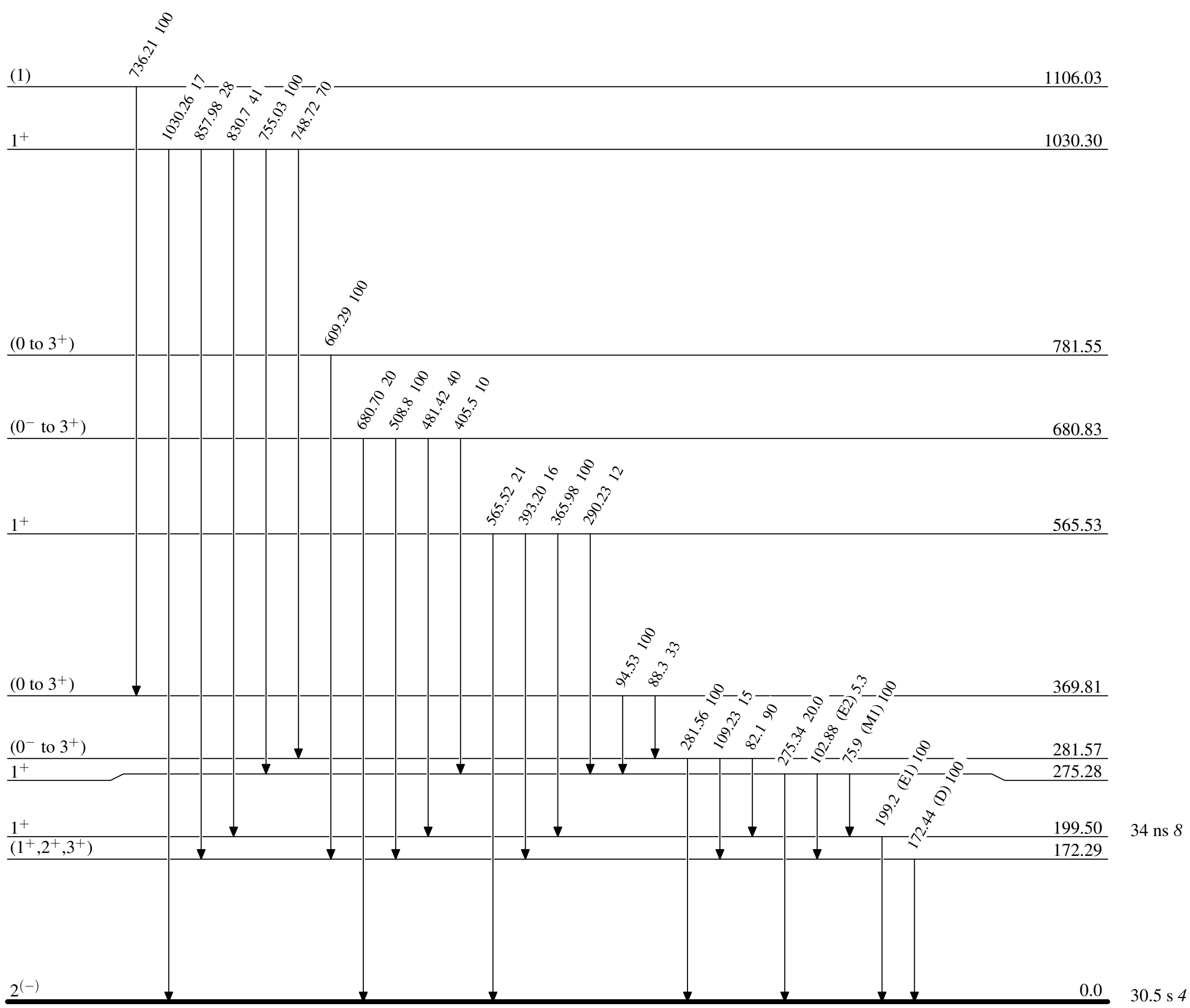


$^{76}_{31}Ga_{45}$

Adopted Levels, Gammas

Level Scheme (continued)

Intensities: Relative photon branching from each level



$^{76}_{31}Ga_{45}$